Symposium:
Understanding the brain functioning with EEG: perspectives in sport sciences

Abstract:
In the field of sports performance, the brain plays a predominant role in the regulation of physical exertion and in the processing of environmental cues to generate fast and appropriate sporting actions (anticipation, decision making, actions switching). In the recent years, electroencephalography (EEG) has become one of the most widely used tools for investigating brain functioning. But the very existence of what we might call the "sport neuroscience" is questionable as they are based on a fragile relationship between the inherent constraints when acquiring an EEG signal particularly sensitive to artifacts, the complexity and the speed of the electro-cortical processes and the desire to innovate training programs. To legitimize the place of the neurosciences in sport research, it is essential to seek the application of advanced EEG signal analyses methods. The aim of this symposium is to present three types of electroencephalogram analyses and to discuss their benefits to better understand the adaptations of brain functioning in relation to physical exercise and perceptual-cognitive expertise of athletes.

Contribution 1:
The neural correlates underlying the use of contextual and kinematic information processes during anticipation in cricket

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Abstract:
Anticipation is the ability to accurately predict the outcome of an opponent's actions ahead of the act itself. In cricket, recent studies reported that experts are able to use two sources of information: low-level kinematic cues from the bowler but also high-level contextual information related to the event (Runswick et al., 2018).

This study aims to investigate the electrocortical activity underlying the use of these two sources of information in expert and novice cricket players.

We recorded the electroencephalographic (EEG) activity in 14 expert and 10 novice cricket players when anticipating deliveries from bowlers in a video-based simulation task where the type of information presented to participants was manipulated. Video clips were displayed across three conditions, including clips with contextual information (game situation and field setting images), clips with kinematic information (video) and clips with both sources of information. Trials were occluded immediately after the ball release and anticipation measured by marking predicted ball location on scaled diagrams. Differences in anticipation accuracy were assessed with a Group (Expert; Novice) x Condition (Context; Video; Both information) mixed ANOVA analysis. The spectral changes of the EEG signal were evaluated with Event Related Spectral Perturbation (ERSP) analyses. We used non-parametric cluster-based permutation tests (Maris & Oostenveld, 2007) to assess conditional differences in sensor space and cluster-based randomization tests to control for multiple comparisons (Matlab, Fieldtrip toolbox).

Behaviourally, the results demonstrated that experts showed better anticipation accuracy across the three conditions ($p<0.05$). Electrophysiologically, the ERSP analyses showed significant differences ($p<0.01$) in superior alpha and beta bands between the video and the game situation. While both groups demonstrated stronger desynchronisation in the video compared to the game situation, the spatial location of these effects was more widespread in the novices (a cluster of 11 centro-posterior electrodes) than in the experts (a cluster of 4 posterior electrodes). A similar pattern of results was found for the difference between the game situation and the field setting.

Taken together, our results support the hypothesis that all the available sources of information are relevant for the expert players to predict future actions' outcome. In the group of novices, the EEG results suggest that they rely more on the field setting and the kinematic information rather than on the game situation. To the best of our knowledge, this is the first study to provide electrocortical evidence of skill-based differences in the processing of contextual and kinematic information.

References:

Maris, E., & Oostenveld, R. (2007). Nonparametric statistical testing of EEG- and MEG-data. Journal of Neuroscience Methods, 164(1), 177 190. https://doi.org/10.1016/j.jneumeth.2007.03.024

Runswick O. R., Roca A., Williams A.M., Mcrobert A., North J. (2018). The temporal integration of information during anticipation. Psychology of Sport and Exercise 37:100-108. doi:10.1016/j.psychosport.2018.05.001

Contribution 2:

Electrical Neuroimaging analyses of event-related potentials and their relevance for movement and sport sciences

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Abstract:

Electroencephalography is an easily accessible and quickly implemented non-invasive brain measure tool. Thanks to recent technical and analytical advances, EEG has become a true brain-imaging tool. As an example of the many possibilities offered by EEG to study the brain-behavior relationships, we present the so-called 'electrical neuroimaging' analyses of event-related potentials and discuss how sport sciences may benefits from its interpretational strengths.

Electrical neuroimaging analyses of the ERPs go far beyond the canonical analyses of the amplitude and latency ERP voltage waveforms of a subset of electrodes and periods of interest: they take advantage of the entire electrode montage and focus on global measures of the topography and power of the electric field at the scalp. Because changes at the levels of these metrics across experimental conditions necessarily follow from modifications in the configuration and response strength of the underlying active brain networks, their statistical analyses provides neurophysiologically interpretable outcomes. Advances in source estimations analyses further allow identifying the loci of the active sources in the brain.

Combined with the high temporal resolution and portability of the EEG, electrical neuroimaging analyses of the ERP thus constitute an ideal approach to assess the spatio-temporal organization of motor and cognitive functions in naturalistic setting with freely behaving individuals.

References:

Michel, C. M., Murray, M. M. (2012). Towards the utilization of EEG as a brain imaging tool. NeuroImage, 61(2), 371–385. doi:10.1016/j.neuroimage.2011.12.039