Towards understanding the impact of mental task execution on user's state, experience and performances

Léna Kolodzienski, Aline Roc, Aurélien Appriou, and Fabien Lotte

Inria, LaBRI (CNRS, Univ. Bordeaux, BORDEAUX INP), Talence, France

Abstract accepted for communication at JJC-ICON'2021, Grenoble, France
Initially accepted for JJC-ICON'2020, Grenoble, France (canceled due to COVID-situation)

Abstract

Improving BCI user-training methods requires to understand the influence of user's psychological traits and states. To do so, recent studies have focused on user's cognitive traits (e.g. attention or task-related abilities) [1] and state (e.g. mood or anxiety) and their effect on MI-BCI performance [2, 1]. Learning how to use a MI-BCI can be considered as a demanding task in term of cognitive resources [3]. According to the Cognitive Load Theory, optimal learning occurs when the learning material requires a balanced amount of cognitive workload for the user [4]. Assessing users' cognitive workload during MI-BCI training might then help adapting the amount of cognitive resources required by the task to users' state evolution. Currently cognitive workload in MI-BCI experimentations is mostly assessed with indirect and discrete subjective measures (e.g. NASA-TLX) [5, 2, 6] and must be complemented with objective and continuous direct measurements.

We suggest a protocol in which users will, before the MI-BCI training, complete two different cognitive tasks involving a high and low cognitive load. Meanwhile, EEG activity would be recorded and used to build a classifier to assess in real-time the cognitive load level of users during training. The second part of the study will compare, between subjects, traditional instructional design with one based on compatibility between the feedback and the MI task (i.e. transparent mapping) [7]. This should improve the sense of agency [7], reduce task-related cognitive load and, hopefully, allow users to learn faster than the control group.

References

[1] C. Jeunet, B. N'Kaoua, and F. Lotte, "Towards a cognitive model of mi-bci user training," in *7th International BCI Conference*, (Graz, Austria), 2017.

[2] E. A. Felton, J. C. Williams, G. C. Vanderheiden, and R. G. Radwin, "Mental workload during brain–computer interface training," *Ergonomics*, vol. 55, no. 5, pp. 526–537, 2012.

[3] P. Gerjets, C. Walter, W. Rosenstiel, M. Bogdan, and T. O. Zander, "Cognitive state monitoring and the design of adaptive instruction in digital environments: lessons learned from cognitive workload assessment using a passive brain-computer interface approach," *Frontiers in neuroscience*, vol. 8, p. 385, 2014.

[4] S. Puma and A. Tricot, "Cognitive load theory and working memory models," *Advances in Cognitive Load Theory: Rethinking Teaching*, p. 41, 2019.

[5] Z. Emami and T. Chau, "The effects of visual distractors on cognitive load in a motor imagery brain-computer interface," *Behavioural brain research*, vol. 378, p. 112240, 2020.

[6] S. G. Hart and L. E. Staveland, "Development of nasa-tlx (task load index): Results of empirical and theoretical research," in *Advances in psychology*, vol. 52, pp. 139–183, Elsevier, 1988.

[7] R. Vlek, J.-P. van Acken, E. Beursken, L. Roijendijk, and P. Haselager, "Bci and a user's judgment of agency," in *Brain-Computer-Interfaces in their ethical, social and cultural contexts*, pp. 193–202, Springer, 2014.