



**HAL**  
open science

# Reviewing open challenges in Mental Tasks (MT-)based BCI user training

Aline Roc, Fabien Lotte

► **To cite this version:**

Aline Roc, Fabien Lotte. Reviewing open challenges in Mental Tasks (MT-)based BCI user training. Virtual CORTICO days, Oct 2020, Virtual, France. hal-03065258

**HAL Id: hal-03065258**

**<https://inria.hal.science/hal-03065258>**

Submitted on 5 Jan 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Reviewing open challenges in Mental Tasks (MT-)based BCI user training

Aline Roc and Fabien Lotte

aline.roc@inria.fr

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

Abstract accepted for an oral communication at virtual CORTICO days (2020)

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

Schedule of the virtual day: <https://www.cortico.fr/2020/10/13/demi-journee-cortico-2020/>

## Abstract

Traditional MI-BCI training programs could be further improved [1]. This can be done through guidelines [2]; user-centered design [3] and adaptive systems [4]. We conducted a literature review on several aspects of MI-BCI user-training, e.g. environment, cognitive support, exercises. Here, we highlight the elements that we identified as not sufficiently explored or formalized yet.

### Concerning the training environment, these challenges include:

- a) balancing between a relevant control task [5], a motivating environment, and the associated risk of imposing cognitive overload [6, 7, 8];
- b) studying social aspects of training, e.g. feedback content [9].

### Concerning instructions and cognitive support, it includes:

- a) introducing the BCI to foster users' understanding and engagement;
- b) evaluating the learnability/memorability of the MI-BCI skills and instructions [10];
- c) assessing users' strategies [11];
- d) selecting user-centered task(s) [12];
- e) providing guidance based on user-only metrics instead of classification accuracy [13].

### Current challenges for MI-BCI exercise design include:

- a) implementing varied exercises instead of the only same one [1];
- b) studying indirect/incidental MI-BCI training tasks, e.g. mindfulness meditation [14], physical preparation [15];
- c) assessing online learners' states [16] and progress to provide adapted/adaptive environment (e.g. manipulating timing [17]);
- d) exploring the suitable parameters of trials (e.g. order, duration, number [18]) and their influences on users' states and performances.

## References

- [1] R. Chavarriaga, M. Fried-Oken, S. Kleih, F. Lotte, and R. Scherer, "Heading for new shores! overcoming pitfalls in BCI design," *Brain-Computer Interfaces*, vol. 4, no. 1-2, pp. 60–73, 2016.
- [2] F. Lotte, F. Larrue, and C. Mühl, "Flaws in current human training protocols for spontaneous brain-computer interfaces: lessons learned from instructional design," *Frontiers in Human Neuroscience*, vol. 7, p. 568, 2013.
- [3] S. C. Kleih and A. Kübler, "Why user-centered design is relevant for brain–computer interfacing and how it can be implemented in study protocols," in *Brain–Computer Interfaces Handbook*, pp. 585–594, CRC Press, 2018.
- [4] J. Mladenović, J. Mattout, and F. Lotte, "A generic framework for adaptive eeg-based bci training and operation," CRC Press, 2018.
- [5] 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.
- [6] J. Mladenović, J. Frey, M. Bonnet-Save, J. Mattout, and F. Lotte, "The impact of flow in an eeg-based brain computer interface," in *7th International BCI Conference*, (Graz, Austria), 2017.
- [7] S. Enriquez-Geppert, R. J. Huster, and C. S. Herrmann, "Eeg-neurofeedback as a tool to modulate cognition and behavior: a review tutorial," *Frontiers in human neuroscience*, vol. 11, p. 51, 2017.
- [8] 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.
- [9] L. Pillette, C. Jeunet, B. Mansencal, R. N'kambou, B. N'Kaoua, and F. Lotte, "A physical learning companion for mental-imagery bci user training," *International Journal of Human-Computer Studies*, vol. 136, p. 102380, 2020.
- [10] E. Loup-Escande, F. Lotte, G. Loup, and A. Lécuyer, "User-centered bci videogame design," *Handbook of digital games and entertainment technologies*, pp. 225–250, 2017.
- [11] J. Bismuth, F. Vialatte, and J.-P. Lefaucheur, "Relieving peripheral neuropathic pain by increasing the power-ratio of low- $\beta$  over high- $\beta$  activities in the central cortical region with eeg-based neurofeedback: Study protocol for a controlled pilot trial (smrpain study)," *Neurophysiologie Clinique*, vol. 50, no. 1, pp. 5–20, 2020.
- [12] A. Eliseyev and T. Aksenova, "Personalized adaptive instruction design (paid) for brain–computer interface using reinforcement learning and deep learning: simulated data study," *Brain-Computer Interfaces*, vol. 6, no. 1-2, pp. 36–48, 2019.
- [13] F. Lotte and C. Jeunet, "Defining and quantifying users' mental imagery-based bci skills: a first step," *Journal of neural engineering*, vol. 15, no. 4, p. 046030, 2018.
- [14] L.-F. Tan, Z. Dienes, A. Jansari, and S.-Y. Goh, "Effect of mindfulness meditation on brain–computer interface performance," *Consciousness and cognition*, vol. 23, pp. 12–21, 2014.
- [15] S. C. Wriessnegger, C. Brunner, and G. R. Müller-Putz, "Frequency specific cortical dynamics during motor imagery are influenced by prior physical activity," *Frontiers in psychology*, vol. 9, p. 1976, 2018.
- [16] 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.
- [17] L. George, L. Bonnet, and A. Lécuyer, "Freeze the bci until the user is ready: a pilot study of a bci inhibitor," in *5th International Brain-Computer Interface Workshop*, 2011.
- [18] V. Rozand, F. Lebon, P. J. Stapley, C. Papaxanthis, and R. Lepers, "A prolonged motor imagery session alter imagined and actual movement durations: potential implications for neurorehabilitation," *Behavioural Brain Research*, vol. 297, pp. 67–75, 2016.