

Tilburg University

Improving User Experience and Performance through Gamification of MI-BCI Training

Atilla, Fred; Alimardani, Maryam; Postma, Marie

DOI:

[10.3217/978-3-85125-962-9-40](https://doi.org/10.3217/978-3-85125-962-9-40)

Publication date:

2023

Document Version

Publisher's PDF, also known as Version of record

[Link to publication in Tilburg University Research Portal](#)

Citation for published version (APA):

Atilla, F., Alimardani, M., & Postma, M. (2023). *Improving User Experience and Performance through Gamification of MI-BCI Training*. 45-45. Abstract from 10th International Brain-Computer Interface Meeting 2023, Brussels, Belgium. <https://doi.org/10.3217/978-3-85125-962-9-40>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Improving User Experience and Performance through Gamification of MI-BCI Training

Fred Atilla^{1*}, Maryam Alimardani¹, Marie Postma¹

¹*Department of Cognitive Science and Artificial Intelligence, Tilburg University, Tilburg, Netherlands*

*P.O. Box 90153, Tilburg, Netherlands. E-mail: f.atilla@tilburguniversity.edu

Introduction: Motor Imagery Brain-Computer Interfaces (MI-BCI) decode brain patterns associated with motor intentions into control commands for a variety of applications, bypassing traditional motor inputs. To use these systems, the user must produce identifiable and stable MI patterns [1], which requires multiple training sessions in a lab. However, MI-BCI training protocols are often repetitive and suboptimal as some users remain incapable of BCI control. This problem, known as **BCI illiteracy/deficiency** [2, 3], has been related to psychological and cognitive factors such as motivation and attention [1, 4]. While some studies have tried to improve users' MI skills and BCI performance through enriched feedback [5] or motor priming [6], a unified protocol that considers various aspects of user training has not yet been introduced.

Potential solutions: The current study aims to develop a more user-centered MI-BCI training protocol by implementing principles from human-computer interaction and game design. Through a systematic review, we examine how gamification of user training can improve user experience and BCI performance. Here, gamification refers to the use of game elements such as interactive objects, goals, and rewards, which can make BCI training more engaging, motivating, and effective [4, 7, 8]. A potential platform for such a BCI training game is virtual reality (VR). Not only does VR offer richer, immersive feedback during BCI training, it can also embody the user into a virtual character, giving them more agency over virtual movements performed with the BCI [8, 9]. We discuss how virtual environments have been used in MI-BCI training in combination with gamification, and introduce empirical studies that can further incorporate and test a gamified VR MI-BCI training protocol.

Significance: An overview of effective design principles for MI-BCI training can provide future BCI researchers and developers with a framework for creating more engaging and effective protocols that reduce the BCI inefficiency problem and accelerate the technology's mainstream adoption.

References

- [1] Jeunet C, N'Kaoua B, Lotte F. Advances in user-training for mental-imagery-based BCI control: Psychological and cognitive factors and their neural correlates. *Progress in brain research*, 228, 3-35. 2016.
- [2] Allison BZ, Neuper C. Could anyone use a BCI?. *Brain-computer interfaces*, 35-54. Springer, London. 2010.
- [3] Thompson MC. Critiquing the concept of BCI illiteracy. *Science and engineering ethics*, 25(4), 1217-1233. 2019.
- [4] Jeunet C, N'Kaoua B, Lotte F. Towards a cognitive model of MI-BCI user training. *International Graz BCI Conference*. 2017.
- [5] Gargiulo GD, Mohamed A, McEwan AL, Bifulco P, ... & van Schaik A. Investigating the role of combined acoustic-visual feedback in one-dimensional synchronous brain computer interfaces, a preliminary study. *Medical devices (Auckland, NZ)*, 5, 81. 2012.
- [6] Vourvopoulos A, Cardona JEM, i Badia SB. Optimizing motor imagery neurofeedback through the use of multimodal immersive virtual reality and motor priming. *2015 International Conference on Virtual Rehabilitation (ICVR)* (pp. 228-234). IEEE. 2015
- [7] Lotte F, Faller J, Guger C, Renard Y, Pfurtscheller G, Lécuyer A, Leeb R. Combining BCI with virtual reality: towards new applications and improved BCI. *Towards practical brain-computer interfaces*, 197-220. Springer, Berlin, Heidelberg. 2012.
- [8] Škola F, Tinková S, Liarokapis F. Progressive training for motor imagery brain-computer interfaces using gamification and virtual reality embodiment. *Frontiers in human neuroscience*, 13, 329. 2019.
- [9] Alimardani M, Nishio S, Ishiguro H. The importance of visual feedback design in BCIs; from embodiment to motor imagery learning. *PLoS one*, 11(9), e0161945. 2016.