

# Comparison Between Discrete and Continuous Motor Imageries: toward a Faster Detection

Sébastien Rimbart, Laurent Bougrain

► **To cite this version:**

Sébastien Rimbart, Laurent Bougrain. Comparison Between Discrete and Continuous Motor Imageries: toward a Faster Detection. International Brain Computer Interface Meeting 2016, May 2016, California, United States. <hal-01389948v2>

**HAL Id: hal-01389948**

**<https://hal.inria.fr/hal-01389948v2>**

Submitted on 22 Feb 2016

**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.

# Comparison Between Discrete and Continuous Motor Imageries: toward a Faster Detection

S. Rimbert<sup>1,2,\*</sup>, L. Bougrain<sup>2,1</sup>

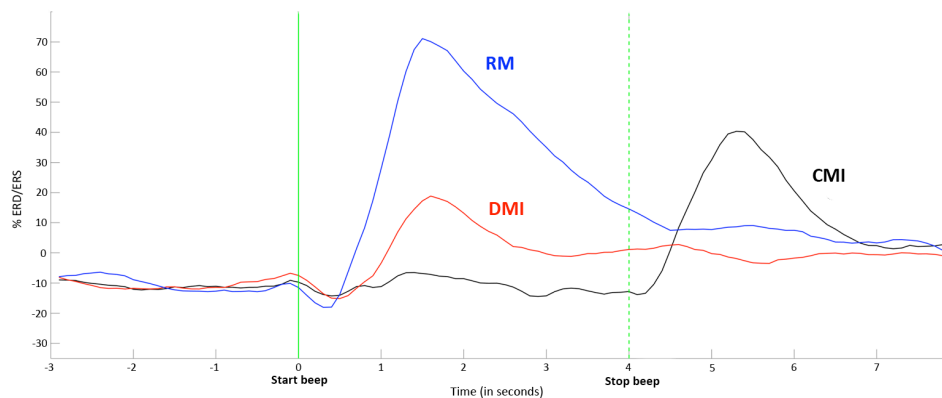
<sup>1</sup>Inria, Villers-lès-Nancy, F-54600, France;

<sup>2</sup>Université de Lorraine, LORIA, UMR 7503, Vandœuvre-lès-Nancy, F-54000, France.

\*E-mail: sebastien.rimbert@inria.fr

*Introduction:* A large number of Brain-Computer Interfaces (BCIs) are based on the detection of changes in sensorimotor rhythms within the electroencephalographic signal [1]. Moreover, motor imagery (MI) modifies the neural activity within the primary sensorimotor areas of the cortex in a similar way to a real movement [2]. In most MI-based BCI experimental paradigms, subjects realize a continuous MI, i.e. one that lasts for a few seconds, with the objective of facilitating the detection of event-related desynchronization (ERD) and event-related synchronization (ERS) [3]. Currently, improving efficiency such as detecting faster a MI is a major issue in BCI to avoid fatigue and boredom. In this regards, a recent article showed that a brief intention of movement corresponding to a 2s-MI, leads to more informative ERS features than continuous motor imageries [4]. Thus, in this study, we are investigating differences between continuous MIs and discrete, i.e. simple short, MIs.

*Material, Methods and Results:* 17 healthy subjects carried out real movements, discrete and continuous MIs, in the form of an isometric flexion movement of their right hand index finger. Each subject realized first a session of real movements, and then a discrete and a continuous sessions of motor imageries in a randomized order. Each session is divided into runs for a total number of 100 trials. Beeps were used as go and stop signals. Finally we computed ERD/ERS% for 9 electroencephalographic channels (FC3, C3, CP3, FCz, Fz, CPz, FC4, C4, CP4) using the “band power method” [3] (Fig. 1), topographic and time-frequency representations.



**Figure 1.** Grand average ( $n = 17$ ) ERD/ERS% curves estimated for the real movement (blue), the discrete motor imagery (red) and the continuous motor imagery (black) within the beta band (18-25 Hz) for electrode C3.

*Discussion:* When subjects imagine a continuous movement for several seconds, it usually corresponds to a succession of imagined movements. In this case, several ERD and ERS seem to be generated. Thus, the temporal contraction of several ERD and ERS generated can be less detectable by a system [4]. Moreover, continuous MIs generate a delayed ERS compared to a discrete MI. Nevertheless, it appears that a longer imagined movement increases the power of the beta rebound.

*Significance:* Results show that both discrete and continuous MIs modulate ERD and ERS components. Both ERSs are different but ERDs are close in term of power of (de)synchronization. These results show that discrete motor imageries may be preferable for BCI systems design in order to faster detect MIs and reduce user fatigue.

*Acknowledgements:* This work has been partially funded by the BCI-LIFT Inria project lab.

## References

- [1] Pfurtscheller G. and McFarland D., BCIs that use sensorimotor rhythms in E. W. W. Jonathan Wolpaw, Ed., *Brain-Computer Interfaces Principles and Practice*. Oxford university press, 2012.
- [2] Neuper C. and Pfurtscheller G., Motor imagery and ERD in *Event-Related Desynchronization. Handbook of Electroencephalography and Clinical Neurophysiology*, Revised Series, Elsevier, vol. 6. pp. 303-325, 1999.
- [3] Pfurtscheller G. and Lopes da Silva F. H., Event-related EEG/MEG synchronization and desynchronization: basic principles, *Clinical Neurophysiology*. vol.110, no. 11, pp. 1842-57, Nov 1999.
- [4] Thomas E., Fruitet J. and Clerc M., Combining ERD and ERS features to create a system-paced BCI. *Journal of Neuroscience Methods*, Elsevier, 2013, DOI: 10.1016/j.jneumeth.2013.03.026.
- [5] Kilavik B. E., Zaepffel M., Brovelli A., MacKay W. A. and Riehle A., The ups and downs of beta oscillations in sensorimotor cortex. *Exp Neurol*, vol. 245, pp. 15-26, Jul 2013.