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

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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.

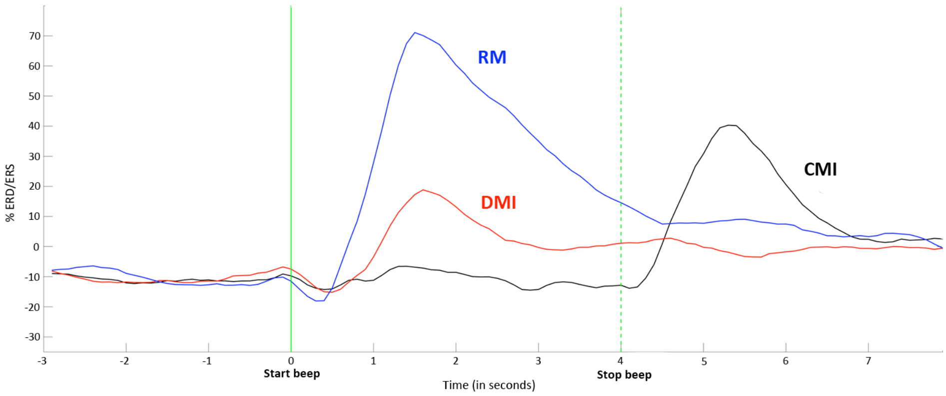

***Figure 1**. Grand average (n = 17) ERD/ERS% curves estimated for the real movement (blue), the discrete motor imagery (red) and the continuous motor imagery (black) within the beta band (18-25 Hz) for electrode C3.*

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.

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