Using computational modelling to better understand and predict Mental-Imagery based BCI (MI-BCI) users' performance

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Mental-Imagery based Brain-Computer Interfaces (MI-BCIs) use signals produced during mental imagery tasks to control the system. Using an MI-BCI requires a dedicated user-training. The more users practice, the better they should become. In other words, their mental commands will most likely be more often correctly recognized by the system. Current MI-BCIs are rather unreliable, which is due at least in part to the use of inappropriate user-training procedures. Understanding the processes underlying user-training by modelling it computationally could enable us to improve MI-BCI training protocols and adapt the latter to the profile of each user. Our objective is to create a statistical/probabilistic model of training that could explain, if not predict, the learning rate and the performances of a BCI user over training time using user's personality, skills, state and timing of the experiment.

In order to build such a model, we are currently using data obtained from three different studies [1, 2, 3], which are based on the same protocol. In total, 42 participants were instructed to learn to control an MI-BCI by performing three MI-tasks (i.e., left-hand motor imagery, mental rotation and mental subtraction) across different training sessions (3 to 6 depending on the experiment). Data are divided into four categories: the user's traits (e.g., mental rotation, tension), the user's state (e.g., level of fatigue and difficulty), the timing of the experiment (e.g., hour, lapse between two sessions) and the user performances (e.g., online classification accuracy -CA-, offline cross validation CA).

Preliminary analyses revealed positive correlations between MI-BCI performances and mental rotation scores among two of the three studies, suggesting that spatial abilities play a major role in MI-BCI users' abilities to learn to perform MI tasks, which is consistent with the literature [4].

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