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Improving motor imagery detection with a BCI based on somesthetic non invasive stimulations

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Introduction: One of the most prominent BCI types of interaction is Motor Imagery (MI)-based BCI. Users control a system by performing MI tasks, e.g., imagining hand/foot movements detected from EEG signals. Indeed, movements and imagination of movements activate similar neural networks, enabling the MI-based BCI to exploit the modulations known as Event-Related Desynchronization (ERD) and Event-Related Synchronization (ERS) [1]. However, two important challenges remain before using such MI-BCIs on a large scale: (i) be able to detect the MI of the user without any temporal markers for instructions (often given by sound or visual cues) and (ii) achieve sufficient accuracy (>80%) to ensure the reliability of a BCI device that could be used by the participants.

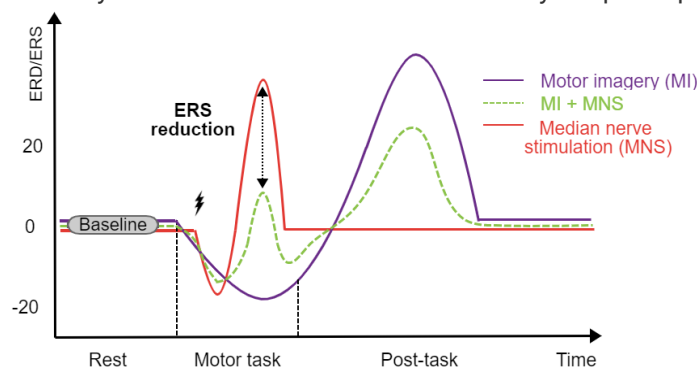


Figure 1. Illustration of modulations of neuronal desynchronization and synchronization over time induced by median nerve stimulation (MNS) during motor imagination (MI), and simultaneous MI and MNS (from [3])

Method: To address these challenges, we argue that somesthetic non-invasive stimulations (tactile, vibrotactile or nerve painless stimulations) is a very promising approach. Indeed, previous studies have shown that painless Stimulation of the Median Nerve (MNS) induces an ERD during stimulation while an ERS appears after stimulation [2]. Most interestingly, a motor task performed during MNS would suppress the ERS patterns generated by this stimulation due to the gating hypothesis (i.e., ERDs and ERSs contract within a time window and cancel each other out; [3]). The same phenomenon seems to happen with passive skin or vibrotactile stimulation. Thus, we can envisage a routine system where the user would be regularly stimulated (e.g., at the median nerve position), while a BCI device would analyze the ERD and ERS modulations in the motor cortex to check whether the user is intending to move or not.

Result/Discussion: Using a MNS-based BCI on healthy users, our results show that the MI state is 19% more accurately detected compared to a standard BCI (i.e., based on MI vs Rest). For several subjects, the use of MNS improves performance by more than 20% [3, 4]. In this abstract, we show that somesthetic stimulations applied during MI tasks could be the keystone of a BCI specialized in the detection of MI without any cue (e.g., sound or visual) with a high detection rate. These results are very promising to improve the performance of MI-based BCI and could be extended to other forms of non-invasive stimulation (tactile and vibrotactile).

References

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