Predicting high-quality movements in post-stroke motor rehabilitation from EEG

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Introduction: A promising new concept for post-stroke motor rehabilitation is using EEG-based brain-computer interface (BCI) systems [1], e.g., providing patients with EEG-based feedback on their decoded movement intent [2]. Here, we explore the possibility of extending BCI-based rehabilitation paradigms from decoding movement intent to decoding movement quality. Toward this goal, we study whether the quality of hand opening and closing movements in stroke patients with arm and hand spasticity can be decoded from their EEG.

Material, Methods, and Results: We investigated twelve patients with chronic stroke and hand spasticity performing hand opening/closing tasks. To quantitatively assess the quality of the hand movements, the muscular activity during the patients' hand movement was measured with three EMG electrodes. We investigated the EEG by computing the band power of individual mu-rhythms and divided the tasks into high- and low-quality classes according to their EMG power. We applied a standard LDA classifier with a 10-times 10-fold CV and CSP to predict the movement quality with mu-power as a feature. Our classification model reached a group-level accuracy of around 90% predicting high- versus low-quality movements throughout different trial phases.

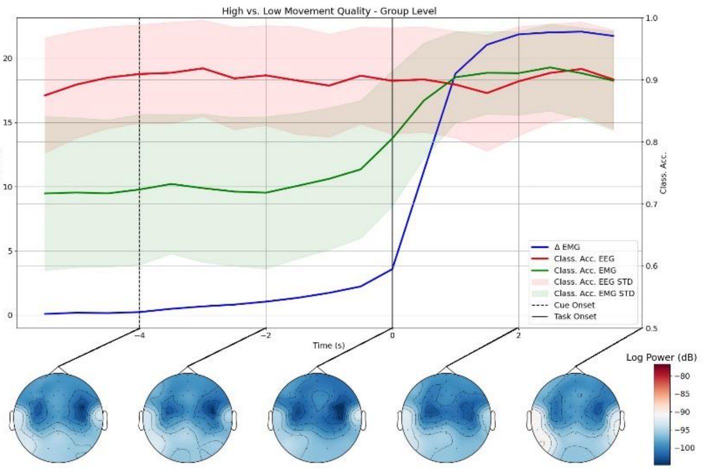

***Figure 1**. High- vs. low-quality movement prediction, EMG power, and μ-power topographies*

Discussion: Using μ-power as a feature for our classification model, we could predict high- vs. low-quality movement with a group-level accuracy of around 90% throughout different trial phases. In contrast, the accuracy of classifying EMG power increases at task onset and only reaches 90% during task execution. Also, the sequence of μ-power topographies indicates that differences in brain activity patterns occur even before the start of the movement. These findings can be used to apply our model to an online BCI system, where the patients receive feedback on their brain activity before the actual onset of the movement task, which can focus their attention on the task execution and improve the rehabilitation progress.

References:

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