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Enriching the Image: Does Combining Motor Imagery with Haptic Input Affect the Event-Related Desynchronization?

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***Introduction**:* Motor imagery (MI), often combined with neurofeedback (NF), has proven effective in promoting neural plasticity and aiding motor rehabilitation. A key element of MI-NF applications is event-related desynchronization (ERD), which serves as a marker of neural activation and sensorimotor engagement. Stronger and more stable ERD modulation can help optimizing MI-NF protocols, particularly for neurorehabilitation and brain-computer interface development. Haptic input during MI may help achieving this. By bridging perception and interaction, haptic input may close the sensorimotor loop and support neuroplasticity mechanisms necessary for motor recovery [1], and could also strengthen the memory trace for movement during MI [2]. Despite its potential, the impact of haptic input on MI-induced ERD remains underexplored. This study investigates whether congruent haptic input amplifies ERD during simple and complex MI tasks, narrowing the gap between motor execution (ME) and MI.

Material, Methods, and Results: We analyzed 64-channel EEG data from 20 healthy, right-handed participants (12 females, 57-82 years, M and SD: 68.1 ± 7.6 years) performing ME and MI of a finger-tapping task. For the ME and the haptic input MI conditions, participants' fingers rested on the keys of a keyboard. In the no-haptic MI conditions, the hand was relaxed and suspended. Two task difficulty levels were implemented to explore the effect of task complexity on haptic input in the ERD. The simple variant involved tapping with a single finger, while the complex variant required executing a pre-learned and practiced sequence involving multiple fingers. Preliminary data analysis focused on contralateral mu and beta frequency range (8–30 Hz) ERD. Conditions were compared using ANOVA and *t*-tests. Descriptively, the haptic condition was associated with a slightly larger ERD then the no-haptic condition, but the difference did not reach significance. A significant effect of task complexity on ERD was evident, with more complex tasks eliciting stronger desynchronization. Additionally, ERD was significantly stronger during ME compared to MI.

Conclusion: While the haptic condition showed a slight trend towards a larger ERD compared to the no-haptic condition, preliminary results do not support that congruent haptic input alone can significantly amplify contralateral ERD during finger-tapping MI. The absence of a significant effect may be attributed to a small effect size, high variability in participants' ERD responses, or a combination of both factors. However, task complexity significantly enhanced contralateral ERD, supporting previous findings that more cognitively demanding MI tasks elicit stronger neural activation [3].

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