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Motor imagery and execution activate similar finger representations that are spatially consistent over time

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Introduction: Sensorimotor representations can be activated through top-down processes in the absence of somatosensory input or motor output, e.g., through attempted or imagined movements. Such top-down tasks can even reveal fine-grained sensorimotor representations of individual fingers. These top-down activated representations are increasingly used to plan implantation of and control brain-computer interfaces (BCIs) in individuals with impaired sensorimotor function. While executed finger movements activate representations in the primary sensorimotor cortex that are spatially consistent over time within participants, the stability of top-down activated finger representations remains largely unexplored. Here, we investigated the spatial consistency, and thereby reliability, of top-down activated finger representations in the primary somatosensory (S1) and primary motor cortex (M1) during a motor imagery task over time. Additionally, we tested the neural similarity of fine-grained finger representations activated trough motor imagery and motor execution.

Material, Methods and Results: Sixteen able-bodied participants imagined and executed individual finger movements (thumb, index, or little finger) in two 3T fMRI sessions that were ~2 weeks apart. We observed both highly overlapping finger-selective activity clusters (Fig. 1) and highly reproducible finger-specific activity patterns across sessions in S1 and M1 within participants (Fig. 2a) in the motor imagery and motor execution task. Further, we found that activity patterns elicited by motor imagery and execution share mutual information (Fig. 2b).

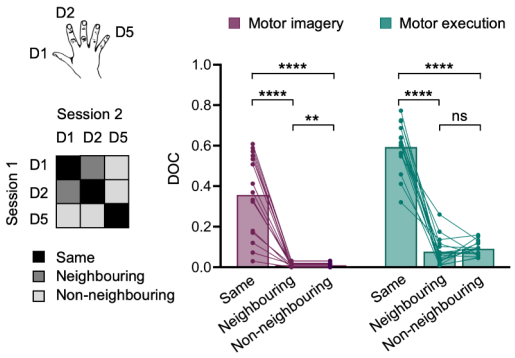

Figure 1: *Spatial overlap* (i.e., *dice overlap coefficient; DOC) between univariate S1 activity clusters of same, neighbouring, and non-neighbouring fingers across sessions. Higher DOC for same compared to other finger representations shows consistent somatotopy across sessions. Similar results were obtained for M1. Dots depict data of individual participants. D1 (digit 1) = thumb; D2 = index; D5 = little.*

Conclusion: Our results show that motor imagery activates neural activity patterns in S1 and M1 that are highly consistent across sessions. We further demonstrate neural similarity between finger representations activated through motor imagery and execution. These findings validate the use of top-down tasks, such as motor imagery, to reliably target finger representations in the context of BCIs.

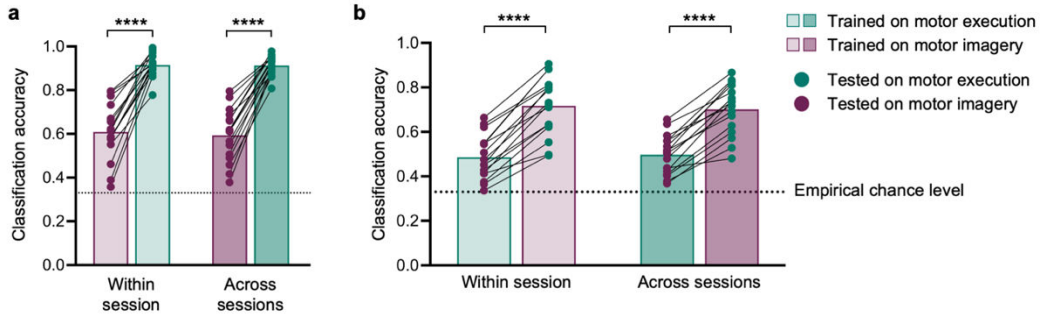

Figure 2: *Classification accuracy of individual fingers in the S1 hand area based on multivariate voxel-wise activity patterns. a) A classifier trained on activity patterns of one session successfully decoded individual fingers of the other session, demonstrating highly consistent activity patterns associated with individual fingers across sessions. b) A classifier trained on activity patterns elicited by motor execution successfully decoded imagined finger movements (and vice versa), indicating similar activity patterns between the two tasks. Similar results were obtained for the M1 hand area. Dots depict data of individual participants.*

Disclosures: The authors declare no competing interest.

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