Somatotopy of facilitatory and inhibitory paired-pulse TMS phenomena

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Introduction

Transcranial magnetic stimulation (TMS) is used in different neurological and psychiatric diseases as both therapeutic and diagnostic tool. Paired pulse TMS (ppTMS) is utilized to non-invasively probe excitatory and inhibitory circuits, especially in the motor system. ppTMS phenomena can be differentiated by the length of the interstimulus interval (ISI), thus relating to the local or more widespread transsynaptic neurocircuits. However, little is known about the somatotopy of ppTMS phenomena.

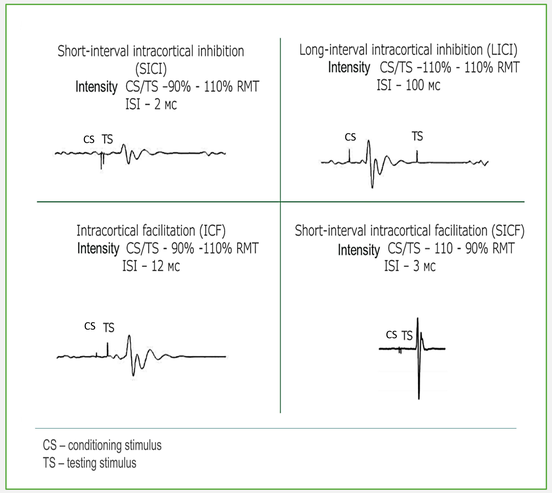


Figure 1. Studied ppTMS phenomena

Methods

Participants

24 healthy right-handed volunteers
(12 females, 12 males, 18-34 y.o.)

Procedure

- MRI-navigated TMS was applied to the abductor pollicis brevis (APB) hotspot in the left primary motor cortex.
- Motor evoked potentials (MEPs) were recorded from the right upper limb muscles: APB, extensor digitorum communis (EDC), abductor digiti minimi (ADM), and biceps brachii (BB). Each TMS paradigm was tested with 45 trials. We used principal component analysis (PCA) to quantify common variability among muscles for each ppTMS paradigm using either (1) across-subject approach, quantifying consistency of somatotopy or (2) within-subject approach, quantifying effects of the current neuronal states.

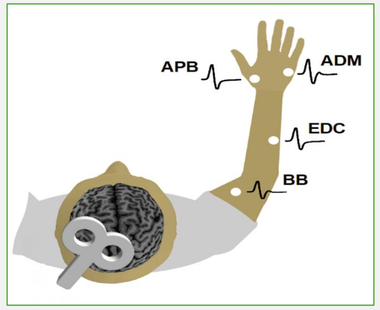


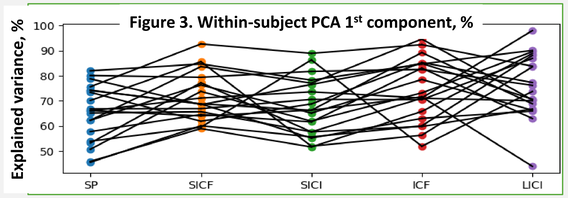
Figure 2. Studied muscles

Results

Average strength of ppTMS phenomena:

	Muscle		
	APB	ADM	EDC
SICI, mean(sd)	0.98±0.58	1.03±0.68	1.10±0.57
SICF, mean(sd)	1.82±0.66	1.96±0.79	1.71±0.72
ICF, mean(sd)	2.98±2.31	3.86±3.03	2.85±1.72
LICI, mean(sd)	0.37±0.56	0.59±0.63	0.50±0.42

Within-subject PCA 1st component, reflecting the comodulation among muscles was the smallest for single pulse TMS (SP). Explained variance was significantly smaller compared to all ppTMS phenomena except for SICI. SICI PCA 1st component was, in turn, significantly smaller than PCA 1st component in LICI or ICF.



A common variability for across-subjects PCA differed among ppTMS phenomena as well, but in a different way. The largest explained variability among muscles was observed for LICI and the smallest - for SICF.

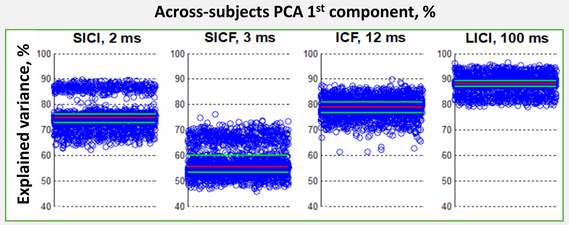


Figure 4. Permuted combinations (blue dots) of 19 from 24 subjects. Red line – median, green lines – 1st and 2nd quartiles.

Conclusion

We demonstrate that the strength of ppTMS phenomena correlates considerably across muscles. Such shared variance differed among ppTMS phenomena but the length of the ISI was not the main discriminative factor. When data across subjects are considered, SICF - having ISI similar to SICI`s - has much smaller PCA 1st component, indicating that it is more topographically specific. Meanwhile, when trial-to-trial MEP fluctuations are considered, the situation is different: the main finding is that PCA 1st component is smaller for SP compared to ppTMS paradigms, while among ppTMS SICI is characterized by the smallest comodulation among muscles. We suggest that our findings are useful for the development of more functionally focal TMS approaches, including TMS cortical mapping and somatotopical neuromodulation in patients with motor impairment, including stroke.

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