BOOSTING WORKING MEMORY CAPACITY BY STRENGTHENING THE OSCILLATORY FUNCTIONAL FRONTOPARIETAL PATHWAY

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Background: Oscillatory brain activity serves long-range networks communication including the fronto-parietal network, involved in cognitive control functions such as working memory (WM).

Aims: Here we implemented and validated for the first time a novel information-based Transcranial Magnetic Stimulation (TMS) protocol to selectively enhance frequency-tuned long-range communication within the fronto-parietal network and impact WM performance in a frequency specific fashion.

Method: A paired TMS protocol, namely, frequency-tuned cortico-cortical paired associative stimulation (ccPAS), was applied to the right frontal and parietal nodes of the fronto-parietal network, to induce Hebbian-like plasticity to 180 healthy volunteers. In four groups (30 participants each), the stimulation could follow a fronto-parietal or a parieto-frontal direction with an interpulse interval set to a timing corresponding to the duration of each individual alpha (8-14Hz) or theta (4-7Hz) oscillatory peak. As a control, one group (N=30) received no stimulation (sham) while another group (N=30) received simultaneous stimulation unable to induce Hebbian plasticity. Electroencephalographic (EEG) fronto-parietal functional connectivity was measured before and after ccPAS, both during eyes-open resting state and WM performance.

Preliminary results: EEG results showed enhanced fronto-parietal alpha-band connectivity following fronto-parietal alpha-tuned-ccPAS, both at rest and during task execution, but not following the opposite parieto-frontal direction or sham. This effect was frequency specific as no modulation was observed for control frequency bands, i.e., theta. Conversely, we found no effect after theta-tuned ccPAS, independently of the stimulation direction. Lastly, no effect was found after simultaneous stimulation. At the behavioural level, fronto-parietal alpha-tuned ccPAS induced an enhanced performance for items ipsilateral to the stimulation site, compared to sham. Performance of all the other groups did not significanty differ from sham.

Conclusions: Here we demonstrated that alpha-tuned timing and direction of stimulation are critical in modulating long-range alpha-phase coherence between the stimulated areas. Furthermore we provide direct evidence of oscilatory functional relevance. Specifically, we show the causal involvement of alpha rhythms in the top-down suppression of irrelevant items with a concurrent release of resources to facilitate memorization of the relevant ones.

Keywords: Working memory, Alpha oscillations, Theta oscillations, ccPAS, Functional connectivity

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