Boosting WM capacity by strengthening the oscillatory functional fronto-parietal pathway

ABSTRACT:

Background
Brain oscillations serve long-range communication including the fronto-parietal network, involved in cognitive control functions such as working memory (WM).

Aims
To implement a novel cortico-cortical paired associative stimulation (ccPAS) protocol to selectively enhance frequency-tuned long-range fronto-parietal network communication and impact WM performance in a frequency specific fashion.

Method
ccPAS was applied to 180 healthy volunteers. The stimulation followed a fronto-parietal or parieto-frontal direction. The interpulse interval was set to the duration of each individual's alpha or theta cycle. As a control, one group received no stimulation (sham) and another received simultaneous stimulation. Electroencephalographic (EEG) fronto-parietal functional connectivity was measured before and after ccPAS during resting state and WM performance.

Results
EEG showed enhanced fronto-parietal alpha-band connectivity following fronto-parietal alphatuned-ccPAS, but not following the opposite parieto-frontal direction or sham. This effect was frequency specific. No effect was found after theta-tuned ccPAS, independently of stimulation direction or after simultaneous stimulation. At the behavioural level, fronto-parietal alpha-tuned ccPAS enhanced performance for items ipsilateral to the stimulation site, relative to sham. Performance of all the other groups did not significantly differ from sham.

Conclusions
Alpha-tuned (but not theta-) ccPAS can modulate long-range fronto-parietal connectivity. The project provides evidence for a 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, Hebbian Plasticity, Brain Oscillations, Frontoparietal connectivity, Neurostimulation

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