Inter-individual variability in rTMS target connectivity

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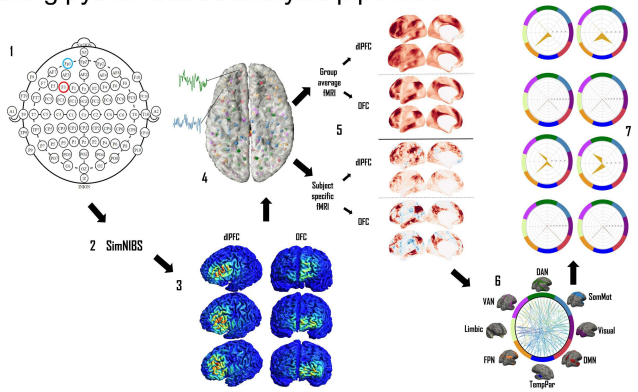
Introduction

Repetitive transcranial magnetic stimulation (rTMS) is an emerging alternative to existing treatments for major depressive disorder (MDD)[1]. However, its effects are variable, which may be related to individual differences in structural and functional brain connectivity[2]. Previous approaches to finding a target site for rTMS have focused on individual brain regions implicated in MDD, such as the dorsolateral prefrontal cortex (dlPFC) and orbitofrontal cortex (OFC)[1, 3].

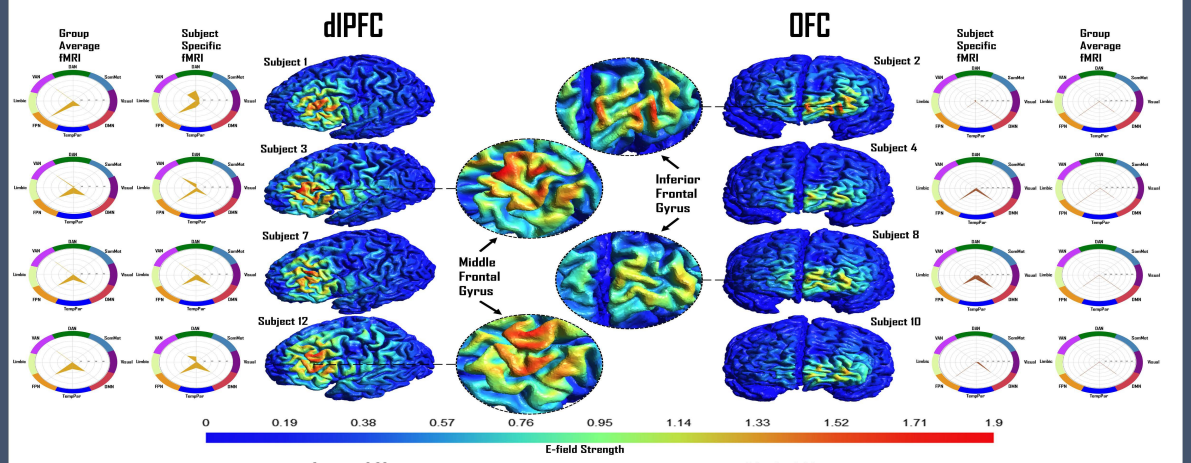
Methods

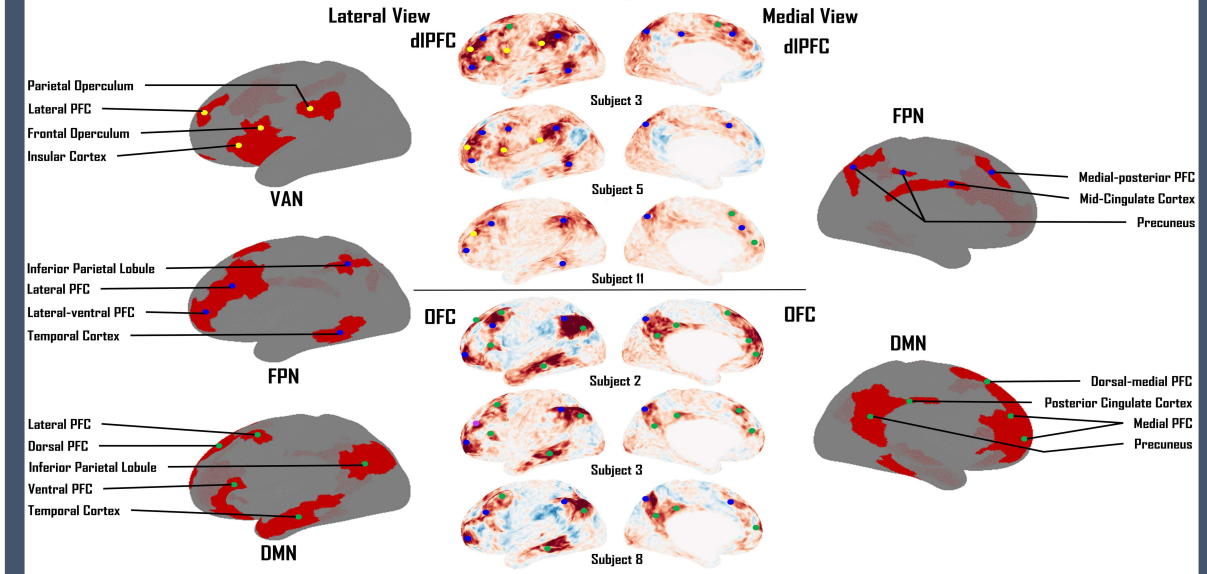
1) We used the 10-20 EEG electrode positioning system to determining our dlPFC and OFC rTMS targets. ***2)*** Once we had our rTMS targets, we ran SimNIBS to model rTMS stimulation at these sites. ***3)*** Simulation from SimNIBS generates an E-field which we then binarized at an arbitrary threshold. ***4-5)*** We then used the 'patch' created from the binarized E-field and looked at its functional connectivity using resting-state fMRI data from the Human Connectome Project for 12 subjects[4]. ***6-7)*** Once the functional connectivity maps were obtained, we determined what functional networks are being targeted using python-based analysis pipelines[5].



Results

Functional Connectivity of rTMS targets





VAN - Ventral Attention Network || FPN – Fronto-Parietal Network || DMN – Default Mode Network

Results

Our results showed 3 primary functional networks being targeted by simulated rTMS. These were the VAN, FPN and DMN in dlPFC and the FPN and DMN in the OFC. The connectivity strengths to each of these networks, however, were seen to vary across subjects, highlighting the inter-individual variability of rTMS target connectivity. Important downstream nodes within each of these functional networks were also observed. While some nodes consistently appeared across many subjects, others were subject-specific, again highlighting inter-individual variability of downstream rTMS target connectivity.

Conclusions

MDD is a heterogeneous condition where patients with varying symptoms can have different effects, following rTMS treatment. The results of this study show that different rTMS stimulation targets have different downstream functional connectivity profiles. The connectivity profiles of rTMS to downstream brain regions will inform how we select network-based rTMS targets. In turn, this information can help shape personalized treatment strategies in the future.

References

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