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# Model-guided and MEG-controlled tDCS strategy optimisation in Alzheimer's disease

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## Background

Disrupted brain network activity in Alzheimer's disease (AD) is a potential therapeutic target for transcranial direct current stimulation (tDCS)[1]. However, optimal stimulation parameters, such as electrode position and stimulation intensity, and their effect on brain network dynamics, are not known and may differ for individuals. To address these issues, we developed a novel approach to explore optimal tDCS strategies by simulating their effects on brain network activity in a computational neural mass network model[2]. Promising strategies will then be selected for simultaneous tDCS-MEG sessions in AD patients to ascertain their effect.

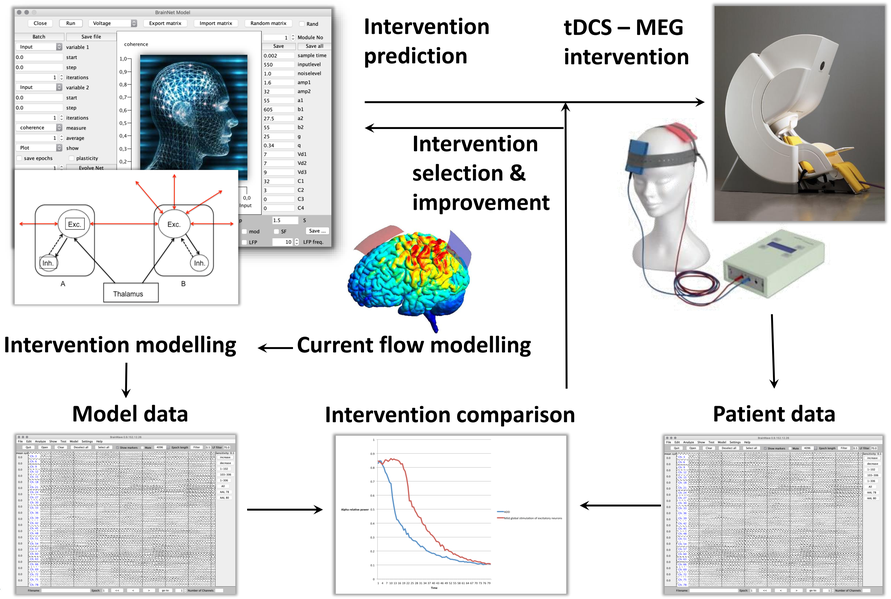
## Aim

To optimize tDCS strategies in AD patients by simulating their effect in a computational AD model, and verify effects with simultaneous tDCS-MEG.

## Methods

The computational model consists of 78 neural masses, which describe the behaviour of large groups of interconnected excitatory and inhibitory neurons, and are coupled according to human brain network topology.

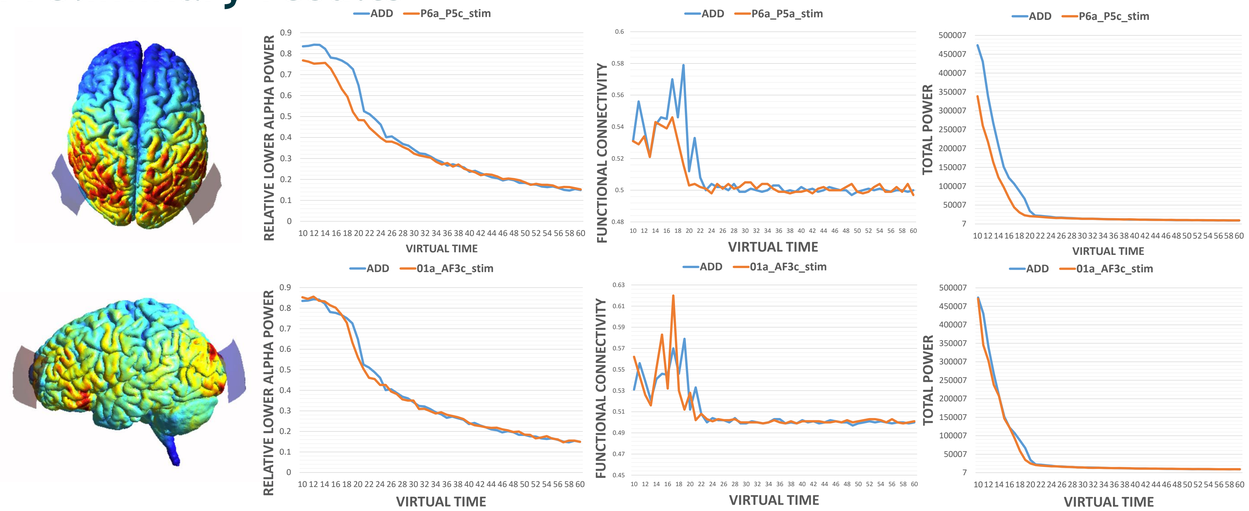
The model generates MEG-like physiological data and can simulate the damage caused by AD over time[3], such as oscillatory slowing.



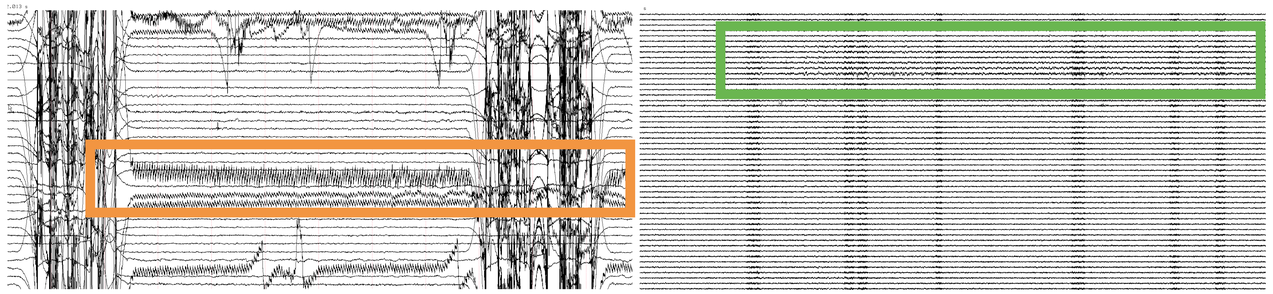

The effects of tDCS are simulated by **changing the excitability of the targeted neuronal masses**, guided by **current flow modelling**[4]. Virtual stimulation strategies are considered successful when they are able to steer key quantitative neurophysiological measures such as **spectral power and functional connectivity** in the ADD condition towards healthy values[1].

Modelled tDCS strategies can be personalised by using an individual's functional (MEG-based) connectivity matrix. In the final stages of the study, the most promising general and personalized interventions will be compared in **mild-to-moderate AD** patients by **simultaneous tDCS-MEG.**

## Preliminary results




Shown above are modelled effects of two tDCS strategies (orange) to counter AD damage over time (blue, ADD algorithm[3]). Each strategy has its corresponding current flow modelling on the left of the row. They differ in their capability to retain normal power (relative lower alpha (8-10 Hz) and broadband (0.5-48 Hz) power and functional connectivity (AEC, 8-13 Hz) levels.



This figure presents simultaneous tDCS-MEG pilot data from healthy volunteer, both before (left) and after (right) artefact filtering (tSSS[5]). Outlined in orange is a typical artefact during the ramp-up period of the stimulation, while outlined in green is activity during 1mA tDCS.

For both simulated and pilot scan data, we detected changes in areas distant from the stimulated region. Different electrode montages and stimulation intensities produce different network effects. However, further analysis is needed to optimise stimulation parameters.

## Conclusion

We present a novel model-guided tDCS approach for optimizing, personalizing and validating treatment strategies in AD patients.

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