INTRODUCTION

- Vast literature on tDCS modulation of motor regions\(^1\).
- Most evidence comes from motor-evoked potentials and, in fewer cases, BOLD signal changes or functional connectivity\(^2\).
- Lack of mechanistic explanations on the specific effects of tDCS on cortical and subcortical networks.
- Evidence often obtained by comparing the changes after tDCS with baseline\(^4\).
- Little information on the temporal dynamics of tDCS.

We investigated the temporal changes in effective connectivity across cortical and subcortical motor regions during tDCS.

METHODS

- **Participants:** 21 right-handed healthy volunteers (8 Males, 13 Females), aged 18 - 32 (M = 22.1; SD = ± 3.9).
- **Design:** Within-subjects; 3 tDCS sessions: anodal, cathodal, sham (counterbalanced).

### tDCS stimulation

- **Procedure:** online tDCS inside MRI scanner.
- **Montage:** left M1 (active) and right orbitofrontal area (reference).
- **Duration:** 20 minutes.
- **Intensity:** 1 mA.

### MRI

- **Preprocessing:** standard pipeline (SPM12) + denoising (Tapas PhysIO toolbox) via modelling of physiological noise.

### Analysis

**Regions of interest:** left M1, SMA, thalamus and right cerebral (ROI coordinates were taken from task data).

1. **Spectral DCM:** Effective connectivity estimation from the rs-fMRI data through Bayesian Model Inversion and Comparison.
2. **Hierarchical PEB:** Bayesian Model Comparison, Reduction and Averaging to test for group differences.

### Whole time-series

1. Individual spDCMs for each participant and session.
2. Group PEB with contrasts: a) [tDCS - sham]; [anodal - cathodal]; b) [anodal - sham]; [cathodal - sham].

### Sliding Windows

1. Individual spDCMs for each participant, session and time window.
2. PEB1: basis functions designs across time windows for each participant and session (multiple designs tested – the design with most positive Free Energy index best fits the data).
3. PEB2: average across participants for each polarity.
4. PEB3: group effects with same contrasts as whole time-series analysis.

**RESULTS**

**Estimated parameters after model comparison - thresholding based on Free Energy (Pp > 0.95)**

**Whole time-series**

- **tDCS vs sham**
- **Anodal vs sham**
- **Cathodal vs sham**

**Sliding Windows**

- **PEB2 - group effect for each polarity**
- **PEB3 - differences across polarities**

**CONCLUSIONS**

- Real tDCS (anodal & cathodal) elicits online changes in effective connectivity.
- The effects extend beyond the stimulated site and have different temporal patterns in different regions.
- Cosine oscillations best explain the data: tDCS perhaps follows the resting-state fluctuations.
- Different thalamic and M1 connectivity between real tDCS and sham:
- The thalamus is affected in a polarity-specific manner (more inhibition in anodal tDCS).
- In conclusion: when at rest, anodal and cathodal M1-tDCS appear to clearly affect thalamic connectivity with an oscillatory (cosine) trend.

REFERENCES


For further info or questions: S.Calzolari@bham.ac.uk