Targeting visual area V5 and frontal eye fields with personalized tDCS to modulate smooth pursuit eye movements

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Background

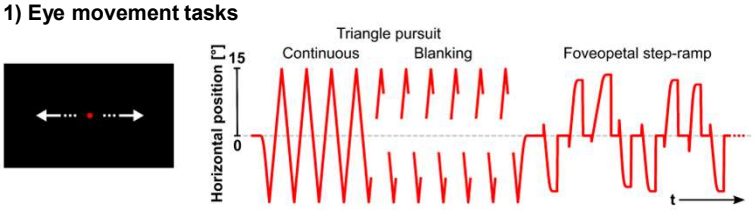
Activity in human visual area V5 and frontal eye fields (FEF) correlates with the processing of smooth pursuit eye movement [1,2]. To assess the causal relationship, normative transcranial direct current stimulation (tDCS) was applied over right V5 and FEF but showed only limited effect. However, normative tDCS suffers from low replicability [3] due to inter-individual variability in brain function and anatomy. Personalized tDCS in contrast optimizes the applied electric fields with respect to stimulation targets and individual head volume conduction and thereby might facilitate the modulation efficacy.

→ ***We present results from two studies using normative tDCS over V5 and FEF, and a pipeline for personalized tDCS targeting individual V5 and FEF for the modulation of smooth pursuit eye movement***

Normative tDCS

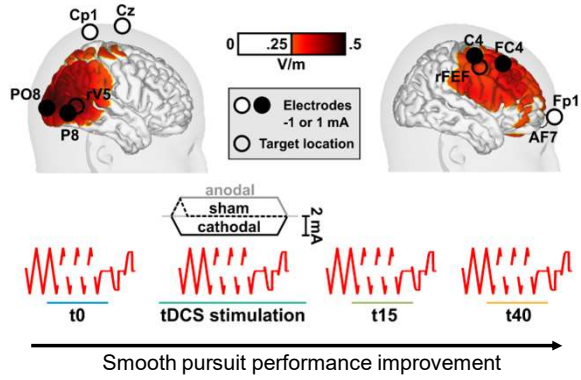
- Horizonzal smooth pursuit eye movements were recorded during three tasks: a) continuous triangle, b) triangle blanking and c) foveo-petal step-ramps (18.7°/s target velocity, 15° ramp amplitude) and velocities were analyzed (Fig. 1)
- Normative tDCS was applied over the right V5 and FEF, respectively (each N = 30; 20 min., 2x 1 mA; Fig. 2)

1) Eye movement tasks

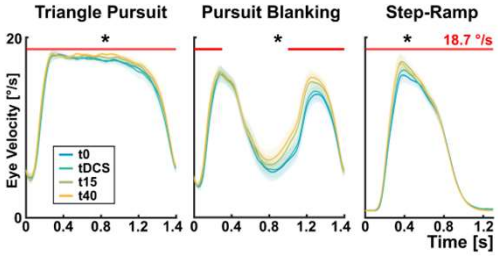


- Eye movements were evaluated before (t0), during and after (t15, t40) tDCS application comparing anodal, cathodal and sham stimulation (Fig. 2)

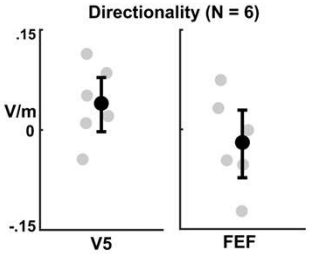
2) Experimental design



3) Smooth pursuit learning effect



4) Limited individual targeting



→ *No tDCS effects, but learning effects within measurement sessions, indicating plasticity of the smooth pursuit network* (Fig. 2, 3)

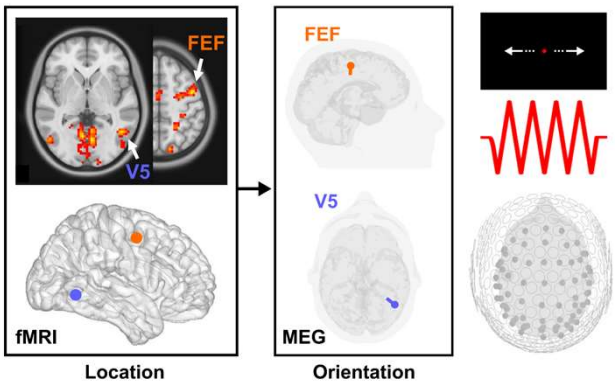
→ *In a subsample (N = 6), electric field simulations revealed a large variability of directionality in individual V5 and FEF stimulation targets* (Fig. 4)

Personalized tDCS (ongoing study)

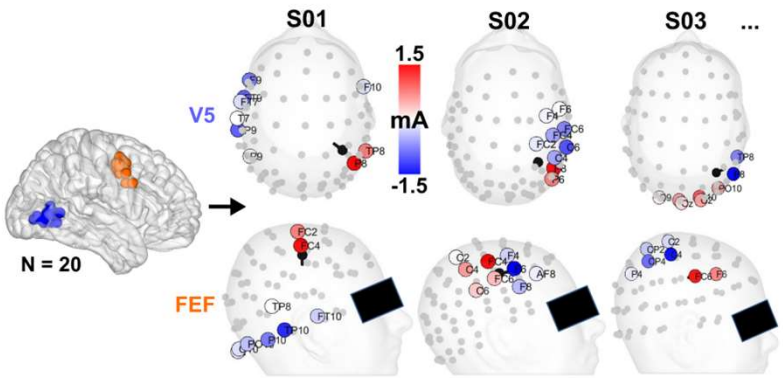
- V5/FEF stimulation targets are defined based on fMRI (location) and combined EEG/MEG measurements (orientation; Fig. 5)
- Individual calibrated six-compartment finite-element headmodels (T1, T2 and DTI, skull conductivity calibration using MEG/EEG)
- Personalized tDCS montages are optimized for directionality of the electric field in right V5 and FEF using the D-CMI optimization algorithm [4]
- Ongoing study: Personalized tDCS targeting FEF and V5 in a full within-subject design (N = 20; 2 mA, 20 min.; anodal, cathodal, sham)

→ See Fig. 6 for individual tDCS montages in three exemplary subjects

5) Example for individual stimulation target definition



6) Target variability and personalized stimulation montages



References

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