Effects of transcranial direct current stimulation (tDCS) over brain area V5 on smooth pursuit eye movements

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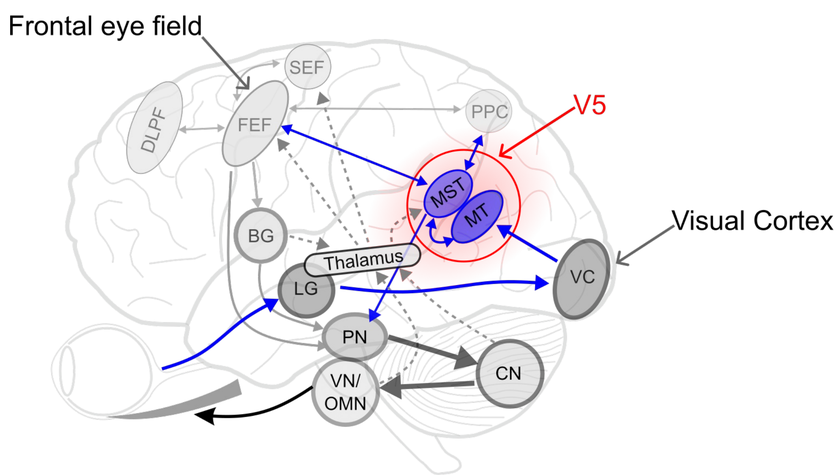
Introduction

Smooth pursuit enables clear vision of small moving objects in daily life.
Patients with **psychotic disorders** show **impairments of smooth pursuit**, which are regarded as a potential biomarker[1,2].



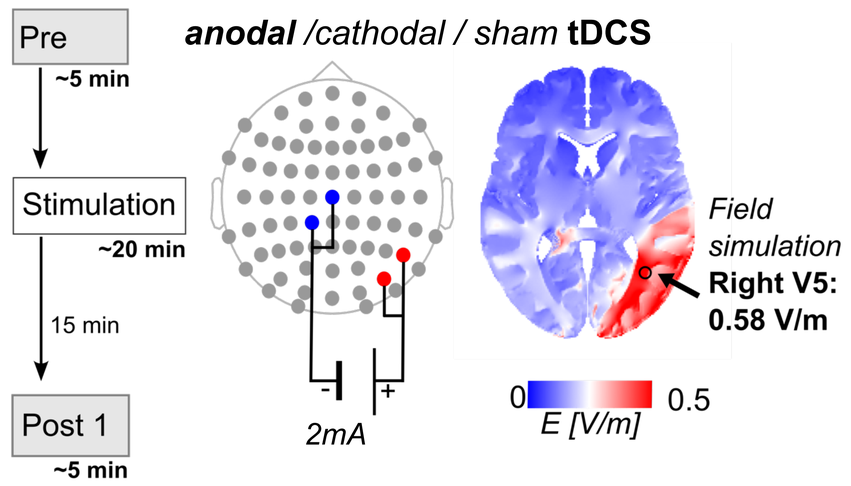
Smooth Pursuit Network[3]

Research question:

(1) Can cathodal tDCS over V5 (MT/MST) simulate smooth pursuit dysfunctions in healthy subjects?
(2) Can anodal tDCS over V5 (MT/MST) improve pursuit performance in healthy subjects?

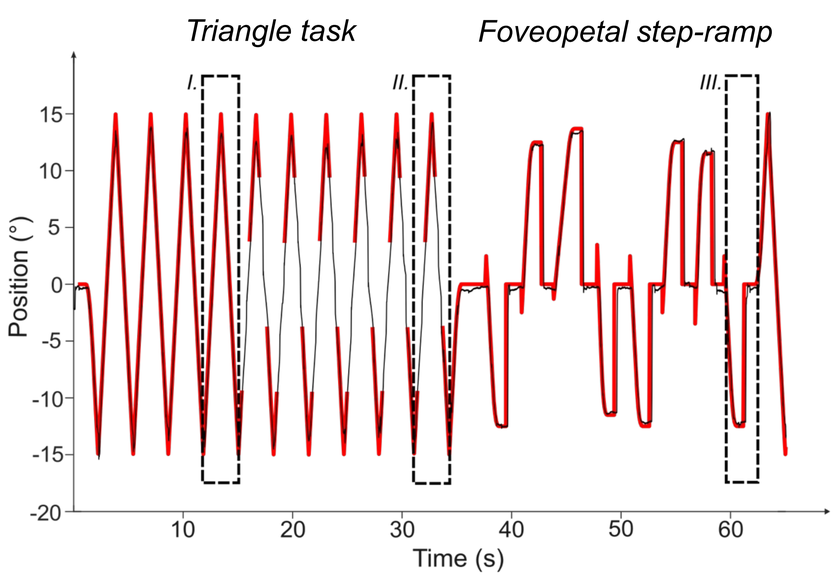
Methods

tDCS experiment (N = 24)



tDCS is a non-invasive method to change membrane polarization.

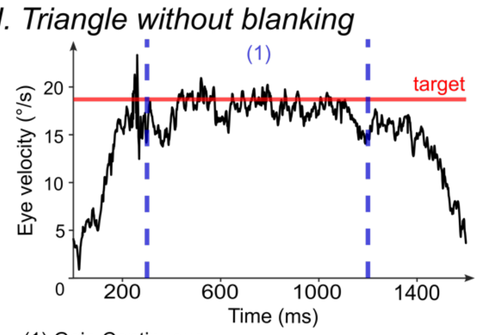
Eyetracking tasks



Parameters of interest

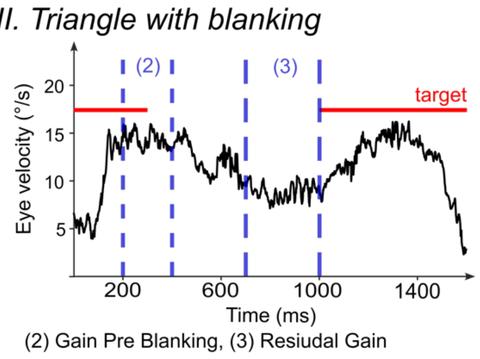
$$Gain = \frac{target\ velocity}{eye\ velocity}$$ in defined intervals

I. Triangle without blanking



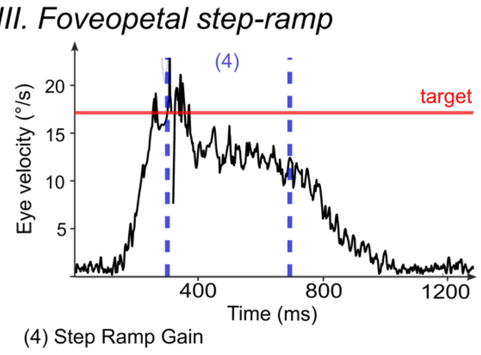
(1) Gain Continuous

II. Triangle with blanking



(2) Gain Pre Blanking, (3) Resiudal Gain

III. Foveopetal step-ramp

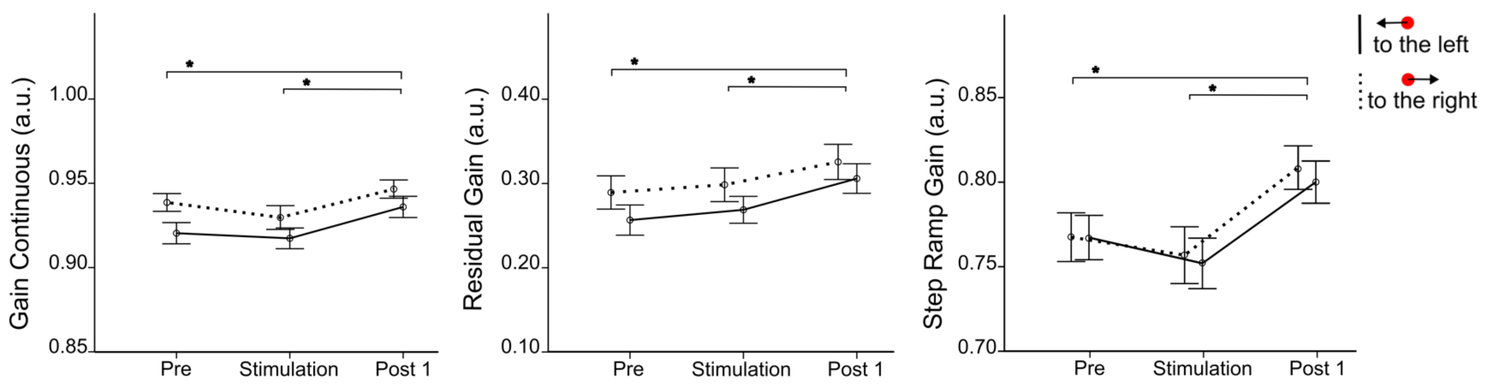


(4) Step Ramp Gain

Results

Learning effects

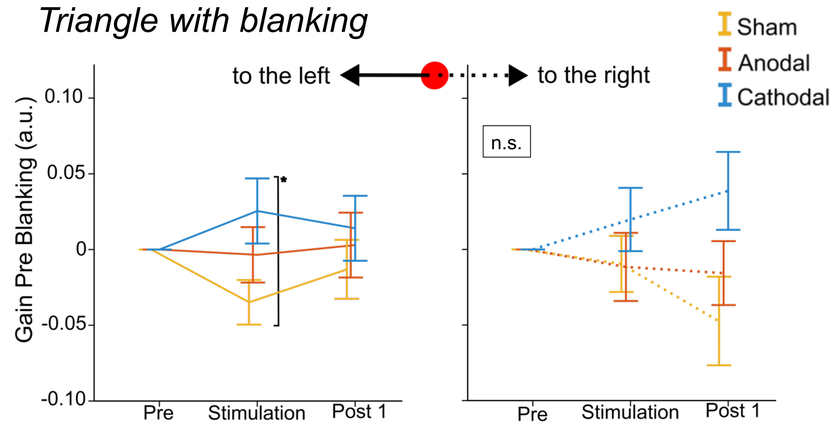
I. Triangle without blanking | *II. Triangle with blanking* | *III. Foveopetal step-ramp*



*no significant side differences, * p < 0,05, a.u. = arbitrary unit*

tDCS effects (difference values[i])

Triangle with blanking



*[i] differences to "Pre", * p < 0,05, n.s. = not significant , a.u. = arbitrary unit*

– Improvement of smooth pursuit performance in all tasks over time independent from stimulation conditions.
– Cathodal tDCS during active smooth pursuit to the left improves pre blanking performance compared to sham tDCS.
rm ANOVA interaction effect ($F_{2,46}$ = 3.712, p = 0.032), post hoc analysis ($M_{cathodal}$ = 0.025 ± 0.21, M_{sham} = -0.035 ± 0.015, p = 0.036)

Conclusions

1. Cathodal tDCS over V5 did not disturb but rather improved smooth performance in intervals prior to target blanking.
2. Rather small effects of tDCS in healthy subjects may be explained by generally high performance levels and by disregarding individual anatomy in standard stimulation set-ups.
3. Learning effects within sessions may reflect extraretinal input such as predictive mechanisms.

[1] Sweeney, J. A. *et al.* Pursuit tracking impairments in schizophrenia and mood disorders: step-ramp studies with unmedicated patients. *Biol Psychiatry* 46, 671–680 (1999).
[2] Lencer, R. *et al.* Pursuit eye movements as an intermediate phenotype across psychotic disorders: Evidence from the B-SNIP study. *Schizophrenia Research* 169, 326–333 (2015).
[3] Adapted from Eye Movement Research, by A. Sprenger, 2019, p.148.

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