# Normative tDCS over brain area FEF for the modulation of smooth pursuit eye movements


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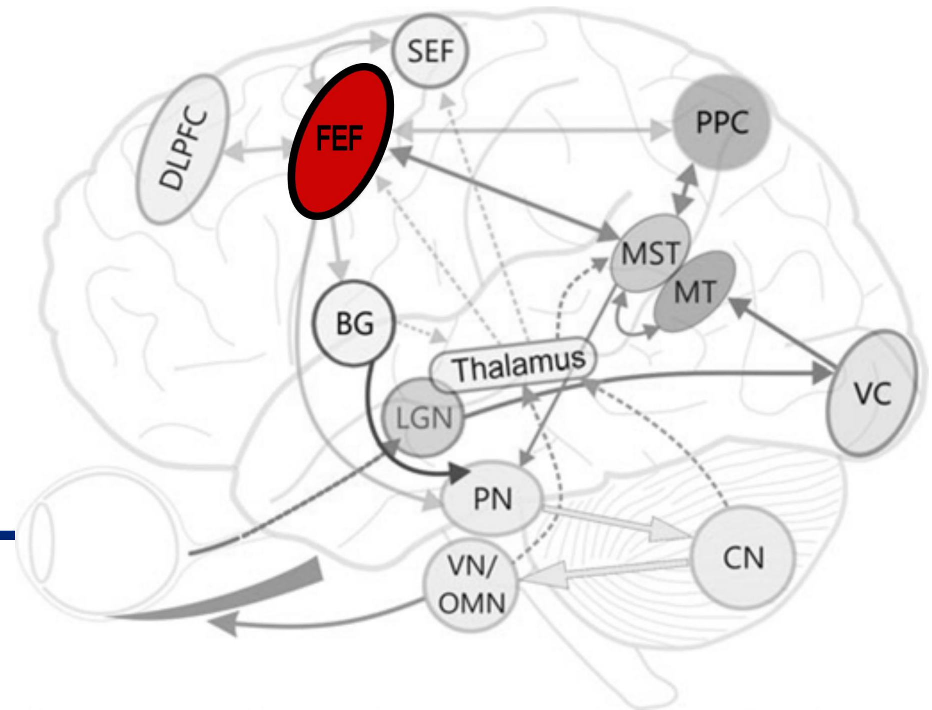
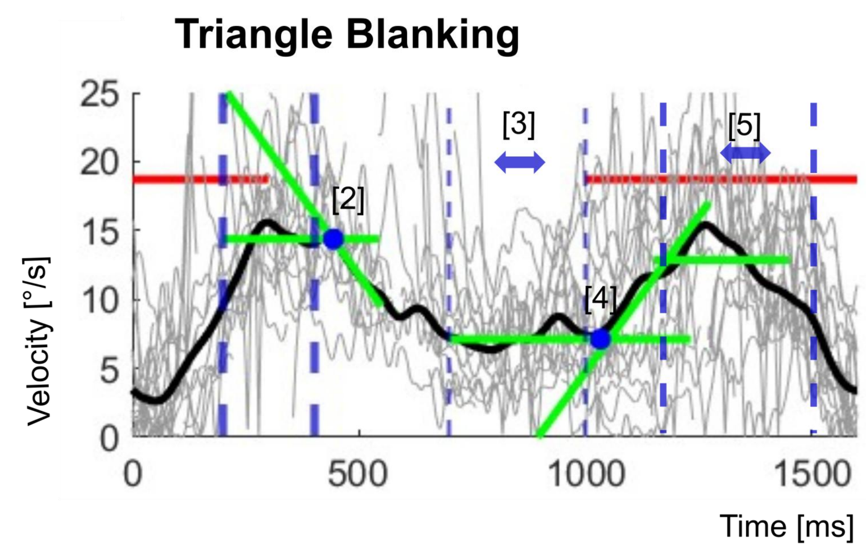


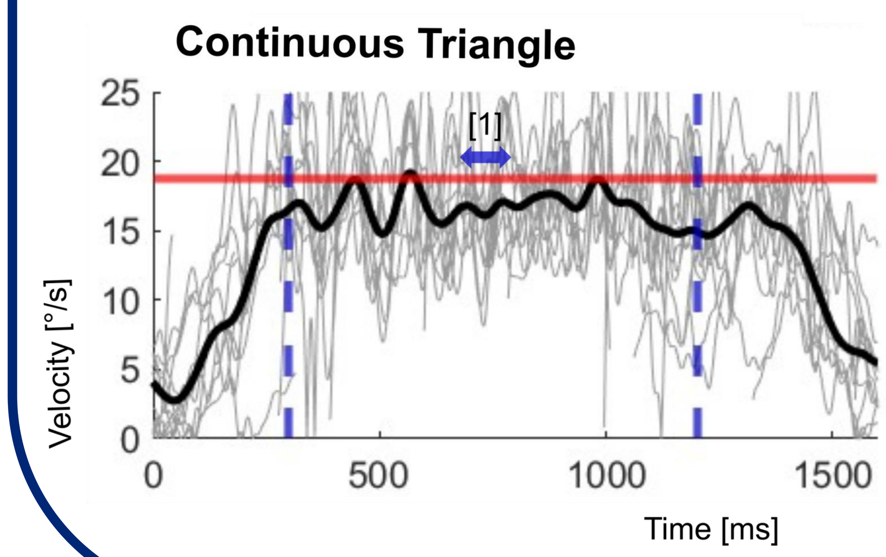

## Background

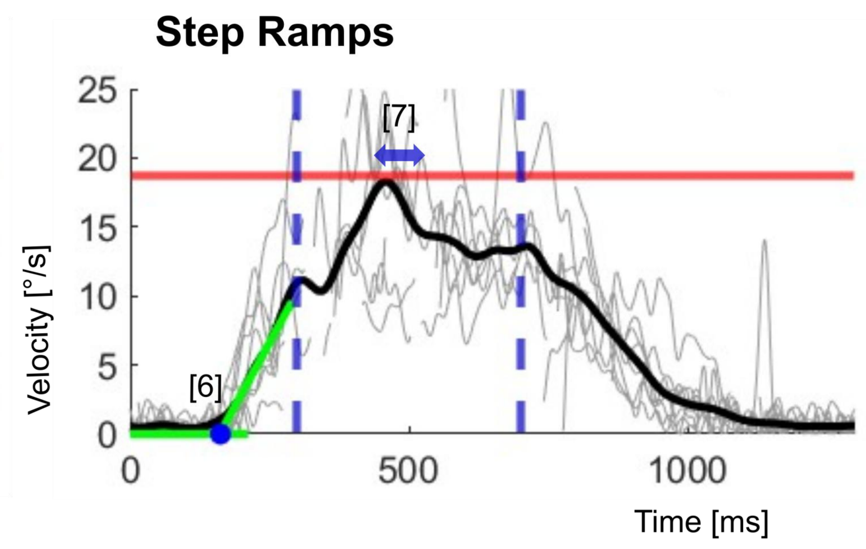
In order to visually follow small moving objects in the environment **smooth pursuit eye movements** (SPEM) are necessary to have a clear vision of the target. The brain area **FEF** is mainly associated with the initiation and maintenance of the pursuit, as well as the integration of anticipatory and predicitve mechanisms[1]. Impairments in SPEM are considered potential biomarkers for **psychotic disorders**[2]. There is only limited data whether the modulation of brain areas via tDCS can influence the performance of SPEM.

## Parameters

1) maintenance gain
2) deceleration
3) residual gain
4) reacceleration latency
5) postblanking gain
6) acceleration
7) step ramp mainenance gain



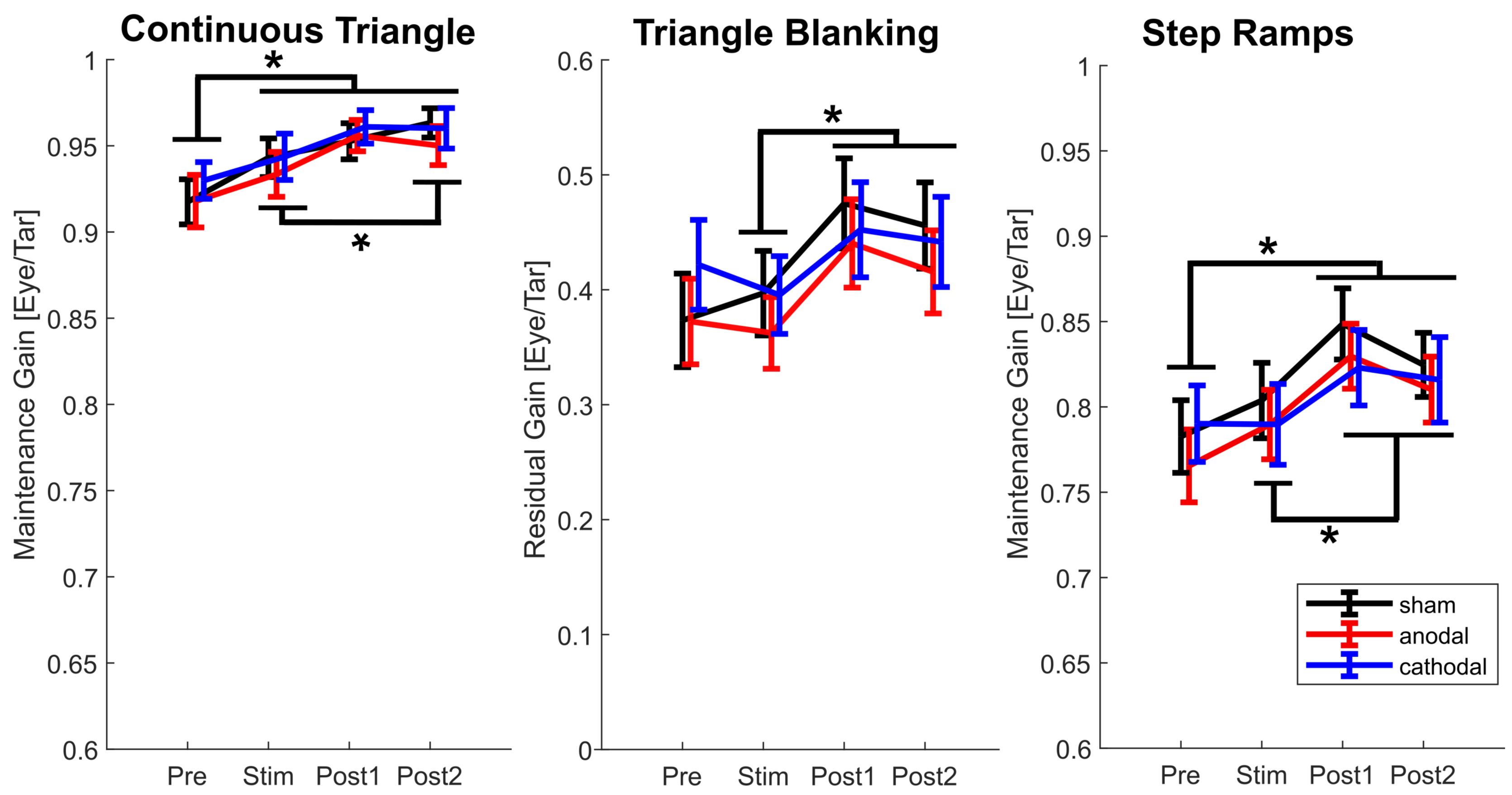

## Hypotheses:

- **Anodal** stimulation over FEF → excitatory modulation of oculomotor networks : improvement of SPEM-performance
- **Cathodal** stimulation over FEF → inhibitory modulation of oculomotor networks : deterioration of SPEM-performance
- **Sham** stimulation over FEF → no effects on SPEM-performance

## Results

→Improvement of SPEM performance in all tasks consistently over time within sessions, regardless of the tDCS stimulation conditions

**Within session learning effects:**




**Continuous Triangle:**
Maintenance gain $p < .001$
**Triangle Blanking:**
Residual gain $p < .001$, post blanking gain $p < .001$, deceleration $p < .015$, reacceleration latency $p < .002$
**Step Ramps:**
Step ramp maintenance gain $p < .001$, acceleration $p < .001$

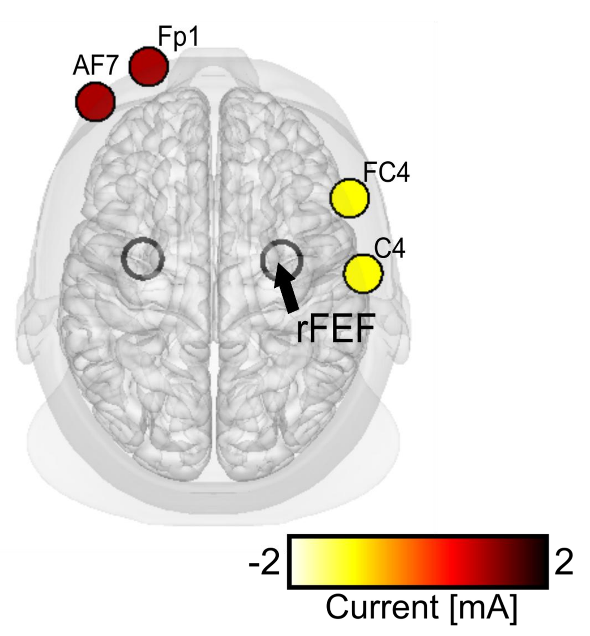
## Methods

**SPEM**

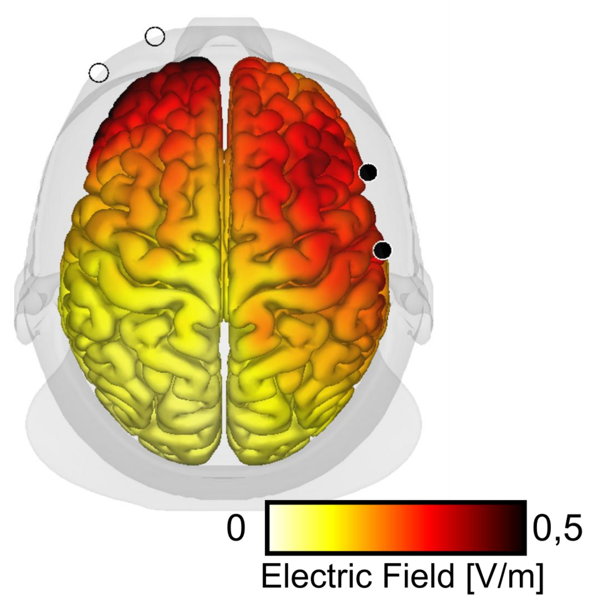
- N=25 healthy participants
- Tasks: continuous triangle, triangle blanking, (foveopetal) step ramps
- Analysis of eye tracking data: before (t0), during (tDCS) and after (t15, t40) tDCS application

→ **Normative tDCS** was applied over the right FEF (rFEF) during three sessions using either cathodal, anodal or sham stimulation.

**tDCS montage**



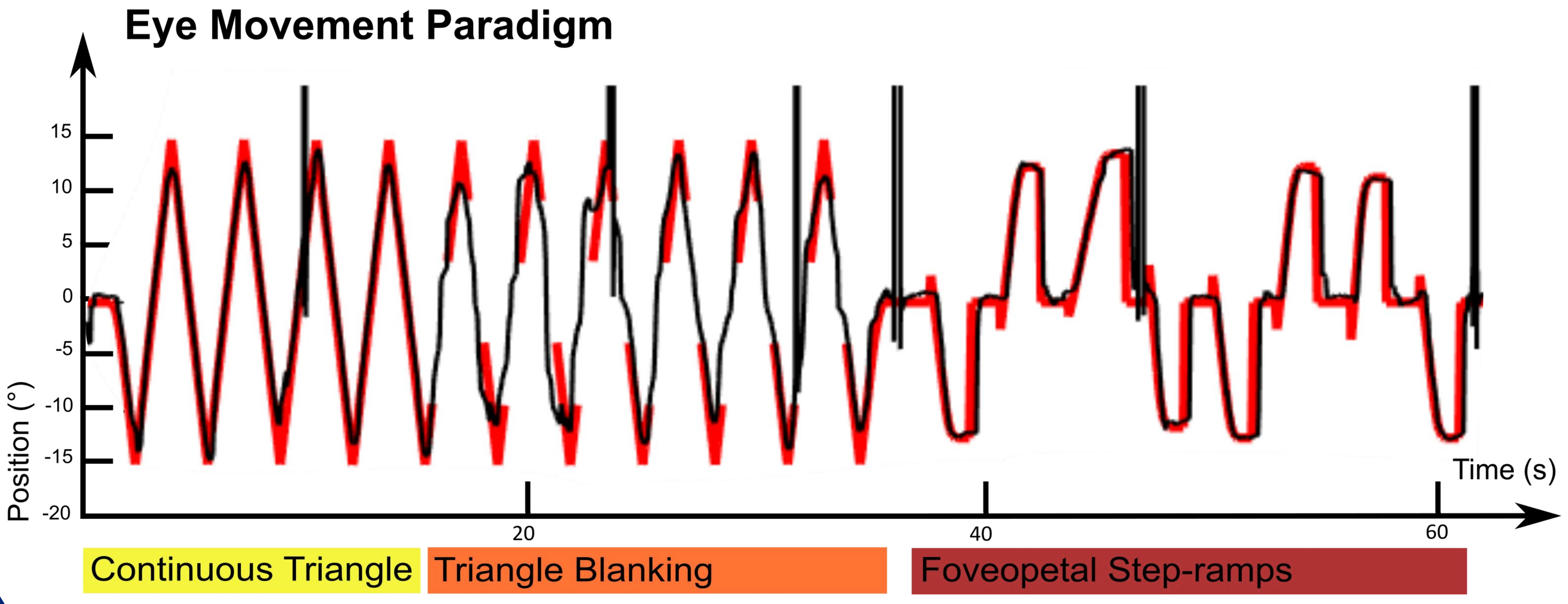

**Electric field simulation**




**Experimental procedure**

Pre ~5min
↓
Stimulation ~20min
↓ +15min
Post 1 ~5min
↓ +25min
Post 2 ~5min

**Eye Movement Paradigm**




## Conclusion

1. **Learning effects** within sessions were observed across different SPEM parameters.
2. The learning effects during triangle blanking (residual gain, reacceleration latency) and early step ramps (acceleration) indicate the modulation **of top down predictive and anticipatory mechanisms** that drive learning effects and also affect more global measures of SPEM performance (maintenance gain).
3. tDCS effects were not observed on neither of the assessed SPEM parameters using normative montages. **Personalized tDCS methods** that consider individual anatomy and functional localization might increase tDCS efficacy.

## References


[1]Lencer, Rebekka, und Peter Trillenberg. „Neurophysiology and Neuroanatomy of Smooth Pursuit in Humans". *Brain and Cognition* 68, Nr. 3 (Dezember 2008): 219–28. https://doi.org/10.1016/j.bandc.2008.08.013.
[2] Lencer, Rebekka, Andreas Sprenger, James L. Reilly, Jennifer E. McDowell, Leah H. Rubin, Judith A. Badner, Matcheri S. Keshavan, u. a. „Pursuit Eye Movements as an Intermediate Phenotype across Psychotic Disorders: Evidence from the B-SNIP Study". *Schizophrenia Research* 169, Nr. 1–3 (Dezember 2015): 326–33. https://doi.org/10.1016/j.schres.2015.09.032
[3] Adapted from Eye Movement Research, by A. Sprenger, 2019, p.148.



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