Personalized tDCS targeting V5 mimics smooth pursuit initiation deficits associated with psychosis

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Background

In patients suffering from psychosis, impairments in the initiation of smooth pursuit eye movement (SPEM) have been associated with altered activity in the visual area V5 [1,2]. Transcranial direct current stimulation (tDCS) might serve as a model to transiently modulate V5 activity in the healthy brain to understand SPEM mechanisms in the patient population. Since *normative* tDCS, i.e., using the same tDCS montage across participants, in general shows limited replicability, *personalized* tDCS has been introduced to algorithmically optimize tDCS montages based on individual anatomical and functional information. A recent study showed that normative tDCS did not modulate SPEM but proposed personalized tDCS to yield more effective tDCS electric fields [3].

→ **Here we applied *personalized tDCS* targeting V5 in healthy participants to mimic SPEM deficits observed in psychosis patients.**

Computation of personalized tDCS montages

TDCS design
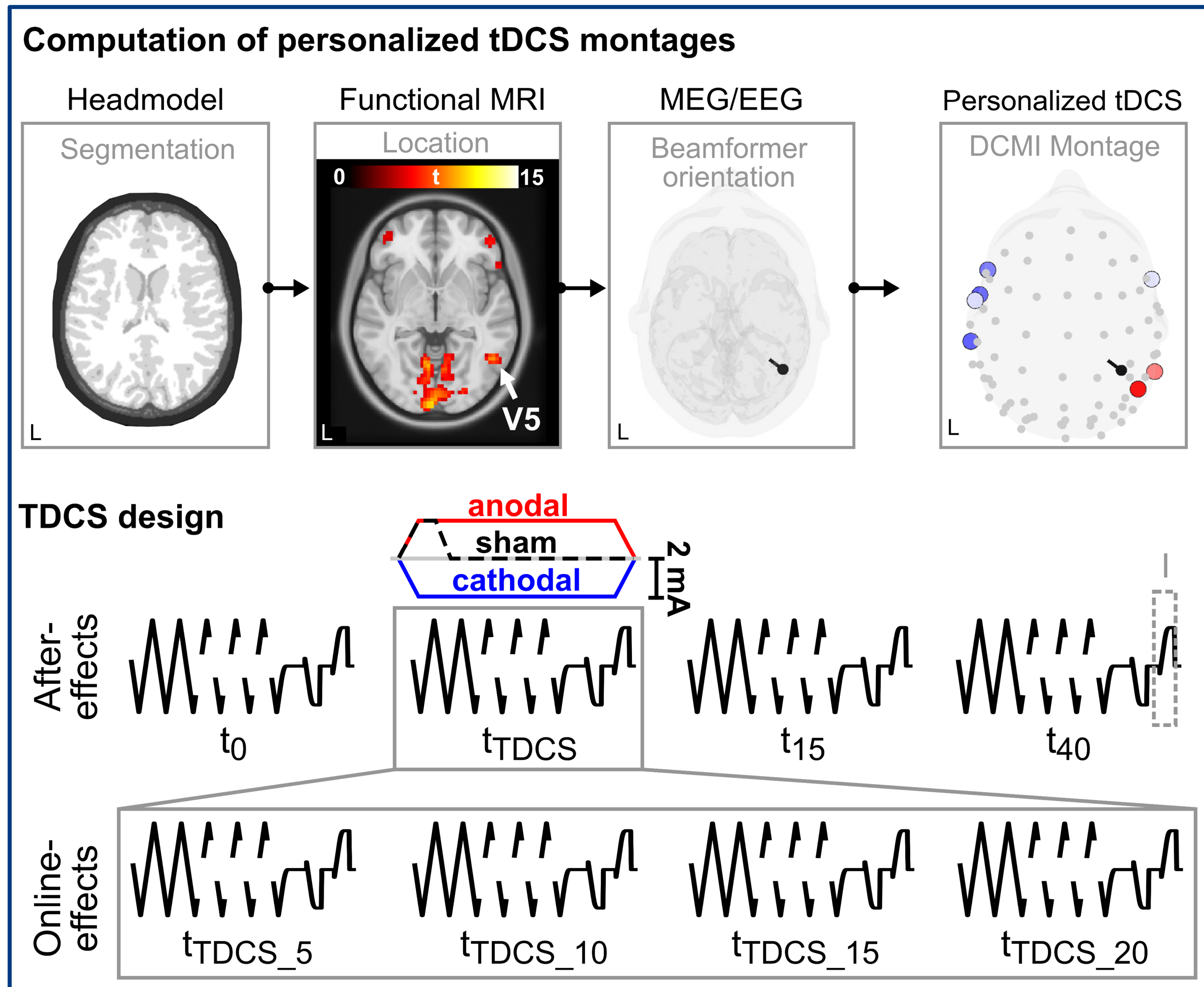
Methods

- For N = 19 healthy participants, individual area V5 was defined (fMRI; combined MEG/EEG), and individual head models were computed

- Personalized tDCS was applied targeting right V5 (2 mA, 20 min)

- Eye movements were analysed with respect to SPEM initiation (step-ramp stimuli), overall pursuit performance (ongoing SPEM stimulus) and top-down modulation of SPEM (ongoing SPEM stimulus with blanking; 18.7 °/s target velocity, ±15° amplitude)

- Linear mixed model analysis was performed including tDCS condition (anodal, cathodal, sham), stimulus direction (leftwards, rightwards) and measurement timepoints to assess online-effects (t_{TDCS_5}, t_{TDCS_10}, t_{TDCS_15}, t_{TDCS_20}) and after-effects (t_0, t_{TDCS}, t_{15}, t_{40}) of tDCS

- Impairing (cathodal) or facilitating (anodal) tDCS effects were hypothesized for pursuit initiation directed ipsiversive to the right V5 [4]

Step-ramp stimuli
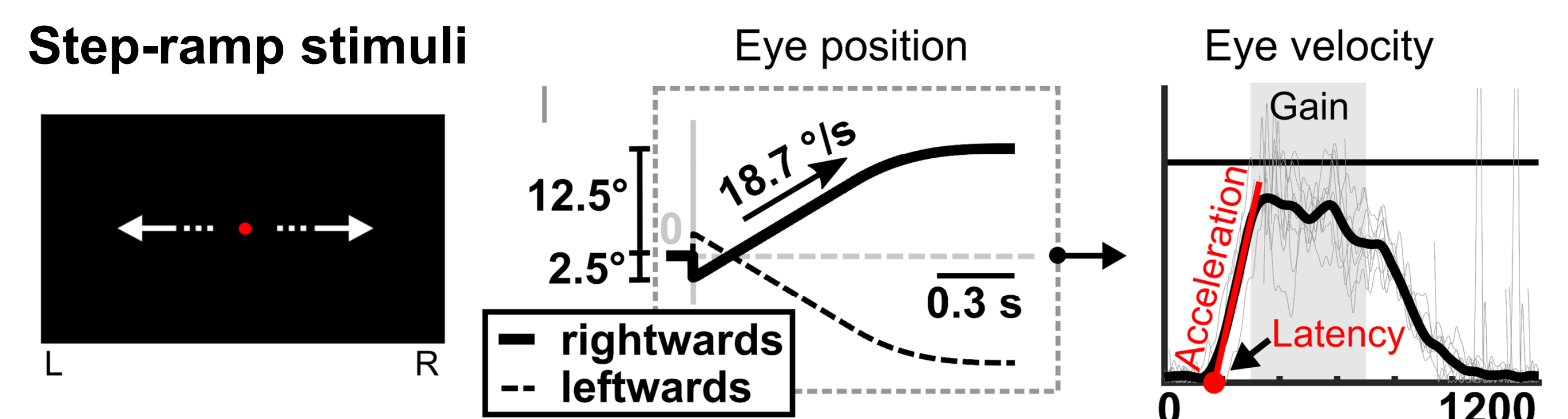
Results

Personalized tDCS modulated SPEM initiation during tDCS (online-effect; interaction effects of tDCS condition x stimulus direction x timepoints):

- Step-ramp acceleration (p = .02)
    - → post-hoc tests did not survive conservative Bonferroni-correction
- Step-ramp latency (p = .015)
    - → Cathodal tDCS delayed oculomotor response latencies, specifically for eye movements ipsiversive to the stimulation target in the right V5
    - → …thereby reducing rightward latencies to the level of overall slower latencies observed for leftwards eye movements
    - → Paradoxical effects were observed during the third quarter of tDCS
- No tDCS modulation was observerd for after-effects, for any other eye movement task, for normative tDCS, nor for personalized tDCS targeting the right frontal eye field as a control region

tDCS online-effects on SPEM initiation (step-ramp)
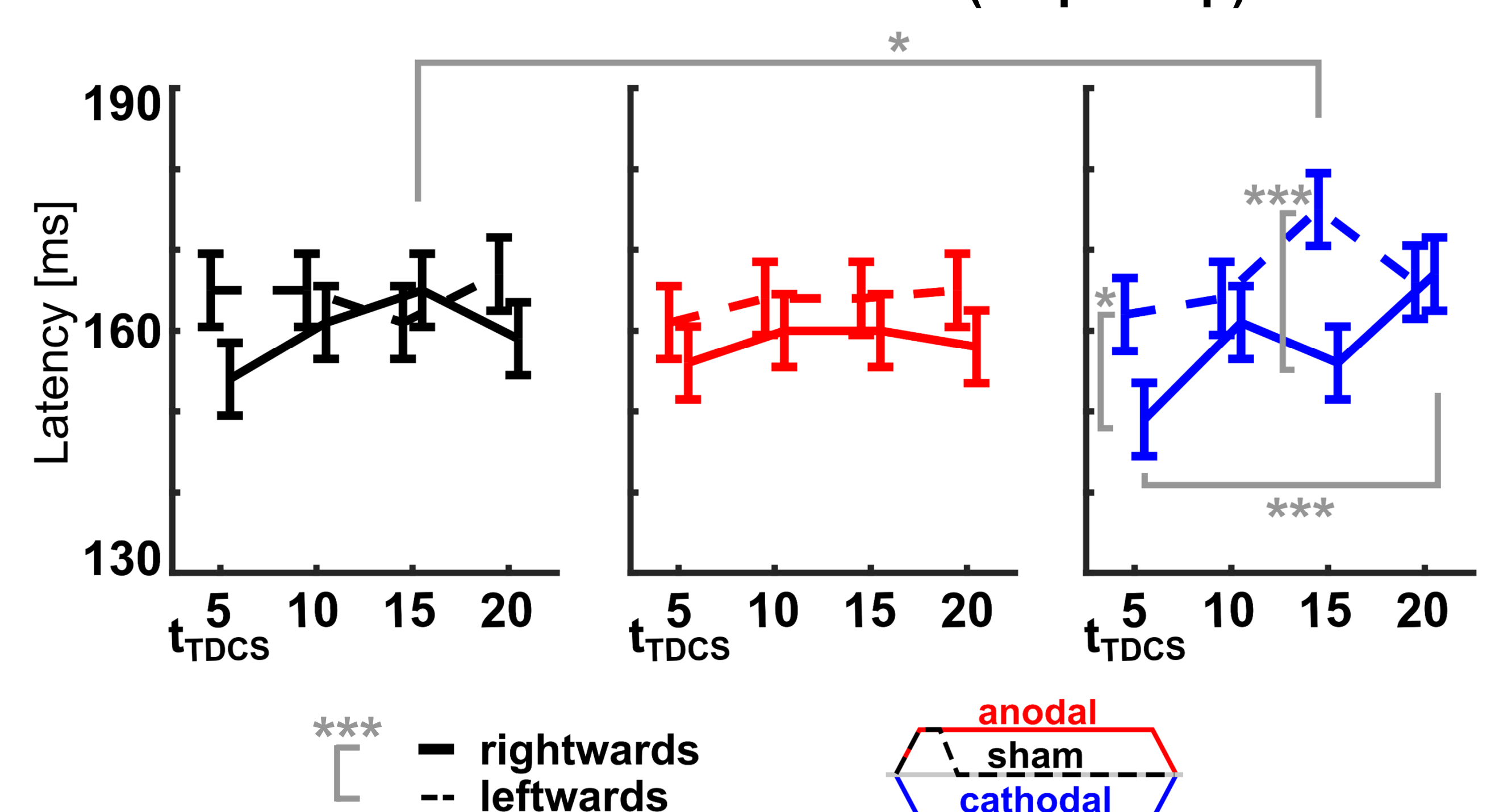
Conclusion

- **Personalized cathodal tDCS targeting V5 modulates SPEM initiation…**
    → Acceleration modulations relate to psychosis [1,2], but post-hoc tests did not survive conservative correction; More specific analysis might stabilize these results (*ongoing analysis*)
    → Cathodal tDCS hampers oculomotor response latencies ipsiversive to the stimulated hemisphere, as described before in lesion studies [4]
    → Latency deficits are not associated with psychosis deficits [1,2], but with other disorders such as Parkinson's disease [5]

- **… while normative tDCS did not show an effect**
    → No tDCS effect was observed in a matched sample using normative tDCS (p > 0.609 [3])
    → Overall, results indicate an increased efficacy of personalized tDCS that may elevate the individual gain by tDCS, especially in therapeutic applications

References

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