

Objectives:

- Induce behavioral changes upon working memory tasks (WMT) in a double-blind cross-over trial using tDCS of the frontoparietal network
- Explore both – online and offline behavioral tDCS effects and neural underpinnings of induced changes by resting-state fMRI (rs-fMRI).

Methods:

- Double-blind randomized controlled trial with a cross-over design; see Fig 1, 2 and 3 for the study design and WM tasks.
- 27 young healthy volunteers (age: 27 ± 4.1 years)

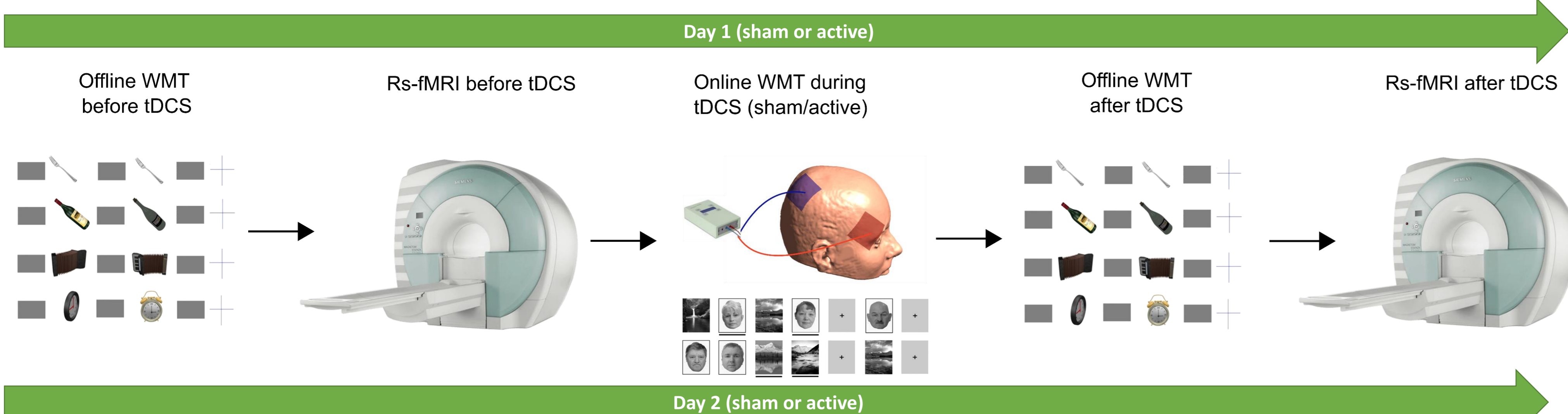


Fig 1 Study design



Fig 2 Online WMT (Gazzaley et al., 2005) Press the YES button, if the target photo was in the previous photo series.



Fig 3 Offline WMT (Elfmarková et al., 2017) Press the YES button, if the two objects are the same. First two rows – conventional view, last two rows – unconventional view

- tDCS active: 2mA; 20min; **Anode:** rMFC (MNI = 44 40 -10), **Cathode:** rPPC (MNI = 30 -55 52) see fig. 4 ; frameless stereotactic neuro-navigation of electrodes (5x5 cm2)

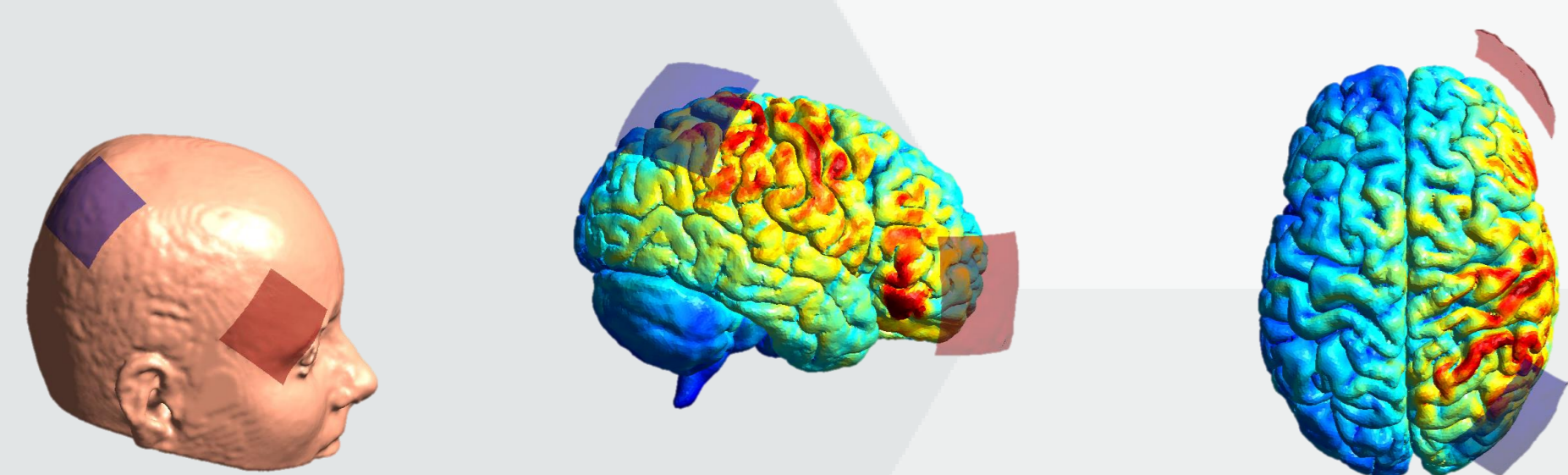
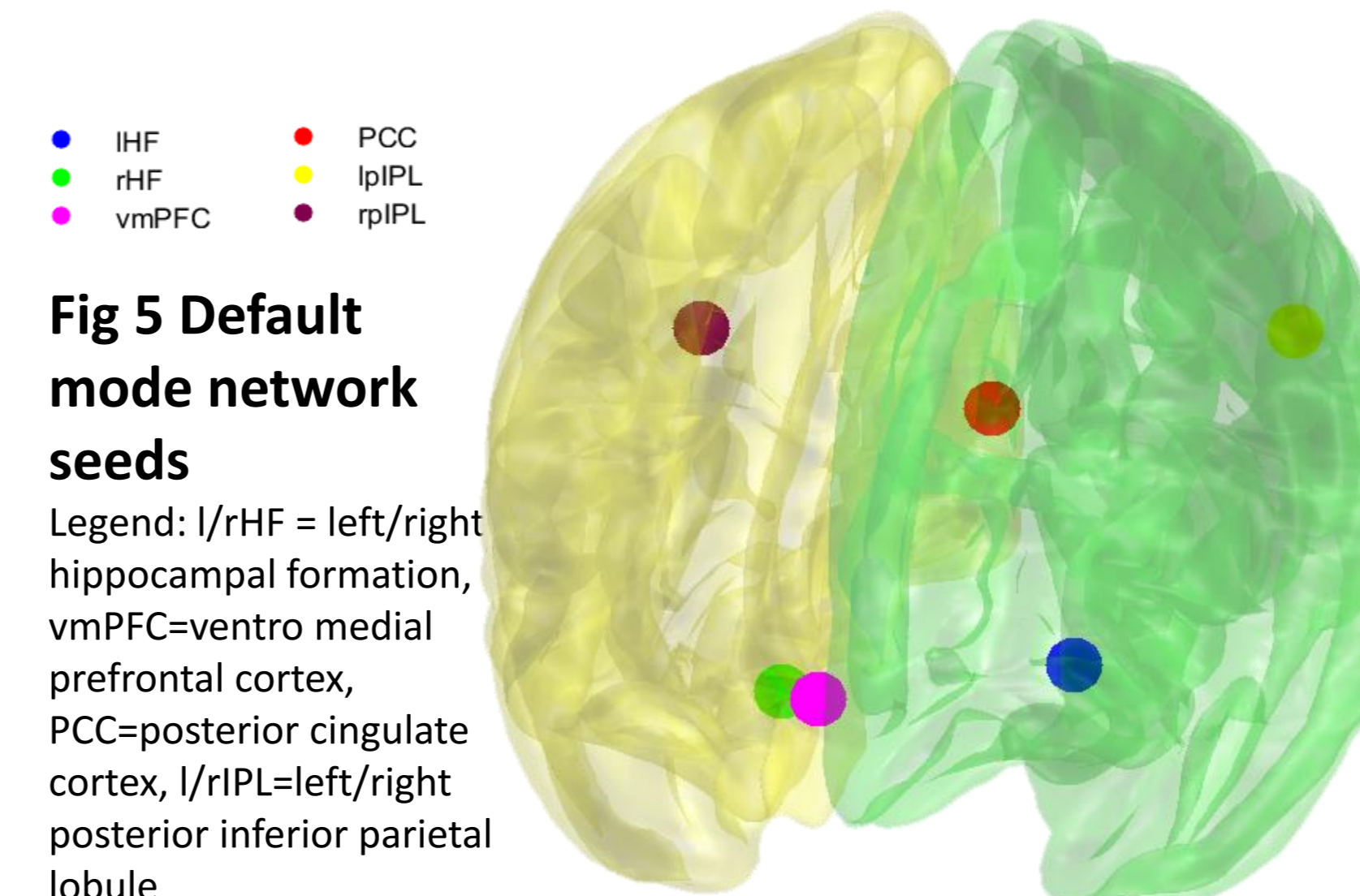


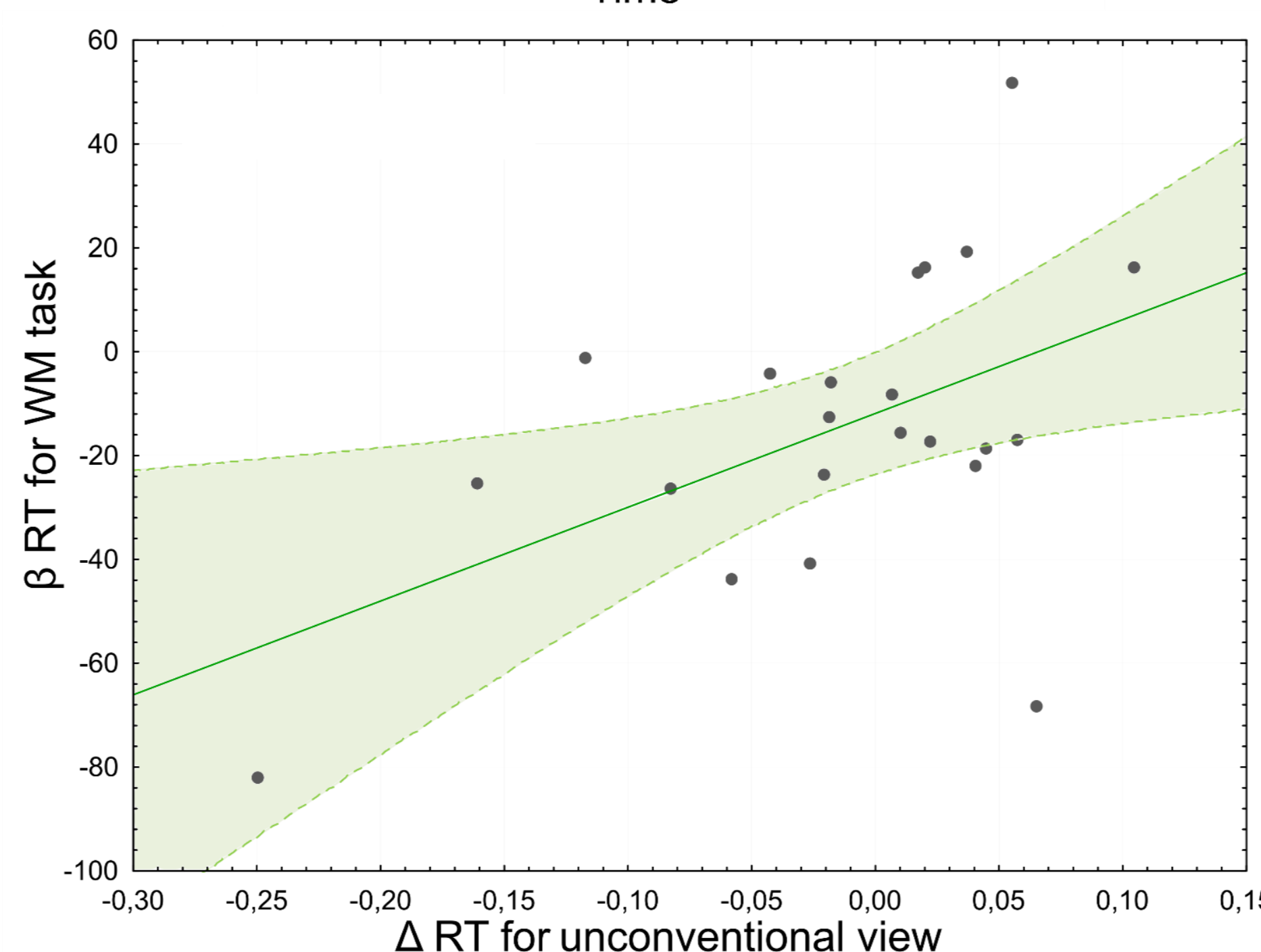
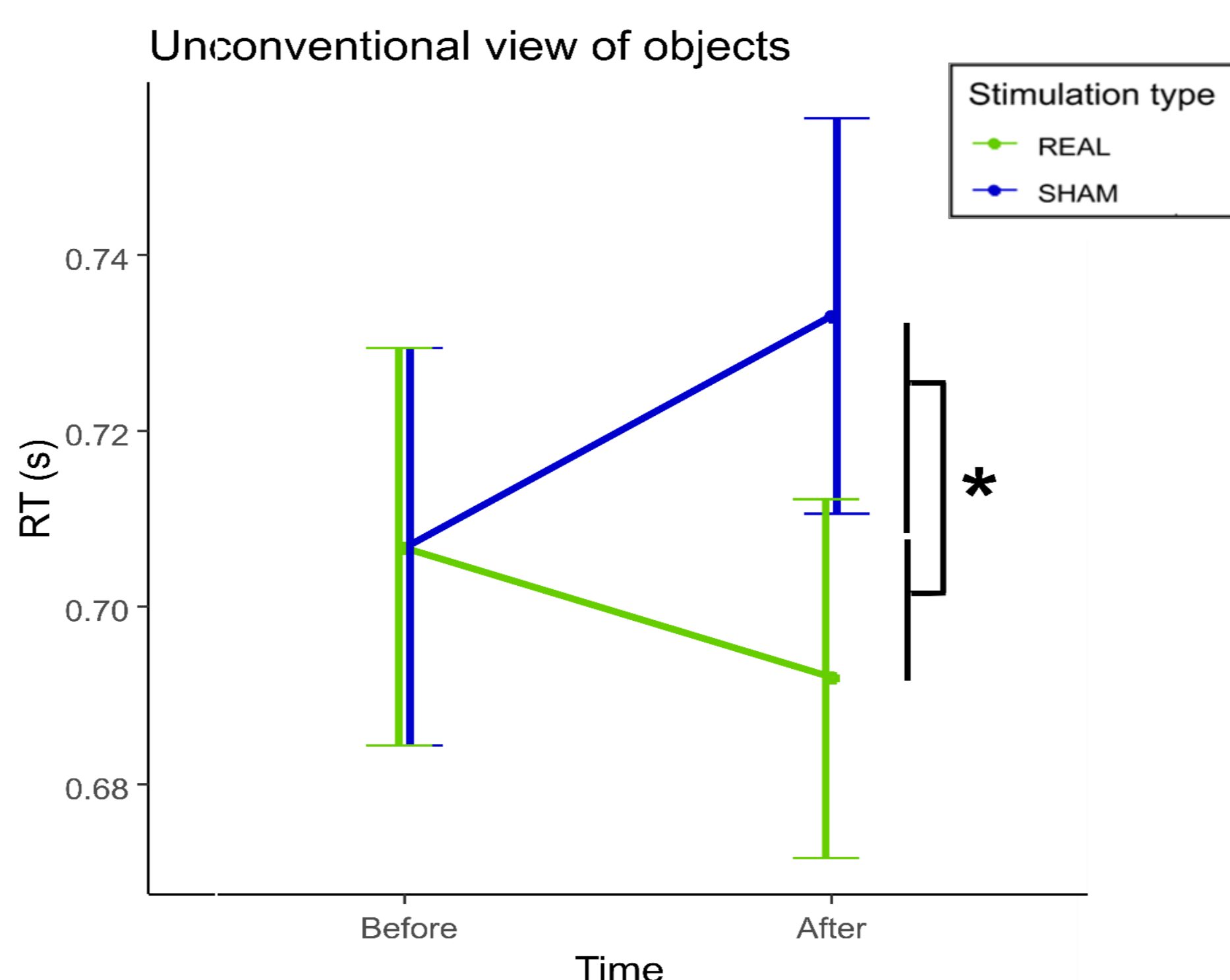
Fig 4 tDCS montage with rMFG – anode, rPPC - cathode and an example of current flow model in one participant

- Behavioral data analysis:** Online WMT learning curves (β RT) and offline WMT changes (Δ RT) compared between active and sham conditions.
- fMRI data analysis:** Functional connectivity changes (Δ FC) between the ROI seeds (rMFG-anode) and the default mode network (DMN), **Fig 5**



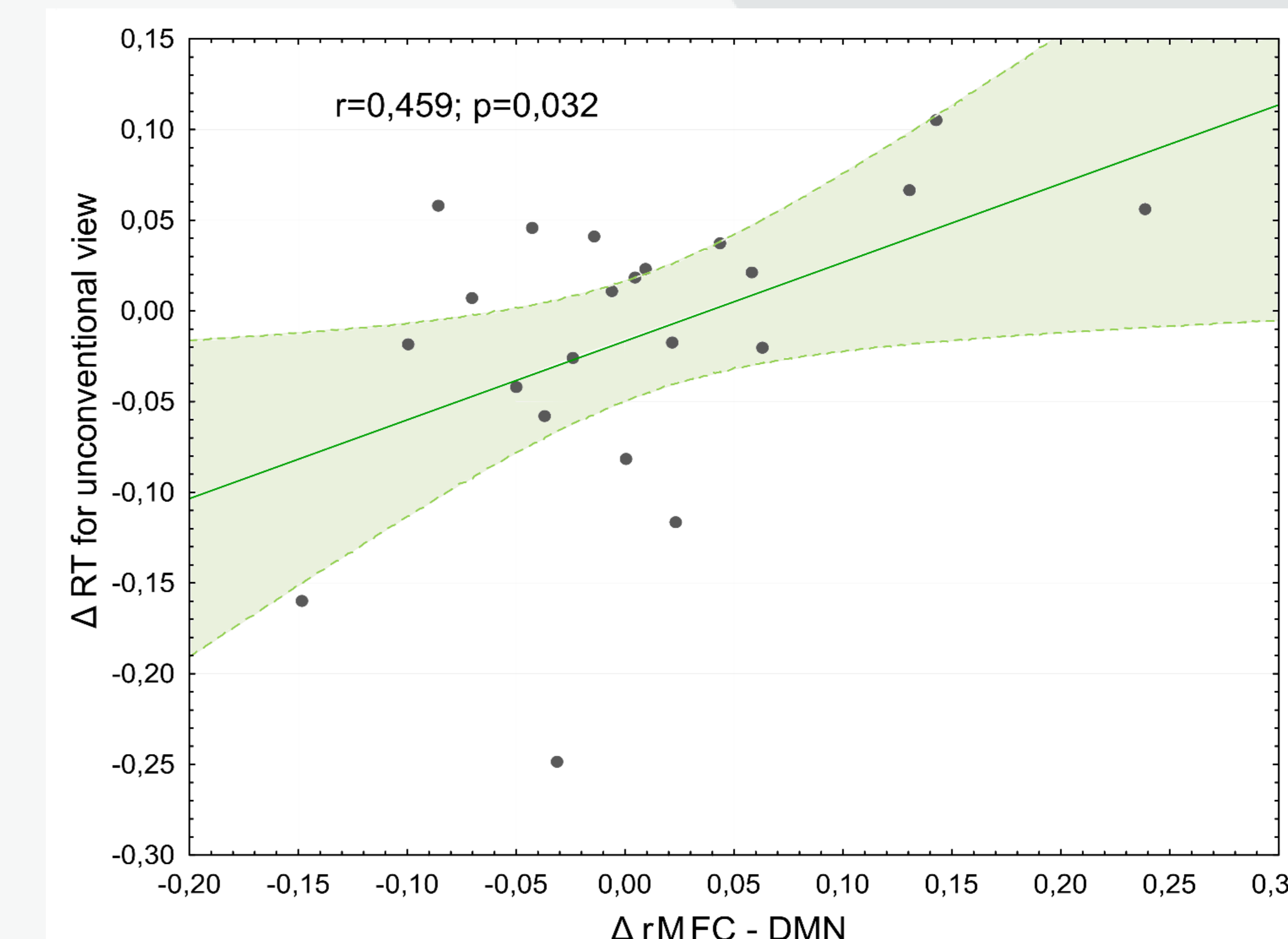
Results – behavioral data

- OFFLINE WMT:** A sig. difference in Δ RT for unconventional view of objects condition ($p=0.049$) \rightarrow shortening of RT after real vs. sham stimulation, Fig 6a.
- ONLINE WMT:** No sig. difference in β RT ($p=0.326$).
- Positive correlation of online and offline WMT for real tDCS, $r=0.501$, $p=0.018$ (Fig 6b).



Results – fMRI data:

- No sig. changes of rMFG-DMN connectivity induced by tDCS
- Positive correlation between the rMFG-DMN FC with tDCS-induced changes in offline WMT ($r=0.391$; $p=0.009$, Fig 7): decreased RT correlates with decreased functional connectivity between rMFG-DMN



Conclusion:

Targeting the right fronto-parietal network by tDCS leads to improved WMT with higher cognitive load in young healthy subjects.

Changes in cognitive outcomes are associated with changes in resting state functional connectivity between the task-positive (fronto-parietal) and the task-negative (DMN) networks.

Offline effects are related to online behavioral changes, although the latter result was not significant.