

SIGNIFICANCE

- Precise placement of coils used in transcranial magnetic stimulation paradigms promise better avenues to understand basic and higher cognitive brain functions
- Real-time tracking of TMS coil relative to brain target – **Neuronavigation (NN)**: **But, where to place the TMS coil on the scalp in relation to brain target?**
 - Individual head tissue modeling of TMS-induced electric field (E-field) in ROI & sampling of coil setups (location/orientation) on scalp surface to find the one that maximizes directional ROI E-field on average [2]

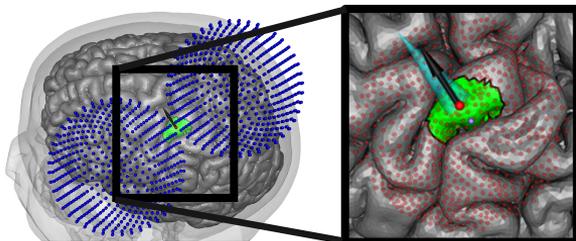


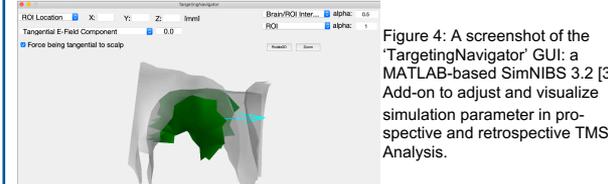
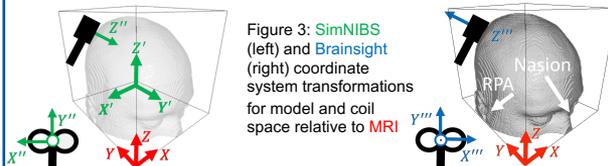
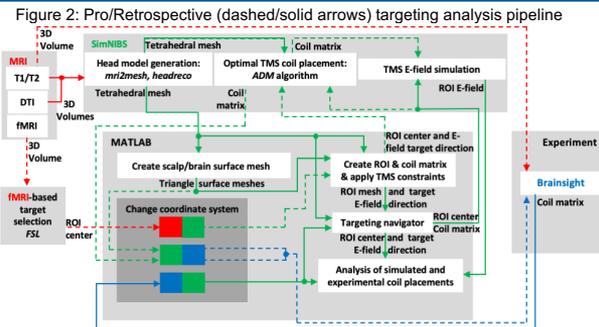
Figure 1 (from [2]): Coil placement optimization for ROI (green) and inward sulcal-wall normal = desired dir. E-field (eq. black arrow); Optimum: solid red dot and black arrow among coil candidate setups (transparent dots); Cyan cone: provides averaged dir. ROI E-field vector; ROI center projected to scalp (traditional coil placement approach) depicted as smaller purple dot located more over the sulcus.

- NEW:** MATLAB-based software pipeline for prospective and retrospective TMS ROI targeting analysis ('TAP') based on E-field simulations coupled with individual imaging and neuronavigation data
- Prospective targeting for future TMS session:
 - Optimal coil placement for possible hair thicknesses (measured in session)
 - Restrict TMS coil orientation: effective (E-Field pointing into sulcal wall) and exp. applicable (coil trackers/cables are visible/invisible for NN/subject)
- Retrospective analysis of NN data recorded during TMS session:
 - Assessment of TMS coil placement accuracy and variability as well as estimation of induced ROI E-field related to experimental and/or computationally optimal coil setup

ACKNOWLEDGMENTS & DISCLOSURES

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SPECIFIC AIMS AND APPROACH



https://github.com/moritzdannhauer/fMRI-based_TMS_Targeting_Pipeline.git

REFERENCES

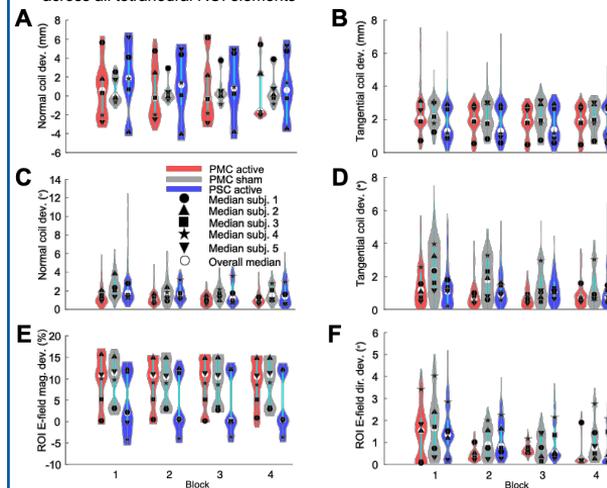
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- Gomez, L.J., Dannhauer, M., Peterchev, A.V. (2021). Fast computational optimization of TMS coil placement for individualized electric field targeting. *NeuroImage*, 228 (2021), 117696
- SimNIBS v3.2.4, <https://simnibs.github.io/simnibs/build/html/>

RESULTS & DISCUSSION

Proof-of-concept: 5 Dystonia and healthy participants for 3 sessions:

- Primary motor and sensory cortex (PMC, PSC) and sham (over PMC)
- fMRI activity of active writing task resulting in 4mm ROI (see Figure 4)
- ADM: Coil search grid 25/1 mm (radius/grid distance) on scalp, 1° coil orientation step size, maximize directional E-field scalp tangential and oriented relative to sulcal wall pointing inwards

Figure 5: Retrospective analysis results - Normal (A/C) and tangential (B/D) TMS Coil deviation in (in mm or °); Deviation of induced E-field (E/F in %/°) across all tetrahedral ROI elements



- Optimal vs. experiment: across median distance/angular/E-field deviation of 2.3 mm / 2° / 10% show excellent precision of experimenter using NN
- In comparison: Robotic TMS coil tracking accuracy: 1.34 mm / 3.48°

CONCLUSIONS / NEXT STEPS

- Conclusion:** We implemented and tested TAP with 5 subjects in 3 TMS sessions each
- Next Steps:**
 - User feedback and more testing
 - Include more support for other NN software (Localite and others)