

Targeting stimulus-brain synchrony via tACS modulates auditory perception

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Introduction | Background

- Synchronization between auditory stimuli and brain rhythms has been shown to facilitate perception and comprehension [1-3].
- Transcranial alternating current stimulation (tACS) could improve auditory perception by improving neural entrainment to rhythmic stimuli like speech.
- However, tACS effects in this context can be small and highly variable across participants, in part due to inter-subject variability in brain state and brain anatomy.
- The present project tests the suitability of individually optimized tACS protocols to improve auditory perception.
- **Aims:**
 - To optimize tACS protocols to individually target brain regions showing auditory entrainment, by using individual functional localizer, finite element method models (FEM) and electric field stimulations.
 - To modulate auditory perception by manipulating the phase lag between the auditory signal and the brain.

Methods | Materials

21 healthy participants were included in the study.

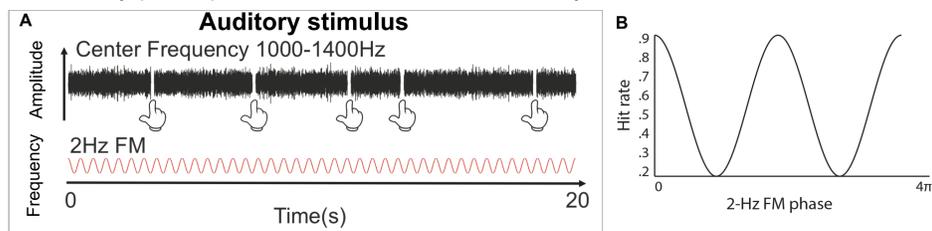


Figure 1. (A) Frequency-modulated (FM) noise with silent gaps presented at different phase bins of the FM. Participants reported gap occurrence via button press. (B) During this task, gap detection performance is not normally distributed but sinusoidally modulated by the FM stimulus phase into which the gap falls.

(f)MRI design (sessions 1)

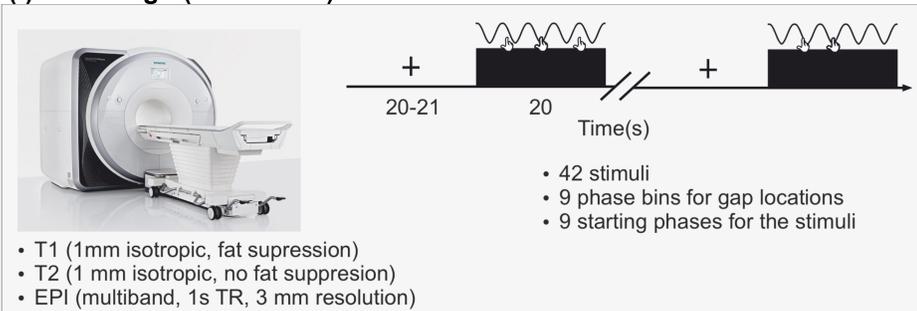


Figure 2. (f)MRI acquisition parameters and task conditions (session 1).

tACS design (sessions 2 and 3)

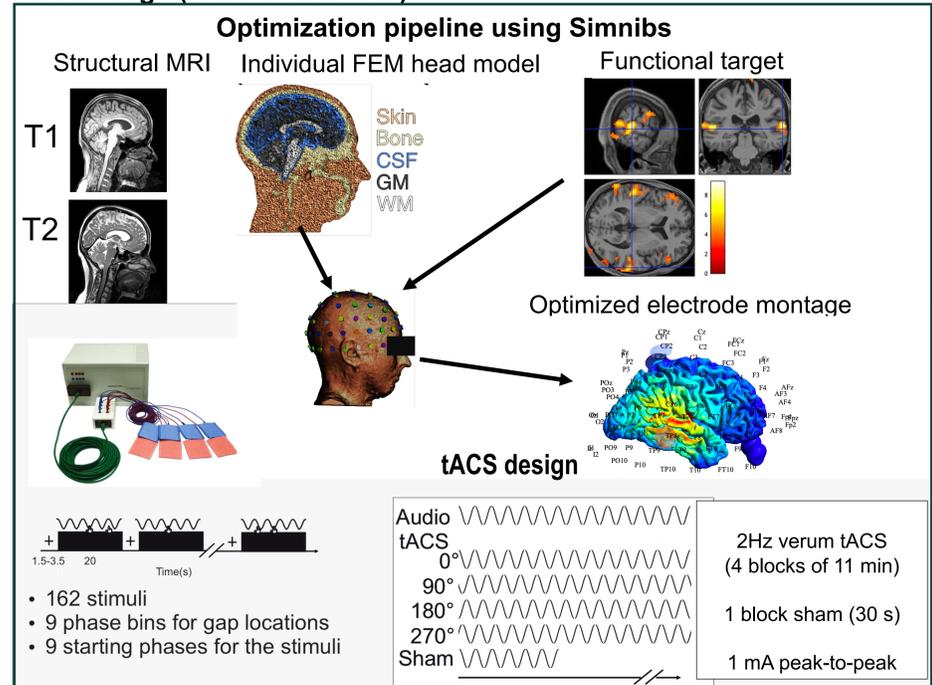
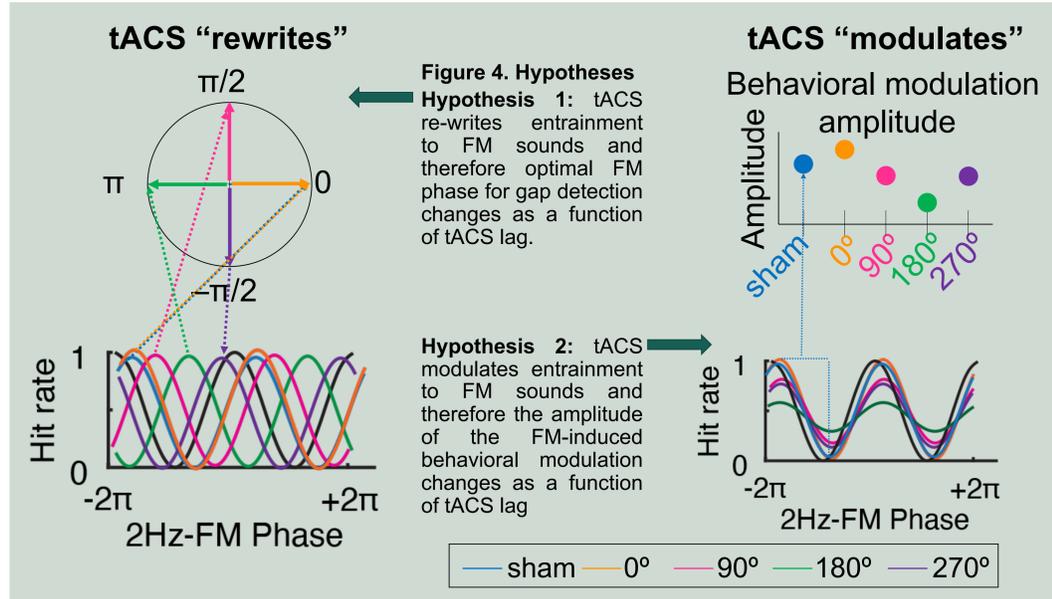


Figure 3. tACS design (sessions 2 and 3). Electrode montage was individually optimized to induce the strongest electric field in individually defined functional ROIs in bilateral auditory cortices. tACS was applied at different phase lags with respect to the auditory stimulus

Hypotheses



Results

Optimization results

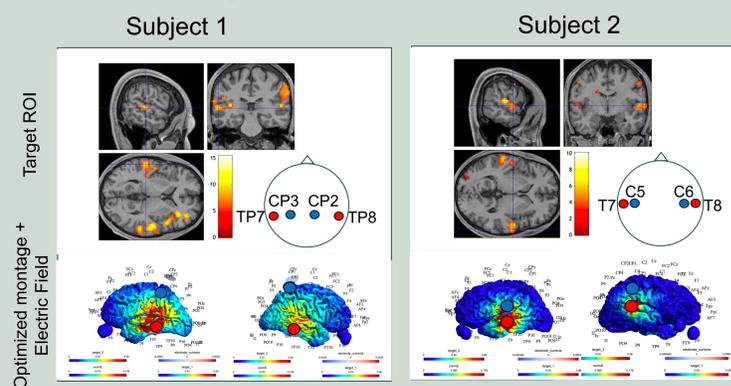


Figure 5. Optimization results for two participants. On top, target ROIs were functionally defined for each individual based on functional MRI (contrast FM stimulus vs. rest). On the bottom, optimized electrode montages and electric field simulations. Different montages are then used for each participant in the tACS session.

tACS modulates behavioral signatures of entrainment

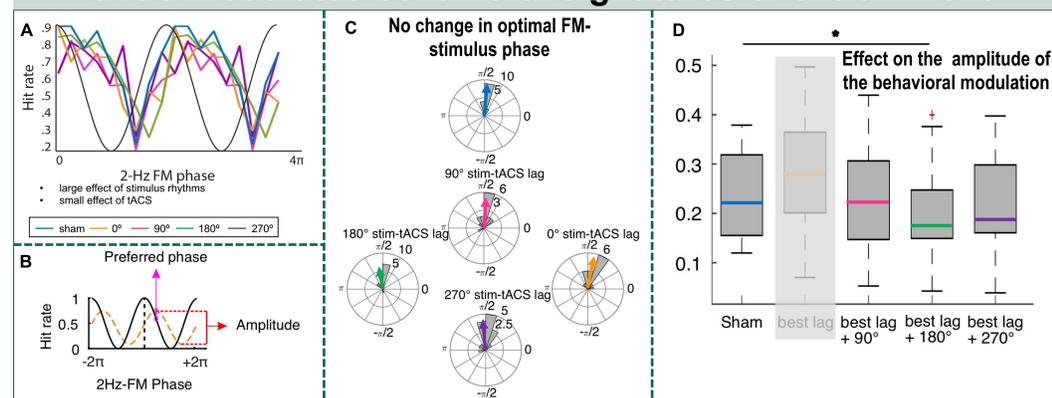


Figure 6. Effect of tACS lag. (A) Trials were binned according to the phase lag between tACS and the FM stimulus. For each tACS lag condition, the hit rate as a function of FM stimulus phase was calculated. (B) Cosine functions were fitted to the data. The best FM stimulus phase for gap detection and the amplitude of the FM stimulus-driven behavioral modulation were extracted for each subject and tACS lag. (C) Effect of tACS lag on the best FM stimulus phase. (D) Effect of tACS lag on the amplitude of the FM-stimulus driven behavioral modulation. Individual amplitude parameters were aligned to the best-tACS lag (i.e., lag with the highest amplitude parameter) and then averaged across participants. This best lag was excluded from the analysis and statistical comparisons were done between sham and the remaining tACS-lag conditions.

Discussion | Conclusion

- tACS did not change the FM-stimulus optimal phase for gap detection → no overwriting effect.
- Compared to sham, tACS at the phase-lag opposite to best-lag decreased the amplitude of the FM-stimulus driven behavioral modulation → modulatory effect.
- **NEXT:**
- Are tACS effects with optimized tACS electrode montages significantly different than those with standard montages? → data collection to answer this question is ongoing
- Can the modulation depth of the FM-stimulus modulate tACS effects?