Introduction

- Transcranial ultrasound (TUS) modulates brain function [1, 2, 3] and behavior [4, 5].
- In double blind, placebo controlled trials, we showed that TUS to the right inferior frontal gyrus (rIFG) improved mood [6, 7].
- rIFG: Involved in cognitive control and emotion processing [8]; implicated among a dysfunctional network in mood disorders [9].
- Resting-state fMRI network connectivity changes were investigated here to elucidate how TUS to rIFG enhances mood.
- Prediction: TUS to the rIFG would alter connectivity in cognitive control, default mode, and affective networks.

Methods

Procedure

- Mood scales (VAMS) and resting state fMRI were administered.
- Mood scales and resting state fMRI was recorded at baseline (N = 9).
- Focused TUS was delivered to the seed regions; decreased connectivity predicted (increased in mood disorders).
- All participants received active TUS.

TUS Device and Waveform

- Used focused ultrasound (2 MHz, Thync, Inc.)
- 30mm focal length, 4mm focal area (FEM model, pictured right)
- 500 kHz, 40 Hz PRF, lpsq = 272 mW/cm²

fMRI Analysis

- Siemens SKYRA 3T MRI
- CONN Toolbox, SPM12, MATLAB
- Seed-to-voxel analysis
- Threshold: voxel-wise p < .005 (uncorrected), cluster-level p < .05 (FDR-corrected)

Seeds Regions

- Cognitive Control (IFG, DLPFC, ACC); increased connectivity predicted (decreased in mood disorders)
- Default Mode (PCC, MPFC); Decreased connectivity predicted (increased in mood disorders)
- Affective/Reward (Subgenual, nACC, PaHc, Amygdala, Insula); decreased connectivity predicted (increased in mood disorders)

Results Behavioral

- Behavioral replication: Participants reported enhanced affect (an increase on the scale).
- Note: There was no placebo control in the fMRI pilot; data for 5 kHz and Placebo are from a behavioral study and are superimposed for display purposes.

Results fMRI Connectivity

- Enhanced connectivity between cognitive control regions; decreased connectivity between frontal and affective/reward areas.

Results fMRI Control

- Pre and post resting-state fMRI from a previous non-TUS experiment. "Post" = 25 minutes after baseline, following an emotion dot probe task; participants stayed in scanner.
- Very few changes in connectivity, and the minor connectivity changes do not replicate the main experiment.

Discussion

- Altered resting state connectivity:
  - Cognitive Control Network (generally increased)
  - Affective/Reward Network (generally decreased)
  - Default Mode Network (decreased)
- TUS to rIFG may create positive mood effects by enhancing emotion regulation and decreasing perseverative thinking.
- TUS could be used to modulate mood in healthy and clinical populations (see poster: P2-162).

References


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