A Double-Blind Pilot Study of Transcranial Ultrasound (TUS) as a Five-Day Depression Intervention: TUS Reduces Worry

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Background

- Transcranial ultrasound (TUS) is a novel, noninvasive brain stimulation technique with increased spatial resolution compared to existing methods.
- TUS can excite neurons in animals.[1]
- First use of TUS in humans found that 8 MHz for 15s opposite pain at fronto-temporal sites increased positive mood.[2]
- Work in our laboratory found that 0.5 MHz for 30s at right fronto-temporal sites increased mood, and left fronto-temporal decreased mood.[3]

Question

- Can TUS show preliminary evidence of positive mood change in people with depressive symptoms?

Methods

Participants. Participants were 26 University of Arizona students with Beck Depression Inventory (BDI) scores of 10-25, indicating mild to moderate depression levels.

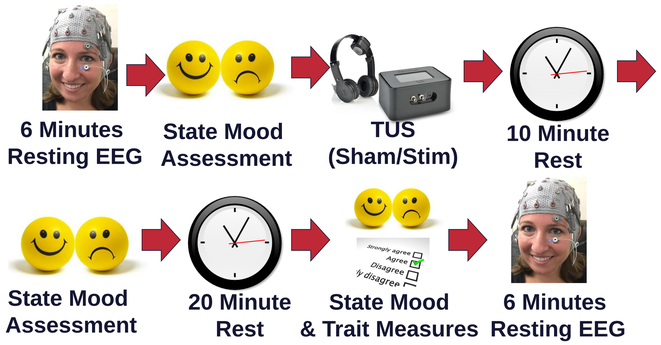
Parameters. 30 secs, 500 kHz; PRF 40 Hz of TUS with lower power than previous studies (11% versus 21%) due to repeated stimulation.

Recruitment. Introductory psychology students were invited to take online screener with BDI and exclusionary criteria.

Methods

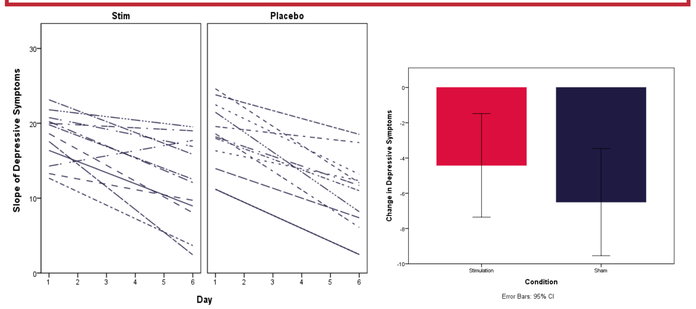
Procedure.

- Eligible and interested participants were randomly assigned to TUS stimulation or TUS sham at right fronto-temporal area.
- Participants were invited to attend five sessions of the intervention and then given the option to extend for another five sessions.
- 6 minutes of resting 64-channel EEG was recorded Day 1 & Day 5 pre and post ultrasound administration.
- State mood was assessed before, 10, and 20 minutes after stimulation.



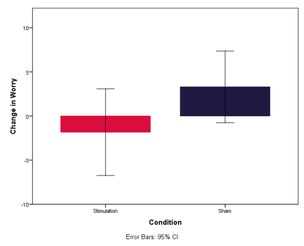
Results

Symptom Outcomes



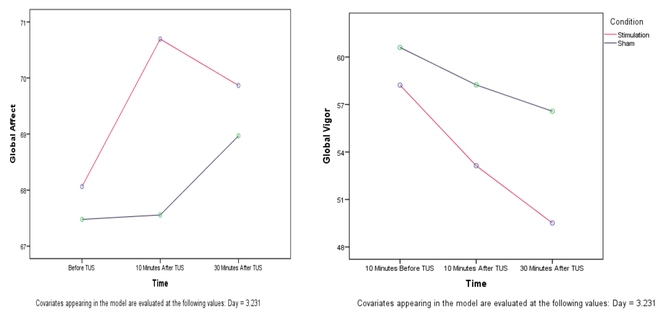
- Contrary to expected results, depression scores did not change as a function of condition, r=-.237, p=.288.

Results



- However, there was a medium effect size of condition on worry change from Day 5 to 1, such that those in the stimulation condition had decreased worry over the course of the intervention compared to those in the placebo, t=-1.742, p=.097.

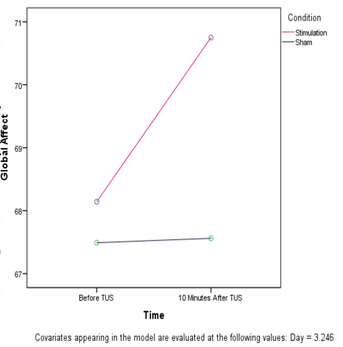
Mood Effects



- Because this study used lower power TUS stimulation due to repeated sessions, TUS stimulation was compared to TUS sham to determine if previous mood effects replicated with this lower dose across 5 days. Although descriptively effects were in the right direction, they were not significant (left panel). Global vigor significantly decreased in TUS stimulation compared to TUS sham, F=3.481, p=0.06.

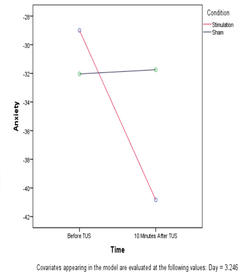
Follow-Up Analysis

- In order to compare directly to prior research, mood was evaluated Day 1 only. Replicating past effects, TUS stimulation compared to TUS sham improved mood 10 minutes after stimulation Day 1, r=.757, p<.01.



Results

- To explore decrease in global vigor, we combined the tense and calm items from the VAMS r and found that TUS significantly reduced anxiety, r=.203, p=.025.



Discussion

- The lower power of ultrasound used in the present study compared to our previous studies may contribute to shorter-lived mood effects
- TUS may impact anxiety rather than depression related symptoms at the right fronto-temporal area, such as repetitive thought that is future rather than past-focused.
- Future research may explore TUS at left fronto-temporal area.

References

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2. Hameroff, S., Trakas, M., Duffield, C., Annabi, E., Gerace, M. B., Boyle, P., … Badal, J. J. (2013). Transcranial ultrasound (TUS) effects on mental states: A pilot study. *Brain Stimulation*, *6*(3), 409–415. doi:10.1016/j.brs.2012.05.002
3. Sanguinetti, J. L., Smith, E., Goldstein, M., Dieckman, L., Sato, T., Opitz, A., … Allen, J. J. B. (2014). Transcranial Ultrasound (TUS) Brain Stimulation Affects Mood and EEG in Healthy Volunteers with a Prototype Ultrasound Device, *1*(1), 4208470.

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