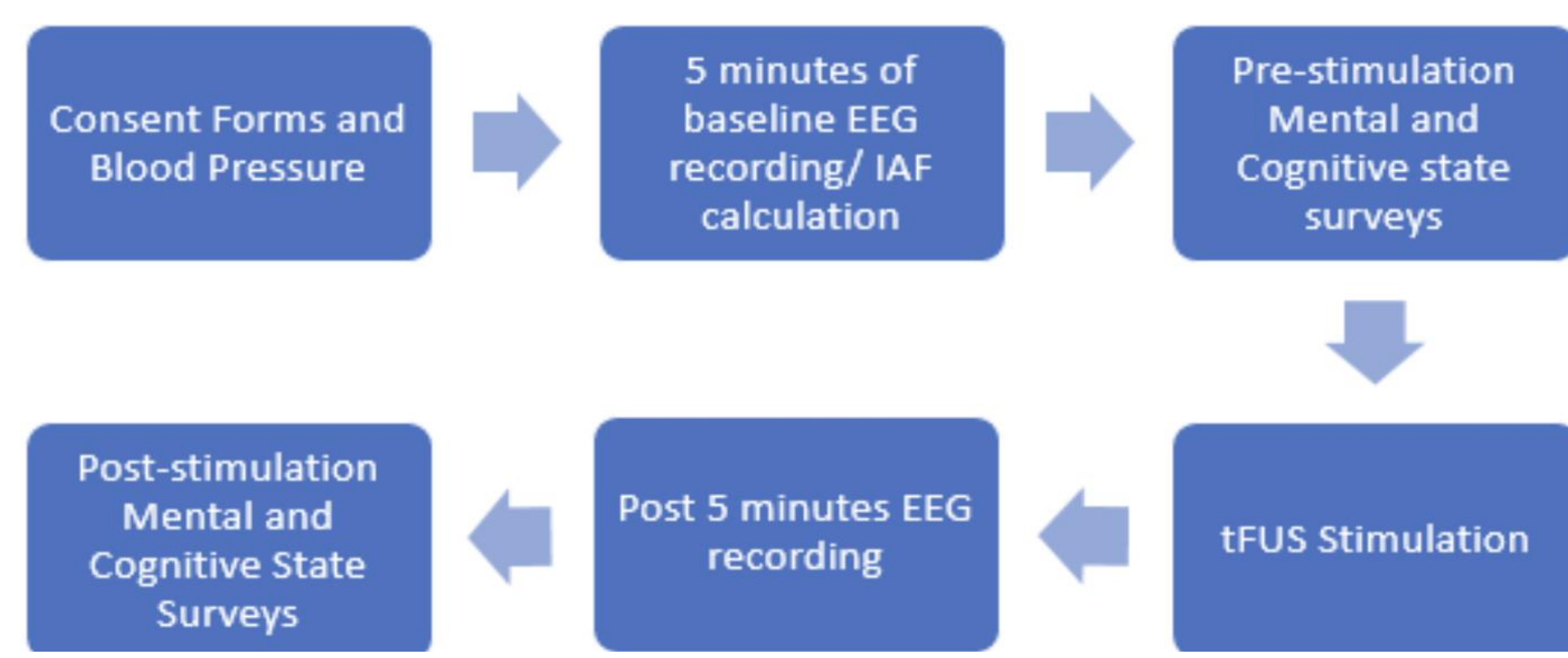


## Introduction

- Higher individual alpha frequencies (IAF) are associated with improved memory and cognitive performance (Klimesch, 1998) as well as improved mindfulness (Saggar, 2012).
- Rusniniak and colleagues (2018) found that the Posterior Cingulate Cortex (PCC) node of the Default Mode Network (DMN) was a source of alpha oscillations.
- Transcranial Focused Ultrasound (tFUS) is a noninvasive neuromodulation technique that may affect neural oscillations (Sanguinetti, 2022).
- By stimulating the PCC with tFUS we aimed to modulate the alpha burst activity associated with DMN processes.
- We hypothesized tFUS targeted to the PCC will modulate the oscillatory activity there, changing the power and/or frequency of alpha activity. Tuning the tFUS's pulse repetition frequency to each person's IAF will induce greater increase in alpha power or frequency than when the ultrasound is set to a standard 10 Hz frequency.

## Materials and Methods



- Participants (n=30)
- Three stimulation conditions (10 participants per condition)
  - Sham
  - Tuned Individual Alpha Frequency (IAF)
  - 10 Hz
- EEG recorded from 25 scalp locations while the participant's eyes were closed
- Mental and Cognitive Surveys:
  - Toronto Mindfulness Scale (Lau et al., 2006)
  - Penn State Worry Questionnaire (Meyer et al., 1990)
  - Visual Analog Mood Scale (Luria, 1975)
  - Metacognitive Processes of Decentering Scale (Hanley et al., 2020)
- Visor2 Neuronavigation software was used to target the participant's PCC based on an averaged structural MRI scan
- tFUS Parameters:

Acoustic Frequency (AF)	Pulse Repetition Frequency (PRF)	Pulse Duration (PD)	Duty Cycle	Stimulation pattern
500 kHz	10.0 Hz or tuned to IAF	5ms or 2500 cycles	5.0%	5 sec ON, 10 sec OFF, for 5 minutes

- IAF was calculated using Corcoran's method following Welch's method for estimating power spectral density

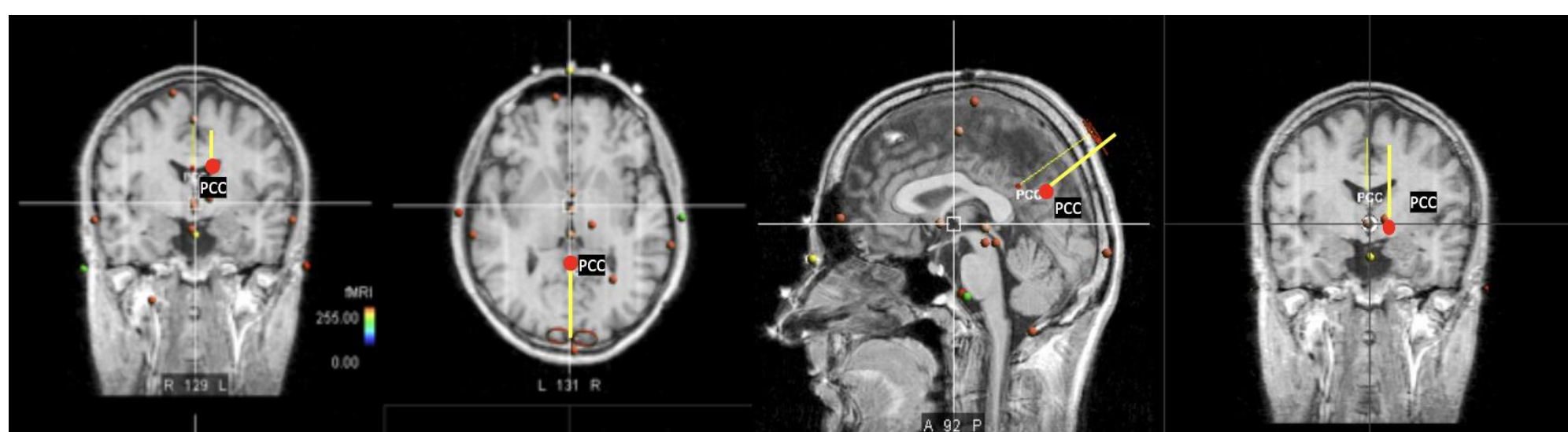


Figure 1. Posterior Cingulate Cortex stimulation target viewed through Neuronavigation software

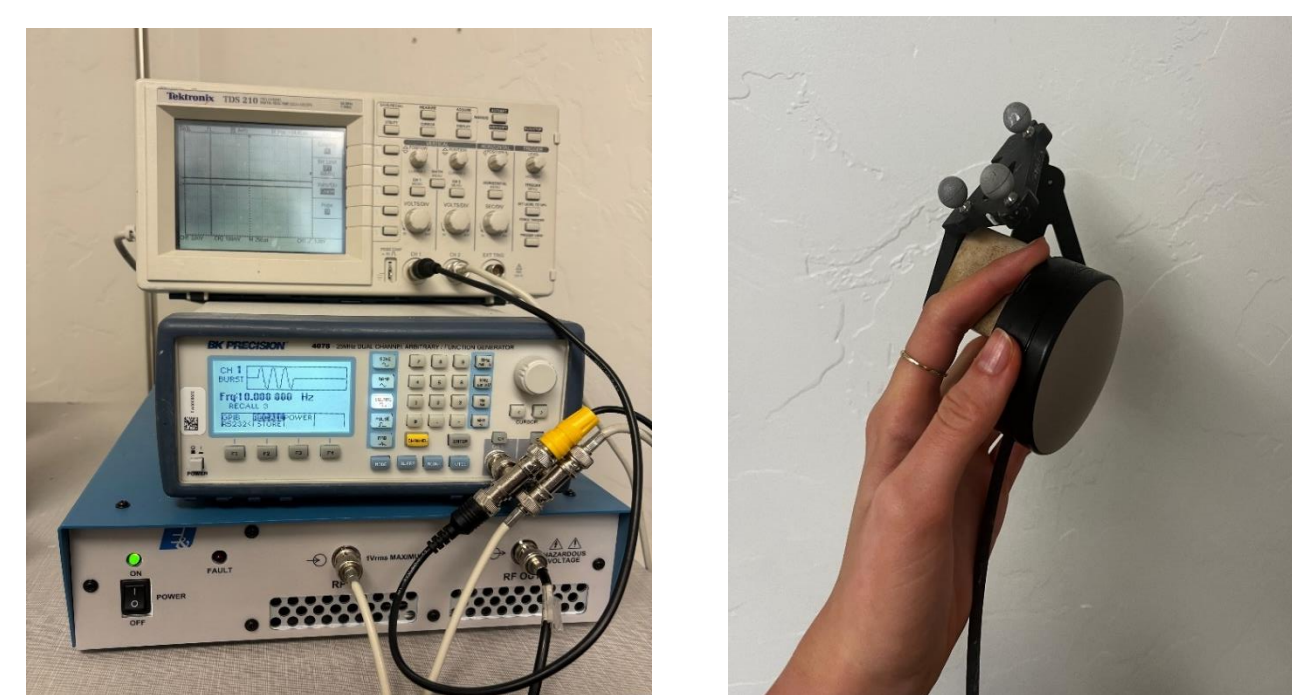


Figure 2. Amplifier, transformer, and function generator (left) and ultrasound transducer (right)

## Results

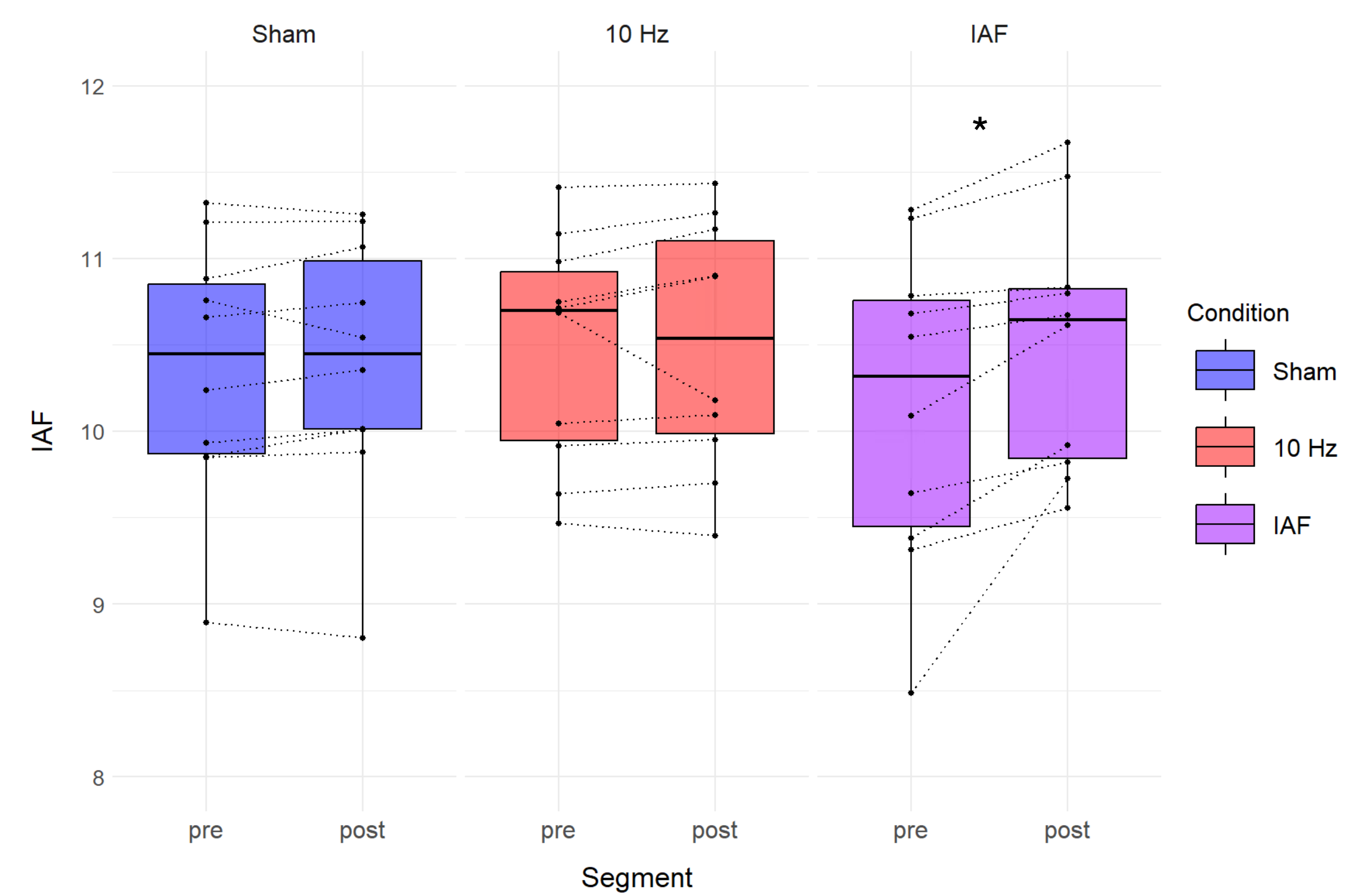


Figure 3. Pre and Post stimulation Measured Individual Alpha Frequencies Individual Alpha Frequency tuned stimulation showed a statistically significant ( $p = .00314$ ) increase in alpha frequency (estimate = 0.33723 Hz) between pre to post stimulation

Condition	F	df	P
Condition	0.76901	0.38451	.0053064

Table 1. One way ANOVA results of the change in IAF after tFUS stimulation. Significant differences ( $p=0.005$ ) between the three conditions

Condition	Estimate	Standard Error	P Value	Lower	Upper
Sham	0.02818	0.073529	0.70454	-0.12269	0.17905
IAF	0.33723	0.10399	.00314	0.12387	0.55059
10Hz	0.10399	0.10399	.96383	-0.21812	0.2086

Table 2. Linear Mixed Model Regression Fixed Effects Coefficients (95% CI) for IAF changes. IAF Condition shows significant increase ( $p=0.003$ ) in IAF change, while other conditions show no changes.

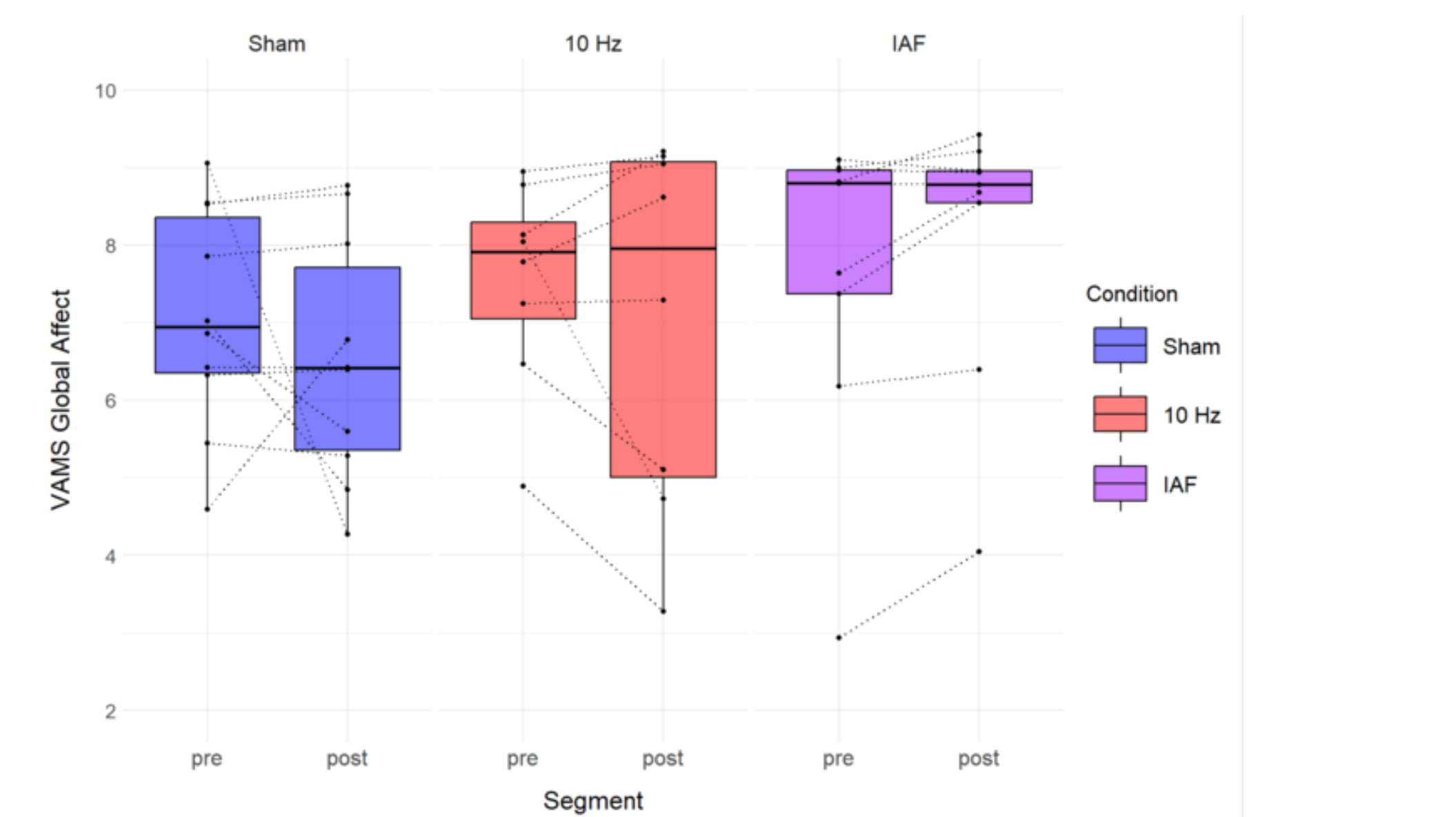


Figure 4. Pre and Post Stimulation Visual Analog Mood Scale Global Affect Score

Condition	Estimate	Standard Error	P Value	Lower	Upper
Sham	-0.56058	0.42547	0.2001	-1.4387	0.31756
IAF	1.0273	0.6182	0.10957	-0.24861	2.3032
10Hz	0.075606	0.075606	0.90668	-1.2416	1.3928

Table 1. Linear Mixed Model Regression Fixed Effects Coefficients (95% CI) for IAF change. Possible trend of increase in IAF Condition, but not significant ( $p=0.11$ ).

## Conclusion

- Individual Alpha Frequency tuned stimulation showed a statistically significant ( $p = .00314$ ) increase in alpha frequency (estimate = 0.33723 Hz) between pre to post stimulation
- Sham ( $p = 0.70454$ ) and 10 Hz ( $p = 0.96383$ ) stimulation yielded no statistically significant change in alpha frequency between pre and post stimulation
- Although a physiological neuromodulatory effect was observed this was not reflected in the qualitative behavioral analysis. A nonsignificant upward trend in the Global Affect subscale of the Visual Analog Mood Scale was observed.
- The mechanism of this modulation is not yet entirely understood. There are multiple proposed theories in place to explain this effect, including an induced change in membrane conformational state and opening of mechanosensitive ion channels.
- Future Direction:
  - In previous studies tFUS has been explored as a therapeutic technique for neurological conditions (Zhang et al., 2021), and higher alpha frequency was linked to improved cognitive function (Grandy et al., 2013).
  - With the ability to modulate individual alpha frequency, we can explore tFUS as a therapeutic technique for neurological conditions linked to alpha frequency

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Poster available for reprint

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