# Resting state cortical frequencies in human EEG are differentially associated with negative cognition in adults with and without a history of major depressive disorder

*A. ALARIO[1], J. LABRADA[1], R. STEWART[1], N. R. GRIFFIN[1], J. J. ALLEN[2], C. BEEVERS[1], D. M. SCHNYER[1];
[1]The University of Texas at Austin, Austin, TX; [2]University of Arizona, Tucson, AZ

**TEXAS**
The University of Texas at Austin

## Background

- Major depressive disorder (MDD) is characterized by persistent negative thoughts that have been associated with a negative attention bias.
- Alpha frequency oscillations of the human EEG and resting prefrontal EEG alpha asymmetry (FAA; relatively greater left than right alpha power) have been examined as promising risk factors for MDD as a stable trait[1] and is related to mood disorders, specifically history of depression[2].
- Given the role of prefrontal cortex in attention control, little to no research has examined the potential linkage between prefrontal alpha features (frontal asymmetry or midfrontal alpha) linked to MDD and negative attention bias.

## Methods

**Participants:** 218 adults living in the Austin area were recruited with normal distributed depression scores (BDI). 216 of those participants with artifact free data were used in this analysis. Following online screening, participants engaged in 2 experimental sessions 1 week apart that included a battery of experimental and survey measures.

**EEG data collection**: 64 channels (Fig1) of resting state EEG were collected where participants alternated between eyes open and closed for a minute each for a total of 8 minutes of recording. Data was re-referenced off line to an average (AVG) and current source density (CSD) transform. Alpha was the average power over 8-13 Hz. Frontal alpha asymmetry (FAA) was calculated by subtracting log transformed right alpha power from left alpha power. Midfrontal alpha (MFA) scores were the means of log transformed frontal channels along Sheline's Dorsal Nexus (Sheline et al 2010).



Figure 1: Modified 10/20 head montage for collected 64 channels. Pink circles identify left/right pairs used for the FAA calculations. Blue circles were averaged together for MFA.
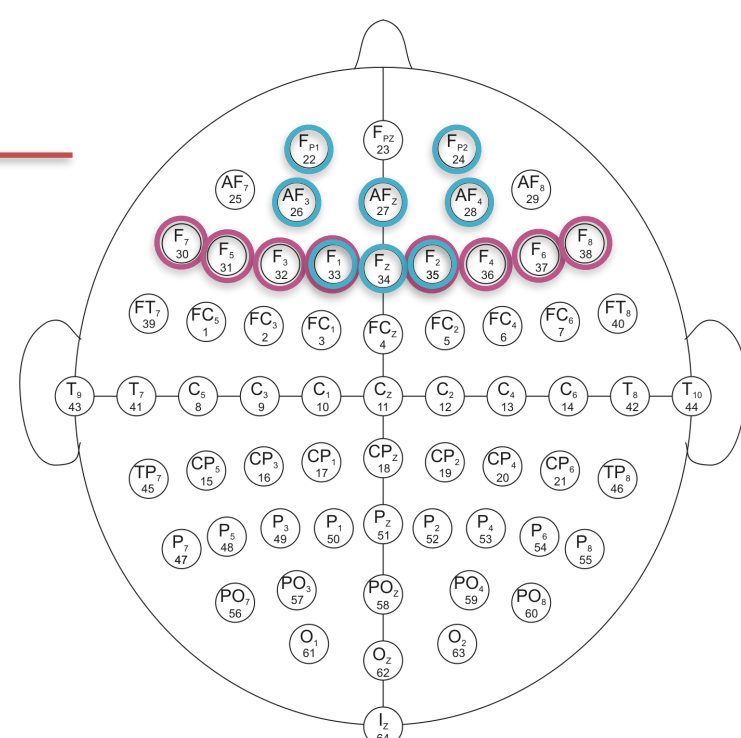
**Depression measures:** Collected with a clinical interview by trained research assistants. Measures include BDI scores, and MDD history (H+/H-) through MINI interview. 132 participants had a history of depression.

**Attention bias measures:** Calculated from eye tracking measures during performance of a emotional face dot probe task. For each trial, participants viewed 2 faces (sad/neutral or happy/neutral). After the faces disappeared, they had to identify an O or a Q in place of one of the faces (Fig2). The gaze towards sad faces (weighted by total amount of fixation time for each trial) and gaze bias variability are used in the current analysis as an index of negative attention bias.
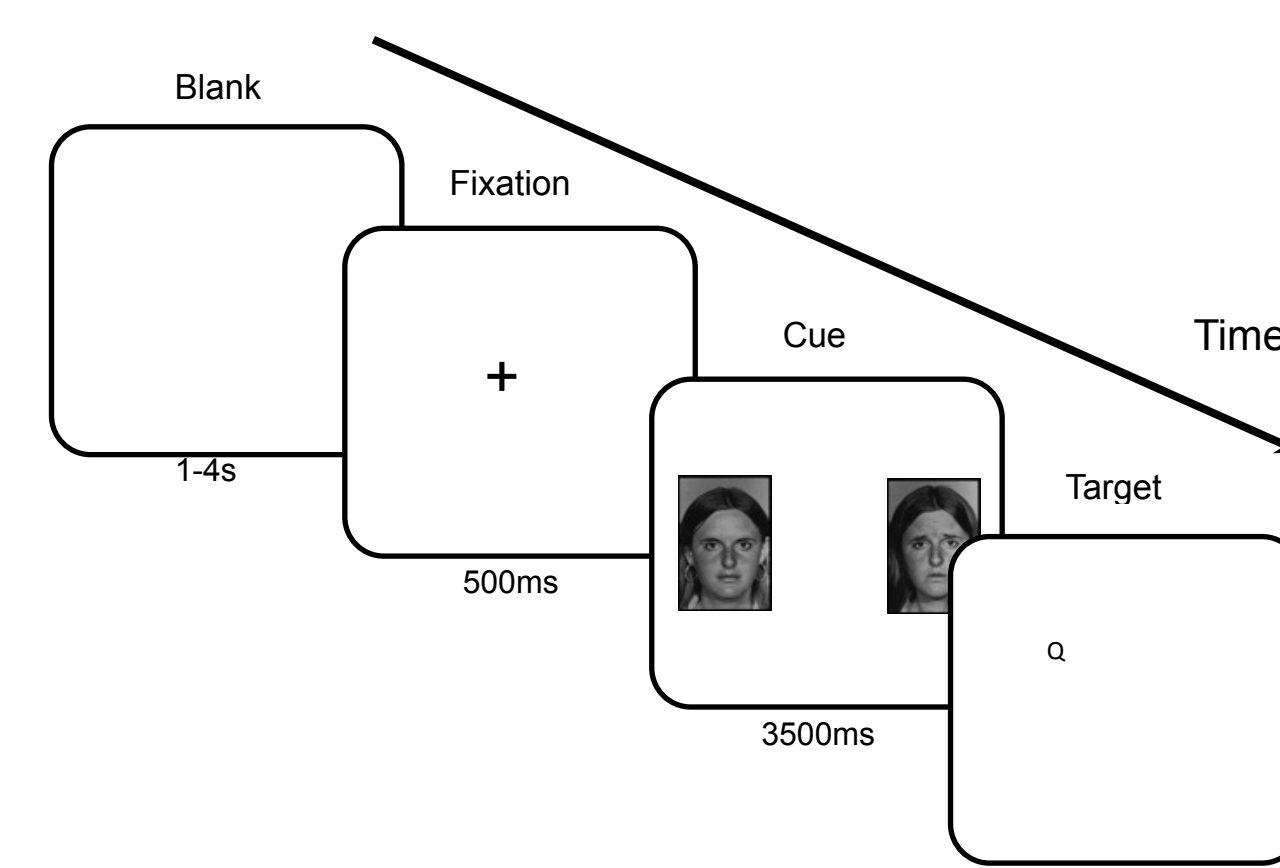


Figure 2: Schematic diagram of the dot probe task to collect attention bias measures. Participants were presented two faces (negative/neutral or positive/neutral) for 1000ms. After the faces disappeared, there was either an O or a Q in the same location as one of the faces. Participants used a response box to identify which letter was presented. Gaze time for sad minus neutrals faces measured negative attention bias. Variability in gaze bias was defined as the mean difference between sequential gaze bias scores. Lower values reflect a more stable gaze bias, whereas larger scores reflect more trial to trial variability in gaze bias.
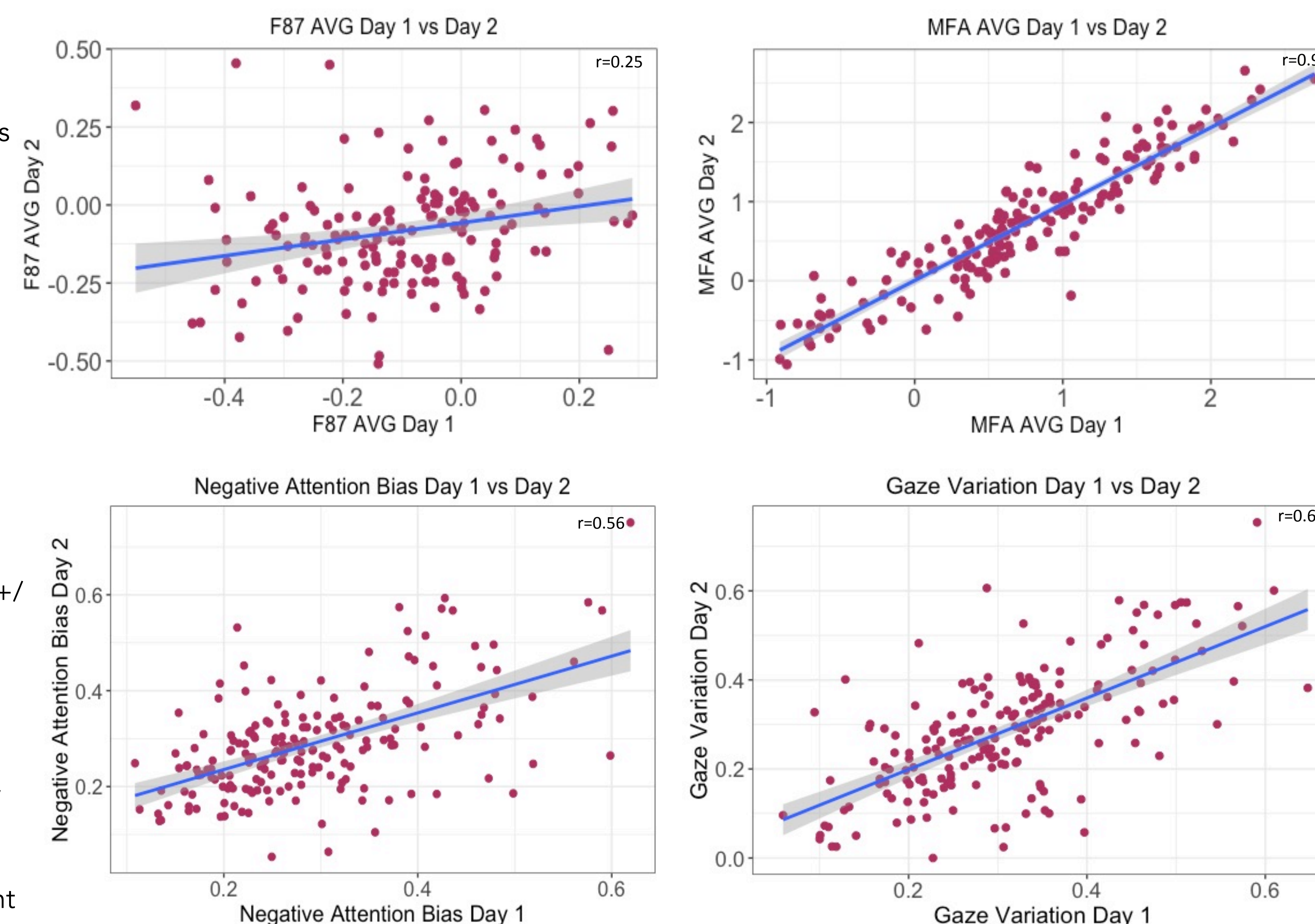
## Research Questions

The current work seeks to determine –
1) Are frontal asymmetry or midfrontal alpha reliable biomarkers of negative attention bias?
2) What is the reliability of frontal asymmetry or midfrontal alpha metrics from across 2 time points separated by 1 week?
3) How are these related to current and past history of depression?

## Reliability of Measures

MFA, FFA, gaze variation, and negative attention bias measures were significantly correlated from Day 1 to Day 2 (p-values <1.163e-11).
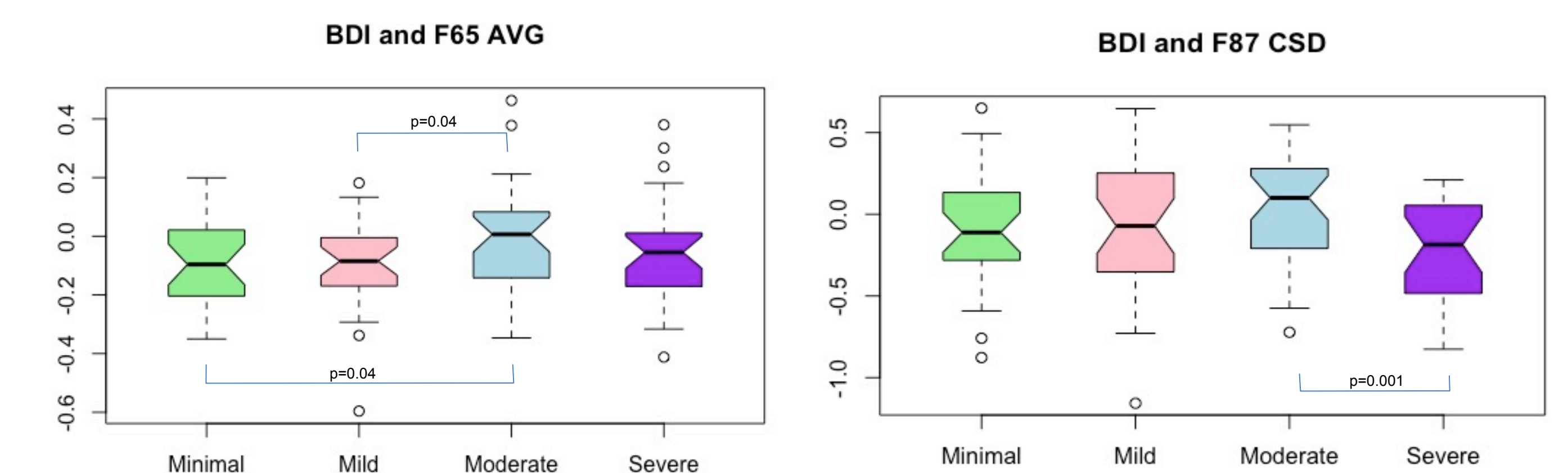


## Alpha and Depression

As seen in previous research, FAA at the pairs F65 AVG and F87 CSD both showed a significant (p<0.05) differences between groups divided on BDI scores such that the individuals with the most severe current symptoms showed great left frontal alpha relative to right. However, this was only seen in MDD H+.
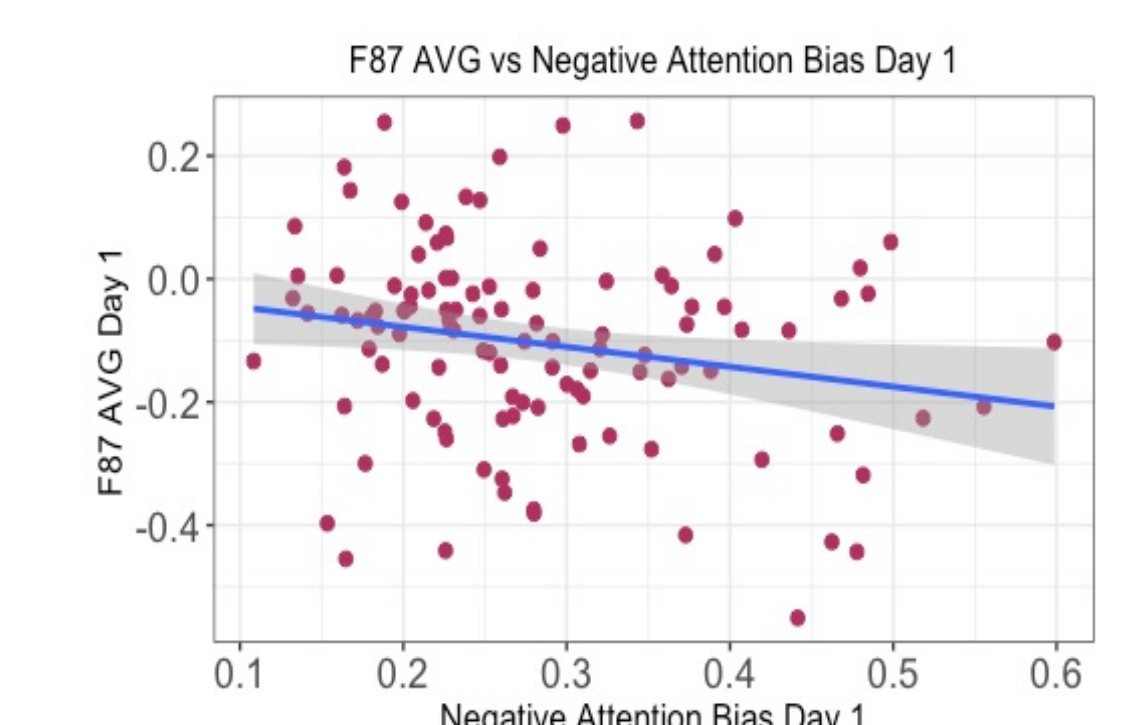


## Alpha and Attention Bias

MFA AVG scores showed a significant interaction between mean gaze and variation gaze bias but only in H+ participants. The negative relationship in H- was not significant.

Significant interaction between attention bias and H+ on MFA. In H+ participants, the MFA score increases as the attention bias metrics increase, and vice versa.
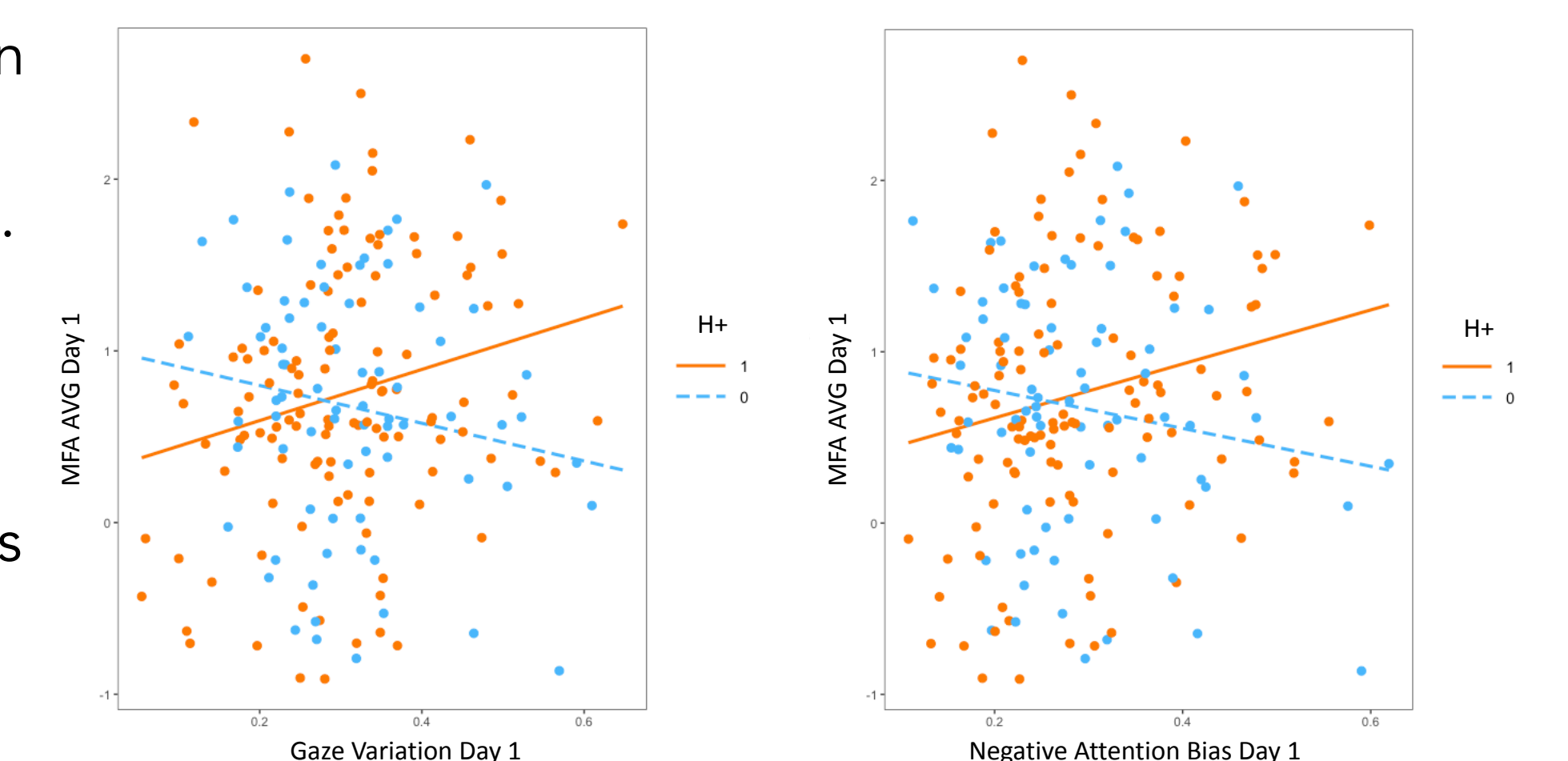


Although the interaction with H+ group was not significant, a negative relationship was seen only in the H+ group between bias and F87 FAA AVG.



## Summary

- Individual measures were correlated from Day 1 to Day 2, though the relationships between the measures were not correlated.
- MFA and F87 FAA from H+ participants had significant positive correlations with negative attention bias and gaze variation.
- F65 and F87 FAA in H+ participants showed a higher FAA for greater depression severity (BDI score).
- These findings imply that FAA and MFA are useful biomarkers of depression, though the variation of relationships calls for a more stable biomarker of depression.

## References

1. Allen, JJB, Urry, HL, Hitt, SK, Coan, JA (2004). The stability of resting frontal electroencephalographic asymmetry in depression. *Psychophysiology*, 41, 269-80.
2. Stewart, JL, Bismark, AW, Towers, DN, Coan, JA, Allen, JJ (2010). Resting frontal EEG asymmetry as an endophenotype for depression risk: sex-specific patterns of frontal brain asymmetry. *Journal of Abnormal Psychology*, 119, 502-12. PMCID: PMC2916182.

## Acknowledgements