RESTING FRONTAL EEG ASYMMETRY AND LEVELS OF IRRITABILITY

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INTRODUCTION & HYPOTHESIS

- Irritability is a symptom characterized by excessive angry or aggressive behavior when provoked by negative emotional stimuli (Leibenluft & Stoddard, 2013). The symptom has debilitating effects; for example, children with Disruptive Mood Dyregulation Disorder (DMMD), a condition characterized by severe persistent irritability, have poorer social, health, educational, and financial functioning in adulthood (Copeland et al., 2014).
- Research into brain mechanisms may help in understanding the pathophysiology of mental disorders. Studies suggest that frontal hemispheric lateralization, measured using EEG asymmetry, reflects individual differences in emotional state and emotion reactivity (Coan & Allen, 2004). As of today, there has been no research evaluating the asymmetry profile of irritability. However, since anger is associated with greater left prefrontal activation at rest, and high anger levels are seen in irritable populations (Carver and Harmon-Jones, 2009), we explored whether trait irritability and responses to a laboratory provocation are associated with greater left prefrontal activation.
- **Hypothesis:** We hypothesized that individuals with greater left prefrontal activation would have higher levels of trait irritability and higher levels of frustration in response to a laboratory provocation.

METHODS

- 42 undergraduates from a liberal arts college in the Boston area participated in the study. Participants were excluded from analysis if they were deceived (N=8) or had poor behavioral data (N=5), yielding a final sample size of 29 young adults.

① TRAIT MEASURES OF IRRITABILITY

Completion of questionnaires (Affective Reactivity Index, Brief Irritability Test).

② EEG ASYMMETRY MEASURES

Baseline EEG collected while participant sat quietly.

③ FRUSTRATION TASK

Non-frustration condition

Mood ratings

Frustration condition

Mood ratings

Figure 1: Affective Posner task. In the non-frustration condition, participants received accurate feedback. In the frustration condition, they were deceived into thinking they were going too slow even when they made accurate responses.

EEG ACQUISITION

- Baseline electroencephalography (EEG) was collected through 32 electrodes using the ActiChamp amplifier (Brain Products, Germany) and referenced online to Cz. Impedances were kept below 45 kΩ. Data was digitized at sampling rate of 250 Hz and filtered initially through a 100 Hz low pass and 0.01 high pass filter. Data were recorded over eight 1-minute trials, in either eyes-open (EO) or eyes-closed (EC) conditions.

EEG DATA REDUCTION

- After acquisition, EEG data were filtered offline through 30 Hz low pass filter. Ocular and muscular artifacts were removed manually and using an Independent Components Analysis. Data were segmented into epochs of 2.048s artifact-free data and re-referenced to an average reference. A Fast Fourier Transform (FFT) (75% Hamming window overlap) was applied to these data epochs. Alpha power (8-13Hz) was extracted for each site and log-transformed. Asymmetry scores were computed by subtracting Ln(R)-Ln(L) for homologous pairs. Higher scores were reflective of less brain activity (8-13 Hz) as alpha activity is inversely related to brain activity (Davidson et. al, 1990).
- Channels with excess artifacts throughout the 8 trials were excluded from further analysis.

RESULTS

TRAIT MEASURES OF IRRITABILITY

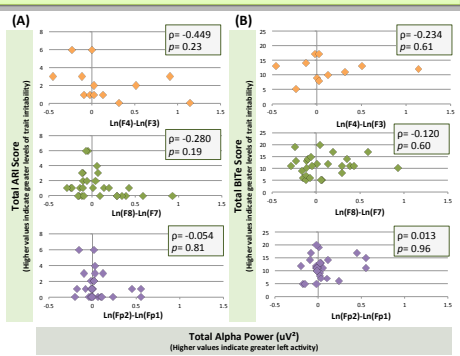
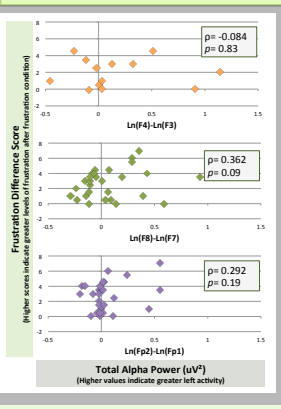


Figure 2: Alpha asymmetry scores (8-13 Hz at F4-F3, F8-F7, Fp2-Fp1) against self-reported irritability scores. Higher (A) Affective Reactivity Index and (B) Brief Irritability Test scores indicate greater levels of frustration. Greater alpha power asymmetry scores imply greater left activation.

- Alpha asymmetry scores at sites F4-F3, F8-F7, Fp2-Fp1 did not correlate with ARI and BITe scores.

STATE MEASURES OF FRUSTRATION



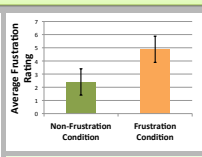


Figure 3: Frustration ratings after non-frustration and frustration conditions. Greater scores indicate higher levels of frustration.

- Frustration ratings significantly increased after the frustration condition ($t(40)=7.98$, $p<0.001$).
- Alpha asymmetry scores at sites F4-F3, F8-F7, Fp2-Fp1 did not correlate with increased self-reported frustration after the laboratory provocation.

Figure 4: Alpha asymmetry scores (8-13 Hz at F4-F3, F8-F7, Fp2-Fp1) against frustration difference scores. Mood ratings were collected after the non-frustration and frustration conditions. Larger scores indicate greater reactivity to frustration manipulation. Greater alpha power asymmetry scores imply greater left activation.

CONCLUSIONS

- Contrary to our hypotheses, alpha asymmetry scores did not correlate with measures of trait irritability or responses to the laboratory provocation, even though there was a significant increase in frustration after the task.
- The lack of correlation may have been a result of participants experiencing different anger types. A study found that anger-in expression, involving anger suppression, is associated with greater right EEG activity, while anger-out, involving outward anger expression, is associated with greater left activity (Hewig et al., 2004). As our study did not identify participants with different anger styles, it is possible that the lack in correlation may be due to presence of opposing symmetries which cancelled each other.
- Considerations for future study include investigating asymmetry profiles for different anger styles. Also, since EEG activity was collected over the duration of the laboratory provocation, future projects could include looking at event-related brain potentials.

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