Occipital Resting-State Alpha Lateralization as a Predictor of Social Responsiveness in Adults with Autism Spectrum Disorder (ASD)

Eiland, A., Kala, S., Bagdasarov, A., Cummings, E., Carlos, C., Naples, A., Wolf, J., Foss-Feig, J., Anticevic, A., Srihari, V., & McPartland, J

Developmental Electrophysiology Laboratory
Yale Child Study Center

YALE CHILD STUDY CENTER
Where discovery inspires care

Background

- Autism spectrum disorder (ASD) is a developmental disorder characterized by difficulties in social functioning.
- Abnormalities in electroencephalography (EEG) alpha-band (8-13Hz) oscillations are a potential ASD biomarker.
- Alpha-band activity is associated with complex cognitive processes, such as attention and semantic orientation (the ability to be consciously oriented in time, space, and context).
- Increased occipital resting-state alpha power may be associated with low social responsiveness (Edgar, 2015).
- Limited research has investigated alpha power asymmetries across hemispheres and the effect of alpha lateralization on social responsiveness.
- Anxiety is a comorbidity in 40% of individuals with ASD and is associated with increased alpha power.
- The relationship between resting-state alpha power and social responsiveness should be explored while controlling for anxiety, a potential confounding variable.

Objectives

- To understand lateralized resting-state alpha power as a predictor of social responsiveness, controlling for anxiety, in adults with ASD and typically developing (TD) controls.

Methods

Participants

- Participants were 22 adults with ASD (18 male) and 37 TD controls (21 male) aged 18-38 (Table 1).

Cognitive & Behavioral Assessments

- Participants' ASD diagnoses were confirmed using the Autism Diagnostic Observation Schedule (ADOS-2) and DSM-5 clinical criteria.
- Participants completed the Social Responsiveness Scale (SRS-2) to measure social impairment in natural settings.
- Beck Anxiety Inventory (BAI) was used to assess physical symptoms of anxiety.

Table 1. Participant demographic data. ASD and TD groups were matched on age but not on SRS *T*-scores or ADOS-2 CSS scores (p<.05).

Group	N (Males)	Mean Age (SD)	ADOS-2 CSS (SD)	SRS-2 *T*-score (SD)
ASD	22 (18)	25.1 (5.7)	7.8 (1.8)	62.1 (10.8)
TD	37 (21)	27.2 (6.4)	1.5 (0.7)	46.7 (7.7)

References

Edgar, J.C., Heiken, K., Chen, Y. *et al.* Resting-State Alpha in Autism Spectrum Disorder and Alpha Associations with Thalamic Volume. *J Autism Dev Disord* **45,** 795–804 (2015).

Methods (continued)

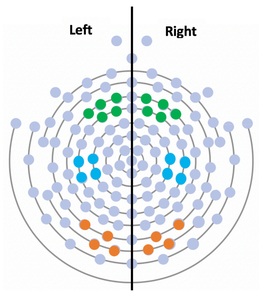

Figure 1. Frontal, central, and occipital electrodes.

EEG Data Acquisition and Collection

- Eyes-closed resting-state EEG data was collected using a 128-channel HydroCel Geodesic Sensor Net.
- Data was recorded continuously at 500 Hz.

Analysis Plan

- Alpha lateralization was quantified as the log of left alpha power subtracted from the log of right alpha power in central, frontal, and occipital electrode clusters over both hemispheres (Figure 1).
- Absolute alpha power in each region was also calculated.
- A repeated measures ANOVA was used to analyze absolute alpha power difference in ASD and TD groups.
- Linear regression, controlling for anxiety, was used to evaluate whether alpha lateralization predicts SRS T-Scores.

Results

- ANOVA revealed a significant difference in absolute alpha power between ASD and TD groups in the left occipital region (p=.023) and a marginally significant difference in the right occipital region (p=.050) (Figure 2).
- Within a linear regression model, absolute alpha power from neither hemisphere independently predicted SRS *T*-scores.

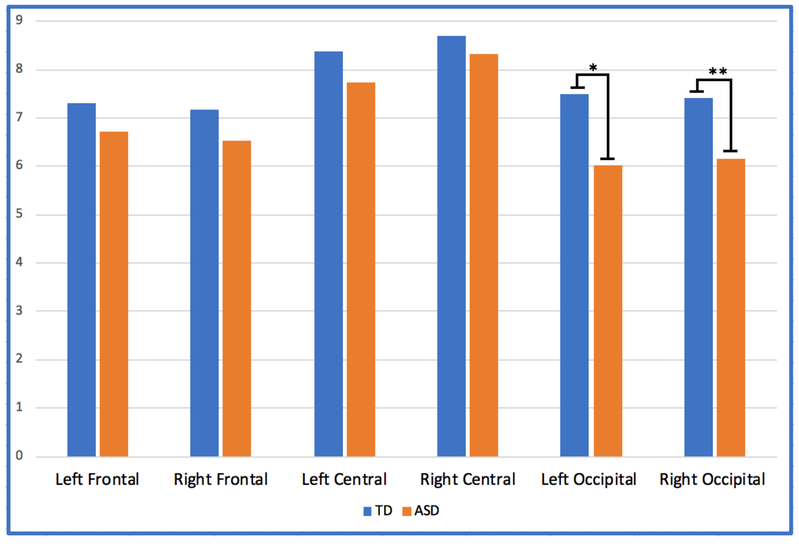

Figure 2. Comparison of absolute alpha power between ASD and TD groups in different brain regions. * p=.023, ** p= .050.

Results (continued)

- Higher alpha lateralization over occipital scalp regions significantly predicted lower SRS *T*-scores in individuals with ASD, [R^2=.306, F(1,20)=8.798, **β**=-.553, p=.008] but not in TD individuals (Figure 3a&b).
- Alpha lateralization did not significantly predict SRS *T*-scores in frontal or central regions for ASD or TD groups .
- When controlling for scores on the BAI, occipital lateralization still predicted SRS *T*-scores in the ASD group [R^2=.417, F(2,17)=6.081, **β**=-.453, p=.033].

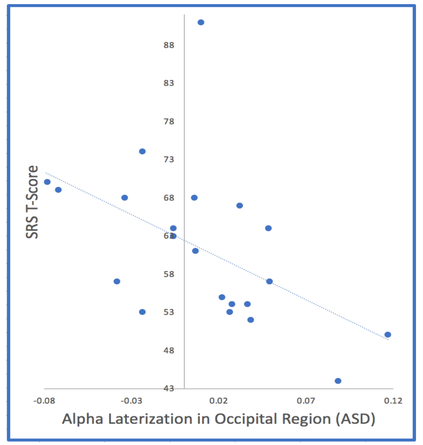

Figure 3a. Alpha lateralization in occipital region and SRS *T*-Score for ASD group (p<.05).

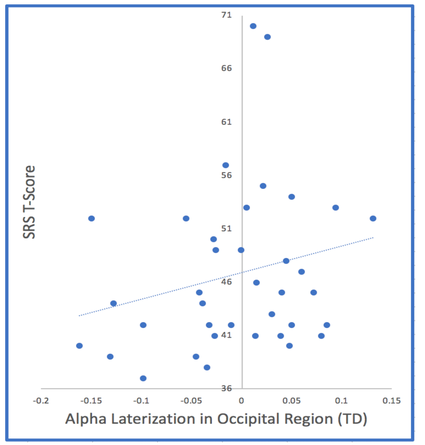

Figure 3b. Alpha lateralization in occipital region and SRS *T*-Score for TD group (p>.05).

Conclusions

- Greater resting-state alpha lateralization in the occipital region predicted social responsiveness in adults with ASD, even when controlling for anxiety, a common comorbidity of ASD that is associated with increased alpha activity.
- While occipital resting-state alpha lateralization predicted social responsiveness, absolute alpha power in the left occipital and right occipital regions did not independently predict social responsiveness.
- This data suggests the importance of considering hemispheric difference in alpha power analyses of resting-state EEG.
- Future research using a larger sample population should examine whether gender or age differences influence resting-state alpha lateralization.

Acknowledgements

- McPartland Lab, Yale Child Study Center, New Haven, CT
- mcp-lab.org
- Funding sources: UL1 RR024139 (McPartland); NIMH R01 MH107426 (McPartland, Srihari)