Sex-Related Differences in Youth with ASD: Alpha EEG Power in Eyes-Open and Eyes-Closed Conditions

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Background

- The EEG alpha frequency band (8-12 Hz) is thought to reflect levels of cortical excitability, with greater alpha power indicating lower cortical activity. Prior studies have demonstrated that individuals with ASD have decreased alpha power at rest (with eyes open) compared to control but comparable alpha power in eyes-closed (for review: Wang et al., 2013).
- The disparity in eyes-open vs eyes-closed alpha power is attributed to failure of individuals with ASD to increase cortical activity in preparation for visual input (e.g., Mathewson et al., 2012).
- Additionally, male and female neurotypical participants have different baseline resting-state EEG activity— with females spending more time in attentional processes, while men have more lapses of attention (Tomescu et al, 2018).
- Little is known about sex-based difference in functioning in individuals with ASD, as most studies enroll few females with ASD.
- This study evaluated resting-state EEG alpha power in youth with ASD, comparing alpha power during eyes-open and eyes-closed resting conditions. Analyses will focus on exploring sex differences within youth with and without ASD.
- We hypothesize that alpha power will be higher in females than in males. We also hypothesize that youth with ASD will have lower alpha power than neurotypical youth, and the sibling group will have alpha power intermediate to both.

Methods

Participants:

- Three groups of individuals participated in this study:

(1) Neurotypical Control children with no family history of autism (CON), and no elevated autism traits as assessed through parent report and standardized questionnaires (SRS and SCQ).
(2) Children who are siblings of youth with ASD (SIB).
(3) Children with a diagnosis of ASD (ASD).

- All children were between 8 years and 17 years 11 months.
- No participant had a history of or current seizure disorder, nor were taking anti-epileptic medications.
- Only children with valid Eyes Open and Eyes Closed EEG data were included in this analyses.
- Children provided assent and parents provided consent.

Procedure:

- EEG was collected as part of the ACE GENDAAR network.

EEG Collection:

- EEG data was collected using 128 electrode hydrocel net from Electrical Geodesic Inc.
- EEG was recorded at 500Hz sampling rate and referenced to single vertex electrode.
- Impedances were kept below 200 kiloOhms.

Funding:
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Resting Task:

- EEG data were collected in 3 blocks across the EEG visit. In each block, participants passively watched 2 sets of 32 seconds of screen-saver-like videos (eyes-open) followed by 16 seconds of eyes closed resting (eyes-closed). A total of 192 seconds of eyes open and 96 seconds of eyes closed was available.

Data Processing:

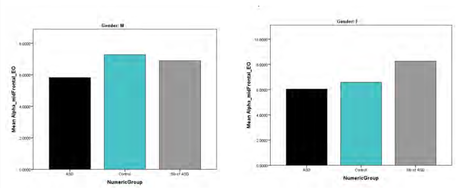
1. Data was processed in NetStation and trials containing artifacts were removed.
2. Resting EEG data were bandpass filtered at .1 Hz and 100Hz with a 60Hz notch filter. Data were segmented with NetStation 4.5.6 in 2048 msec segments and data with poor attention were removed.
3. Electrodes with greater than a 100 microvolt difference between their lowest and highest point were rejected for that segment. Segments with more than 24 bad electrodes (including eye electrodes) were removed. Hand editing was then performed to remove segments with significant eye movements and eye artifacts. Trials were rejected for eye artifacts if (1) the first two rows of electrodes (25, 21, 14, 8, 22, 15, 9) were all rejected by the NetStation bad channel algorithm, or (2) the first two rows of electrodes were partially rejected by the bad channel algorithm and the third row of electrodes (23, 18, 16, 10, 3) still showed the morphology of a blink or eye artifact.
4. On the remaining good trials, bad electrodes were replaced using the Replace Bad Channel Function in NetStation. Data was then re-referenced to an average reference.
5. To be included in the analysis, participants had to provide 20 seconds of artifact free data in both conditions.
6. A fast fourier transformation (FFT) was performed on artifact-free EEG data to isolate alpha signal, and power was averaged for mid-posterior electrodes.
7. ANOVAs and linear regressions were used to evaluate the effects of sex and diagnosis on alpha power.

		Female			Male		
		ASD (n=39)	CON (n=57)	SIB (n=21)	ASD (n=52)	CON (n=60)	SIB (n=13)
Age (mos)	Mean	160.95	161.05	148.76	155.73	164.97	138.23
	SD	32.507	33.845	32.139	35.375	31.954	33.124
NVIQ	Mean	100.97	109.72	114.10	101.00	109.47	117.85
	SD	18.345	16.612	18.286	17.686	14.622	13.422

Results

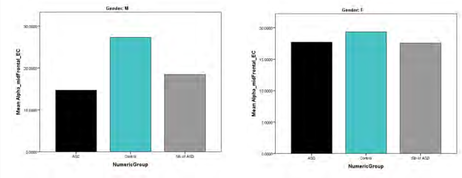
Question 1: Is there an effect of group or sex on alpha power?

EYES OPEN



- There were no significant difference between groups for eyes-open power in the left, mid, or right regions for either females (ps>.087) or males (ps>.541).

EYES CLOSED



- There was significant difference between groups for eyes-closed power in the left (F(2,122) = 8.404, p<.001), mid (F(2,122) = 9.373, p<.001), and right (F(2,122) = 9.447, p<.001) frontal regions for males, but not for females (ps>.051).
- The control group had higher power than the ASD group (p<.001).

Question 2. Is there an effect of group or sex on alpha power?

EYES OPEN

The regression model with group, sex, and age as predictors of eyes-open frontal alpha power was significant at each of the frontal regions.

left (F=12.30, p<.001, R^2 = .137)
midline (F=9.698, p<.001, R^2 = .111)
right (F=14.193, p<.001, R^2 = .155)

EYES CLOSED

For eyes-closed frontal alpha power, the regression model was significant at the lateral regions but not midline.

left (F=2.98, p =.03, R^2 = .037)
right (F=3.15, p=.026, R^2 = .039)
midline (F=2.62, p=.05, R^2 = .033)

Question 2: Cont.

EYES OPEN

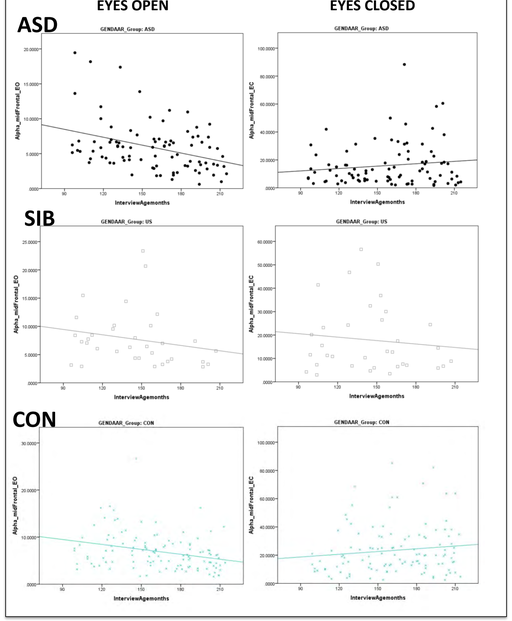
- Group (ps<.05) and age (ps<.01) were significant predictors of alpha power in the eyes-open condition.
- The SIB group had higher power than the CON group, which had higher power than the ASD group.
- Additionally, older children had lower power values compared to younger children.

EYES CLOSED

- For left and right frontal regions, group (p<.05) and sex (p<.05) were significant predictors, but not age (p>.19).
- Again, the US group had higher power than the CON group, which had higher power than the ASD group. Furthermore, males had higher power than females.

Relation between age and power by group

EYES OPEN **EYES CLOSED**



Summary

- EEG resting brain activity significantly differed between youth with ASD and youth with NT development, but only in the eyes-closed condition., and only for males.
- Regression for eyes-open alpha power was significant for all frontal regions, and group and age were significant predictors.
- Regression for eyes-closed alpha power was significant for left and right regions, and group and sex were significant predictors.