Relative Alpha Power in Autism Spectrum Disorder: Sex Differences and Association with ASD Features

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Background

- Autism spectrum disorder (ASD) affects males at a rate of 4:1 compared to females[1], and females with ASD tend to exhibit fewer repetitive behaviors[2] and lower IQ[3].
- These sex differences remain poorly understood, and there is increasing effort to understand neural mechanisms involved.
- Alpha activity is an electroencephalographic (EEG) measure of particular interest given that shifts in alpha activity throughout childhood index neural development[4].
- In typically developing (TD) children, females exhibit reduced alpha power, indicating increased neural activation[5].
- Recent research found similar sex differences in children with ASD[6], but there remains a notable lack of literature examining sex differences in alpha activity within this population.

Objective: The current study examined sex differences in relative alpha activity in TD and ASD cohorts of children and evaluated the relationship between relative alpha activity and ASD symptomatology.

Methods

Participants

Table 1. Participant demographics.

	n (female)	Age in years mean (SD) range	FSIQ mean (SD) range
ASD	70 (19)	13.7 (2.6) 8.6 – 18.0	102 (19.9) 71 – 161
TD	47 (21)	12.8 (2.8) 8.2 – 17.7	107 (12.5) 79 – 135

Note. ASD and TD samples were matched on age, sex, and IQ.

Behavioral Measures

- ASD diagnoses were confirmed with the *Autism Diagnostic Observation Schedule (ADOS-2)* and clinician endorsement of DSM-IV criteria for ASD.
- Cognitive ability was assessed with the Differential Ability Scales-II (DAS-II).
- Autism symptomatology was measured with the *Social Responsiveness Scale (SRS-2).* Higher scores indicate greater symptomatology.

EEG Acquisition and Analysis

- Resting EEG data (with eyes closed) was recorded at 1000 Hz with a 128-channel Hydrocel Geodesic sensor net.
- At least 30 seconds of artifact-free EEG data were available for each participant.
- Alpha frequency was defined as 6 – 12 Hz.
- Spectral power was extracted from and averaged across O1 and O2 electrodes (Fig 1).
- Relative alpha power was calculated as alpha power/total power from 2 – 55 Hz.

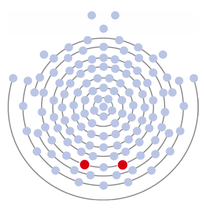

Figure 1. Electrodes included in analysis.

Results

- A significant effect of sex on relative alpha power was observed ($F(1, 110)=10.92$, $p = .001$), such that **females showed reduced alpha power.**
- There was **not a significant effect of diagnosis on relative alpha power.**

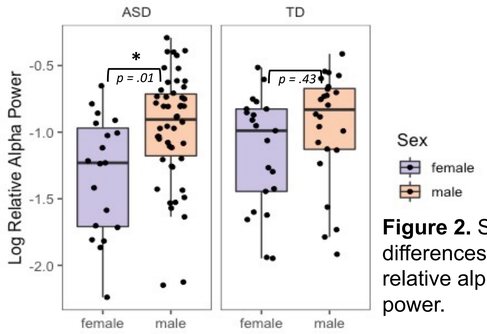

Figure 2. Sex differences in relative alpha power.

- Post-hoc comparisons indicated that, in the ASD group, males exhibited significantly increased relative alpha power compared to females (p=.01).
- This pattern was also observed in TD children but was nonsignificant (Fig 2).

- **Relative alpha power was positively associated with SRS scores in the ASD group as a whole (Fig 3), but these relationships differed by sex.**
- Among females:
  - In ASD, alpha power was not associated with SRS scores.
  - In TD, alpha power was positively associated with social communication scores ($r(19)=.52$, p=.02) and not associated with RRB scores (Figs 4, 5).
- Among males:
  - In ASD, alpha power was positively associated with social communication scores($r(49)=.32$, p=.03) and RRB scores ($r(49)=.32$, p=.03).
  - In TD, alpha power was not associated with social communication scores and was negatively associated with RRB scores ($r(24)=-.37$, p=.09) (Figs 4, 5).

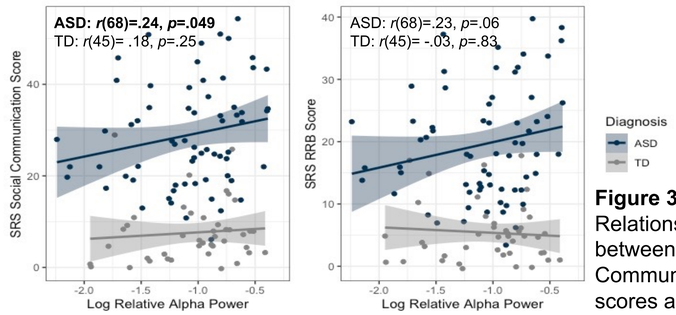

Figure 3. Relationship between Social Communication scores and relative alpha power.

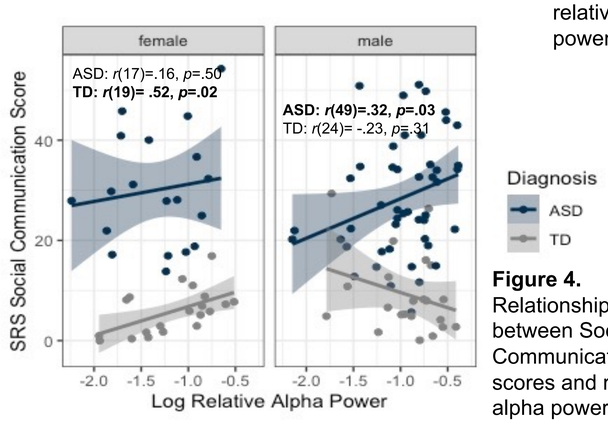

Figure 4. Relationship between Social Communication scores and relative alpha power.

Results

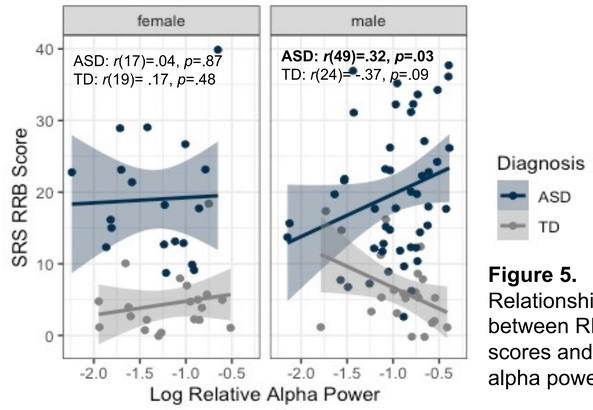

Figure 5. Relationship between RRB scores and relative alpha power.

Conclusions

- Our results replicate prior findings indicating **females with ASD exhibit greater neural activation at rest.**
- Similar to previous studies[6,7], we found that **reduced neural activation is associated with greater ASD symptomology**, however, we demonstrated that this relationship depends on sex and diagnostic status.
- Findings suggest that, within the ASD population, **males may drive this trend, which was absent among females with ASD.**
- Results underscore the importance of considering sex differences in EEG power spectra, particularly in the context of ASD.
- It remains to be determined if sex differences in alpha activity reflect a differential mechanistic pathway to social function in ASD.
- Future research should further examine the relationship among neurophysiological measures and phenotypic outcomes associated with ASD.

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