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, and females with ASD tend to exhibit fewer repetitive behaviors\(^2\) and lower IQ\(^1\).
- 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

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<tr>
<th>n</th>
<th>Age in years mean (SD) range</th>
<th>FSIQ mean (SD) range</th>
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<tr>
<td>ASD</td>
<td>70 (19)</td>
<td>13.7 (2.6)</td>
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<td></td>
<td>102 (19.9)</td>
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<tr>
<td>TD</td>
<td>47 (21)</td>
<td>12.8 (2.8)</td>
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<td>107 (12.5)</td>
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Note. ASD and TD samples were matched on age, sex, and IQ.

Behavioral Measures

- Autism 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.

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.

- 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).

- 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).

Conclusions

- Our results replicate prior findings indicating females with ASD exhibit greater neural activation at rest.
- Similar to previous studies\(^7\), 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.

References


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