Neural Response to Emotional Faces as a Predictor of Anxiety in Adults with Autistic Traits

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

Developmental Electrophysiology Laboratory, Yale Child Study Center

YALE CHILD STUDY CENTER — Where discovery inspires care

Background

- Adults with autism spectrum disorder (ASD) have high rates of co-occurring anxiety.
- Both ASD and anxiety have been linked to atypical neural response to faces, most notably in the P1 event-related potential (ERP) and face sensitive N170 ERP.[1-2]
- Little is known about the relationship between neural responses to emotional faces, ASD symptomatology, and anxiety.
- To capture the complexity and wide variance in ASD symptomology and anxiety, we examined this relationship across individuals with and without ASD diagnoses.

Objective: To evaluate interrelationships among neural response to emotional faces, autistic traits, and anxiety in a transdiagnostic sample.

Methods

Participants

	n (female)	Age (SD)	Full Scale IQ (SD)
ASD	26 (6)	24.6 (5.6)	104.5 (17.9)
TD	39 (18)	26.6 (6)	112.9 (13.8)
DNM	17 (5)	24.3 (6.1)	109.9 (12.7)

Table 1. Participant demographics; DNM, did not meet traditional research standards of ASD diagnosis or had comorbid conditions; age and IQ did not differ across groups.

Behavioral Measures

- ASD diagnoses were confirmed with the *Autism Diagnostic Observation Schedule (ADOS-2)* and clinician endorsement of DSM-5 criteria for ASD.
- Autism-specific social impairment - *Social Responsiveness Scale (SRS-2)*
- Anxiety - *Beck Anxiety Inventory (BAI)*

Trial Structure

- Following a crosshair, participants viewed a neutral face that shifted to an emotional (fearful or happy) face after 500 ms of fixation on the neutral face (Figure 1).

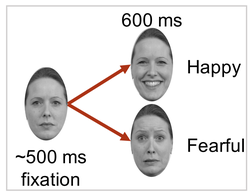

Figure 1. Trial structure with sample stimuli.

EEG Acquisition and ERP Analysis

- EEG was recorded at 1000 Hz with a 128-channel Hydrocel Geodesic sensor net.
- Data were segmented from -100 to 500 ms relative to emotional face presentation and averaged separately for happy and fearful faces.
- N170 latency, N170 peak amplitude, and P1 mean amplitude were extracted from electrodes over right occipitotemporal scalp (Figure 2).

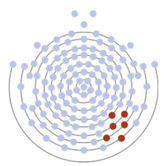

Figure 2. Electrodes included in analysis.

Statistical Analysis

- Relationships among neural response (N170 latency, N170 amplitude, and P1 amplitude) to fearful and happy faces, autistic traits (SRS-2 raw score), and anxiety (BAI score) were analyzed using correlations and multiple regressions across diagnostic groups.

Results

- SRS-2 scores were positively correlated with BAI scores (r=.589, p<.001; Figure 3).

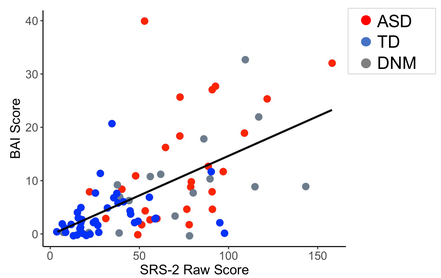

Figure 3. Relationship between SRS-2 raw score and BAI score.

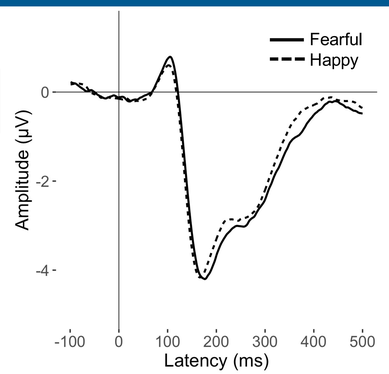

Figure 4. Grand averaged waveforms to fearful and happy faces across diagnostic groups.

- P1 mean amplitude for emotional faces and SRS-2 scores predicted BAI scores, regardless of whether the face was fearful [R^2=.398, F(2,79)=26.10, p<.001; Figure 5A; Table 2A] or happy [R^2=.402, F(2,79)=26.56, p<.001; Figure 5B; Table 2B].

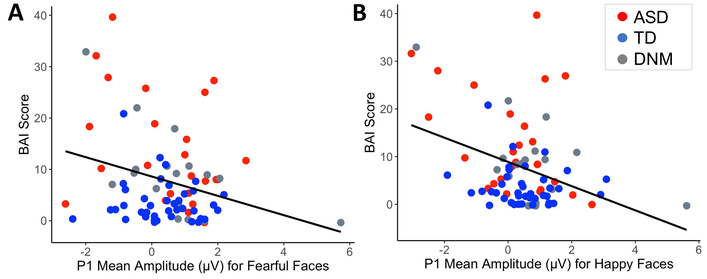

Figure 5. Relationship between P1 mean amplitude for (A) fearful and (B) happy faces and BAI scores.

- N170 latency for fearful faces (but not happy faces), SRS-2 scores, and the interaction between N170 latency and SRS-2 scores predicted BAI scores [R^2=.423, F(3,78)=19.03, p<0.001; Figure 6A; Table 2C]
- N170 peak amplitude for fearful faces, but not happy faces, and SRS-2 scores predicted BAI [R^2=.383, F(2,79)=24.562, p<.001; Figure 6B; Table 2D].

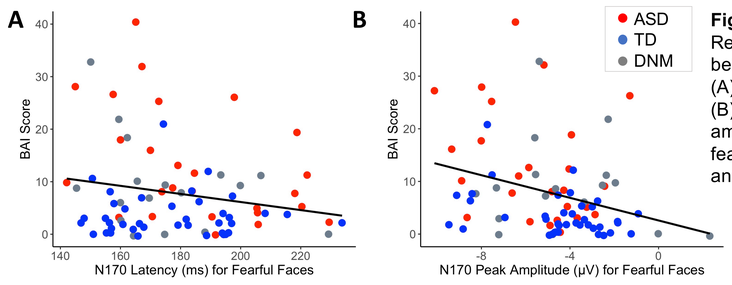

Figure 6. Relationship between N170 (A) latency and (B) peak amplitude for fearful faces and BAI scores.

Results

Table 2. Summary of Linear Regression Models

Model	Source	*B*	*SE B*	*β*	*t*	*p*
A	P1 Mean Amplitude (fearful)	-1.537	.596	-.226	-2.578	.012
	SRS-2 Raw Score	.143	.022	.569	6.492	<.001
B	P1 Mean Amplitude (happy)	-1.663	.618	-.241	-2.691	.009
	SRS-2 Raw Score	.134	.023	.532	5.934	<.001
C	N170 Latency (fearful)	-.073	.034	-.187	-2.167	.033
	SRS-2 Raw Score	.140	.022	.554	6.321	<.001
	SRS-2 x N170 Latency (fearful)	-.002	.001	-.192	-2.190	.031
D	N170 Amplitude (fearful)	-.701	.326	-.194	-2.154	.034
	SRS-2 Raw Score	.139	.023	.553	6.150	<.001

Conclusions

- Consistent with previous literature, higher levels of autistic traits (specifically social impairment) were associated with increased anxiety.
- Highest levels of anxiety were associated with individual differences in emotional face processing, indexed by the P1 and N170 ERPs.
- Smaller P1 amplitudes were associated with increased anxiety, regardless of emotion type, suggesting that P1 may reflect basic visual processes relevant to anxiety but not sensitive to specific emotional expressions.
- Faster N170 latency and larger N170 amplitude were associated with increased anxiety, but only for fearful faces, suggesting that heightened sensitivity to fearful expressions may relate to anxiety.
- However, the interaction between SRS and N170 latency indicates that faster N170 latency is associated with increased anxiety for individuals with elevated autistic traits, whereas slower N170 latency to fearful faces is associated with heightened anxiety in individuals with lower levels of autistic traits.
- Further research should consider the combination of neural responses to emotional faces and autistic traits as a potential means for identifying subgroups of individuals with ASD that are more susceptible to anxiety.

References

1. Staugaard, S. (2010). Threatening faces and social anxiety: A literature review. *Clinical Psychology Review, 30*(6), 669–690.
2. Kang, E. Keifer, C. M., Levy, E. J., Foss-Feig, J. H., McPartland, J. C., Lerner, M. D. (2018). Atypicality of the N170 event-related potential in autism spectrum disorder: A meta-analysis. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging, 3*(8),657–666.

Funding Sources

NIMH R01 MH100173 (McPartland), NIMH R21 MH091309 (McPartland) Autism Speaks Translational Postdoctoral Fellowship (Naples), Waterloo Foundation1167-1684 (McPartland), Patterson Trust13-002909 (McPartland), NIMH R03MH079908 (McPartland), NARSAD Atherton Young Investigator Award (McPartland), NIMH R01 MH100173 (McPartland), CTSA Grant Number UL1 RR024139 (McPartland)

McPartland Lab
mcp-lab.org
mcp.lab@yale.edu