The Relationship Between Neural Correlates of Face Processing and Social Communication in Individuals with ASD and Schizophrenia

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Background

- Social communication difficulties, including deficits in maintaining and interpreting eye contact, are one of the hallmark characteristics of autism spectrum disorder (ASD).
- This impairment is not unique to ASD and also affects individuals with schizophrenia (SCZ), a disorder with many genetic, neurobiological, and phenotypic similarities to ASD.
- Consistent with the NIMH's Research Domain Criteria (RDoC) initiative, we sought to investigate the neural correlates of face processing and visual attention across these disorders by examining individuals across diagnostic groups.
- This study applied interactive neuroscience methods to study electrophysiological brain response (EEG) during a gaze-contingent paradigm that simulated face-to-face social interactions.
- We evaluated whether specific differences in facial expression processing and attention are general indicators of social dysfunction across neurodevelopmental disorders.

Objectives: To examine the relationship between a clinician-rated social communication measure (eye contact) with a) face-processing event-related brain potential (ERP) components and b) attention across diagnostic categories.

Methods

Participant Demographics:

	N (Female)[a]	Age (SD)[a]	FSIQ (SD)
ASD	21 (7)	23.8 (4.8)	103.9 (15.6)
SZ	20 (2)	25.4 (6.7)	94.4 (13.2)
TD	8 (6)	25.1 (5.1)	116.9 (13.3)

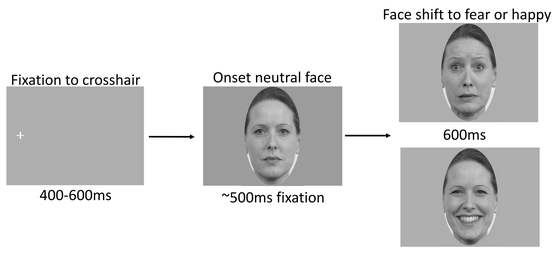
[a] The sample was matched for age and sex.

Diagnostic groups differed significantly on the Wechsler Abbreviated Scale of Intelligence – Second Edition (WASI-II) measure of full scale IQ (FSIQ) such that those with ASD and SCZ differed significantly from typically developing (TD) individuals (p=.02 and p<.01, respectively) but did not significantly differ from one another (p=.06).

Experimental Paradigm:

- Participants were presented with 80 distinct, photorealistic, animated faces matched for low-level visual features.
- Utilizing gaze-contingent eye tracking (ET) technology, on-screen faces responded to a participant's direct fixation by exhibiting happy or fearful emotions (Figure 1).

Figure 1. Trial Structure. Trials begin with counterbalanced fixation crosshairs at the left or right side of the screen for 400-600ms, followed by a centrally presented neutral face. After the participant looks to the neutral face for ~500ms, the face shifts to the fear or happy condition for 600ms. A 500ms blank screen separates each trial.



Clinical Measure:

- To measure social communication difficulties and clinical symptomology, the *Autism Diagnostic Observation Schedule, Second Edition (ADOS-2)*, a diagnostic assessment, was administered by research-reliable clinicians with expertise in ASD.
- For analyses, participants were sorted into two groups based on the individual's score on the *ADOS-2* eye contact item. Those with a score of 0 (appropriate gaze) were considered the typical eye contact group. Those with a score of 2 (poorly modulated eye contact) were considered the atypical eye contact group.
- All TD participants scored a 0 on the eye contact item. SCZ and ASD participants varied on the eye contact item.

Methods

EEG and ET Data Acquisition and Collection:

- EEG recorded at 1000Hz with 128 channel Geodesic Sensor Net.
- ET data collected using an Eyelink-1000 remote camera.

ERP and ET Processing:

- Data were filtered from 0.1-30Hz, re-referenced to the average reference, segmented from -100 to 500ms relative to shift in stimulus gaze, baseline corrected, and artifact detected.
- ERP components were extracted from occipitotemporal electrodes (Figure 2). P100 and N170 peak latency and mean amplitude were extracted from 60-160ms and 150-220ms, respectively. N250 mean amplitude was extracted from 250-350 ms; peak latency could not be extracted because there were no reliable peaks.
- Eyelink DataViewer extracted dwell time in AOIs (Figure 3).

Statistical Analyses:

- Multivariate analyses of covariance (MANCOVAs) were conducted to investigate interactions between the *ADOS-2* eye contact item (covariate) and P100, N170, and N250 components of face processing.
- Independent *t*-tests were conducted to investigate attentional differences to regions of the face between those with typical and atypical eye contact.

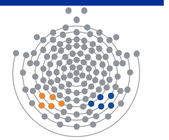


Figure 2. Left and right electrode regions.

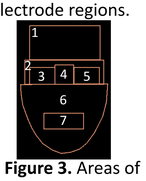


Figure 3. Areas of Interest (AOIs). 1=Upper Face; 2+3+4+5=Eyes; 3=Left Eye; 4=Between Eyes; 5=Right Eye; 6+7=Lower Face.

Preliminary Results

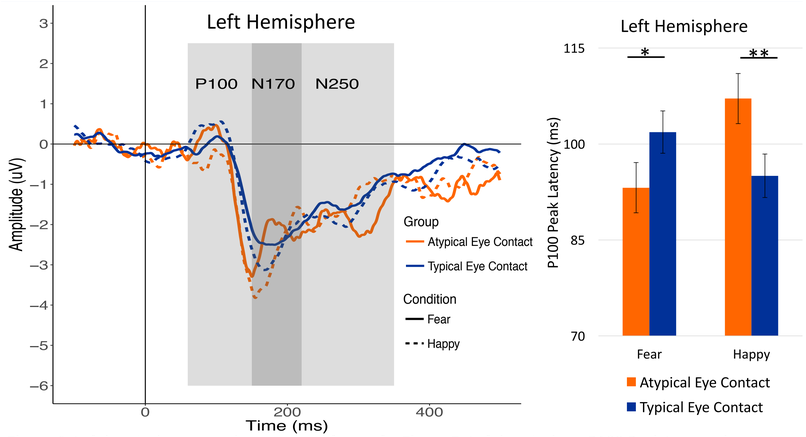


Figure 4. Left hemisphere neural response to faces of those with atypical/typical eye contact.

Figure 5. Left hemisphere P100 Peak Latency by eye contact. ** marks statistical significance (p<.05) and * marks trending significance (.05<p<.10).

P100 Peak Latency and Mean Amplitude:

- A significant interaction was found between hemisphere, emotion, and the eye contact item [$F(1,60)$=8.00, p<.01] on peak latency. Follow-up *t*-tests showed a) those with atypical eye contact had significantly slower responses to happy in the left hemisphere (p=.02) than those with typical eye contact and b) a trend that those with atypical eye contact had faster responses to fear in the left hemisphere (p=.09) than those with typical eye contact (Figure 5). There were no interactions or main effects involving diagnostic group on peak latency.
- There were no significant interactions or main effects with eye contact or diagnostic group on mean amplitude.

N170 Peak Latency and Mean Amplitude:

- No significant interactions or main effects with eye contact or with diagnostic group.

N250 Mean Amplitude:

- There was a marginal interaction between hemisphere, emotion, and the eye contact item [$F(1,60)$=3.67, p=.06], such that those with typical and atypical eye contact differentially trend toward lateralized patterns of N250 amplitude in response to emotion. Follow-up *t*-tests indicated no significant differences between eye contact groups (p's >.4).
- There were no interactions or main effects involving diagnostic group.

Preliminary Results

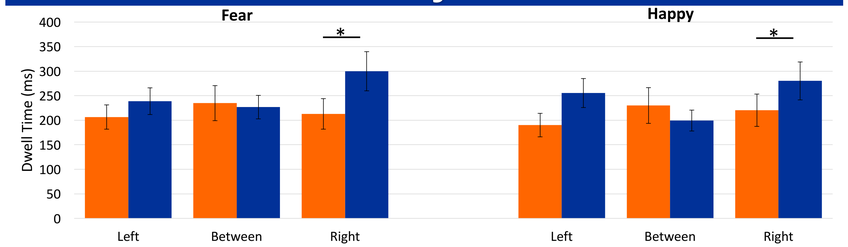


Figure 6. Dwell time in eye regions (left eye, between eyes, and right eye) by condition.

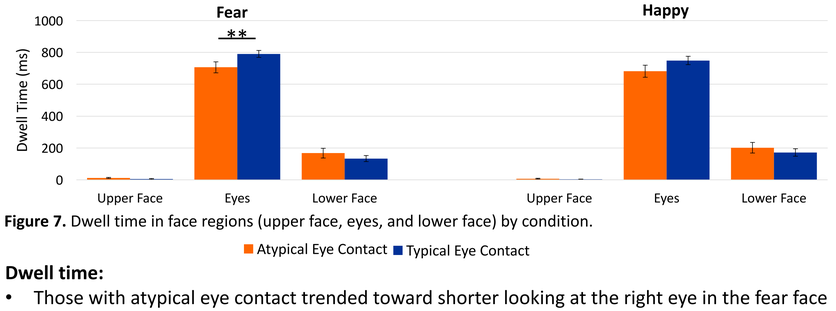


Figure 7. Dwell time in face regions (upper face, eyes, and lower face) by condition.

Dwell time:

- Those with atypical eye contact trended toward shorter looking at the right eye in the fear face [$t(62)$=1.67, p ≤.10] and the left eye in the happy face [$t(62)$=1.67, p ≤.10] than those with typical eye contact. Those with typical and atypical eye contact did not significantly differ in dwell time between the eyes AOI in either condition (Figure 6).
- Those with typical eye contact looked significantly longer at the eyes in the fear condition than those with atypical eye contact [$t(62)$=2.13, p=.04) but did not differ in the happy condition. There were no differences in either condition in the upper and lower face regions (Figure 7).
- Further, those with atypical eye contact trended toward shorter total looking time in fear trials than those with typical eye contact [$t(62)$=1.69, p=.09] but did not differ in the happy trials.

Conclusions

- Results indicate that clinician ratings of eye contact, as a measure of social communication, were associated with neural response and attention to emotional faces. Distinct patterns of responsivity were observed for different facial expressions, and eye contact during in vivo social interactions was associated with lateralization of brain responses to emotional expressions.
- Measures of social communication, in this case eye contact, were more predictive of differences in neural response than diagnostic categories.
- Further, results suggest that a pattern may exist in how distinct types of emotions are processed and attended to. The faster neural response to fear and reduced looking to fear faces in the atypical eye contact group suggests that this group of individuals may have an increased sensitivity to fearful stimuli that makes them more avoidant of the stimuli. This is consistent with suggestions that eye contact is anxiety-provoking or aversive to individuals with ASD.
- These findings reveal relationships between nonverbal social communication and a) neural sensitivity to facial expressions and b) measures of attention that span diagnostic categories, suggesting the importance of examining social communicative biomarkers in transdiagnostic samples.
- Limitations include significant IQ differences across diagnostic samples and a limited sample size of TD individuals.

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