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.

Methods

- 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.

**Participant Demographics:**

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (SD)</th>
<th>FSIQ (SD)</th>
<th>N (Female)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASD</td>
<td>21 (7)</td>
<td>23.8 (4.8)</td>
<td>103.9 (15.6)</td>
</tr>
<tr>
<td>SZ</td>
<td>20 (2)</td>
<td>25.4 (6.7)</td>
<td>94.4 (13.2)</td>
</tr>
<tr>
<td>TD</td>
<td>8 (6)</td>
<td>25.1 (5.1)</td>
<td>116.9 (13.3)</td>
</tr>
</tbody>
</table>

*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<0.05 and p<0.01, respectively) but did not significantly differ from one another (p>0.05).

**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 feedback responded to a participant’s direct fixation by exhibiting happy or fearful emotions (Figure 1).

- A significant interaction was found between hemisphere, emotion, and the eye contact variable (F(1,60)=8.00, p<0.01) on peak latency. Follow-up t-tests showed that those with atypical eye contact had significantly slower responses to happy in the left hemisphere (p<0.02) than those with typical eye contact and a trend that those with atypical eye contact had faster responses to fear in the left hemisphere (p<0.09) than those with typical eye contact (Figure 5).

- There were no interactions or main effects involving diagnostic group on peak latency.

**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 stimulus. 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.

**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 eye tracker.

**ERP and ET Processing:**

- Data were filtered from 0.1-30Hz, re-referenced to the average reference, segmented from -500 to 2500ms relative to first stimulus onset, gazed baseline corrected, and artifact detected.

- ERP components were extracted from occipitotemporal electrodes (Figure 2). P300 and N170 latency and mean amplitude were extracted from 60-160ms and 50-220ms, respectively. N250 mean amplitude was extracted from 250-350ms; peak latency could not be extracted because there were no reliable peaks.

**Stimuli:**

- In conditions that included face as a stimulus, 600ms stimulus duration was followed by a 500ms blank screen.

**Figure 1. Trial Structure.**

- Trials begin with a fixation cross 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 0 on the eye contact item. SCZ and ASD participants varied on the eye contact item.

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- All TD participants scored 0 on the eye contact item. SCZ and ASD participants varied on the eye contact item.

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

- Those with atypical eye contact trended toward shorter looking at the right eye in the face fear ([t(62)=1.67, p<0.10] and the left eye in the happy face ([t(62)=1.67, p<0.10] than those with typical eye contact. Those with typical and atypical eye contact did not significantly differ in dwell time between the eyes ASD in either condition (Figure 6).

- Those with atypical eye contact looked significantly longer at the eyes in the fear condition than those with atypical eye contact ([t(62)=2.13, p<0.04] 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 total looking time in fear trials than those with typical eye contact ([t(62)=1.69, p<0.09] but did not differ in the happy trials.

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

- Those with atypical eye contact trended toward shorter looking at the right eye in the face fear ([t(62)=1.67, p<0.10] and the left eye in the happy face ([t(62)=1.67, p<0.10] than those with typical eye contact. Those with typical and atypical eye contact did not significantly differ in dwell time between the eyes ASD in either condition (Figure 6).

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**Table 1. Group Differences in Neural Response as a Function of Diagnostic Group and Emotion.**

- There were no differences in neural response as a function of diagnostic group and emotion.

**Conclusion:**

- The 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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