Shared and distinct features of dynamic emotional face processing in autism spectrum disorder and schizophrenia as measured by neural and behavioral responses

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Background

- Social impairment and difficulties with emotional face perception are shared features of autism spectrum disorder (ASD) and schizophrenia (SZ).
- Electroencephalography (EEG) and eye-tracking (ET) reveal similar brain and behavioral atypicalities in individuals with ASD and SZ in response to emotional faces.
- The N170 is an event-related potential (ERP) observed ~170 ms after a face is presented. It reflects the structural encoding of faces and may index emotional facial information.
- Collecting EEG and ET simultaneously during dynamic changes in facial expressions allows for the examination of brain-behavior relationships in more ecologically valid contexts.

The main objectives of this study were to:

1. Characterize N170 response evoked by dynamic emotional faces in adults with typical development (TD), ASD, and SZ.
2. Examine the relationship between N170 and visual attention measured by ET.
3. Examine the relationship between N170 and affective self-expression.

Methods

Characteristics of the sample population:

Group	*N*	Age *m* (*SD*)	IQ *m* (*SD*)	ADOS CSS *m* (*SD*)
ASD	21	23.3 (5.6)	105 (18)	7.6** (1.7)
SZ	15	26.7 (7.1)	96** (10)	3.0** (2.2)
TD	31	26.1 (5.7)	111** (16)	1.3** (0.6)

Note. ** p<.01. The ASD group had significantly higher CSS scores than both the SZ and TD group, and the SZ group had significantly higher scores than the TD group.

Experimental Paradigm:

- Affective self-expression was measured using a clinician interview, the Scale for the Assessment of Negative Symptoms. Unchanging Facial Expression, item 1 in the Affective Flattening or Blunting domain, was rated from 0 (absent) to 5 (severe).
- ET and EEG were collected concurrently during a gaze-contingent paradigm where, contingent on the participant's gaze, a neutral face shifted to an emotional (happy or fearful) face (Figure 1).

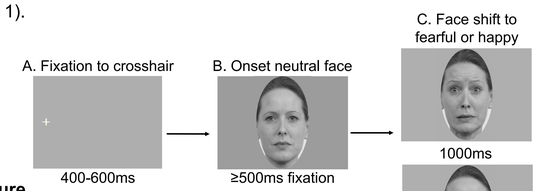

Figure 1. Trial Structure.
A crosshair appeared. Once the participant fixated on the crosshair for ~500 ms (A), a neutral face appeared (B). After looking at the eyes for ≥500ms, the face shifted from neutral to emotional (happy or fearful) for 1000 ms (C).

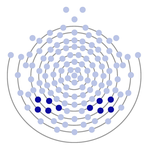

Figure 2. Occipitotemporal electrodes.

ET-EEG Acquisition:

- ET was collected using a SR Eyelink-1000 remote camera system.
- EEG was recorded with 128-channel Geodesic Sensor Net at 1000 Hz.

ET-EEG Processing:

- EEG data were:
  - Filtered from 0.1 to 30 Hz.
  - Re-referenced to average reference.
  - Segmented from -100 to 500 ms post face shift.
  - Baseline corrected.
  - Artifact detected.
- Post emotional face shift, the N170 (130–220 ms) response was extracted from occipitotemporal electrodes over the left (58, 64, 59, 66, 65) and right (96, 95, 91, 84, 90) hemisphere (Figure 2).
- ET data were processed with Eyelink DataViewer to find dwell time in areas of interest (AOIs) from 0–1000 ms of emotional face onset. The AOIs included the whole eye region, the left eye, between the eyes, and the right eye.

Data Analysis:

- ERP and ET data were analyzed using repeated measure ANOVAs with Bonferroni corrected *t*-tests to clarify significant findings.
- Relationships between ERP/ET and affective self-expression were examined with Spearman's correlations.

Results

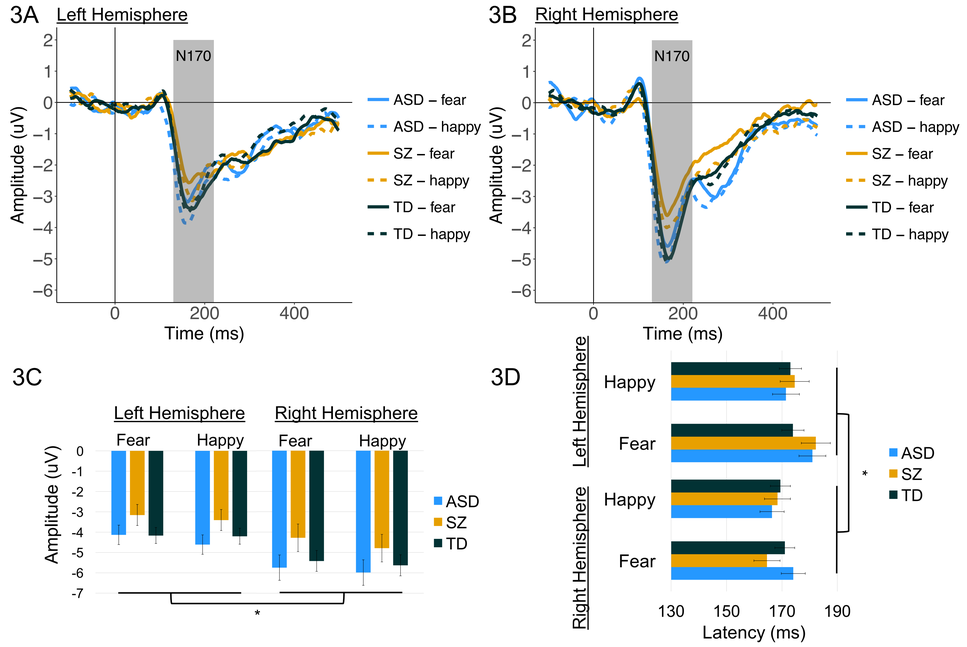

Figure 3. Grand average waveforms from left (3A) and right (3B) occipitotemporal electrodes, and differences in N170 amplitude (3C) and latency (3D) to emotional faces. * p<.05.

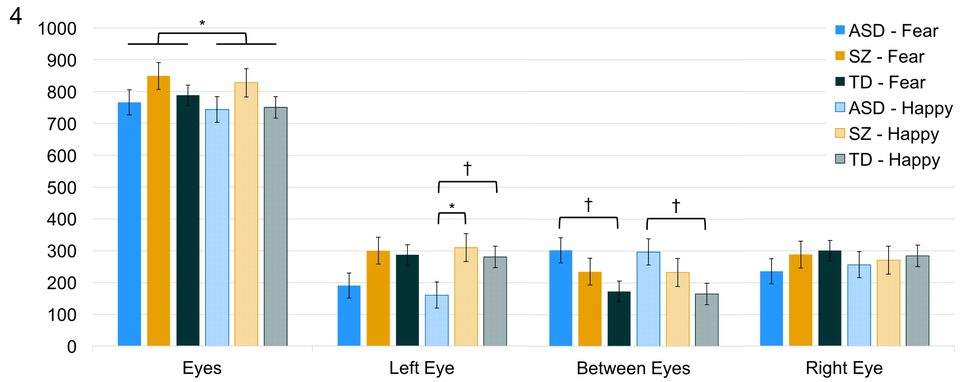

Figure 4. Differences in time spent viewing regions of the emotional face by diagnostic group and condition. * p<.05, † p<.10.

N170 Findings: (Figure 3)

- Amplitude: A main effect of hemisphere [F(1,67)=34.6, p<.01] indicated larger amplitude over right hemisphere relative to left (3C); a marginally significant main effect of condition emerged [F(1,67)=3.7, p=.06], such that amplitude to happy faces was more negative than to fearful faces.
- Latency: A main effect of hemisphere [F(1,67)=11.0, p<.01] indicated faster response in right hemisphere than left (3D); there was a marginally significant main effect of condition [F(1,67)=3.9, p=.05] such that the response to happy faces was faster than the response to fearful faces.

ET Findings: (Figure 4)

- Eyes: A main effect of condition emerged [F(1,67)=10.9 p<.01] such that more time was spent looking at the eyes of fearful faces.
- Left Eye: A main effect of diagnosis was observed [F(2,67)=3.3, p<.05] such that the ASD group looked at the left eye marginally less than the SZ (p=.08) and TD (p=.10) groups. An interaction effect between condition and diagnosis [F(2,67)=3.2, p<.05] indicated the ASD group looked to the left eye of happy faces at least marginally less than the SZ (p<.05) and the TD (p=.06) groups.
- Between Eyes: A marginally significant group effect emerged [F(2,67)=3.0, p=.06] indicating that the ASD group looked between the eyes more than the TD group (p=.05).

Results

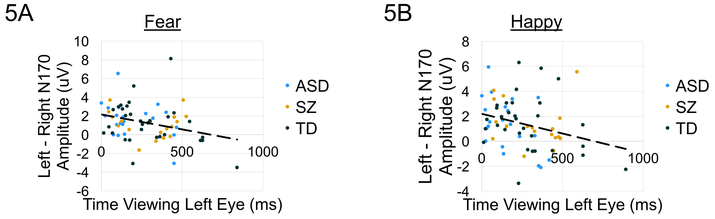

Figure 5. Relationship between time viewing the left eye and lateralization (left-right) of N170 amplitude while viewing fearful (A) and happy (B) faces.

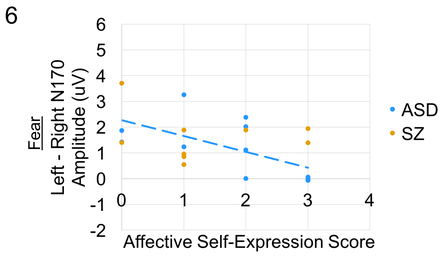

Figure 6. Relationship between affective self-expression and lateralization (left-right) of N170 amplitude in the fear condition.

- N170 and visual attention: In the fear (Figure 5A) and happy (Figure 5B) conditions, the difference between N170 amplitude across hemispheres (left-right) was calculated (i.e., more positive value indicates right lateralization). In the fear [r_s(70)=-.31, p=.01] and happy [r_s(70)=-.32, p<.01] condition less time spent looking at the left eye was related to greater right lateralization.

- N170 and affective self-expression: In the ASD group only (Figure 6), a lower unchanging facial expression score, that is, more typical affective self-expression, was related to right lateralization [r_s(11)=-.65, p<.05] in the fear condition.

Conclusions

- Transdiagnostic comparison of social function revealed both common and distinct elements of brain-behavior responses to emotional faces in ASD, SZ, and TD.
- Across groups, neural response to emotional faces was larger in amplitude and shorter in latency over right hemisphere. Additionally, fearful and happy faces elicited distinct neural responses, with a marginally larger and faster response to happy faces. This pattern was observed in individuals with ASD and SZ suggesting that directing attention to the eyes may increase sensitivity to emotional expressions.
- Across groups, more time was spent looking at the eyes of fearful faces compared to happy faces. Diagnostic differences revealed that when individuals were asked to look at the eyes, individuals with ASD looked at the left eye less and between the eyes more. Here, the experience of looking to faces between individuals with ASD, SZ, and TD may differ such that individuals with ASD may avoid direct eye contact by looking between the eyes.
- The relationship between brain and behavior in response to happy and fearful faces demonstrates that time spent viewing the left eye is related to a more lateralized brain response.
- The association between observed affect and emotional face processing may serve as a bridge between clinical phenotype and underlying biological response in ASD.

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