Developmental Neuropsychology

Brain-behavior relationships in autism spectrum disorder and typical development during an interactive social paradigm


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Background

- Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social communication and the presence of restricted and repetitive behaviors. Atypical eye contact in individuals with ASD is present early in life.7
- Individuals with ASD exhibit slower neural response to faces during passive viewing,2 and atypical gaze patterns during social scenes.7 Neural response to dynamic eye contact allows for insight into face processing in more ecologically valid contexts.8
- Right- and left-hand individuals show different viewing patterns of faces, but it is unclear whether hand preference modulates neural response to face and gaze.
- We examined whether (1) behavior, namely hand use and patterns of viewing faces, differed between individuals with ASD and typical development (TD), (2) an event-related potential (ERP) associated with early face processing, the N170, differed based on hand preference diagnosis, and (3) brain and behavior were related.

Methods

- **Table 1. Characteristics of the sample population.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Total n (male %)</th>
<th>Age m (g)</th>
<th>Qt m (g)</th>
<th>Edinburgh m (Right %)</th>
<th>EEG &amp; Edinburgh m</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASD</td>
<td>132 (73%)</td>
<td>15.9 (5.7)</td>
<td>103 (18)</td>
<td>101 (82%)</td>
<td>57</td>
</tr>
<tr>
<td>TD</td>
<td>89 (69%)</td>
<td>16.9 (6.3)</td>
<td>109 (15)</td>
<td>70 (84%)</td>
<td>55</td>
</tr>
</tbody>
</table>

Sample population (Table 1):
- All participants contributed eye-tracking (ET) data except for one individual in the ASD group due to file transfer error (total n = 132).
- A subset of these participants contributed data to hand preference (Table 1; Edinburgh m and EEG & Edinburgh m). The final sample included those with hand preference data that passed electroencephalography (EEG) artifact detection (EEG & Edinburgh m). The final ASD and TD groups were age-matched.

Experimental Data Collection:
- Hand use was assessed using the Edinburgh Handedness Inventory. Participants reported the hand used (e.g., always right hand, prefer right hand) to perform tasks (e.g., writing, brushing teeth). The Laterality Quotient (LQ) was calculated, and a LQ greater than 0 was considered right-handed.
- EEG and ET were collected concurrently during gaze-contingent simulated eye contact. 12 faces, matched on low-level visual features, were presented. The faces responded to the participant’s gaze by making (direct gaze) or breaking (averted gaze) eye contact (Figure 1).
- EEG was collected at 1000 Hz using a 128-channel Digital BrainNet. ET was collected with an EyeLink1-2000 remote camera system.

ERP Prepossessing:
- Data were filtered between 1 and 30 Hz.
- Re-referenced to average reference.
- Bandpass filtered from 100 to 500 ms relative to gaze shift.
- Baseline corrected and artifact detected.
- Trials were excluded if eye movement exceeded 1.5° of visual angle.
- The N170 (150-300 ms, post gaze shift) response was collected from occipitotemporal electrodes (Figure 2) in the left (58, 64, 59, 66, 69) and right (86, 85, 91, 94, 80) hemisphere.

ET and ERP Analysis:
- Non-parametric data were analyzed with a Mann-Whitney U Test. Parametric data were analyzed with repeated measures ANOVA (rANOVA) that included between-subjects factors of diagnosis (TD or ASD) and hand preference (right or left) and within-subject factors of condition (direct or averted) and hemisphere (EEG only; right or left). Follow-up tests included independent and paired sample t-tests, and brain-behavior relationships were analyzed with Pearson and Spearman correlations.

Results

- **Figure 3. Handedness of individuals as measured by the LQ where 100 is always prefers right hand and -100 is always prefers left hand.**

- **Figure 4. Time spent in various regions of the eyes by diagnosis.**

- **Figure 5. The N170 ERP to direct and averted gaze in left-handed (A, B) and right-handed (C, D) individuals. For each handedness group, left (A) and right (B) hemisphere, diagnosis and condition are depicted.**

- **Figure 6. The N170 amplitude in the left- and right-handed groups in response to direct and averted gaze.**

Conclusions

- The distribution of handedness between individuals with ASD and TD was marginally different. This adds to the body of literature that atypical hand preference, or weaker handedness, is present in individuals with ASD.6
- In a constrained viewing setting, individuals with ASD look to the left eye less and between the eyes more than individuals with TD. Individuals with TD demonstrate gaze bias when viewing faces. Individuals with ASD may be missing key social cues during dynamic social interactions even when cues to look specifically to a region like the eyes due in part to differences in left gaze bias.9
- Hand preference impacts laterality response as evidenced by the interaction between handedness and hemisphere in ERPs. Right-laterized neural response to direct gaze was present in right-handed individuals with ASD and to averted gaze in left-handed individuals with ASD and right-handed individuals with TD. Handedness should be considered when examining lateralized brain response to faces.2
- Relationships between neuroresponse and viewing patterns did not emerge in left- or right-handed individuals. Together, individuals with ASD demonstrated a faster neural response as time spent viewing the left eye increased. Viewing specific regions of the face may lead to more efficient face processing specifically in ASD.

References