Objective

- Autism spectrum disorder (ASD) is marked by atypical visual attention to socially meaningful stimuli.
- “Attention to socially meaningful stimuli” is designated as an a priori derived variable, but collected eye-tracking (ET) data may contain other discriminative characteristics with less straightforward lexical descriptions.
- By treating ET data as a high-dimensional input for machine learning models, the variability in these latent characteristics can train models to discriminate effectively between groups and also elucidate psychometric factors that drive gaze behavior.

Objective: To explore latent, conceptually abstract ET data patterns that have predictive power for diagnostic grouping or given clinical variables.

Methods

ABC-CT Study Details

- Methodologically rigorous, multi-site evaluation of potential biomarkers in a large sample of children with and without ASD.
- Longitudinal study evaluating children across 6 months, including clinical assessment, video-tracking during play, electroencephalograph (EEG), and eye-tracking.

Inclusion/Exclusion Criteria

- ASD Group: Age 6-11; met criteria for ASD based onADOS-2, ADI-R, and DSM-5; IQ 60-150; stable medication for 8 weeks; no sensory or motor impairments; no epilepsy; no genetic or neurological conditions; no clinically significant score on the Child and Adolescent Symptom Inventory, 5th Edition (CASI-5).
- Typically Developing (TD) Group: Age 6

Participant Demographics

<table>
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<tr>
<th></th>
<th>n (Female)</th>
<th>Age (SD)</th>
<th>IQ (SD)</th>
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<tbody>
<tr>
<td>TD</td>
<td>64 (22)</td>
<td>8.71 ± 7.7</td>
<td>114.64 ± 13.52</td>
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<tr>
<td>ASD</td>
<td>161 (10)</td>
<td>8.71 ± 1.42</td>
<td>95.80 ± 18.91</td>
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Diagnosed groups did not differ on age but were significantly different on sex (F(1,223) = 101, p<0.001) and IQ (F(1,223) = 52.746, p<0.001).

ET Acquisition & Experiment

- Binocular ET data were collected at 500 Hz using SR EyeLink 1000 Plus.
- Children were presented with static images (51, 52) images and sets of 5 images equidistant from the center of the screen (P1).

ET data with all data corresponding to social features of image (i.e. eyes, hand) removed.

Model for Regression on Clinical Variables

- The Gaussian Process/PCA model G was applied to continuous clinical variables (see Table 1 for variables investigated).
- Metric for regression: Explained variance score, measures the quality of the regression (best possible score is 1.0, a model that guesses the expectation of the variable without any learning scores a 0).
- Trained on S1, S2, and ET data.

Figure 1.

Figure 2.

Figure 3.

Results

- The significant mean difference in CASI shows that there are ET data characteristics not specific to regions of interest that differ between groups, indicating that there may be other latent measures in the ET data useful for discrimination other than attention to social stimuli.
- The eCNN model had a lower Brier score than its CNN counterpart, suggesting that the inclusion of the stimulus image's data only serves to increase the complexity of the input data without benefit to discriminative ability.
- Both the “NoSoc” and “OnlyFac” models of all three stimulus image sets scored as less accurate than their counterpart that contained all possible ET data from the trial. While these two methods do decrease the complexity of the input data, they fail to utilize data with high learning utility.
- The p2CNN model was the scorer, far outranking the others in its inability to learn differences in diagnostic groups. This may be because the collected data for this model is from a very small subset of the initial ET data.
- In the regression models, across all stimuli, the IQ measures (fsiq, viq, nviq) scored highest. Additionally, across all stimuli, the CASI-5 Inattention score also ranked relatively high in ability to be learned.
- Age was able to be predicted relatively well only in the P1 dataset, suggesting that age-related ET patterns are more likely to appear in this stimulus design versus the stimulus designs of S1 and S2.

References