Adolescents with ASD Show Attenuated Neural Response to Reciprocal Eye Contact

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Background

Difficulty with interpersonal interactions is a unifying symptom of autism spectrum disorders (ASDs). Yet most social neuroscience research in ASD has focused on passive perception of static images. Brain mechanisms subserving interactive social behavior are poorly understood.

Event related potential (ERP) studies in typical development (TD) have examined brain response to dynamic faces, revealing two components sensitive to facial movement: an occipital N170 and a central P300. Neural responses to facial movements that occur contingent to one’s own actions in the context of social interaction, such as responsive eye gaze, remain unexplored.

We investigated the relationship between visual attention to faces and neural response to shared gaze in TD and in ASD by using a gaze-contingent paradigm. We predicted:

- modulation of face-sensitive ERP components by reciprocal gaze in TD children and adults
- reduced neural sensitivity to reciprocal gaze and atypical patterns of looking to faces (i.e., the absence of a characteristic bias to look towards the left eye) in ASD

Method

Experimental Design

- **Experiment 1 (Eye Contact).** Four conditions in which participants looked to:
  - closed eyes and the eyes opened (eyes-eyelid eye-contact)
  - closed eyes and the mouth opened (eyes-mouth)
  - closed mouth and the eyes opened (mouth-eye)
- **Experiment 2 (Gaze Shift).** We examined two-conditions:
  - reciprocal direct gaze in response to participant fixation
  - averted gaze in response to participant fixation

Study Design

- Study 1 included 20 TD adults who participated in Experiment 1.
- Study 2 included a sample of 6 children with ASD and 5 TD children who participated in Experiment 1 and Experiment 2.

Data Acquisition

- ERPs were recorded using a 128 electrode Hydrocel Geodesic Sensor Net
- Eye-tracking (ET) was concurrently recorded from: Co-Registered Smart Eye Pro v5.8 and Hydrocel Geodesic Sensor Net during Experiment 1.
- Eye-tracking (ET) was concurrently recorded from: SR-Research Eyelink 1000 (Study 2)

Data Extraction

ERPs were time-locked to face movement. The minimum amplitude of the N170 was measured at occipito-temporal sites between 130 and 210 ms, and mean amplitude of the P300 was measured at central electrodes between 250 and 350 ms.

Results

**Adults: Experiment 1**

- **N170**
  - ASD: μ = 20.22, SD = 13.39
  - TD: μ = 22.73, SD = 10.22
  - t(37) = 2.34, p = .026
  - Post-hoc tests revealed that the eye-eye condition differed significantly from all other conditions (all p < 0.01).

- **P300**
  - ASD: μ = 30.68, SD = 14.92
  - TD: μ = 31.28, SD = 14.56
  - t(37) = 0.93, p = .361

**Children: Experiment 1**

- Percentage of fixations to left eye
  - ASD: μ = 52.8, SD = 14.4
  - TD: μ = 52.1, SD = 20.1
  - t(17) = 0.15, p = .882

**Children: Experiment 2**

- Percentage of fixations between eyes
  - ASD: μ = 30.2, SD = 18.6
  - TD: μ = 30.1, SD = 14.0
  - t(17) = 0.01, p = .994

Conclusions

This study co-registered EEG and eye-tracking in a gaze contingent paradigm to reveal a novel electrophysiological marker of shared gaze. This index of shared gaze was present bilaterally in TD adults and may offer promising clinical applications, such as measuring response to treatment and detecting atypical social development in infants. Work in progress assesses the plausibility of this index of gaze sensitivity.

References

2. Carr, O. et al. (2005). When eye creates the contact! ERP evidence for early dissociation between direct and averted gaze motion processing. Neuroreport, 16(13), 3299-3302.

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