Hemispheric and developmental differences in the neural processing of mutual eye contact in individuals with autism spectrum disorder

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Background

- Autism spectrum disorder (ASD) is defined by difficulties in social interaction.
- Electroencephalography (EEG) can be used to study social perception, with the N170 event-related potential (ERP) marking face-sensitive processing.
- Previous work from our group identified an ERP index of mutual eye contact in adults with typical development (TD) during a simulated face-to-face interaction, enhanced relative to other facial movements.

Method

- Participants were cued by an up or down arrow (A) to look at the eyes or mouth, respectively, of a subsequently appearing face (B).
- In response to participant gaze to the region cued by the arrow, the mouth or eyes of the face opened, resulting in 4 conditions: fixate on eyes, eyes open (eye:eye), fixate on eyes, mouth opens (eye:mouth), fixate on mouth, eyes open (mouth:eye), fixate on mouth, mouth opens (mouth:mouth).

Paradigm

Method

- EEG and ET Data Acquisition and Collection: EEG was recorded at 1000 Hz with a 128-channel HydroCel Geodesic Sensor net.
- ET data was collected using an Eyelink-1000 remote camera system.

ERF Analysis

- N170 (150-300ms) ERPs were extracted from electrodes over left and right occipitotemporal regions (electrodes 58, 64, 59, 66, 65, and electrodes 96, 95, 91, 84, 90 respectively, see Figure 1). Data were filtered at 0.1 to 0.3Hz and segmented from -100 to 500ms relative to eyes or mouth opening.
- Peak amplitude and latency were analyzed for response to gaze-contingent eye and mouth movement in repeated measures ANOVAs (with diagnostic group as a between-subject factor and face condition and hemisphere as within-subject factors).
- Pearson correlations between age and N170 peak amplitude (averaged across hemispheres) were also examined.

Results

- Across diagnoses, there were significantly stronger and faster N170 responses to mutual eye contact than to other gaze-contingent face movements, consistent with previous findings in adults with TD (Naples et al., 2017).

Conclusions

- Individuals with ASD had more right-lateralized brain activity in response to gaze-contingent faces, while individuals with TD had no significant lateralization in N170 response. This finding, which contrasts with previous literature suggesting that individuals with ASD have reduced lateralization of brain response to faces (Senju et al., 2005), may reflect the dynamic nature of the gaze-sensitive stimulus. Additionally, lateralization patterns changed across development, as older individuals with typical development demonstrated more right-lateralized patterns.

- Older individuals with ASD had stronger brain responses to mutual eye contact, while individuals with TD had no changes over the course of development. These developmental differences could reflect divergent patterns of circuit maturation or differences in intervention or treatment history across the course of development.

- As autism is a developmental disorder, future longitudinal work could better characterize developmental changes in social information processing and the relationship between neural and environmental changes.

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References:

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Figure 1. N170 response to mutual eye contact (eye:eye) differs from response to reciprocal movement or non-reciprocal face movement (mouth:mouth, eye:eye, mouth:eye) (Naples et al., 2017).

Figure 2. Selection of electrodes for analysis.

Figure 3. Grand average waveforms of left hemisphere (A) and right hemisphere (B) brain response to gaze-contingent eye and mouth movement for individuals with TD and ASD.

Figure 4. Differences in N170 peak amplitude (A) and latency (B) in response to faces displaying gaze-contingent mouth and eye movements for individuals with ASD and TD. (*) indicates right hemisphere peak amplitude significantly more negative than left hemisphere amplitude (p<0.01).

Figure 5. Change in lateralization of N170 amplitude to dynamic faces across development. (△) indicates correlations significantly different (p<0.05). RH=right hemisphere, LH=left hemisphere.

Figure 6. Change in N170 amplitude to mutual eye contact over age. There was a significant main effect of condition (B) on N170 amplitude. There was a significant main effect of condition (F1, 120)=9.0, p<0.01, such that there were faster N170s to mutual eye contact than other conditions. There was a significant main effect of condition (F1, 120)=9.1, p<0.01, such that there were faster responses in the right hemisphere.