Modulatory Effect of Context on Face Processing in Children With ASD

Coffman, M., Shultz, S., Jones, W., Klin, A., McPartland, J.

Yale Child Study Center, New Haven, CT

Developmental Electrophysiology Laboratory — Yale Child Study Center

Yale Child Study Center SINCE 1911

Background

Autism Spectrum Disorder (ASD) is characterized by difficulties in social behavior and communication.

- Face perception is a key facet of interpersonal interaction that is impaired in ASD
- Face processing is subserved by a specialized network of brain regions, including the fusiform gyrus and superior temporal sulcus
- Event-related potentials (ERPs) reveal an electrophysiological marker of face perception, the N170, that is delayed in individuals with ASD

The process of face perception is influenced by multiple perceptual and cognitive factors.

- N170 response is sensitive to basic perceptual features of visual stimuli, such as the presence or absence of and configuration of facial features
- N170 is also influenced by perceptual context, such as faces appearing in fearful versus neutral scenes
- Cognitive processes in the perceiver also influence N170 response, with face-like responses being elicited in the absence of faces when a viewer believes a face is present

The current project adapted a fMRI paradigm applied to study contextual influences on face processing in typical adults (Cox, 2004).

- Participants viewed ambiguous stimuli without facial features
- Face-sensitive regions of the fusiform gyrus activated (a) when faces or intrinsic facial features were absent but implied by context and (b) when ambiguous stimuli were viewed in social context (e.g., the presence of a human body)
- Face-sensitive brain regions flexibly adapt to available information, imputing social attributes of ambiguous percepts based on social contexts

This study examined the adaptability of perceptual mechanisms in face processing in ASD. We aimed to:

1. Examine whether response to ambiguous stimuli could be modulated in a developmental population.
   - We predicted that TD children would display ERP amplitudes modulated by social context
2. Utilize the temporal sensitivity of EEG to determine the stages of face processing influenced by social context in typical and atypical development.
   - We predicted that effects of social context on face perception would be evident at the N170
3. Determine whether face-sensitive brain regions adapt to social context in ASD.
   - We predicted that children with ASD would fail to display enhanced N170 amplitude to ambiguous stimuli after exposure to contextual cues

Methods

Study Design

- Block 1: images of faces degraded such that internal features were no longer visible (Blur Face 1)
- Blocks 2-6: intact faces alone, contextual cues disambiguating the blur face (e.g., bodies with blur faces)
- Block 7: blur faces (Blur Face 2)

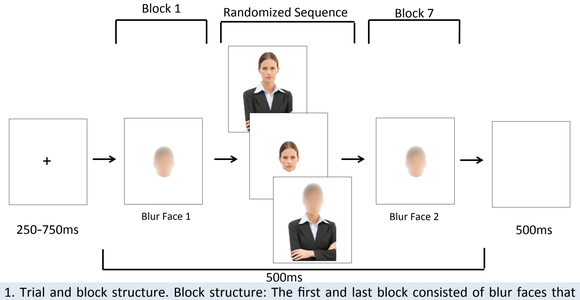

Figure 1. Trial and block structure. Block structure: The first and last block consisted of blur faces that were degraded such that internal features were no longer identifiable. Intermediate blocks provided contextual information to disambiguate the blur face. These blocks consisted of clear faces alone, clear faces on bodies, degraded faces on bodies, and bodies without a face.

Methods

Participants

- 13 TD children (Mean age = 10.89, *SD*=1.55)
- 18 children with ASD (Mean age = 9.33, *SD*=1.21)

ERP Extraction

P1 and N170 peak amplitude and latency were extracted for electrodes over occipitotemporal scalp (shown in figure 2) for the following conditions:

- First block of blur faces (Blur Face 1)
- Face stimuli from intermediate block (Face)
- Final block of blur faces (Blur Face 2)

ERP Data Analysis

P1 and N170 peak amplitude and latency were compared across conditions as follows:

(1) faces and the first block of blur faces (Faces – Blur Face 1)
(2) faces and the final block of blur faces (Faces – Blur Face 2)
(3) blurry faces *prior* to and *subsequent* to establishing social context (Blur Face 2 – Blur Face 1)

Data Acquisition

- Sampled at 250 Hz
- Impedances < 40 kOhms
- Segmented 400ms post stimulus onset
- Artifact detection
- Bad channels replaced
- Re-referenced to average
- 100ms baseline correction

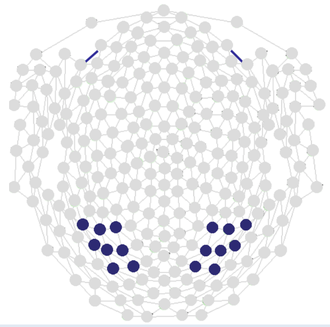

Figure 2. Electrode clusters for ERP component extraction shown in blue.

Results

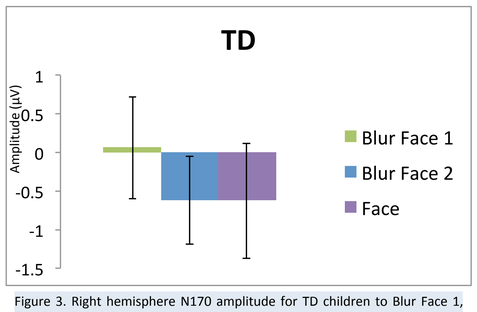

Figure 3. Right hemisphere N170 amplitude for TD children to Blur Face 1, Blur Face 2, and Face.

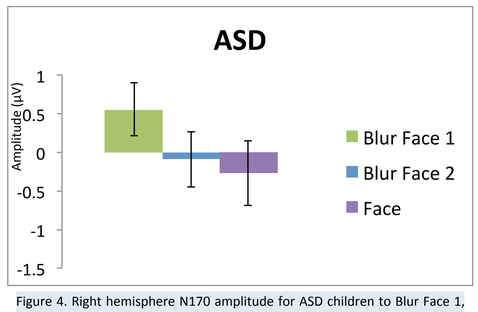

Figure 4. Right hemisphere N170 amplitude for ASD children to Blur Face 1, Blur Face 2, and Face.

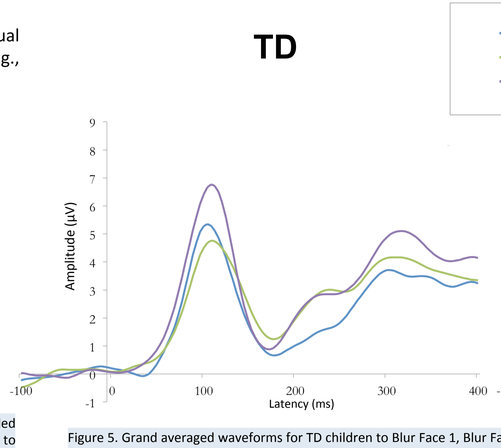

Figure 5. Grand averaged waveforms for TD children to Blur Face 1, Blur Face 2, and Face conditions over right hemisphere.

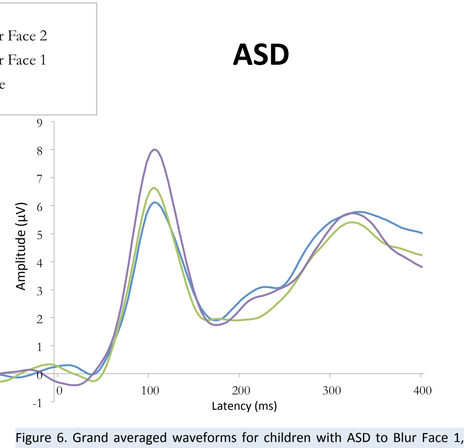

Figure 6. Grand averaged waveforms for children with ASD to Blur Face 1, Blur Face 2, and Face conditions over right hemisphere.

Results

N170 amplitude

A main effect of condition [$F(1,46) = 8.358$, $p<.01$] indicated differentiation between faces, Blur Face 1, and Blur Face 2. Post-hoc paired samples t-tests were conducted to explore results of the omnibus test:

- Relative to Blur Face 1, Blur Face 2 elicited enhanced N170 amplitude in both TD ($p<.05$) and ASD ($p<.05$) groups
- Faces elicited larger N170 amplitude relative to Blur Face 1 in both ASD ($p<.01$) and TD ($p=.06$).
- Blur Face 2 elicited comparable amplitude to faces in both TD and ASD groups ($ps>.26$).

No group by condition interaction ($F(1,46) = .515$, $p=.601$)

N170 latency

No significant effects of latency were found (All F's <1.84, $ps>.16$)

Conclusions

- Adaptability in face processing systems previously observed in adults was observed in a developmental population.
  - TD children showed enhanced processing of ambiguous stimuli subsequent to viewing contextual cues
- We found that face-sensitive brain mechanisms in children with ASD also adapted to social contextual cues.
  - Children with ASD demonstrated enhanced processing of ambiguous stimuli subsequent to viewing contextual cues
- In individuals with TD and ASD, social context modulated face processing at early stages of processing, reflecting structural encoding and marked by the N170.

Implications

Children with ASD in this study demonstrated a social bias for ambiguous stimuli in response to the provision of contextual cues. These results indicate receptivity to contextual information and flexibility in face processing mechanisms in ASD, suggesting potential treatment strategies for children with ASD.

- Scaffolding social context and increasing social learning opportunities may improve neural response to ambiguous social stimuli
- Ongoing research in our lab is exploring neural and behavioral response in young children before and after social intervention

The children with ASD in this sample did not exhibit previously observed anomalies in basic face perception. Work in progress investigates the influence of social context on face processing in children with ASD who display expected delays in face processing.

References

1.Dalrymple, K., Oruc, I., Duchaine, B., Pancaroglu, R., Fox, C., Iaria, G., Handy, T., Barton, J. (2011).The anatomical basis of right face-selective N170 IN acquired prosopagnosia: a combined ERP/fMRI study. Neuropsychologia, 49(9), 2553-63.

2.Cox, D., Meyers, E., Sinha, P. (2004). Contextually evoked object-specific responses in human visual cortex. Science, 304 (5667), 115-117.

3.Righart, R., de Gelder, B. (2006). Context influences early analysis of faces – an electrophysiological study. Cerebral Cortex, 16, 1249-1257.

4.Wild, H., Busey, T. (2004). Seeing faces in the noise: Stachasticc activity in perceptual regions of the brain may influence the perception of ambiguous stimuli. Psychonomic bulletin & review, 11(3), 475-481.

Acknowledgements

The authors gratefully acknowledge the contributions of Drs. Kevin Pelphrey and Linda Mayes and the Developmental Electrophysiology Lab. This work was supported by: NIMH (R03MH079908), NIMH K23MH086785 (JM), NIMH, R21MH091309 (JM), NARSAD Atherton Young Investigator Award (JM), CTSA Grant Number UL1 RR024139