Neural Response to Interactive Faces is Associated with Clinical Characteristics in ASD and Typical Development

Law, K., Naples, A., Levy, E., Reuman, H., Tillman, R., Stavropoulos, K., Williams, Z., Czemerinski, D., and McPartland, J.
McPartland Lab, Yale Child Study Center, New Haven, CT

Yale Child Study Center
SINCE 1911

Background

- Individuals with ASD exhibit atypical facial processing and eye contact[1]
- The P100, N170, and P300 are event-related potentials (ERPs) that index distinct stages of face perception
- Previous ERP studies indicate that face perception is affected in individuals with ASD[2]
- Social difficulties are most apparent in interactive contexts[3]
- This study examined brain response to interactive eye contact in relation to social function and dysfunction in ASD and typical development (TD)

Method

Participants

Age- and IQ-matched children with ASD (n = 27), unaffected siblings (US; n = 8), and TD controls (n = 25) participated in the study

		ASD	US	TD
Age	Mean	14.51	13.20	13.68
	SD	2.71	1.73	2.63
	Range	8.33-17.62	11.73-16.75	9.07-17.99
IQ	Mean	112.05	116.25	105.20
	SD	21.11	12.06	13.32
Sex	Males	23	3	14
	Females	4	5	11

Characterization

- Autism diagnosis was ascertained using the Autism Diagnostic Observation Schedule (ADOS)
- Cognitive ability was measured with the Differential Abilities Scale – Second Edition (DAS-II)
- Anxiety symptomatology was characterized using the Multidimensional Anxiety Scale for Children – Parent (MASC-P)

Experimental Paradigm

- EEG (128 channel Hydrocel Geodesic Sensor Net) and eye-tracking (SR-Research Eyelink 1000) data were collected concurrently, such that onscreen faces responded to participant gaze
- Participants looked to dynamic face stimuli in four conditions:
  - Looked to eyes and eyes opened (Eye: Eye)
  - Looked to eyes and mouth opened (Eye: Mouth)
  - Looked to mouth and eyes opened (Mouth: Eye)
  - Looked to mouth and mouth opened (Mouth: Mouth)

Data Extraction

- Amplitude and latency extracted for P100 and N170 at occipitotemporal sites and for P300 at central sites (Fig. 5)
- Effects of condition were analyzed for each component using separate repeated measures analysis of variance (ANOVA) with condition as a within-subjects factor and group as a between-subjects factor
- Gaze sensitivity index was calculated by subtracting the difference between reciprocal eye vs. mouth (Eye: Eye – Mouth: Mouth)
- Correlations between gaze sensitivity index and behavioral measures were computed
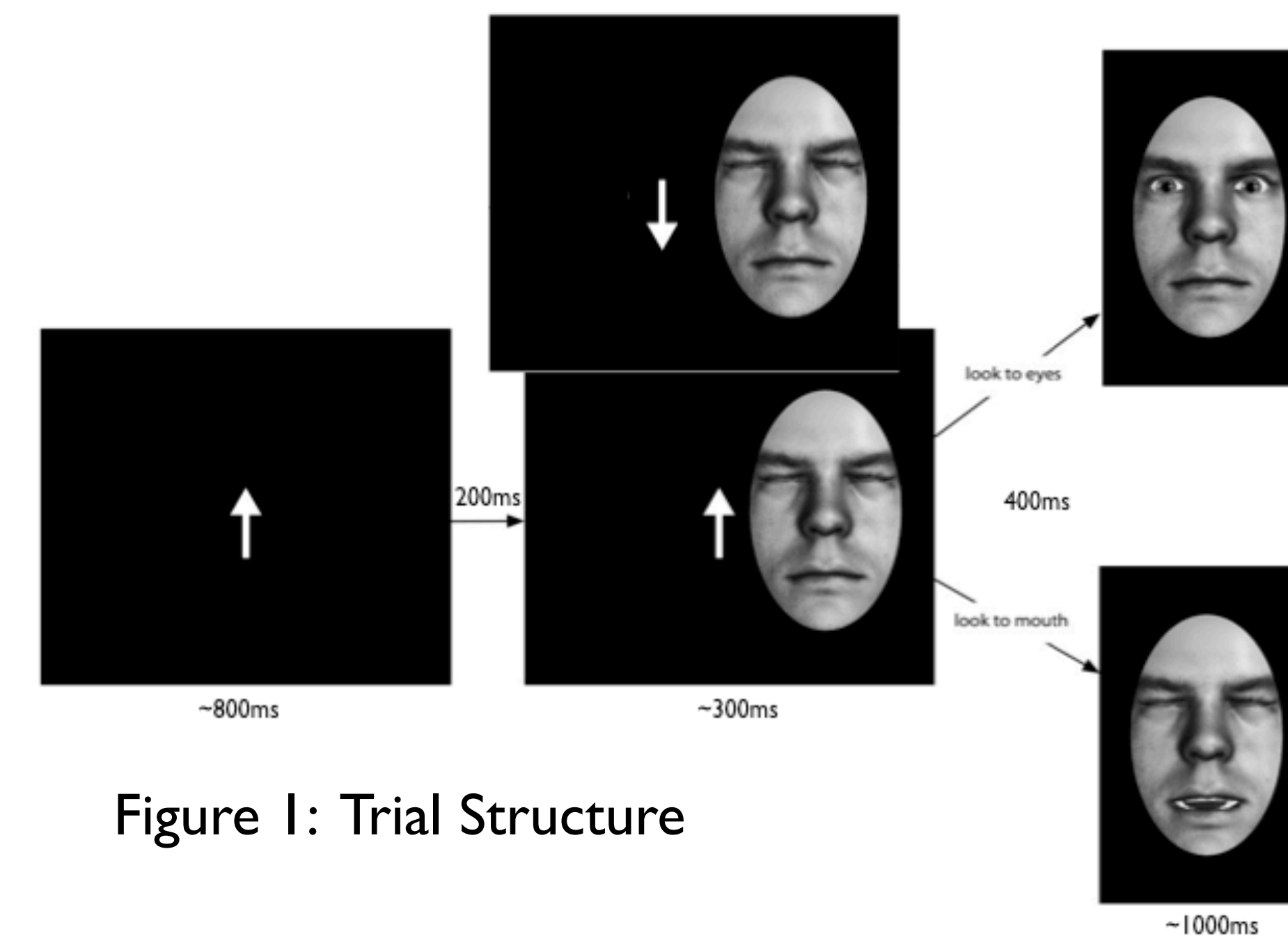
Figure 1: Trial Structure

Preliminary Results

Grand Averaged Waveforms over Right Occipitotemporal Scalp

Eye: Eye
Eye: Mouth
Mouth: Mouth
Mouth: Eye
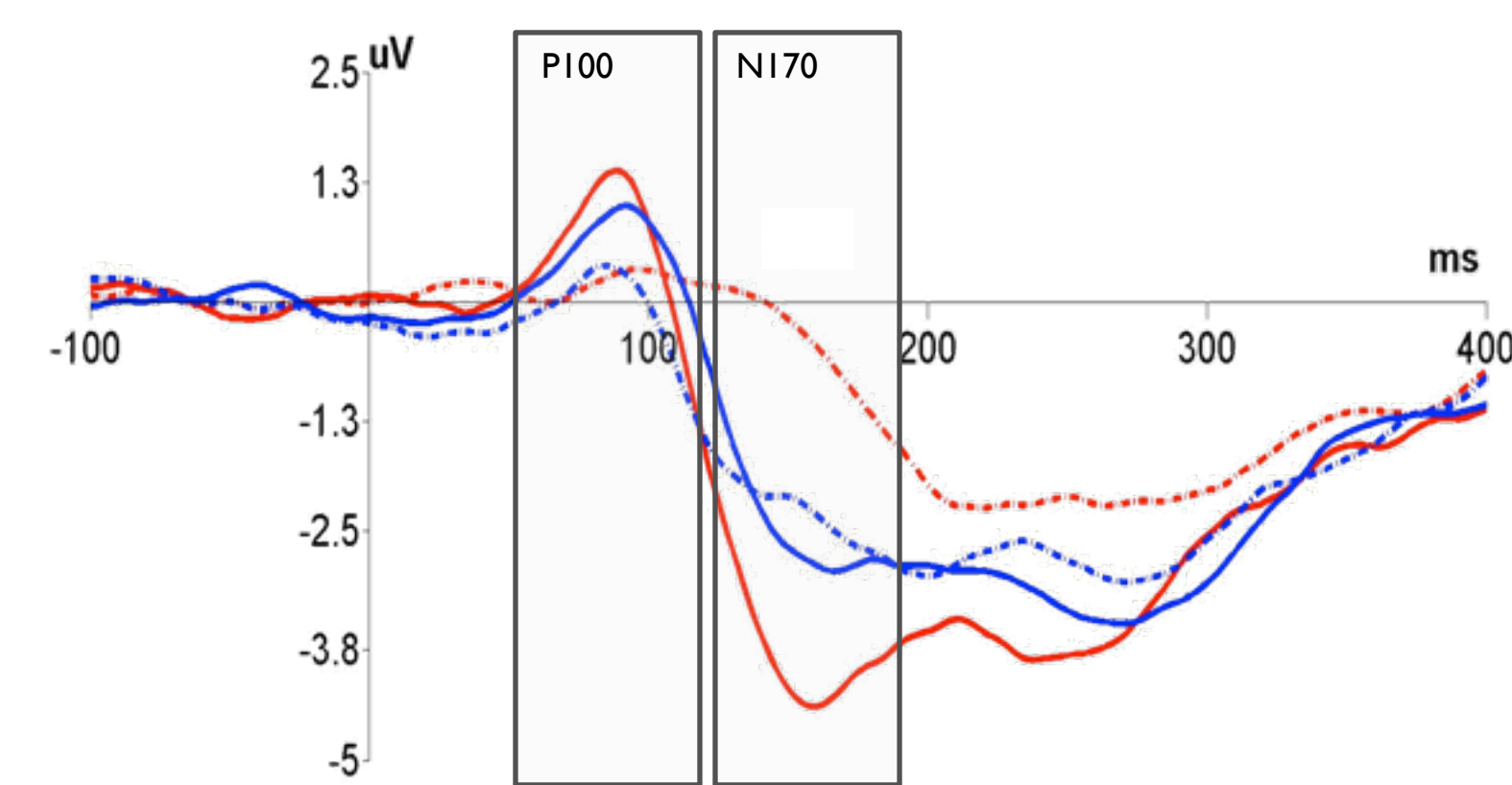
Figure 2: ASD Group
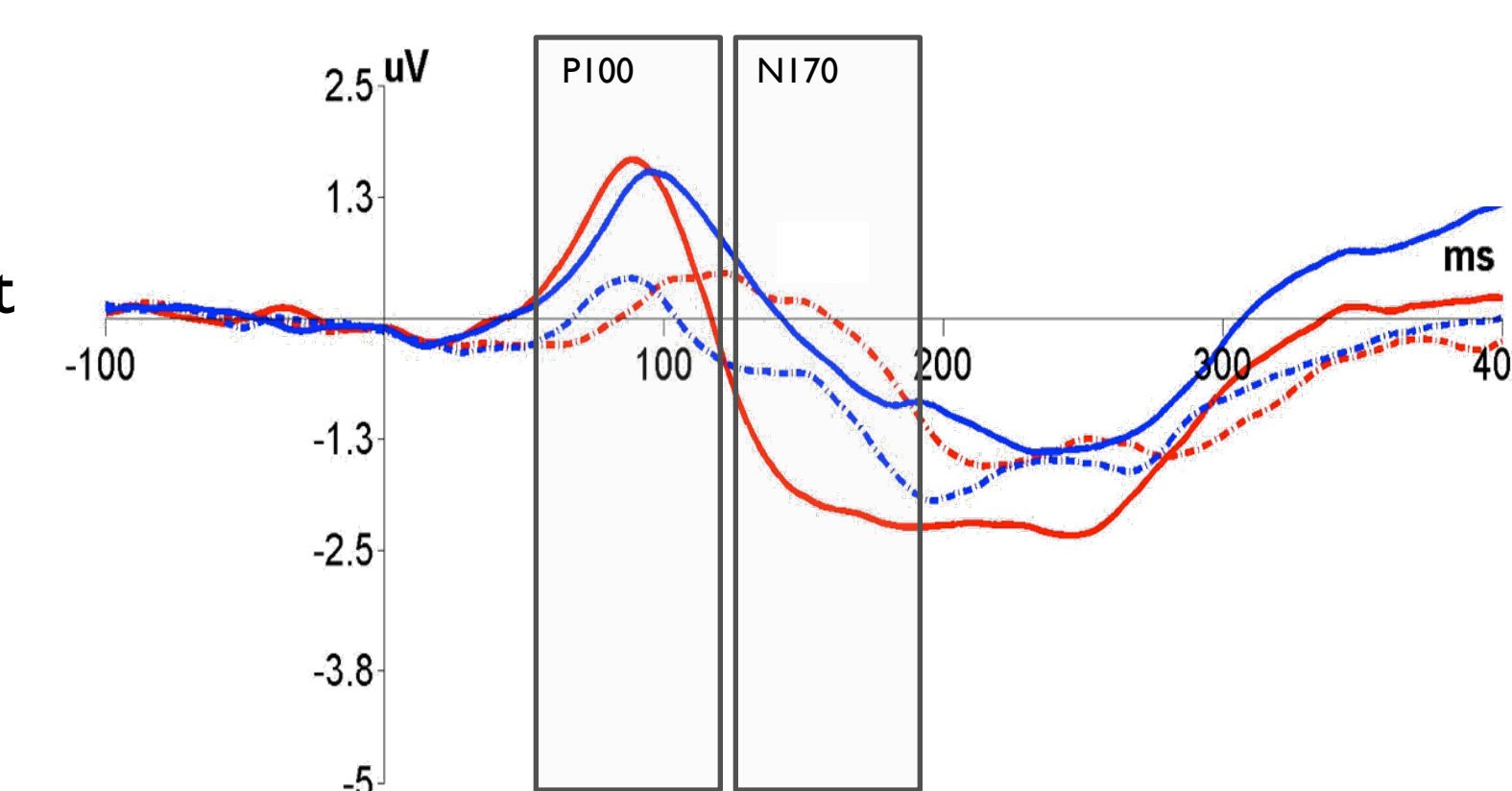
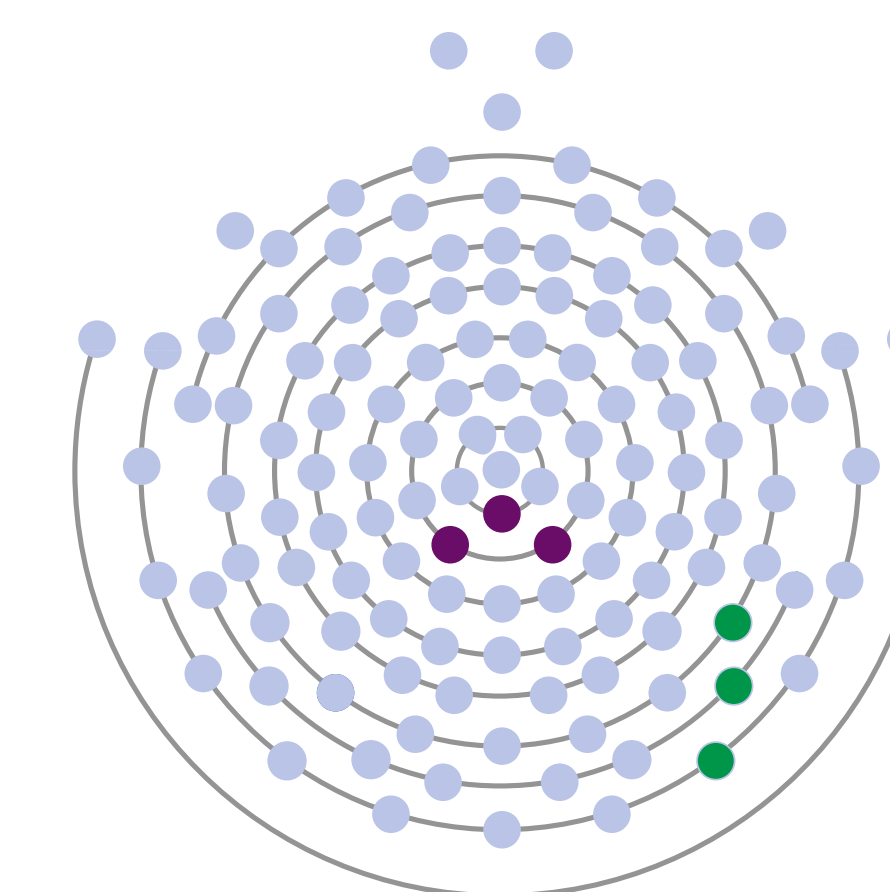Figure 3: TD Group
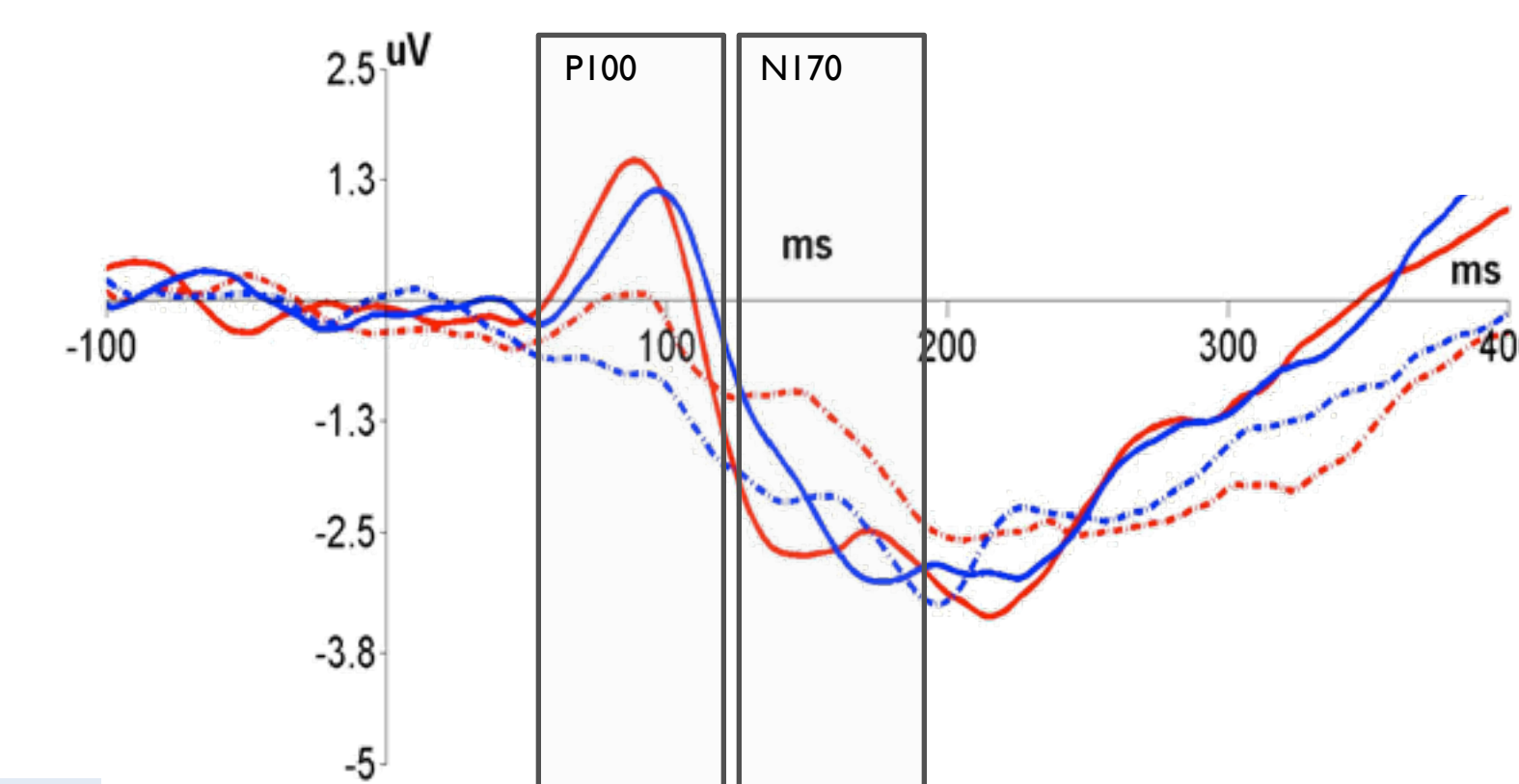
Figure 4: US Group

Figure 5: Recording sites for P100, N170 (green), and P300 (purple)
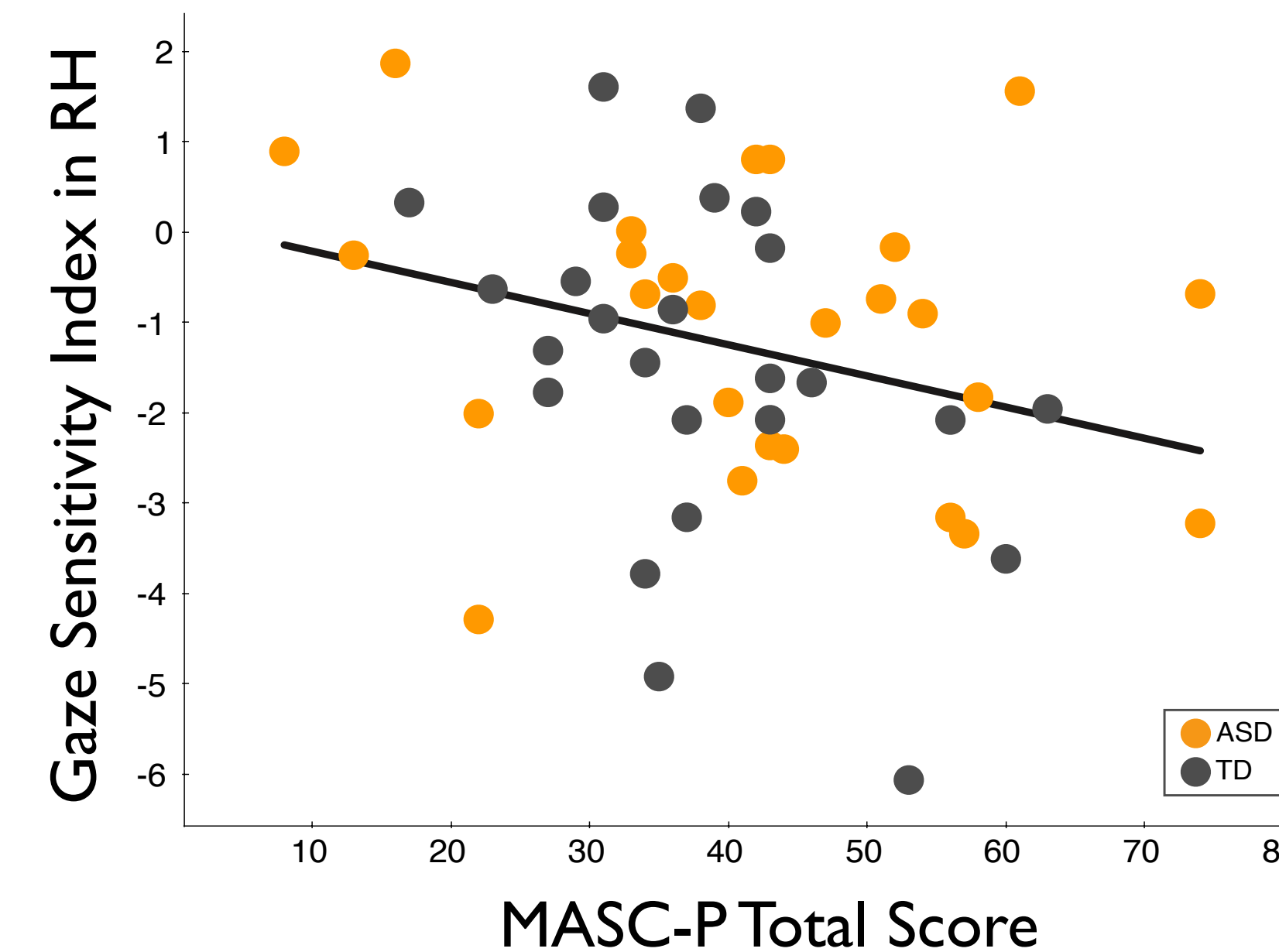

Figure 6: MASC-P Total Score and RH Gaze Sensitivity

Preliminary Results

- P100 Amplitude
  - Main effect of condition
    - $F(3, 48) = 11.20, p<0.01$
    - Eye: Eye = Mouth: Mouth > Eye: Mouth = Mouth: Eye ($ps<0.01$)

- N170 Amplitude
  - Main effect of condition
    - $F(3, 48) = 14.63, p<0.01$
    - Eye: Eye > Mouth: Mouth = Eye: Mouth > Eye: Mouth ($ps\leq0.01$)

- N170 Latency
  - Main effect of condition
    - $F(3, 48) = 4.25, p=0.01$
    - Eye: Eye < Mouth: Mouth = Eye: Mouth = Mouth: Eye ($ps<.05$)

- P300 Mean Amplitude
  - Marginal main effect of condition
    - $F(3, 48) = 2.35, p=0.08$
    - Mouth: Mouth = Eye: Eye = Mouth: Eye > Eye: Mouth ($ps<0.05$)

- Higher levels of anxiety as measured by the MASC-P Total Score were correlated with greater gaze sensitivity at the N170 ($r = -0.29, p<0.05$)

Conclusions and Future Directions

Conclusions

- This is the first investigation of the temporal dynamics of face perception in the context of interactive eye contact

- ERPs to contingent facial movement revealed distinct response patterns representing indices of social cognition:
  - P100: Early perceptual attention to motion; Enhanced amplitude in response to changes in attended facial movement (Eye: Eye, Mouth: Mouth)
  - N170: Detection of eye contact; Enhanced amplitude and increased efficiency to reciprocal eye contact (Eye: Eye)
  - P300: Salience of biological motion; Enhanced amplitude to (a) any attended facial movement or (b) eye movements, irrespective of attention (Mouth: Mouth, Eye: Eye, Mouth: Eye)

- Enhanced N170 response to eye contact was associated with higher levels of anxiety
  - These data emphasize the importance of measuring anxious symptomatology in understanding face perception in ASD

Future Directions

- Continue data collection to increase sample size

- Explore the utility of gaze-contingent interactive protocols to drive attention to the eyes and examine plasticity of neural response to eye contact

REFERENCES
[1]Klin, A., Jones, W., Schultz, R., Volkmar, F., & Cohen, D. (2002). Visual fixation patterns during viewing of naturalistic social situations as predictors of social competence in individuals with autism. Archives of general psychiatry, 59(9), 809-816.

[2]McPartland, J., Dawson, G., Webb, S. J., Panagiotides, H., & Carver, L. J. (2004). Event-related brain potentials reveal anomalies in temporal processing of faces in autism spectrum disorder. Journal of Child Psychology and Psychiatry, 45(7), 1235-1245.

[3]Rolison, M. J., Naples, A. J., & McPartland, J. C. (2015). Interactive Social Neuroscience to Study Autism Spectrum Disorder. The Yale Journal of Biology and Medicine, 88(1), 17.