Functional Analyses of Biological Motion Perception in ASD

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ABC-CT Autism Biomarkers Consortium for Clinical Trials

YALE CHILD STUDY CENTER *Where discovery inspires care*

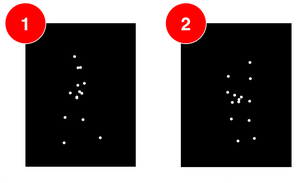
Background

- Biological motion perception (BMP) supports successful social function as it allows us to identify social conspecifics in our environments.
- Because social perception is thought to be different in autism spectrum disorders (ASD), biological motion perception has been the topic of much eye-tracking and neuroimaging research.
- Prior Event Related Potential (ERP) investigations of biological motion perception have been hindered by highly variable waveform morphologies.
- Methodological advances allow us to extract functional Principle ERPs (pERPs)[1] that capture individual variability among ERP waveform shapes without the need to measure individual waveform peaks.
- Here we sought to address two questions:
  - Can BMP be characterized using pERP analytic approaches that decompose waveforms into a reduced set of components?
  - Using these functional approaches, does biological motion perception differ between participants with ASD and a neurotypical (NT) comparison sample?

Methods

	ASD (n=213)	NT (n=113)	Statistical Test
Age (in years)	*M*=8.77 (1.57)	*M*=8.50 (1.61)	$F(1,324) = 2.1$, $p = .14$
Sex (male)	160 male	77 male	$\chi^2(1) = 1.81$, $p = .22$
DAS-II GCA (Full Scale IQ)	99.6 (17)	115.12 (12.2)	$F(1,324) = 74$, $p < .001$
Verbal Standard Score	99.4 (18.6)	115.9 (11)	$F(1,324) = 76$, $p < .001$
Nonverbal Standard Score	99.85 (16.2)	112.23 (14)	$F(1,324) = 48$, $p < .001$

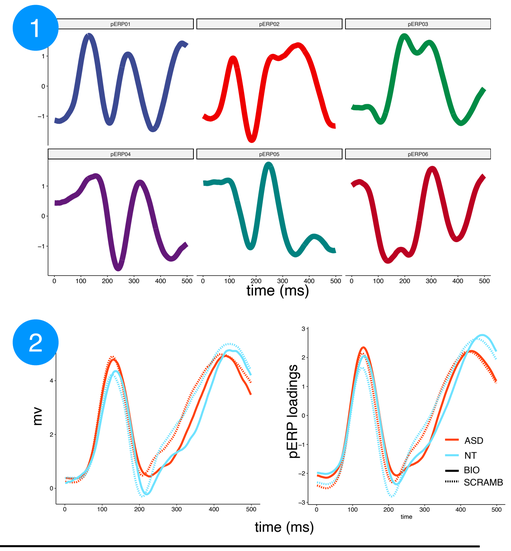
- Data were collected from 213 individuals with ASD and 113 NT controls between the ages of 6 and 11 across five sites as part of the Autism Biomarkers Consortium for Clinical Trials (ABC-CT).
- ERP data were collected using a high-density electrode montage while participants viewed one-second segments of point light animations depicting either humans walking (BIO) or phase scrambled comparison stimuli (SCRAMB).
- Principle ERPs were calculated from grand averaged ERPS across conditions and across electrodes, conforming to the 10-20 locations.
- Segmented and averaged ERPs for all participants were then processed to estimate principle ERPs (pERPs). pERPs are a set of maximally independent basis functions, or waveform shapes, shared among all participants, which represent the time courses of distinct sources of neural activity.
- In accord with our pre-specified hypotheses and prior literature, analyses were focused on right lateralized occipitotemporal sites, conforming to electrode T6 in the 10-20 nomenclature.



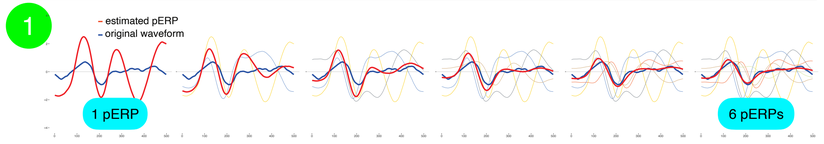
Biological (1) or scrambled (2) displays

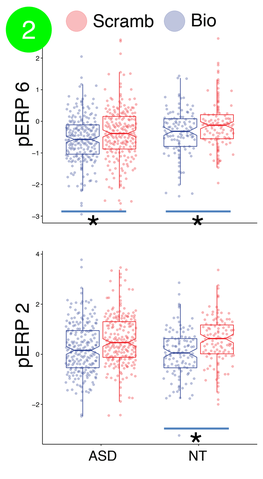
Results: Condition Differences

- Six pERPs were sufficient to explain >80% of the variance in the sample across the entire scalp.
- Of these six, two pERPs, pERP 2 and pERP 6, showed significantly different activation between biological and scrambled motion and were maximally different at occipitotemporal sites.
- The first pERP was most prominent at ~200ms ($t = 4.1$, $p < .05$), whereas the second spanned the entire time course ($t = 2.5$, $p < .05$).

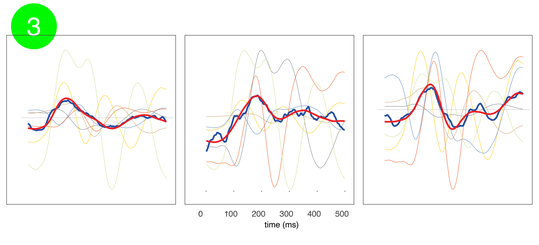


1. The estimated pERP waveforms.
2. Grand averaged ERP and pERP waveforms for diagnostic group and condition at electrode T6.

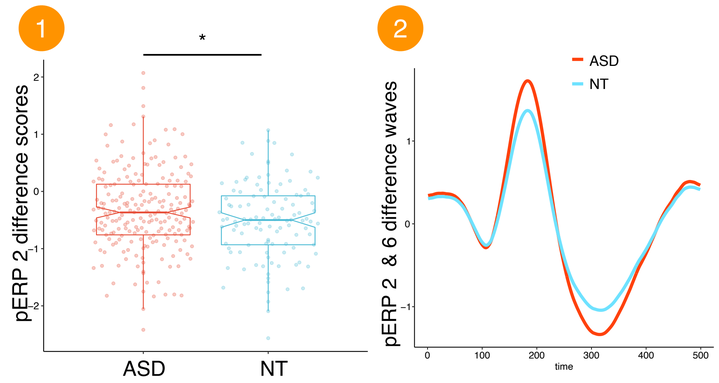




1. Evolution of pERP waveform by successive addition of pERPs for a single participant. Each panel shows the pERPs contributing to the waveform as thin lines and the composite pERP in red.
2. Diagnostic group and condition boxplots of pERP scores for pERPs 2 and 6.
3. Individual averaged waveforms and pERPs for 3 representative individuals demonstrating heterogeneity of pERP loadings despite similar averaged waveforms.



Results: Group Differences



1. An interaction with diagnostic group revealed that NT individuals, relative to ASD, showed increased differentiation between biological and scrambled motion at the pERP, impacting activity in the 200ms range ($t = 2.3$, $p < .05$).
2. The difference wave for pERPs 2 & 6 between scrambled vs biological motion across ASD and NT samples reveals maximal group differences starting in the first 200ms of processing.

Conclusions

- These data show that biological motion is differentiated from non-biological motion in the brain as early as <300ms. This time course is commensurate with facilitating the deployment of attention to socially relevant information in the environment.
- These data reveal novel differences between ASD and NT groups that capture characteristics of waveform shape, without the vulnerabilities of peak-picking or the multiple comparisons problem of sample-by-sample approaches.
- Individuals with ASD showed reduced neural specialization in this early time range. This finding suggests that reports of reduced attention to biological motion in ASD may be evident in the first milliseconds of perception.
- Ongoing analyses evaluate whether these patterns of neural activity can explain heterogeneity in clinical presentation or patterns of attention to social information.

1. Campos, E., Hazlett, C., Tan, P., Truong, H., Loo, S., DiStefano, C., ... & Şentürk, D. (2020). Principle ERP reduction and analysis: Estimating and using principle ERP waveforms underlying ERPs across tasks, subjects and electrodes. *NeuroImage*, *212*, Article 116630. https://doi.org/10.1016/j.neuroimage.2020.116630

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