Specificity of Atypical Neural Development for Language in Infants at Risk for ASD

Yang, J.F.[1,2], Reuman, H.S.[1], Brooks, E.D.[2], Hashim, P.W.[2], Travieso, R.[2], Levy, E.J.[1], Law, K.[1], Stavropoulos, K.K.M.[1], Steinbacher, D.M.[2], Landi, N.[3], Mayes, L.C.[1], Persing, J.A.[2] & McPartland, J.[1]

[1]McPartland Lab, Child Study Center, Yale University School of Medicine [2]Section of Plastic and Reconstructive Surgery, Yale University School of Medicine
[3]Haskins Laboratories, New Haven, CT

Introduction

Background:

- Atypical language development is a characteristic feature of Autism Spectrum Disorder (ASD).
- An important skill that develops before children produce speech is the ability to discriminate speech sounds.
- Abnormalities have been identified in the developmental trajectory of language perception in ASD.[1]
- However, given that multiple developmental conditions are associated with language delay, it is unknown whether these atypicalities are specific to ASD or reflective of non-specific developmental disturbance.
- Infant ERPs to speech stimuli can predict future language ability.[2]

Non-syndromic craniosynostosis (CSO; Fig. 1)

- Congenital headshape deformity resulting from premature fusion of skull sutures; associated with language delay and subsequent learning disability.[3]
- Is a non-ASD condition that affects auditory processing.
- Used as a clinical comparison group to investigate the specificity and timing of onset of atypical language processing in ASD.

Objectives:

- To contrast specific patterns of hemispheric dominance and discrimination of phonemes in infants at high risk for ASD (HR), infants with CSO, and infants at normal risk for ASD (NR).

Figure 1. An infant with CSO skull deformity [4]

Methods

Participants:

	Normal Risk for ASD	High Risk for ASD	Craniosynostosis
# Participants	24	12	13
Mean age (months)	6.66 ± 1.9	6.46 ± 2.4	7.0 ± 2.1

Methods

Experimental Design:

- Auditory presentations of two different consonant phonemes: the dental /da/ and retroflex /da/.
- 5 blocks, 20 trials per block (10 dental; 10 retroflex).
- Stimulus duration = 250 ms; ISI = 610 ms.

Data Acquisition and Analysis:

- EEG was recorded at 250Hz with a 128 channel HydroCel Geodesic Sensor Net.
- Data was processed using Net Station 4.5 software.
- Peak amplitudes of the P150 and N450 ERP components were analyzed, given their reported correlation with future language ability.[2]
  - *P150*
    - Initial positive inflection from 100-300 ms post-stimulus
  - *N450*
    - Negative slow wave from 400-550 ms post-stimulus
- Responses over left and right temporal regions (Fig. 2) were contrasted to evaluate hemispheric lateralization.
- Repeated measures analyses of variance (ANOVAs) were computed for P150 and N450 ERP components at temporal locations, with participant group as a between-subjects factor and brain hemisphere and consonant as within-subjects factors.

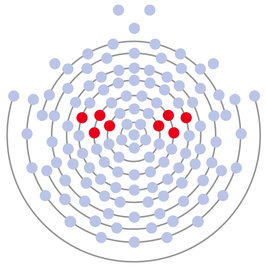

Figure 2. Electrode layout and selected clusters (Left: 29, 30, 35, 36; Right: 104, 105, 110, 111)

Results

- No significant differences in amplitude of neural response to the different phonemes across the HR, CSO, and NR infants (Fig. 3).
- Significant Hemisphere x Group interaction at N450 ($p < 0.05$)
  - NR infants displayed lateralized response to language ($p < 0.01$)
  - HR and CSO infants displayed no detectable hemisphere lateralization ($p = 0.32$ and $p = 0.60$, respectively)
- Marginal Hemisphere x Group interaction at P150 ($p = 0.06$)
  - NR infants displayed right lateralization of response to language ($p = 0.04$)
  - HR and CSO infants displayed no detectable hemisphere lateralization ($p = 0.25$ and $p = 0.57$, respectively)

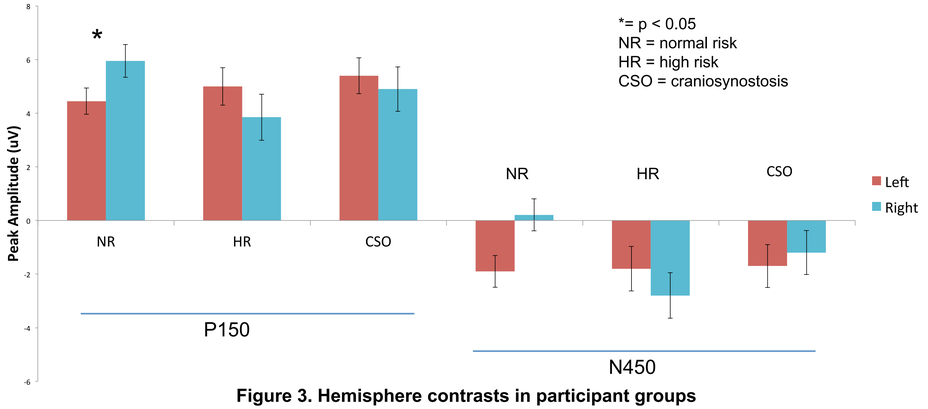

Figure 3. Hemisphere contrasts in participant groups

Results

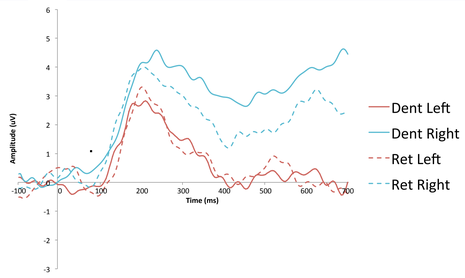

Figure 4. NR grand averaged waveforms showing lateralization at P150 and N450

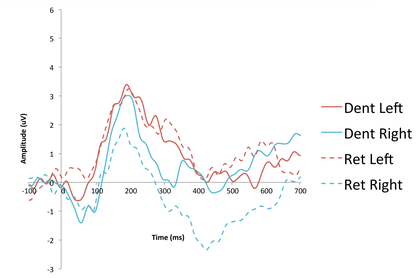

Figure 5. HR grand averaged waveforms

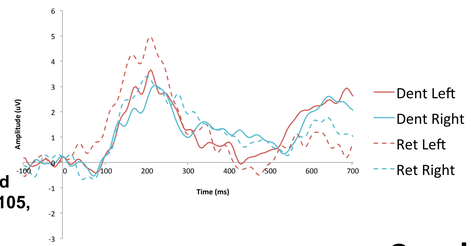

Figure 6. CSO grand averaged waveforms

Conclusions

- Our study utilized a non-ASD clinical comparison group in order to examine the specificity of atypical auditory ERPs in infants at high risk for ASD.
- Infants at NR displayed hemisphere lateralization of neural response while infants at HR and CSO did not, suggesting reduced speech perception in both patient groups.
- Shared patterns of abnormality in the two patient groups suggests that atypical language lateralization may reflect a general disruption of brain development rather than a specific biomarker of ASD.
- Ongoing research examines hemispheric lateralization in larger, equivalent samples of children across a longitudinal development span.

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