Specificity of atypical neural development for language in infants at risk for ASD

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Introduction

Background: Language delay and difficulties in communication are characteristic features of autism spectrum disorder (ASD). Atypical lateralization of neurophysiological responses to language emerge between 6 and 12 months in infants at elevated risk for ASD (Seery et al., 2012).

- It is not known whether atypical neurophysiological response to language is specific to autism or reflects general disruption in development

Our study compared high-risk infants to infants affected by non-syndromic craniosynostosis (NSC). Both disorders involve atypical language development, but NSC does not entail social impairments.

NSC is a craniofacial condition resulting in abnormal head shape:
- Caused by premature fusion at one or more skull growth sites (Fig. 1)
- Early fusion → restricted brain growth
- Associated with an increased risk of learning disabilities, especially in the areas of language (Magge et al., 2002)
- No study to date comparing atypical neural development in ASD and conditions of congenital cranial deformity.

Objectives: To contrast electrophysiological signatures of language processing in infants at high risk for ASD, infants with NSC, and infants at normal risk for ASD.

We compared two hypotheses:
(1) If atypically lateralized ERPs to language are a biomarker of ASD, then only high risk infants will display the atypical response.

(2) If atypically lateralized ERPs reflect general disruption of brain development, then both infants with NSC and those at high risk for ASD will demonstrate atypical neural response to speech.

Methods

Participants:

	Normal Risk for ASD	High Risk for ASD	Craniosynostosis
# Participants	6	3	7
Mean age (months)	9.3	8.6	8.2

Experimental Design:
- Auditory presentations of English retroflex phoneme /Da/ and Hindi dental phoneme /da/
- 5 blocks, 20 trials per block (10 English; 10 Hindi)
- Stimulus duration = 250 ms; ISI = 610 ms

Methods

Data Acquisition and Analysis:
- ERP recorded at 250 Hz using 128 channel HydroCel Geodesic Sensor Net
- Analysis focused on electrophysiological responses to the English phoneme /Da/
- Components:
  - P150
    - Initial positive inflection from 150-300 ms post-stimulus
    - Maximum amplitude extracted over the frontal scalp (Fig. 2)
  - Later negative-going slow wave (LSW)
    - Negative slow wave from 300-700 ms post-stimulus
    - Average amplitude extracted over the frontal scalp
- Responses over left and right frontal regions (Fig. 2) were contrasted to evaluate hemispheric lateralization

Figure 1. An infant with NSC and skull deformity (arrow highlights frontal skull depression)

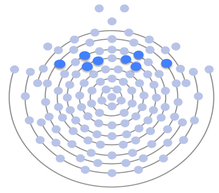

Figure 2. Electrode layout and selected clusters (Left: 19, 23, 24, 33; Right: 3, 4, 122, 124)

Results

- Repeated measures ANOVA compared lateralization in normal risk and craniosynostosis participants (high risk for ASD not included in full model due to limited sample size)
- Significant Group x Hemisphere interaction at P150 (p = 0.036), with no significant main effect of Group
- Post-hoc paired samples t-test revealed hemispheric lateralization in infants at normal risk for ASD (p = 0.043) but not in infants at high risk for ASD (p = 0.43) or NSC (p = 0.33) (Fig. 3)
- No significant Group x Hemisphere interaction over LSW (p = 0.58)

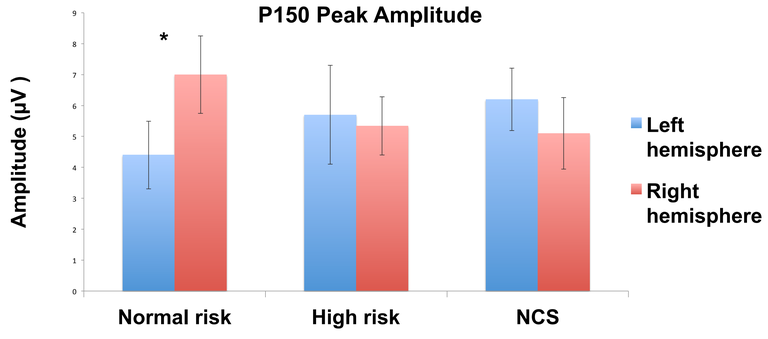

Figure 3. Hemispheric responses in participant groups

Results

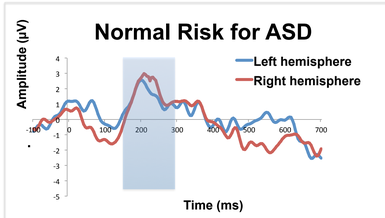

Figure 4. Waveforms from left and right frontal regions in normal risk subjects demonstrating a greater positive response over the right hemisphere than the left at P150

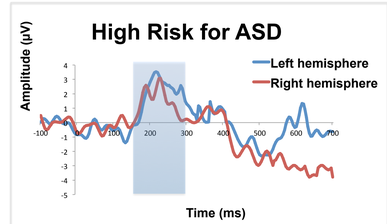

Figure 5. Waveforms from left and right frontal regions in high risk for ASD subjects demonstrating an absence of hemispheric lateralization at P150

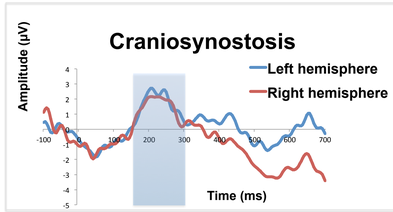

Figure 6. Waveforms from left and right frontal regions in craniosynostosis demonstrating an absence of hemispheric lateralization at P150

Conclusions

- Our study includes a novel non-ASD clinical control group in order to examine the specificity of atypical ERPs to language in high-risk infants.
- Atypical patterns of hemispheric lateralization of neural response to speech were observed in infants at high risk for ASD as well as those with non-syndromic craniosynostosis.
- These shared patterns in our two clinical groups suggests that atypical ERP responses to language may reflect a general disruption of brain development rather than a specific biomarker of ASD.

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