



EEG Indicators of the Effects of Prematurity on Cortical Maturation in Toddlers

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Introduction

Data Collection and EEG Processing

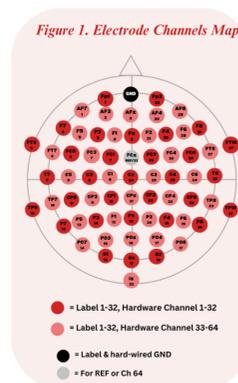
Introduction

- Children born extremely prematurely are at greater risk for developing cognitive and behavioral problems throughout childhood relative to children born full term (Jajour, 2015).
- Growing evidence suggests that alterations in brain development over the first year of life may contribute to disparities in behavioral risks related to extreme premature birth.
- However, the impact of premature birth on brain function and maturation and associated behavioral domains during toddler-hood is poorly understood.
- Using a combination of parent-report questionnaires and neuroimaging techniques, this investigation examines the relations of resting state brain activity and language outcomes in a sample of toddlers born premature.

Current Study

As part of a pre-registered study, we have the following two hypotheses:

- **Hypothesis 1:**
 - We expected that severity of prematurity would be associated with more immature patterns of cortical brain function in toddlerhood, based on resting EEG recordings and spectral analyses of EEG power.
 - Cortical immaturity would be indicated by EEG patterns of higher spectral power in the theta band (3-5 Hz) and lower spectral power in the low alpha band (5-7 Hz) and high alpha band (8-12 Hz) during resting state recordings.
- **Hypothesis 2**
 - **Testing functional significance:**
 - We expected that EEG signatures of greater cortical immaturity would be associated with greater risk for expressive and receptive language delays as indicated in parent report on a validated measure.

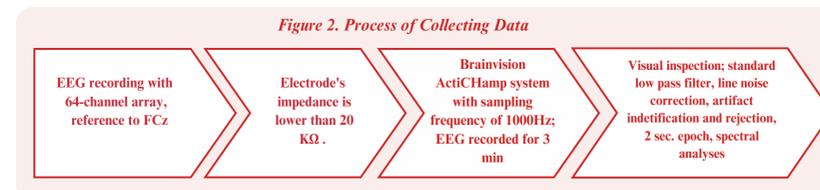


Data Collection

- Children sat in their caregiver's laps while resting EEG was recorded for 3 minutes.
- During a laboratory session, resting state EEG was recorded with a 64-electrode channel array, using an actiCHamp Brain Vision system.

EEG Processing

- The Harvard Automated Processing Pipeline for Electroencephalography (HAPPE, Gabard et al., 2018) was used to process resting EEG data.
- Spectral power in theta (3 to 5 Hz), low alpha (5 to 7 Hz), and high alpha (8 to 12 Hz) bands were computed according to established methods.



Analyses and Results

Associations between high alpha activity and age

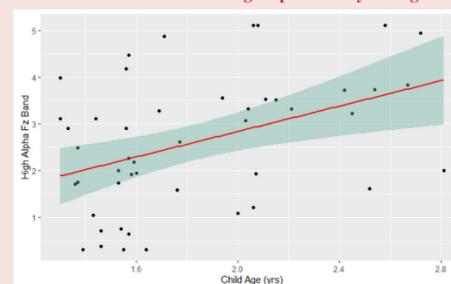


Figure 4

Hypothesis 1: Does prematurity status influence EEG power in toddlerhood?

Analysis: A one-way ANCOVA was used to examine associations between prematurity level and EEG power in toddlerhood. Age and gender were included as covariates.

Results:

As expected, child age was significantly associated with high alpha band power but not theta band power. Older children had more high alpha power than younger children (see Figure 4)

High Alpha Fz: $F(1, 43) = 11.186, p = 0.002$
 High Alpha Pz: $F(1, 43) = 7.400, p = 0.009$
 High Alpha Cz: $F(1, 43) = 7.530, p = 0.009$

Contrary to our hypothesis, prematurity status was not significantly associated with spectral power in theta, low alpha, or high alpha during rest.

Methods

Sample

- N=47 toddlers
- Sex: 62% male (N=25)
- Age: $M=1.83$ years, $SD=0.43$ years
- Levels of Prematurity
 - Gestation of 22-27 weeks (Extremely Preterm): 47%
 - Gestation of 28-33 weeks (Very Preterm): 30%
 - Gestation of 34-36 weeks (Late Preterm): 23%
- Income
 - Range= 1-8, $M= 2.58$, $SD= 2.03$
 - Income was assessed in binned responses, 8 corresponded an annual income of \$200,001 or more, 0 corresponded to an annual income of '<\$50,000 per year'.
- Race
 - American Indian or Alaska Native= 3%, Asian= 5%, Black or African American= 39%, Native Hawaiian or Other Pacific Islander= 3%, White= 50%
- Ethnicity
 - Hispanic= 56%
- Language Exposure
 - English Monolingual ($\geq 90\%$ exposure to English): N= 19
 - Spanish Monolingual ($\geq 90\%$ exposure to Spanish): N= 7
 - English-Spanish Bilingual: N= 12
 - 4 participants did not fit into the language exposure categories

Measures

- **Resting Task**
- **Child's vocabulary (Parent Reported)**
 - MacArthur-Bates Communicative Development Inventories (MB-CDIs, Fenson et al., 2006)

Hypothesis 2: Does EEG indicative of cortical immaturity associate with greater risk for expressive and receptive language delays?

Analysis: Separate linear regression models with EEG (theta, low alpha, and high alpha) power as the independent and variable expressive and receptive language outcomes as the dependent variable were run. Age and gender were included as covariates.

Result: There were no significant associations between EEG power and expressive or receptive language development.

Older toddlers were reported to have better expressive language than younger toddlers ($r = 0.35, p < 0.05$, see Figure 5).

Associations between parent-reported expressive language and age

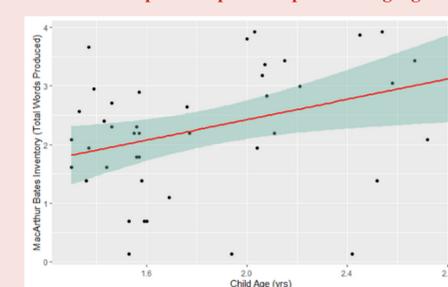


Figure 5

Discussion

Surprisingly, child age was a stronger predictor of resting EEG function than prematurity status.

This study is limited by the small sample size and varying age range. Prospective longitudinal studies that control for contextual factors may be necessary for understanding early childhood effects.

References

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