Differences in Resting State EEG Spectral Power in Infants at Elevated Risk for ASD

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Background

- Clinical diagnosis of autism spectrum disorder (ASD) can be made by two years of age
- Experimental evidence suggests earlier emergence of differences in attention and brain activity in infants who later develop ASD
- Prior work using resting state EEG has found attenuated spectral power in infants at elevated risk for developing ASD (HR) compared to normal risk (NR) infants (Tierney, 2012)
- HR infants demonstrate different trajectories for development of spectral power compared to NR infants
- Resting state EEG offers an inexpensive, non-invasive measure of cortical activity with potential to serve as a practicable biomarker of atypical development

Objective: Examine differences in resting EEG spectral power between HR-ASD and NR infants throughout the first two years of life

Method

Participants

- 41 HR and 42 NR infants were enrolled in the study at 3 or 6 months of age
- Follow-up visits were conducted at 24 or 36 months of age
- Mullen Scales of Early Learning was administered to children at follow-up
- NR and HR-NEG children received no clinical diagnosis at follow-up
- HR-POS children received a diagnosis of ASD or other developmental delay at follow-up

EEG Recording

- EEG data were recorded at 3, 6, 9, 12, 18, and 24 months of age
- 2 minutes of EEG data were recorded in a dimly lit room
- Infants sat on their parent's lap while a research assistant blew bubbles to keep them still
- EEG recorded at 500 Hz using a 128-channel HydroCel Geodesic Sensor Net

Data Processing

- EEG data were processed using the Harvard Automated Processing Pipeline for EEG (HAPPE)
  - Filtered 1-250 Hz and line noise removed
  - Bad channels were rejected
  - Wavelet-enhanced independent component analysis and independent component analysis were performed and independent components were rejected using multiple artifact rejection algorithm (MARA)
  - Segmented into 2 second epochs
  - Bad channels were interpolated, epochs containing artifact were removed, and data were average referenced
- EEG recordings that did not have a minimum length of 30s, had greater than 75% independent components rejected, had less than 25% of variance remaining in post-wavelet data, and greater than 30% artifact probability of remaining components from MARA were omitted from further analysis

Table 1: Number of infants in each outcome group included in analyses

	3m	6m	9m	12m	18m	24m
HR-POS	4	4	6	6	6	3
HR-NEG	3	7	13	11	11	8
NR	8	15	15	13	16	12

- Spectral power was extracted from left and right frontal regions of the scalp
  - Delta (δ; 2-4 Hz)
  - Theta (θ; 4-6 Hz)
  - Low Alpha (α; 6-9 Hz)
  - High Alpha (α; 9-13 Hz)
  - Beta (β; 13-30 Hz)
  - Gamma (γ; 30-50 Hz)
- Both absolute and relative power were compared across groups at each time point
- Spectral power at each age was correlated with Mullen score at follow-up

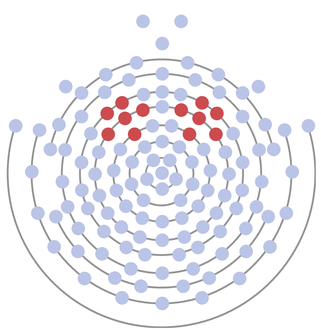
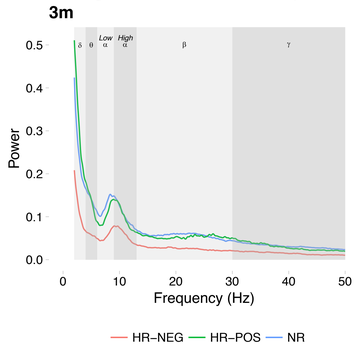
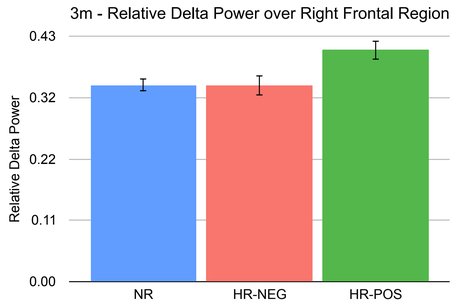


Figure 1: Electrodes in left and right frontal regions were selected for analysis

Results

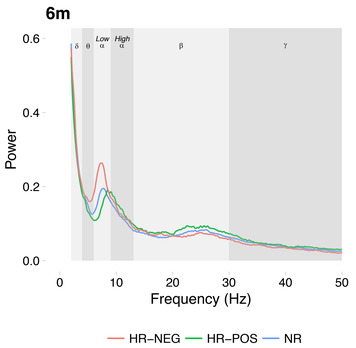
3m: HR-POS infants had greater relative delta activity over right frontal region than NR infants, p=0.024

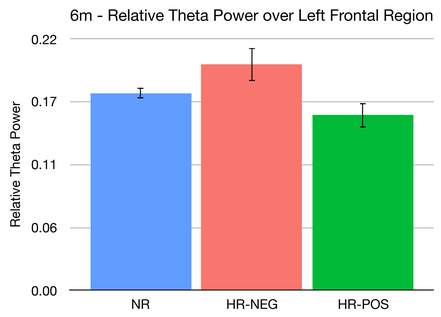


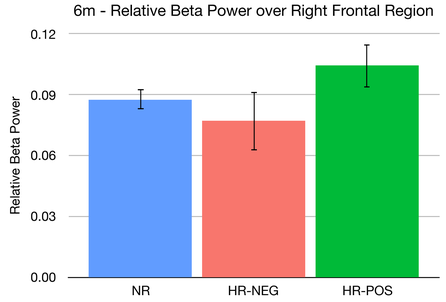


6m:

- HR-POS infants had lower relative theta activity over left frontal region than HR-NEG infants, p=0.033
- HR-POS infants had greater relative beta activity over right frontal region than HR-NEG infants, p=0.044







Behavioral

- Among the infants who contributed EEG data at 3 months:
  - HR-POS infants had lower expressive language t-scores than NR (p=0.002) and HR-NEG infants (p=0.039)
  - HR-POS infants had lower fine motor t-scores than NR infants (p=0.038)

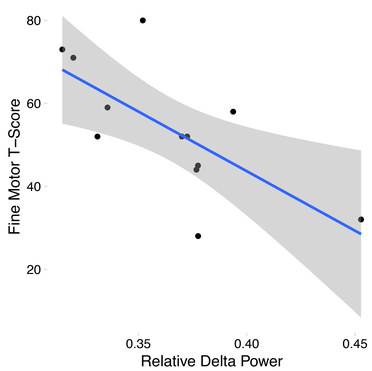


Figure 2: Greater relative delta power over frontal regions at 3 months is associated with poorer fine motor skills at 36 months (r=-.692, p=0.013)

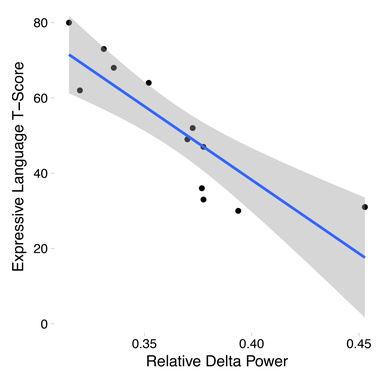
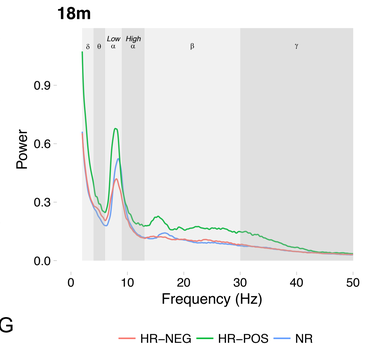
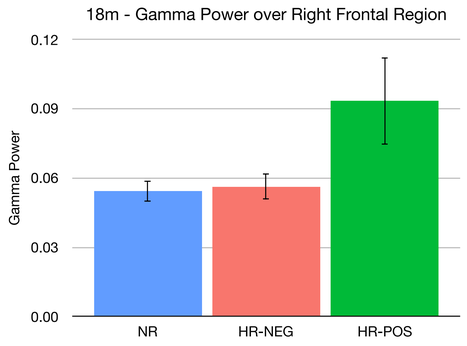


Figure 3. Greater relative delta power over frontal regions at 3 months is associated with poorer expressive language at 36 months (r=-.855, p<0.001)

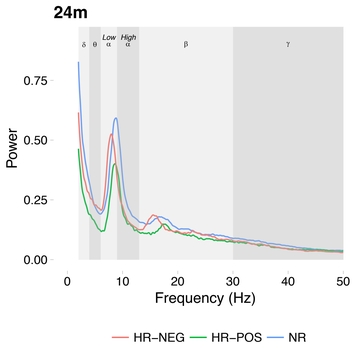
9m & 12m: There were no significant differences in spectral power detected among groups

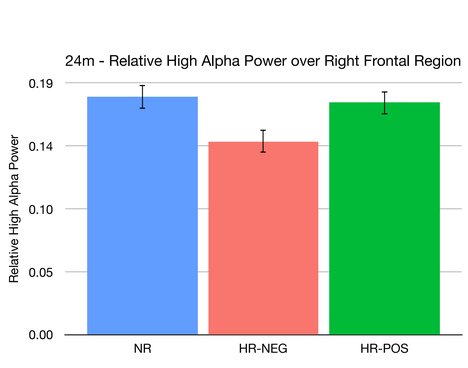
18m: HR-POS infants had greater gamma activity over right frontal region than HR-NEG (p=0.021) and NR (p=0.009) infants





24m: HR-NEG infants had lower relative high alpha activity over right frontal region than NR infants, p=0.046





Conclusions

- Preliminary results indicate both absolute and relative differences in spectral power bands among HR infants who are later diagnosed with ASD or another developmental delay and HR and NR infants who do not receive a clinical diagnosis
- These findings expand upon prior work that has identified differences in delta, theta, and alpha power across development in infants at elevated risk for ASD
- Greater relative delta power at 3 months of age was associated with poorer expressive language ability at 36 months of age
  - Levin et al. (2017) previously reported that reduced high-alpha power at 3 months was associated with poorer expressive language outcomes at 12 months of age
  - These findings suggest that EEG spectral power as early as 3 months of age can potentially hold prognostic value for later developmental outcomes
- Future analyses will explore the development of spectral power across groups over the first two years of life using hierarchical growth curves

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Acknowledgments

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