PERCEIVED BIOLOGICAL MOTION (BM) and Audio-Visual Synchrony (AVS) measures in infants: behavioral and electrophysiological indices

Biological Motion (BM)
- Sensitivity to BM emerges within the first two days of life (Simion et al., 2008).
- By eight months, typically-developing (TD) infants demonstrate adult-like patterns of neural activation to BM (Hirai & Hikami, 2005).
- The perception of BM, a precursor for attributing intentions to others, may be atypical in children with autism spectrum disorder (ASD; Klinc et al., 2009).

Audio-Visual Synchrony (AVS)
- Successful detection of temporal contingency between auditory and visual events is critical for interpreting sensory information.
- Neural facilitation of multisensory events, indexed by a significantly greater response to multisensory stimuli relative to the summed response across unimodal stimuli, has been consistently observed in TD infants, children, adolescents, and adults in electrophysiological studies (Hyde et al., 2010; Brandwein et al., 2011).

Current Study
- Two experiments assessed electrophysiological brain responses to: (1) BM versus scrambled motion (SM) and (2) AVS, in infants from birth to 24 months.
- Infants with an older sibling diagnosed with ASD were classified as high risk (HR; Ozonoff et al., 2011), whereas infants with no family history of ASD were classified as normal risk (NR).
- We evaluated the hypothesis that, relative to NR infants, HR infants would display:
  - Atypical sensory perception (i.e., hypersensitivity to BM).
  - Atypical sensory perception (i.e., weakened neural facilitation to multisensory stimuli).

PARTICIPANTS & METHODS

EEG Data Processing and Analysis
- EEG recorded continuously at 500 Hz using 128-channel HydroCel Geodesic Sensor nets.
- ERPs segmented to stimulus onset, hand-edited for artifact, averaged referenced, and baseline corrected.
- Peak amplitude for the N200R component was extracted in the Biological Motion paradigm and the Audio-Visual Synchrony paradigm.
- Minimum amplitude was analyzed using Repeated Measures ANOVA
  - Between-subjects factor: BM and AVS: Risk (HR/NR)
  - Within-subjects factors: BM: Condition (BM/SM) and Hemisphere (LH/RH); AVS: Condition (AVS/SUM)

RESULTS

9 months
- **Normal Risk Infants (NR)**
  - **Biological Motion**
    - At 9 and 12 month time points, neither HR nor NR infants demonstrated statistically significant differentiation between BM and SM conditions (p > .05).
    - At both time points, NR infants displayed a more negative amplitude to BM relative to SM, indicating increased sensitivity to human movement.
    - HR infants displayed attenuated amplitudes to BM relative to SM at both time points, indicating hypersensitivity to BM.
  - **Audio-Visual Synchrony**
    - At 9 months, NR infants demonstrated significant right lateralization in the BM condition, t(11) = -2.413, p = .034. In contrast, HR infants demonstrated significant right lateralization for the SM condition, t(11) = 2.576, p = .030.

12 months
- **Normal Risk Infants (NR)**
  - **Biological Motion**
    - At 12 months of age, NR infants displayed marginal facilitation of multimodal stimulus.
  - **Audio-Visual Synchrony**
    - At 12 months, NR infants, but not HR infants, displayed marginal facilitation of AVS relative to SUM (audio only + visual only), t(9) = 2.35, p = .10.
- **High Risk Infants (HR)**
  - **Biological Motion**
    - At 12 months of age, HR infants fail to demonstrate neural facilitation of multisensory stimuli.
  - **Audio-Visual Synchrony**
    - At 12 months, NR infants, but not HR infants, displayed marginal facilitation of AVS relative to SUM (audio only + visual only), t(9) = 2.35, p = .10.

CONCLUSIONS
- **Neural response to biological motion in HR infants between 9 and 12 months is comparable to that of NR infants.**
- **HR infants may have normative response to BM early in development, with atypical responses to BM emerging later in life.**
- At 12 months of age, HR infants fail to demonstrate neural facilitation of multisensory stimuli.
- **Early course of ASD may be associated with deficits in sensory processing.**
- **Atypical neural response in HR infants is task-specific.**
- **HR infants evidence intact BM processing during the first year of life but show reduced neural facilitation of multisensory information.**

FUTURE DIRECTIONS
- **Ongoing data collection will follow infants through diagnostic outcomes at 36 months to examine whether HR infants who do and do not develop ASD differ in their response to biological motion and/or audio-visual synchrony prior to the age at which they are diagnosed.**
- **Future work will investigate the developmental unfolding of social and sensory perception and how early developmental abnormalities may influence subsequent development.**

Acknowledgements: Autism Speaks Translational Postdoctoral Fellowship (Haples); Simons Foundation 49424 (Klin; Padmew, McPartland); NHM K25BB018785; NHM R15MH101157, RNM R15MH101157; NRSA (Andersen, McPartland, P10 HD025008, Project 1 (Chawarska), R01MH095704 (Chawarska), CTSI UL 1RR024139 (Yale)).

REFERENCES

Figure 3: Grand averaged waveforms of BM and SM for HR and NR infants at 9 and 12 month time points (N200R recording site only).

Figure 4: N200 amplitude elicited by audio-visual stimuli (AVS) and summed response to audio only and visual only stimuli (i.e., audio only + visual only = SUM) in 12 month infants.

Figure 5: N200 amplitude elicited by audio-visual stimuli (AVS) and summed response to audio only + visual only + sum (SUM) in 12 month normal risk (NR) and high risk (HR) infants.

Figure 6: Grand averaged waveforms of BM and SM for HR and NR infants at 9 and 12 month time points (N200R recording site only).