# Neural Sensitivity to Biological Motion versus Audio-visual Synchrony in Infants at Risk for Autism

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## BACKGROUND

**Biological motion**

- Perceptual sensitivity to biological motion (BM) is critical to social function and evident in infants as young as 2 days old (Simion et al., 2008).
- Neural response to BM is marked by distinct event-related potentials (ERPs) and attenuation of EEG mu rhythm (5-9Hz) in infants as young as 8 months.
- Behavioral studies reveal atypical BM perception by toddlerhood in autism spectrum disorder (ASD).

**Audio-visual synchrony (AVS)**

- Detection of temporal contingency between auditory and visual events is also evident in infancy.
- Electrophysiological studies in typically developing adults and children reveal neural facilitation to audio-visual events, marked by greater response to audio-visual stimuli relative to the sum of auditory-alone and visual-alone events.
- Toddlers with ASD display preferential attention to audio-visual synchrony (AVS) rather than the typical preference for biological motion (Klin et al., 2009).

**Study Aims**

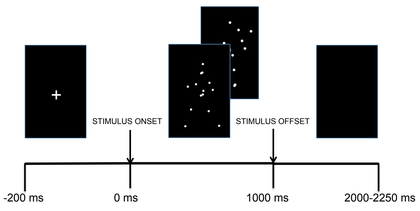
- To investigate the neural bases for observed hyposensitivity to BM and hypersensitivity to AVS in infants at high-risk (HR) for ASD.
- To investigate neural specialization for BM in infants younger than 8 months.

- Two experiments assessed electrophysiological brain responses to BM, scrambled motion (SM), and AVS in infants at elevated risk for ASD in the first year of life.
- We predicted that, relative to normal risk (NR) infants, HR infants would display
  - Hyposensitivity to BM, evidenced by reduced attenuation of EEG mu rhythm
  - Intact or enhanced audiovisual integration in HR infants

## PARTICIPANTS & METHODS

### Biological Motion Paradigm

| | Normal Risk Infants (N) | High Risk Infants (N) |
|---|---|---|
| **3 months** | 7 | 3 |
| **6 months** | 13 | 6 |
| **9 months** | 7 | 4 |
| **12 months** | 14 | 6 |

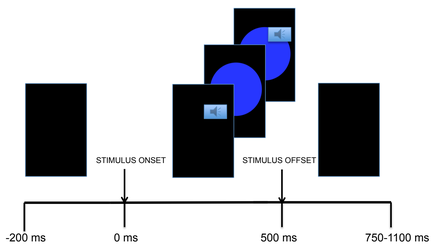



100 trials total:

- 25 point-light display walkers moving right
- 25 walkers moving left
- 25 scrambled patterns moving right
- 25 scrambled patterns moving left

### Audio-visual Synchrony Paradigm

| | Normal Risk Infant (N) | High Risk Infants (N) |
|---|---|---|
| **6 months** | 3 | 1 |
| **9 months** | 3 | 3 |




90 trials total:

- 30 audio only
- 30 visual only
- 30 audiovisual

- EEG recorded continuously at 500 Hz using EGI Net Amps 300, 128-channel Hydrocel Geodesic Sensor Nets.
- EEG and ERPs segmented to stimulus onset, hand-edited for artifact, and averaged referenced.
- Event-related power in the mu band (6-9 Hz) was computed using EEGLab.
- Peak amplitude for the Positive Slow Wave (PSW) was extracted in the Biological Motion Paradigm.
- Peak amplitude and latency for the N200 was extracted in the Biological Motion Paradigm.
- Peak amplitude for the N100 was extracted in the Audio-visual Synchrony Paradigm.

| | Normal Risk Infants | | High-risk Infants | |
|---|---|---|---|---|
| **Mullen T-scores** | 6 months Mean(SD) | 12 months Mean(SD) | 6 months Mean(SD) | 12 months Mean(SD) |
| ***Gross Motor*** | 47 (11) | 49 (16) | 45 (10) | 38 (10) |
| ***Fine Motor*** | 49 (8) | 59 (15) | 52 (11) | 62 (10) |
| ***Visual*** | 52 (7) | 53 (16) | 47 (15) | 56 (6) |
| ***Expressive Language*** | 39 (4) | 43 (14) | 42 (5) | 56 (5) |
| ***Receptive Language*** | 47 (10) | 47 (7) | 54 (6) | 56 (5) |

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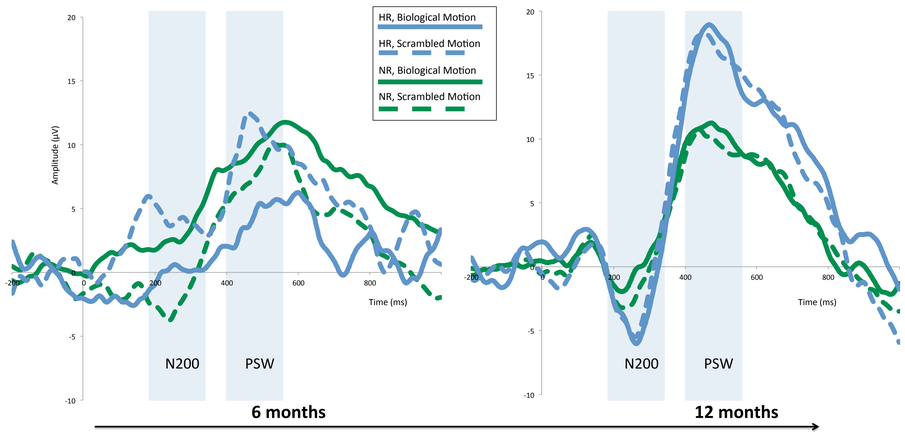


**Figure 1: Grand averaged waveforms for biological and scrambled motion for HR and NR infants at 6 month and 12 month time points.**

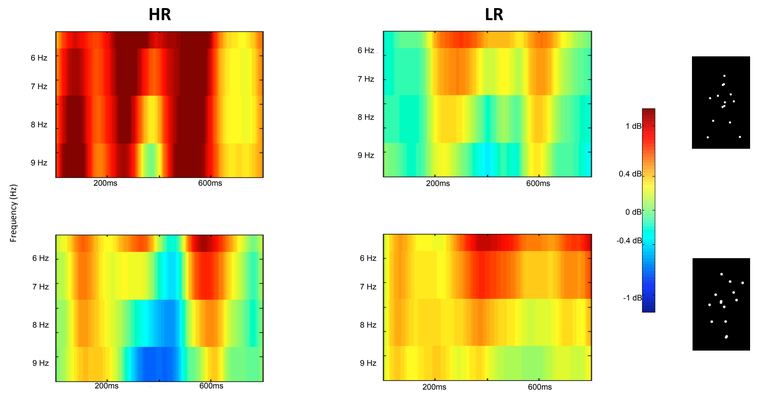


**Figure 2: Event-related Power in the mu frequency in HR and NR infants at 9 to 12 months.**

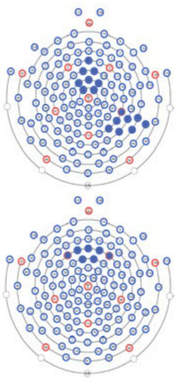

**Figure 3: BM N200, PSW, & Mu recording sites.** Data were averaged across 8 electrodes for the N200 and PSW recording sites (77, 84, 85, 90, 91, 92, 95, 96) and 8 for the mu recording sites (11, 12, 5, 13, 6, 112, 7, 106).

**Figure 4: AVS N100** Data were averaged across 8 electrodes (4, 5, 11, 12, 19, 24, 124).

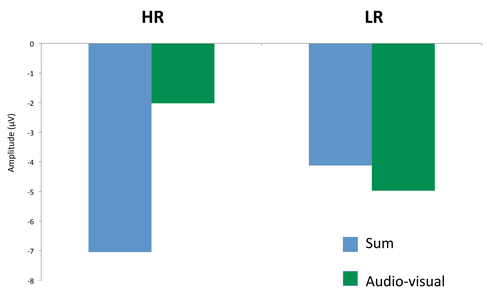


**Figure 5: Amplitude of grand averaged waveforms elicited by audio-visual stimuli and summed response to audio only and visual only stimuli in 6 to 9 month infants.**

## PRELIMINARY RESULTS

**Biological Motion**:

*N200*

- N200 morphology is not observed at 6 months in either group but is evident at 12 months for both groups.
- At 12 months, only NR infants show emergent differentiation between BM and SM.
- At 12 months, HR infants demonstrate greater amplitude compared to NR infants, irrespective of condition [BM, $t(18)=-2.48$, $p<.05$ ; SM, $t(18)=-2.37$, $p<.05$].

*PSW*

- At 6 months, NR infants exhibit enhanced amplitude to BM relative to the HR infants [$t(16)=-2.14$, $p<.05$].
- At 6 months, NR infants demonstrate enhanced amplitude in comparison to SM, whereas HR infants fail to show such a pattern.
- At 12 months, NR infants exhibit enhanced amplitude irrespective of condition.

*Mu Rhythm*

- HR infants fail to display attenuation in EEG mu rhythm to biological motion relative to LR infants at 200 ms [$t(30)=2.49$, $p<.05$], 300 ms [$t(30)=2.43$, $p<.05$], and 500 ms [$t(30)=2.49$, $p<.05$].

**Audio-visual Synchrony**:

*N100*

- Between 6 to 9 months, HR infants show reduced sensitivity to AVS, reflected in a larger summed audio-only and visual-only response than the audio-visual response.
- LR infants demonstrate typical processing of audio-visual contingency; the audio-visual response is more negative going than the summed response.

## CONCLUSIONS

- Rather than an imbalance in the processing of biological motion and audiovisual synchronous stimuli, HR infants demonstrated atypical neural responses to BM and reduced sensitivity to AVS.
- Atypical responses to BM in HR infants related to distinct electrophysiological markers of social perception at different developmental points. At 6 months, reduced differentiation was observed at the PSW, but, at 9-12 months, attenuated EEG mu rhythm indicated weaker differentiation in the action-perception system.
- Diminished responses to audio-visual contingency at 6 to 9 months in HR infants indicated co-existing anomalies in more basic processing, i.e., multi-sensory integration.
- Results suggest pervasive perceptual anomalies in HR infants rather than isolated dysfunction in social or perceptual brain circuitry. Both social processes and multi-sensory integration may represent neural endophenotypes marking early atypical development in ASD.

## FUTURE DIRECTIONS

- Ongoing data collection will follow infants through diagnostic outcomes at 36 months.
- Changing patterns of group differences across time points emphasize the importance of considering developmental trajectories of high-risk infants.
- Work in progress examines AVS in social versus non-social contexts and examines oscillatory activity indexing other cognitive processes (gamma rhythm) and its relationship to clinical characteristics.

**REFERENCES**

Klin, A., Lin, D. J., Gorrindo, P., Ramsay, G., & Jones, W. (2009). Two-Year-Olds with autism orient to non-social contingencies rather than biological motion. *Nature*, *459*(7244), 257-61. doi:10.1038/nature07868

Simion, F., Regolin, L., & Bulf, H. (2008). A predisposition for biological motion in the newborn baby. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(2), 809-13. doi:10.1073/pnas.0707021105