Interpersonal coordination in early interactions: Comparisons of infantdirected singing and speech

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Introduction

Preliminary Results

Interacting individuals coordinate their movement, behaviour, and physiological arousal. Such coordination has social consequences across the lifespan, such as greater cooperation¹, prosocial behaviour² and leader-follower dynamics^{3,4}. We are interested in two types of coordination:

- Information flow how much one signal predicts the future of another signal.
- **Similarity** how similar or correlated two signals are.

Coordinated interactions with caregivers are crucial for infant development.



Across cultures, such interactions involve **infant-directed singing** (e.g., lullabies and playsongs) and **infant-directed speech**^{5,6}. Mothers sing *lullabies* and *playsongs* differently, and impact mother-infant arousal differently⁷, perhaps serving different developmental functions.

In caregiver-infant interactions, how do social signals (e.g., body movement), and physiological signals (e.g., heart rhythm or skin conductance), coordinate? How does this differ during infant-directed singing vs. speech?

Methods

Participants

- 4 Caucasian mother-infant dyads from the Hamilton, Canada area
- Biological mothers who sing regularly to their infants (4-6 months)

Demographics Questionnaire

- Language & music background
- Race, SES

Video (Analysis in progress)

• Eye gaze and facial expressions recorded from tablets

Motion Capture

- Qualisys cameras
- Reflective markers for head, arms and torso





Physiology (Analysis in progress)

- Skin conductance
- Heart rate (see below example)
 - Mother Heart Rate (raw)



Time (min)

Infant Heart Rate (raw)

Paradigm: Mothers prepared songs familiar to their infants, and following a baseline, performed 2 min. blocks (counterbalanced):

- Singing playfully (Playsong)
- Singing soothingly (Lullaby)
- Telling the story of the songs (Speech)
- **Coordination Analysis**^{3,4}:
- 1. Movement speed =
 - $\sqrt{\frac{dx^2+dy^2+dz^2}}/dt$
- Downsampled (8 Hz) and Z-scored
- 2. Information flow (Granger Causality; GC)
- Using optimal model order from MVGC toolbox⁸
- 3. Similarity <u>(Lag-0 cross correlation; CC)</u>
 - Calculated the CC across the trials, with

1. Mothers seem to increase movement speed, while babies decrease movement speed for playsong condition.

Mothers' movements might reflect the higher arousal of playsongs compared to lullabies and speech⁷, which in turn may be more engaging for infants, leading to a reduction in movement.⁹

2. Preliminary results for information flow are variable, however for 3/4 dyads, similarity (cross-correlation) is highest for the playsong condition.

Might reflect greater rhythmicity of sound and movements in the playsong condition, allowing for better movement synchronization, leading to greater similarity in movement speed.

Issues/Next Steps:

- Didn't use infant head movement here due to headband issues, but hope to use head movements subsequently.
- Plan and incorporate physiological coordination analyses, and include video analyses for gaze and facial expressions.
- Record the audio of the mother to investigate acoustic properties of the songs/speech.

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