Bidirectional Effects of Infant-Directed Singing and Speech in Caregiver–Infant Interactions: A Planned Dual Eye-Tracking Study

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BACKGROUND

- The early social interactions between an infant and their primary caregiver set the infant up for life.
- The caregiver's social and physiological cues are among the first environmental signals experienced by their infant[1].
- The *coordination* of these signals benefit infant development:
  - **Behavioural coordination**, such as through movement, promotes a sense of affiliation and prosocial behaviour in infants[2,3].
  - Infant **physiology** (e.g., heart rhythm) is regulated through social contact with their caregiver[4].
  - Infant **gaze** has been shown to support social interaction across development, as infants as young as 2 months look to their caregiver's eyes in time with the beat of infant-directed (ID) singing[5].

- **ID singing** and **speech** are important *social cues* in early caregiver–infant interactions.
- Compared to adult-directed singing and speech:

ID Singing:
Higher pitch, more loving tone of voice, longer inter-phrase pauses, slower tempi[6]

ID Speech:
Higher pitch, expanded pitch contours, slower speaking rate, longer vowels, larger dynamic range, more rhythmicity and repetition[7]

- In adults, music and speech serve different functions:
  - Speech can convey semantic information, whereas music often conveys emotion and contributes to social bonding.
  - Speech tends to involve turn taking, while musical interactions tend to be more synchronized and to involve simultaneous production.
- Caregiver–infant interaction dynamics may differ depending on whether ID speech or singing is used.
  - This research focuses on **gaze** and **blinking** dynamics.

- **Where on the caregiver's face the infant is looking** during ID speech compared to ID singing may provide insight into which visual cues an infant is using during these moments[8,9].
- For adults, **blinking rate** is a marker of engagement: we blink less when we are engaged in something.[10]

Knowledge Gaps

- Few studies have investigated the *bidirectional* aspect of caregiver–infant interactions. That is, not only the caregiver's influence on the infant, but the infant's influence on the caregiver as well.
- Many studies on infant looking behaviour are not naturalistic in the sense that they do not involve the infant's caregiver.

RESEARCH OBJECTIVE

Using dual video-based eye-tracking, we will examine how caregivers and their infants coordinate their **gaze** and **blinking** when they interact and how this coordination differs during ID speech compared to ID singing.

HYPOTHESES

- **Younger infants (4 months) will be more engaged in ID singing**, as singing tends to be more expressive than speech and often conveys emotion. This will be marked by **increased looking to the caregiver's eyes** and a **reduced blinking rate**.
- **Caregiver and infant eye behaviour will be cyclically coordinated:** during moments when the caregiver is highly engaged and therefore blinking at a reduced rate, the infant will then also become more engaged and reduce their own blinking rate.

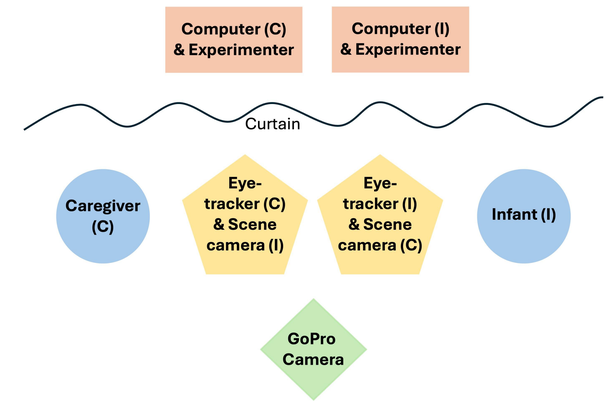
METHODS

Participants:

- Primary caregivers and their infants (4-12 months old).
- Caregivers must sing to their infants regularly.

Setup:

- Infants seated in their car seat secured to an armchair, with their parent seated across from them.
- Two EyeLink 1000 Plus eye-trackers are placed between the parent and infant, to simultaneously track their eyes.
- The scene cameras (webcams) for each are placed on top of the other person's eye-tracker (i.e., the infant's scene camera is placed on the parent's eye-tracker, pointed at the parent.
- A GoPro camera is fixed to the wall to capture a side view of the entire interaction.

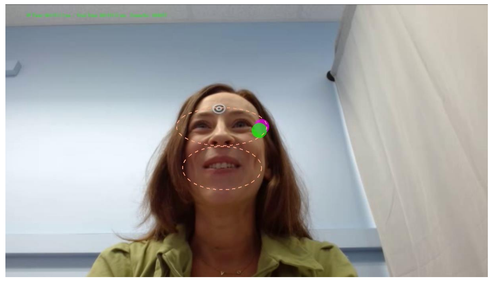


Procedure:

- EyeLink head-tracking stickers are given to the dyad as soon as they arrive. This way, the parent and infant can habituate to seeing each other with the sticker.
- Calibration: The parent performs 3-point calibration by looking at three points around the infant's face. The infant's attention is then directed to each of the parent's shoulders and sticker for their calibration.
- Counterbalanced conditions:
  - ID singing: Caregivers sing the songs they prepared in a playful way.
  - ID speech: Caregivers tell the stories of the songs as if reading from a book.
- Each trial lasts 2 minutes. The paradigm is repeated 3 times or until the infant becomes fussy.

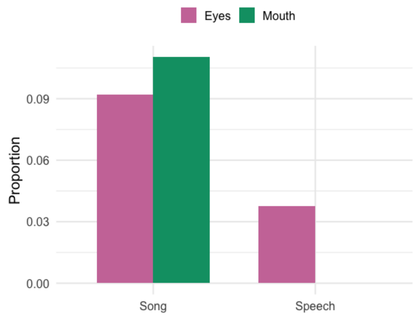
PLANNED ANALYSIS

Infant looking to caregiver's face:



- Define dynamic areas of interest to determine the proportion of infant gaze toward the caregiver's eyes and mouth

- Sample data from one pilot participant showing the proportion of infant eye-looking and mouth-looking relative to all fixations in each trial.



Caregiver–infant blinking coordination:

- Caregiver and infant blinking can be represented as two time series. We can then use measures such as cross-correlation and Granger causality to assess the coordination of the parent's and infant's blinking.
- We also plan to analyze the audio of the caregiver's singing and speech, as well as their facial expressions, to determine whether there are specific features that promote this coordination.

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