Gaze and blinking as social signals during infant-directed song and speech in early caregiver–infant interactions

Sara Ripley[1], Wei Fang[1], Rafael Román Caballero[1], Caitlyn Humber[1], Serena Zhang[1], Naiqi G. Xiao[1], and Laurel Trainor[1]

[1]McMaster University

BACKGROUND

- The early social interactions between an infant and their primary caregiver set the infant up for life.
- A 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].
  - Infant **physiology** (e.g., heart rhythm) is regulated through social contact with their caregiver[3].
  - 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[4].

- **ID singing** and **speech** are also 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[8]

ID Speech:
Higher pitch, expanded pitch contours, slower rate, longer vowels, larger dynamic range, more rhythmicity and repetition[9]

- In infants, music and speech serve similar functions (emotional, communicative).
- In adults, music and speech serve different functions.
- Caregiver–infant interaction dynamics may differ depending on whether ID speech or singing is used, with this difference growing over the first year.
  - This research focuses on **gaze** and **blinking** dynamics.

- **Blinking** is a telling social cue in adults.
  - Adult listeners blink at phrase boundaries[5] and coordinate their blinks with those of a speaker[6].
  - In adults, **blinking rate** is a marker of engagement: we blink less when we are engaged in something[7].

Knowledge Gaps:

- Blinking behaviour at phrase boundaries in caregiver–infant interactions is not well-understood.
- Many studies on infant looking behaviour relied on video stimuli and thus could not examine live, *bidirectional* caregiver–infant interactions.

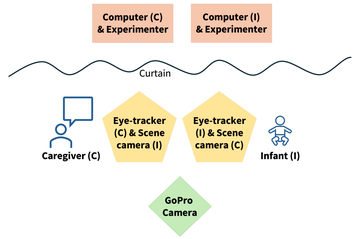
RESEARCH OBJECTIVE

Using dual video-based eye-tracking, we explore how caregiver–infant coordination differs during ID singing and speech. **Here, we present preliminary results of caregiver and infant gaze patterns including infant looking to caregiver eyes around the beats/stressed vowels of ID singing and speech, and caregiver and infant blinking around phrase boundaries.**

HYPOTHESES

1. The younger infants will look more to the eyes in both singing and speech. There caregiver will look more to the infant's eyes.
2. Infants will entrain their looking to the beat of ID singing and the stressed vowel of ID speech.
3. Infants will blink at phrase boundaries, and caregiver and infant blinking will be coordinated.

METHODS



Participants:

- Primary caregivers and their infants (4-5 months old).
- *n* = 9 dyads

Procedure:

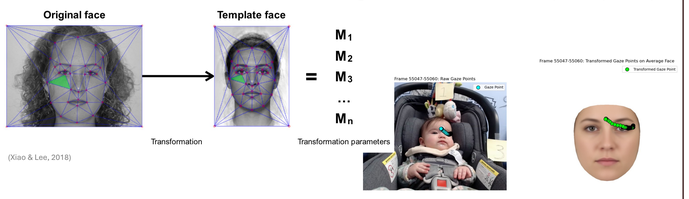
- EyeLink head-tracking stickers are given to the dyad as soon as they arrive.
- **3-point calibration:** The infant's attention is directed to each of the parent's shoulders and sticker. The parent then looks at three points around the infant's face for their calibration.

- **3 trials of ID singing, 3 trials of ID speech**
- Randomized, 2 minutes each:

"[Sing or speak] to your baby in a way to keep their attention and keep them happy."

Data Analysis:

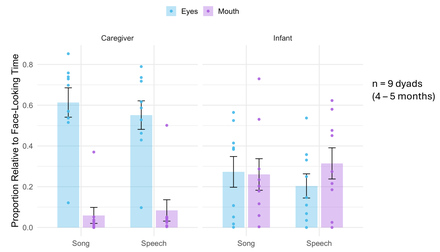
- **Areas of interest** were defined using in-house software (iTemplate)[10].



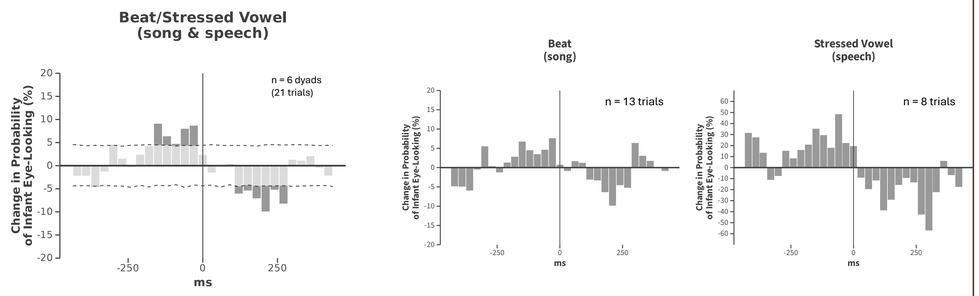
- **Metrically strong beats** (ID song) and **stressed vowel syllables** (ID speech) were manually coded in Praat.
- **Blinks** and **phrase boundaries** were coded in Datavyu.
- Peristimulus time histograms show the probability of blinking around the phrase boundaries, and the probability of infant eye-looking around the beats/stressed vowels.
- Circular shift permutations were used to establish the baselines, where the 5th and 95th percentiles of the permuted data served as the upper and lower bounds.

PRELIMINARY RESULTS

Proportion of caregiver and infant looking to the eyes and mouth:

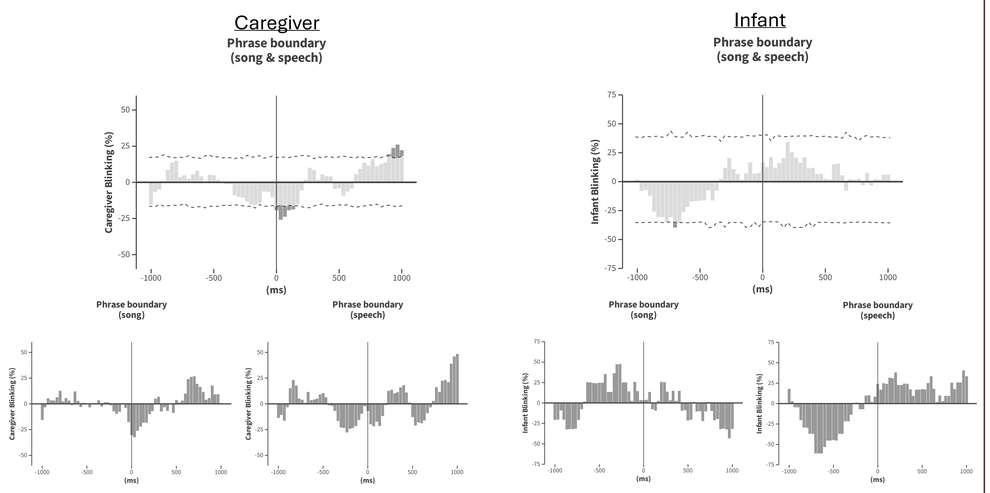


Infant eye-looking to the beat of ID singing & speech:



- Infant looking patterns to the caregiver's eyes seem to coordinate with the beats of caregiver singing and speech in a naturalistic setting.
- The probability of infant looking to the eyes is highest just before the beat.

Blinking at phrase boundaries:



- Caregiver and infant blinks may be coordinated around the phrase boundaries.
- Infant blinking aligns with adult findings of blinking at phrase boundaries.

REFERENCES

1. Feldman, R. The Neurobiology of Human Attachments. *Trends Cogn. Sci.* 21, 80–99 (2017).
2. Cirelli, L. K., Einarson, K. M. & Trainor, L. J. Interpersonal synchrony increases prosocial behavior in infants. *Dev. Sci.* 17, 1003–1011 (2014).
3. Feldman, R., Magori-Cohen, R., Galili, G., Singer, M. & Louzoun, Y. Mother and infant coordinate heart rhythms through episodes of interaction synchrony. *Infant Behav. Dev.* 34, 569–577 (2011).
4. Lense, M. D., Shultz, S., Astésano, C. & Jones, W. Music of infant-directed singing entrains infants' social visual behavior. *Proc. Natl. Acad. Sci. U. S. A.* 119, e2116967119 (2022).
5. Hömke, P., Holler, J. & Levinson, S. C. Eye Blinking as Addressee Feedback in Face-To-Face Conversation. *Res. Lang. Soc. Interact.* 50, 54–70 (2017).
6. Nakano, T. & Kitazawa, S. Eyeblink entrainment at breakpoints of speech. *Exp. Brain Res.* 205, 577–581 (2010).
7. Shultz, S., Klin, A. & Jones, W. Inhibition of eye blinking reveals subjective perceptions of stimulus salience. *Proc. Natl. Acad. Sci.* 108, 21270–21275 (2011).
8. Nguyen, T., Flaten, E., Trainor, L. J. & Novembre, G. Early social communication through music: State of the art and future perspectives. *Dev. Cogn. Neurosci.* 63, (2023).
9. Corbeil, M., Trehub, S. & Peretz, I. Speech vs. singing: infants choose happier sounds. *Front. Psychol.* 4, (2013).
10. Xiao, N. G. & Lee, K. iTemplate: A template-based eye movement data analysis approach. *Behav. Res. Methods* 50, 2388–2398 (2018).