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RESEARCH ARTICLE

Do face-to-face interactions support 6-month-olds' understanding of the communicative function of speech?

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Abstract
Infants by 6 months recognize that speech communicates information between third parties. We investigated whether 6-month-olds always expect speech to communicate or whether they also consider social features of communication, like how interlocutors engage with one another. A small sample of infants watched an actor (the Speaker) choose one of two objects to play with (the target). When the Speaker could no longer reach her target object, she turned to a new actor (the Listener) and said a nonsense word. During speech, the actors were either face-to-face, the Speaker was facing away from the Listener, or the reverse. When the actors had been face-to-face, infants looked longer when the Listener selected the non-target object compared to the target. Infants looked equally regardless of what the Listener chose when either actor had been disengaged. Area-of-interest gaze coding suggests that infants were similarly interested in the interaction across conditions, but their pattern of attention to Speaker and Listener differed when the Listener was disengaged during speech. Although these experiments should be replicated with a larger sample, the findings provide initial evidence that 6-month-olds do not expect speech alone to communicate, but also attend to the social context in which speech is produced.

1 | INTRODUCTION

Face-to-face interactions are the basic setting of human communication (Clark, 1996; Fillmore, 1981). Interlocutors who are facing, and looking towards, one another during conversation can easily infer that they are mutually engaged in the interaction. Third party observers can also use these cues of mutual engagement to infer that communication is likely occurring, as well as determine who is talking to whom. Although adults are certainly able to recognize communication when interlocutors are not face-to-face, facing interlocutors are a strong and often sufficient indicator of a communicative interaction (Clark, 1996). Given the importance of such cues of mutual engagement to adults' inferences about communication, do cues of mutual engagement (e.g., convergent body and face orientation with eye contact) support infants' early understanding of the communicative function of speech?

Infants are attentive to communicative signals and key features of communicative interactions early in life. Newborns show a preference for speech over other sounds (Vouloumanos & Werker, 2007) and, by 5 months, infants associate speech with its typically human source (Vouloumanos et al., 2009). By 6 months, infants consider the contexts in which speech is likely to be produced; for instance, they expect speech to be produced by a human in the presence of humans rather than objects (Legerstee et al., 2000; Molina et al., 2004). Six-month-olds also recognize that speech can communicate information from one person to another (Vouloumanos et al., 2014). After familiarization with one actor's (the Communicator) repeated selection of a target object over a distractor, infants expected a naïve Listener to select the Communicator's target in response to the Communicator's speech but not her coughing. Thus, even at an early stage of word learning, preverbal infants appreciate the role of speech in transferring information.

However, for an adult, the production of speech is not always sufficient for communication to take place. If a waiter at a restaurant were to approach someone and say, “can I take your order?,” it would be surprising (and rude!) for a customer at another table to yell out, “I'll have the fish!” Verbal communicative interactions have both linguistic (the content of speech) and social (the circumstances surrounding speech) components. Mutual engagement—a typical social feature of these interactions—can therefore influence our inferences about information transfer in communication. If the waiter meant to talk to someone other than the person who responds, or if the intended customer was not paying attention, we would likely judge that the speaker and addressee were not mutually engaged and thus that communication is less likely to succeed. Infants might start out with an expectation that the production of speech results in information transfer (Vouloumanos et al., 2014), regardless of the social context in which speech is used. Yet another possibility is that infants attend to cues of mutual engagement when someone speaks, and that these cues support their expectation of successful communication.

Infants attend to cues of engagement in their own social interactions from birth (Csibra, 2010). Even before the emergence of joint attention, newborn infants can discriminate between mutual and averted gaze from an adult interaction partner (Farroni et al., 2002) and, by 3 months, interact differently with people who are facing them than with people who are facing away from them (Striano & Stahl, 2005). Infants also begin to follow another person's gaze direction by 4 months (D'Entremont, 2000; D'Entremont et al., 1997; Gredebäck & Melinder, 2010), and by 6 months not only can infants reliably track the object of another person's gaze when communicative cues are present (Senju & Csibra, 2008), but their pattern of visual attention to a third-party communicative interaction is influenced by viewing interlocutors in the prototypical face-to-face orientation (Augusti et al., 2010).

In Augusti et al. (2010), 6-month-olds (but not younger 4- and 5-month-olds) made more gaze shifts to follow the flow of conversation between speakers who were facing each other than speakers who were facing apart (a finding which is also supported in 24-month-olds; Thorgrimsson et al., 2015). Importantly, infants must have been sensitive to face-to-face interactions or eye contact, rather than only the gaze direction of whoever was speaking; when the two speakers faced the same direction (i.e., one was always looking at the back of the other's head) infants again showed reduced gaze shifts, as in the back-to-back interaction. However, although infants made more gaze shifts in face-to-face interactions, their overall fixation duration to the display did not differ between the face-to-face and facing away interactions (Augusti et al., 2010). Thus, viewing face-to-face interlocutors may facilitate infants' ability to follow a communicative interaction or signal to them that communication is likely to occur, but infants do not necessarily expect (or show increased attention to) mutual engagement between interlocutors.

Since cues of mutual engagement may facilitate infants' ability to track communicative exchanges as early as 6 months, do these cues also support infants' early understanding of the communicative function of speech in transferring information? The current study investigates whether mutual engagement between communicative partners—operationalized as whether each person is looking at and facing the other when speech is produced—influences how 6-month-old infants evaluate the outcome of a communicative interaction. Previous work (Martin et al., 2012; Vouloumanos et al., 2014) presented an interaction with prototypical social features where speech was always produced when the interlocutors were mutually engaged, and so could not assess whether infants' expectations rely only on the presence of speech or also on features of the social context.

In the current study, infants were presented with a third-party live action play (Martin et al., 2012; Vouloumanos et al., 2014). First, they were familiarized with an actor (the Speaker) alone on stage selectively reaching for and playing with a target object. Next, they saw another actor (the Listener), alone in a different part of the stage, looking at and playing with both objects equally. In the test scene, the Speaker, who could no longer reach the objects, turned to the Listener and uttered a novel word, "koba." During speech, the actors were either facing each other (Mutually-Engaged condition, designed to replicate Vouloumanos et al., 2014); the Speaker was facing away from the Listener (Speaker-Disengaged condition); or the Listener was facing away from the Speaker (Listener-Disengaged condition). After the Speaker spoke, the Listener either presented the target or the non-target object.

If infants treat mutual engagement as an important indicator that communication will succeed, they should only look longer when the Listener selects the non-target rather than the target object when the two actors were mutually engaged during speech. If, however, 6-month-olds think the production of speech will result in a successful communicative outcome regardless of engagement between social partners (or generally associate speech with the target object), they should look longer when the Listener selects the non-target rather than the target object in all conditions. It is also possible that infants consider it to be particularly important that the Speaker is looking at the Listener, or that the Listener is looking at the Speaker during speech.

In addition to the main question of how mutual engagement influences infants' evaluation of the outcome of the communicative interaction, we conducted exploratory analyses focusing on infants' pattern of attention during the action portion of the test scene. Previous research found that 6-month-olds make more gaze shifts between interlocutors during a conversation depending on whether the Listener and Speaker were facing one another or not (Augusti et al., 2010). A study using a similar adaptation of the Martin et al. (2012) procedure also found that 12-month-olds showed differential attention to the interlocutors depending on the communicative context, in particular, increased attention to the Speaker if she produced a cough (a non-communicative vocalization) rather than speech (Yamashiro & Vouloumanos, 2018). We wondered if we might similarly find different patterns of attention to interlocutors between our conditions based on communicative disengagement. We therefore looked at whether infants' overall attention to the actions, their overall attention to Speaker versus Listener (Yamashiro & Vouloumanos, 2018), and their gaze shifts between Speaker and Listener (Augusti et al., 2010; Thorgrimsson et al., 2015) differed between conditions.

2 | METHOD

2.1 | Participants

We tested forty-eight, full-term, healthy infants (mean age = 6 months, 6 days; range = 5 months, 20 days to 6 months, 20 days)—16 in the Mutually-Engaged condition (eight female), 16 in the Listener-Disengaged condition (eight female), and 16 in the Speaker-Disengaged condition (eight female). An a priori power analysis (GPOWER; Faul et al., 2007) based on the effect size of $\eta^2 = 0.21$ ($f = 0.52$) from the interaction in Vouloumanos et al. (2014) (testing infants in the same age group also using a 2×3 between-subjects design and the same basic procedure) indicated that a total sample size of 45 would yield power of 0.85 to detect an interaction between condition and outcome at an alpha level of $p < .05$. Five additional infants were tested (three in the Listener-Disengaged condition and two in the Speaker-Disengaged condition) but were excluded from final analyses due to crying (1), not watching during critical events (2), acting (1)[1], or coding error (1). Exclusion criteria were set in advance of the study based on research using the same experimental paradigm. Participants were recruited via a database of families in Wellington, New Zealand who expressed interest in volunteering for research. Most families were white, middle-class, and from entirely English-speaking households. Participation was voluntary, and infants received a small gift for their participation. All research was conducted according to the Declaration of Helsinki guidelines, with written informed consent obtained prior to participating in the study. This research was approved by the Victoria University of Wellington School of Psychology Human Ethics Committee (Application #0000023076).

2.2 | Stimuli and apparatus

Infants were seated on their caregiver's lap. Caregivers were seated on a chair which was positioned directly facing and center to the stage from approximately 70 cm away. The stage was made up of two, curtained–off side panels, a back made of foam board covered with white marble contact paper, and a light granite colored foam board floor. A square was cut out of the back panel for the Speaker's head, and two identical rectangular openings were cut out on either side for the Speaker's arms. This was to allow the Speaker to look towards and reach both objects on the stage but could also be closed off to prevent further access. Online coders coded from a monitor linked to a hidden camera under the stage using the program Baby (Baillargeon & Barrett, 2005).

Stimuli were two novel objects: a hand-crafted, blue plank–like object with a looped ribbon on top (hereafter referred to as “the plank”), and a red, opaque funnel placed upside down (“the funnel”). Stimuli were positioned between the Listener and the Speaker such that both actors could easily reach them and were approximately 15 cm apart. Target object type (plank or funnel) and location (infants' perspective: left or right) were counterbalanced across participants such that half of the infants had the funnel as the target object and, within that sub-group, half of those infants had the funnel on their right and the other half on their left.

[1]The Listener missed their start cue so could not perform all Pre-test actions.

2.3 | Procedure

Participants were tested in a 3 (actor engagement: Mutually-Engaged, Listener-Disengaged, Speaker-Disengaged) × 2 (outcome: target, non-target) between-subjects design. Prior to the study, infants met the actor playing the Speaker in a reception room while the caregiver provided written consent for their participation. Once in the testing room, infants were presented with a total of five trials: three familiarizations, one pre-test, and one test trial. Each trial began and ended with the experimenter—from behind the stage—pulling a curtain, and each action was set to a 1 bps metronome beep. The parameters of the procedure were set in advance to be the same as in previous studies (Martin et al., 2012; Vouloumanos et al., 2014). See Figure 1 for a depiction of the procedure across conditions from the infants' point of view.

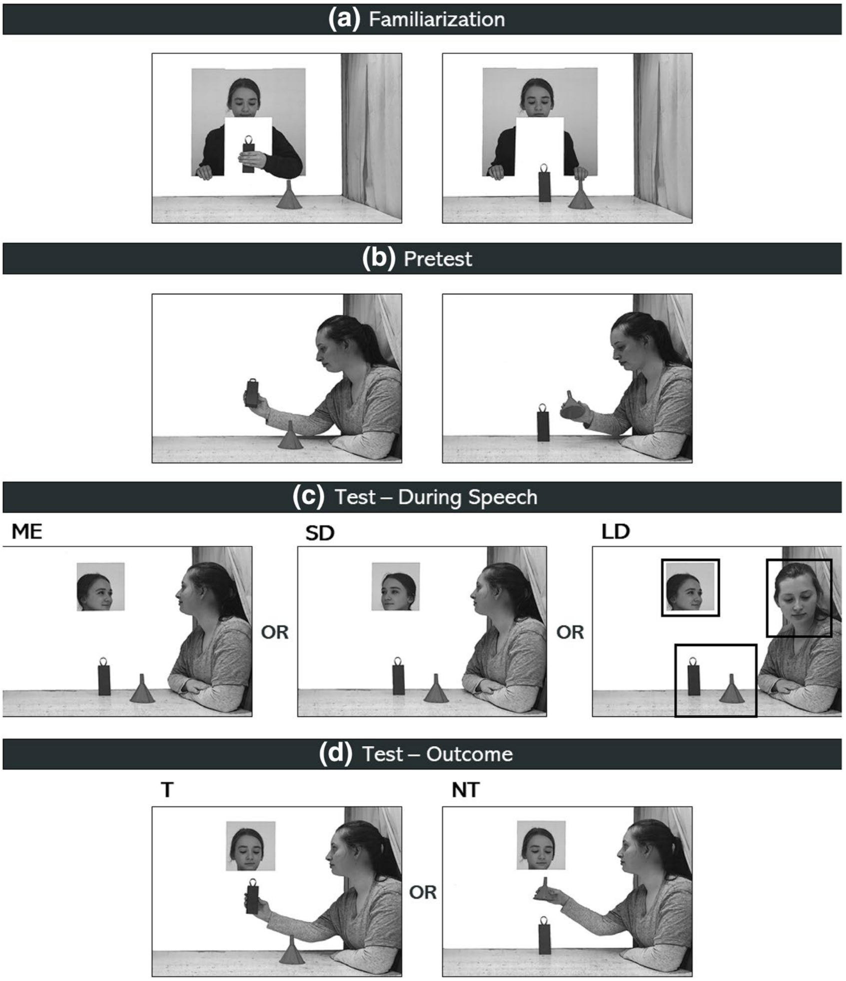

FIGURE 1 Method (from infant POV). (a) Familiarization: The Speaker looked to two novel objects and selected the target object. (b) Pre-test: The Listener picked up both objects. (c) Test: The Speaker could no longer reach the target object, so looked at the objects and said ("koba! koba!"), while either face-to-face with the Listener in the Mutually-Engaged condition (ME), facing away from the Listener in the Speaker-Disengaged condition (SD), or facing the Listener while the Listener faced away in the Listener-Disengaged condition (LD). (d) Test outcome: The Listener then either provided the target (T) or the non-target (NT) object. Approximate areas of interest regions are outlined in the black rectangles (c, LD)

2.3.1 | Familiarizations

Infants were first familiarized to an actor (the Speaker) alone on the back part of the stage. In the first fixed-length portion of the scene, the Speaker's head and arms were visible, but the rest of her torso was hidden. The scene started with the Speaker looking down and center (2 s). She then looked to the right object (2 s), then the left object (2 s), and then to the target object. Finally, she grasped (1 s), lifted (1 s), and brought the target object just below her face (1 s). During the infant-controlled portion of the trial, she played with the target object by tilting it back and forth and remained looking at it until the infant looked away for 2 s or for a maximum of 10 s. This familiarization sequence was repeated in two more trials to establish the Speaker's preference for the target object.

2.3.2 | Pre-test

In the first fixed-length portion of the Pre-test, a second experimenter (the Listener) sat alone on the right side (infant's POV) of the stage. The scene started with the Listener looking down and center (2 s). She then looked to the object closest to her (2 s), then the object farthest from her (2 s). The actor then looked at, picked up, and played briefly with each object in turn, always starting with the object closest to her (10 s). During the infant-controlled portion of the trial, the playing actions were repeated a second time or until the infant looked away for 2 s. The pre-test was a single trial and demonstrated that the Listener could reach both objects and showed no preference for either. The actor playing the Listener did not know which object the Speaker played with in Familiarizations and was therefore blind to which object was the target throughout the procedure.

2.3.3 | Test

In the Test, both the Speaker and the Listener were on stage together for the first time. The objects and scene remained the same with the exception that the foam board panels in the back of the stage were closed to block the Speaker's arms, obstructing her physical access to the objects. The scene started with the Listener either facing the Speaker (Mutually-Engaged and Speaker-Disengaged) or away from the Speaker (Listener-Disengaged). The Speaker was always looking down and center at the beginning of the Test. Once the infant looked at the scene for 2 s, the critical test actions began—the Speaker looked to the right object (2 s), then the left (2 s), then either turned to the Listener (Mutually-Engaged and Listener-Disengaged) or away from the Listener (Speaker-Disengaged) (1 s) and uttered a novel word “koba” twice (4 s). Importantly, during speech (“koba”), the actors were either facing each other (Mutually-Engaged), the Speaker was facing away from the Listener (Speaker-Disengaged), or the Listener was facing away from the Speaker (Listener-Disengaged).

After speech, the Listener either presented the target or the non-target object to the Speaker (4 s). After these actions, the two actors remained frozen in their final position (i.e., with the Listener looking at the Speaker and the Speaker looking down at the presented object) for the infant-controlled portion of the trial (max 40 s). The trial ended when the online observer coded a 2 s look away from the display after observing at least two consecutive seconds of looking, or when the infant looked for a maximum of 40 s. Half of the infants saw the non-target outcome and half the target outcome.

2.4 | Coding

2.4.1 | Overall looking time in infant-controlled portion of the test trial

The main dependent measure was infants' overall looking time to the display during the infant-controlled portion of the test trial (in which no action was happening). Looking time was coded during the study by an online observer. An offline coder verified that the trial ended correctly (i.e., at the first lookaway of 2 s or longer). In cases of disagreement, a third coder was used. All coders were blind to condition and outcome. Coders only saw footage of the infant's face—the event was obscured by a curtain in the room (for online coders) and the event camera feed was disconnected from the coding monitor (for both online and offline coders). There was agreement between two of the three blind coders on the trial end time for 100% of the participants. Looking times were truncated if both offline coders independently indicated that there was an earlier 2 s lookaway than the one indicated by the online coder. If both offline coders agreed that there were no 2 s lookaways in Test, the baby was excluded because there was no way to determine how long this baby would have looked. Only one participant was excluded for this reason (noted as "coding error" in the Section 2.1).

2.4.2 | Visual attention to AOIs during action segments of the test trial

We conducted additional coding and exploratory analyses to examine whether infants' visual attention during the Test reveals insight into differences in infants' processing of the social interaction in the three test conditions (following Augusti et al., 2010; Yamashiro & Vouloumanos, 2018). Specifically, we looked at whether infants attended to the actions, and whether their looking to, and gaze shifts between, Speaker and Listener differed between conditions. In our study, infants watched a live-action play and therefore we did not use an eye tracker. Instead, an offline coder, blind to condition and outcome, judged for each frame of the test event whether infants were looking at one of three areas of interest (AOIs). The AOIs were: Speaker (looks to the Speaker's face), Listener (looks to the Listener's face), and objects (looks to one of the objects). A second coder, blind to the study, was then assigned a random subset of the data (25%) to establish frame-by-frame interrater reliability, which was high ($K = 0.86$, 95% CI 0.85 to 0.87, $p < .001$). Approximate AOI regions are outlined in Figure 1.

Like Yamashiro and Vouloumanos (2018; see also Thorgrimsson et al., 2015), we split the test trial into segments according to the different actions. Segment 1 (Pre-speech segment) started from the beginning of the test trial and ended 7 s later (just before speech). Segment 2 (Speech segment) started from the onset of the first vocalization ("koba") and ended 3.5 s later. Segment 3 (Post-speech segment) started the moment the Listener's hand began moving to reach for the object and ended 3 s later (the approximate moment that the object was held up to the Speaker).

3 | RESULTS

3.1 | Primary analyses: Overall looking time in infant-controlled portion of test trial

To investigate our primary question of whether infants evaluated the outcome of the communicative interaction differently when the interlocutors were mutually engaged or not, we compared infants' absolute looking time to the display in the infant-controlled portion of the test trial. A 3 (condition:

Mutually-Engaged, Speaker-Disengaged, Listener-Disengaged) by 2 (outcome: target, non-target) between-subjects analysis of variance (ANOVA), with looking time in Test as the dependent measure, yielded the predicted significant interaction between condition and outcome, $F(2,42) = 3.551$, $p < .05$, $\eta^2 = 0.131$. We had chosen to use an ANOVA following all other studies using this paradigm (e.g., Krehm et al., 2014; Martin et al., 2012; Vouloumanos, 2018; Vouloumanos et al., 2014); however, although the assumption of homogeneity of variance was met (Levene's test, $p > .05$), a Shapiro-Wilkes test showed violation of normality, $W(48) = 0.914$, $p < .01$. We therefore report both parametric (*t*-tests, following the previous studies) and non-parametric (Mann-Whitney *U*) tests on our planned comparisons between target and non-target outcome in each condition. We set the alpha for the three planned comparisons to .017 (Bonferroni correction).

In the Mutually-Engaged condition, infants looked significantly longer when the Listener selected the non-target object ($M = 32.71$, $SD = 9.30$) than the target object ($M = 14.45$, $SD = 12.76$), $t(14) = 3.27$, $p < .01$, Cohen's $d = 1.64$. An independent-samples Mann-Whitney *U* test showed consistent results, $U = 8.00$, exact $p = .010$. These results replicate the looking time pattern in the speech condition found in Vouloumanos et al. (2014), in the same age group. In the Speaker-Disengaged condition, infants' looking time did not differ significantly when the Listener selected the non-target ($M = 15.21$, $SD = 13.12$) or the target object ($M = 20.26$, $SD = 16.99$, $p = .517$). An independent-samples Mann-Whitney *U* test showed consistent results, $U = 37.00$, exact $p = .645$. In the Listener-Disengaged condition, infants' looking time did not differ significantly when the Listener selected the non-target ($M = 18.98$, $SD = 12.48$) or the target object ($M = 15.25$, $SD = 8.44$, $p = .496$). An independent-samples Mann-Whitney *U* test showed consistent results, $U = 27.00$, exact $p = .645$. See Figure 2.

3.2 | Exploratory analyses: Visual attention to AOIs during action segments of test trial

Exploratory analyses focused on differences in infants' visual attention to three AOIs during the test event: the Speaker's face, the Listener's face, and the objects.

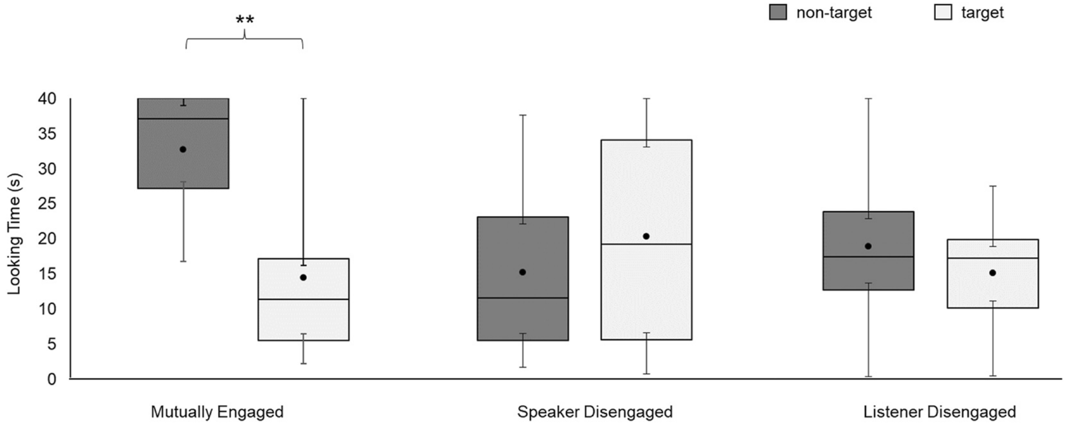

FIGURE 2 Results of overall looking time analysis (from the frozen portion of the Test). Lines inside the boxplots represent the median looking times (s) and points represent the means. ** indicates $p < 0.01$

3.2.1 | Does interlocutor engagement affect infants' overall attention to the test actions?

We first examined infants' overall attentiveness and allocation of attention while observing the interaction event (throughout Segments 1–3, from the beginning of the trial until the Listener holds up an object and pauses). Infants were highly attentive to the event in all conditions, only looking away from the stage for an average of 0.2 s during the 13.5 s event period. Infants' attention to the AOIs differed ($p < .001$), with the majority of the time spent attending to the Speaker ($M = 9.22$ s, $SD = 2.35$ s), followed by the Listener ($M = 2.72$ s, $SD = 1.90$ s) and objects ($M = 1.23$ s, $SD = 1.02$ s). Because we were interested in how infants track the ongoing interaction between Speaker and Listener during the event, similar to other studies manipulating head and gaze direction between interlocutors (Augusti et al., 2010), we focus our analyses on attention to the Speaker and Listener AOIs. See Table 1 for mean looking times to each AOI within each segment by condition.

3.2.2 | Does interlocutor engagement affect infants' attention to Speaker and Listener?

If interlocutor engagement affects infants' attention to the Speaker and Listener during speech, then we might expect different patterns of attention between conditions in Segments 1 and 2 (i.e., the segments before and including speech). In Segment 1, the period before speech, the scene looks different in the Listener-Disengaged condition than in the other two conditions because the Listener is looking away from the Speaker. In Segment 2, the period where the Speaker speaks, the scene looks different in the Speaker-Disengaged condition than in the other two conditions because the Speaker is looking away from the Listener. In contrast, in Segment 3, the scene and unfolding actions are identical across

TABLE 1 Means and (standard deviations) of infants' looking times (s) to each areas of interest (i.e., Speaker, Listener, Objects) during the three action segments of the test trial by condition

Condition	Segment 1 (pre-speech)	Segment 2 (during speech)	Segment 3 (post-speech until object is offered)
Mutually-Engaged			
Speaker	5.11 (1.04)	3.15 (0.60)	1.59 (0.91)
Listener	1.46 (0.92)	0.24 (0.44)	0.44 (0.49)
Objects	0.02 (0.08)	0.00 (0.00)	0.95 (0.68)
Speaker-Disengaged			
Speaker	5.18 (1.36)	3.16 (0.51)	1.28 (0.91)
Listener	1.35 (1.23)	0.22 (0.35)	0.31 (0.27)
Objects	0.35 (0.60)	0.07 (0.20)	1.40 (0.91)
Listener-Disengaged			
Speaker	4.09 (1.54)	2.81 (0.87)	1.29 (0.80)
Listener	2.84 (1.54)	0.59 (0.87)	0.72 (0.41)
Objects	0.00 (0.00)	0.00 (0.00)	0.91 (0.67)

Note: Segment 1 was the first 7 s of the trial (i.e., the beginning of the trial up and until the approximate onset of speech). Segment 2 was the 3.5 s following the onset of speech (i.e., the period when the Speaker said "koba" twice). Segment 3 was the 3 s following the onset of the Listener's response (i.e., the period in which the object was being chosen and presented to the Speaker).

conditions. A 2 (AOI: Speaker, Listener) × 3 (Segment: 1, 2, 3) × 3 (condition: Mutually-Engaged, Speaker-Disengaged, Listener-Disengaged) mixed ANOVA with Greenhouse-Geisser correction for violation of sphericity yielded a significant 3-way interaction, $F(4, 90) = 2.96$, $p < .05$, $\eta^2 = 0.116$. Univariate ANOVAs examined whether infants' attention to the Speaker and Listener AOIs differed between conditions in each Segment. Infants' attention to both Speaker and Listener AOIs differed between conditions in Segment 1, *p*s < .05, but not Segment 2, *p*s > .15. In Segment 3, infants attended similarly across conditions to the Speaker, but differently to the Listener, $p < .05$.

Follow-up *t*-tests showed that in Segment 1, infants spent more time looking at the Listener in the Listener-Disengaged condition ($M = 2.84$ s, $SD = 1.54$) than in the Mutually-Engaged ($M = 1.46$ s, $SD = 0.92$), $t(30) = 3.09$, $p < .01$, and the Speaker-Disengaged Conditions ($M = 1.35$ s, $SD = 1.23$), $t(30) = 3.03$, $p < .01$. There was no difference between the Mutually-Engaged and Speaker-Disengaged conditions in Segment 1, $p = .78$. This pattern is mirrored by greater looking to the Speaker in the Mutually-Engaged ($M = 5.11$ s, $SD = 1.04$) and Speaker-Disengaged conditions ($M = 5.18$ s, $SD = 1.36$) when compared to the Listener-Disengaged condition ($M = 4.09$ s, $SD = 1.54$), *p*s < .05. In Segment 3, infants' differential attention to the Listener across conditions was driven by increased looking to the Listener in the Listener-Disengaged condition ($M = 0.72$ s, $SD = 0.41$) relative to the Speaker-Disengaged condition ($M = 0.31$ s, $SD = 0.27$), $t(30) = 3.32$, $p < .01$. The difference in looking to the Listener between the Listener-Disengaged condition and the Mutually-Engaged condition ($M = 0.44$ s, $SD = 0.49$) in Segment 3 did not reach significance, $t(30) = 1.73$, $p = .095$. There was no difference between the Mutually-Engaged and Speaker-Disengaged conditions, $t(30) = 0.95$, $p = .35$.

3.2.3 | Does interlocutor engagement influence gaze shifts between Speaker and Listener?

Previous research found that 6-month-olds shift their gaze more often between interlocutors to follow an ongoing conversation when interlocutors are face-to-face rather than back-to-back (Augusti et al., 2010). Although our event differed in being much shorter than the interactions in Augusti et al. (2010) and did not include back-and-forth speech between the two actors, increased gaze shifts between Speaker and Listener in our Mutually-Engaged condition might similarly suggest anticipation of conversational turn-taking.

We compared the number of gaze shifts between Speaker and Listener during Segments 1 and 2 (the period in which the interlocutors' gaze and head direction differed between conditions). A univariate ANOVA revealed no significant differences between conditions in the number of gaze shifts between the two interlocutors during Segments 1 and 2 (Mutually-Engaged $M = 6.19$ s, $SD = 3.41$; Speaker-Disengaged $M = 4.81$ s, $SD = 2.69$; Listener-Disengaged $M = 6.50$ s, $SD = 2.45$), $F(2,45) = 1.56$, $p = .22$.

Second, we asked whether infants might differ between conditions in how quickly they shift gaze to the Listener from the onset of the test event, and after the Speaker speaks. Infants' latency to first look at the Listener from the event onset (i.e., during Segment 1) could tell us whether the infants in the Listener-Disengaged condition noticed before speech that the Listener's body was oriented away from the Speaker, whereas infants' latency to shift gaze to the Listener *after* speech (i.e., during Segments 2–3) may indicate an expectation of a contingent (behavioral or verbal) response from the Listener (Thorgrimsson et al., 2015).

A univariate ANOVA showed that infants' latency to look to the Listener during Segment 1 (pre-speech) differed between conditions, $F(2,41) = 4.42$, $p < .05$, $\eta^2 = 0.18$ (note that four infants who did not shift gaze to the Listener at all during Segment 1 could not be included in this analysis).

Infants in the Listener-Disengaged condition were quicker to look to the Listener (M_{LAT} = 0.26 s, SD = 0.42 s) than infants in the two other conditions (Mutually-Engaged M_{LAT} = 1.05 s, SD = 1.31; Speaker-Disengaged M_{LAT} = 1.66 s, SD = 1.76, ps < .05).

Infants' latency to look to the Listener following the Speaker's speech (Segments 2 and 3) did not differ between conditions, (Mutually-Engaged M_{LAT} = 3.47 s, SD = 1.13; Speaker-Disengaged M_{LAT} = 2.78 s, SD = 1.50; Listener-Disengaged M_{LAT} = 2.99 s, SD = 1.48), $F(2,36) = 0.82$, $p = .449$ (note that nine infants who did not shift their gaze to the Listener until the infant-controlled frozen portion of the trial were excluded from this analyses). It appears that infants' latency to shift gaze to the Listener after speech was generally driven by the Listener's movement to pick up an object (which began about 3 s after the speech onset).

4 | GENERAL DISCUSSION

Our interpretation of everyday communicative interactions is often influenced by their social features. Mutual engagement—a key social feature of communication—can help adult third-party observers to infer that communication is likely occurring and determine who is talking to whom (Clark, 1996). Our results suggest that 6-month-olds expected a Speaker's communication to be successful when the Speaker and Listener were mutually engaged during the interaction, but not when either interlocutor had been disengaged. Therefore, mutual engagement (in the form of face-to-face interactions) may support infants' early understanding of the communicative function of speech.

Speech is a unique communicative signal for humans, which infants consider when reasoning about the social interactions they observe (Martin et al., 2012; Vouloumanos et al., 2014). Our results suggest that 6-month-olds do not merely use the presence of speech to evaluate whether information can be transferred from one person to another, nor do they simply associate the speech they hear with the target object highlighted in familiarizations; infants are also attentive to social features of the interaction. These findings complement previous research showing that older 12-month-old infants do not expect the mere presence of speech to result in communicative success; 12-month-olds recognize that speech can communicate information about an actor's object preference, but only when produced by the actor with the preference (Martin et al., 2012). Though we did not probe 6-month-olds' understanding of the source of speech in the current study, we similarly show that even these younger infants attend to social components of communicative interactions in addition to the speech itself.

Interlocutors who are facing each other while speaking can easily infer that they are mutually engaged in the interaction, but how do these cues of mutual engagement affect reasoning about third-party communicative interactions? Previous research raises two possible interpretations. One possibility is that infants and adults possess a conceptual understanding that speakers typically face the person they intend to address (Beier & Spelke, 2012), and that listeners need to be attending to the speaker in order to process the message. According to this conceptual account, face-to-face interactions (or perhaps any interaction in which there are cues of mutual engagement) generate an expectation that communication can occur, facilitating for infants the expectation that speech or another appropriate signal will transfer information to the listener (Augusti et al., 2010; Handl et al., 2013; Thorgrimsson et al., 2015). A second possibility is that the human visual system is more attentive to face-to-face displays (Papeo & Abassi, 2019; Papeo et al., 2017) and/or more familiar stimulus configurations (Gustafsson et al., 2016). According to this perceptual account, attentional resources are allocated differently to pairs of faces oriented towards each other (compared to those facing away from each other) which can facilitate information processing in communication.

In line with a perceptual account, adults tasked with identifying pairs of objects in a complex array of stimuli could detect pairs of people facing each other more quickly and accurately than pairs facing apart (Papeo et al., 2017). This facilitative effect of facing pairs was specific to humans and did not generalize to chairs facing each other or apart, suggesting that attentional differences were likely driven by the functional meaning of face-to-face pairs (i.e., the potential for interaction) rather than the physical structure of the scene (i.e., less physical space between facing pairs; Papeo et al., 2017). Twelve-month-old infants similarly appear to allocate more attention to face-to-face (vs. facing apart) pairs, but this finding was driven by the familiarity of the test stimuli relative to habituation (Gustafsson et al., 2016). Gustafsson et al. (2016) therefore argue that infants' preferences for face-to-face displays are based on perceptual familiarity rather than any functional or conceptual meaning. Familiarity could be an attentional mechanism that facilitates infants' processing of face-to-face interactions in the current study as well. However, it is unclear whether infants *are* in fact more familiar with face-to-face third-party interactions outside the context of experimental manipulations.

Given that infants do not always reliably discriminate between facing and facing away pairs (Beier & Spelke, 2012; Gustafsson et al., 2016), but do show better conversational tracking when observing face-to-face communicative interactions (Augusti et al., 2010; Handl et al., 2013; Thorgrimsson et al., 2015), the unique effect of mutual engagement in the current study may not be fully explained by a perceptual account. In our study, infants paid similar attention to the scene during the initial action segments of the test event across conditions. However, infants' visual attention to the scene diverged (between conditions) during the portion when the actors' engagement was identical across conditions (i.e., during the paused portion when the Listener was looking to the Speaker and the Speaker was looking to the object; see Figure 1,d). In other words, infants' expectation of successful information transfer does not appear to be driven by greater overall attention during mutual engagement.

Infants in our study did exhibit some differential looks to the AOIs during the action segments of the test event between conditions. Infants looked earlier, and more often, to the Listener in the Listener-Disengaged condition compared to the other two conditions. This may be because infants noticed that the Listener was not attending to the Speaker, or that her face was oriented toward the front of the stage in the general direction of the infant. Infants did not look more quickly to the Listener in any condition during the portion of the events following speech (consistent with Thorgrimsson et al.'s results in 12-month-olds, 2015). There were also no differences in infants' attention to the AOIs between Speaker-Disengaged and Mutually-Engaged conditions. We suspect this is because there was not enough time in the procedure for infants to reallocate their attention or shift their gaze *before* the Listener moved to select an object. Perhaps if given more time to shift attention before the Listener's response (more similar to Augusti et al., 2010), we would have seen differences in infants' attention or gaze shifts to Speaker and Listener between the Speaker-Disengaged and Mutually-Engaged conditions as well (though see Yamashiro & Vouloumanos, 2018 for gaze differences between conditions with very short events in 12-month-olds). Ultimately, although differences in attention can theoretically yield insight into how infants' process an interaction, it seems that differential attention to the events in our study did not appear to play a causal role in infants' evaluation of communicative success.

The results from our study and prior research suggest that mutual engagement may facilitate preverbal infants' communicative reasoning. However, we do not yet know precisely which features of the contextual differences between conditions in our study were driving infants' expectations. First, we manipulated two cues of mutual engagement (face-to-face orientation and eye contact) at the same time—two cues that tend to co-occur in real-life interactions as well as in previous studies (Augusti et al., 2010; Thorgrimsson et al., 2015). Further work would be needed to narrow in on whether one or both of these cues matter (e.g., Handl et al., 2013). Second, when the interlocutors were not mutually engaged with each other, they were also not mutually engaged with the scene and the objects. It is thus difficult to conclude whether mutual engagement between interlocutors is necessary, whether general engagement with the scene is sufficient (e.g., interlocutors both looking toward the objects even if not at each other), or whether infants are sensitive to 'joint attention' between Speaker, Listener, and objects (for a review of the role of joint attention in communicative development, see Carpenter & Liebal, 2011). A sensitivity to joint attention, however, seems less likely given that infants themselves do not reliably exhibit joint attention until 12–18 months (Corkum & Moore, 1998). A third and final option is that mutual engagement may not be facilitative, but rather disengagement is *disruptive*. That is, perhaps infants have no expectation of communication between interlocutors who appear actively disinterested in or avoidant of one another, as in our Speaker- and Listener-Disengaged conditions (see Liberman et al., 2017 for evidence that 9-month-old infants treat two actors facing apart as socially disengaged). Future research should further pinpoint the mechanisms by which face-to-face interactions influence infants' expectations of successful communication.

Six-month-olds' sensitivity to mutual engagement in communication, whether best explained by a conceptual or perceptual account, may also play a role in the development of word learning and communication skills. Our findings are consistent with a large body of research showing sensitivity to social cues and social events in the first year of life (e.g., Augusti et al., 2010; Csibra, 2010; Farroni et al., 2002; Hamlin & Wynn, 2011; Legerstee et al., 2000; Liberman et al., 2017; Vouloumanos et al., 2014), even before infants reliably make use of social cues to learn new words (e.g., Baldwin, Bill, & Ontai, 1996; Baldwin, Markman, et al., 1996; Pruden et al., 2006; though see also Bergelson & Swingley, 2012; Tincoff & Jusczyk, 2012). It is possible that infants' growing ability to make sense of social situations in the first year provides part of the foundation for referential understanding in the second (e.g., Spelke & Kinzler, 2007; Tomasello, 2001). A precocious social sense may also play a role in the development of pragmatic competence that is necessary for a more mature consideration of how communication works. Although viewing individuals in a face-to-face orientation facilitates even adults' attentional processing (Papeo & Abassi, 2019), adults can also flexibly use other cues, including the relationship between potential interlocutors or the content of prior conversations, to evaluate who is communicating with whom and whether communication will succeed (Clark & Carlson, 1982). How and when infants move beyond face-to-face cues to flexibly consider the socio-pragmatic context when reasoning about communication is an important question for future research.

5 | LIMITATIONS

The sample size of the current research is very small. At the time that we planned this study, it was still common practice in infant research to base power calculations on the most similar previous research. However, standards in the field are shifting and a number of papers in recent years have raised concern with basing power analyses on previous infant studies using small samples, as effect sizes are likely to be inflated (e.g., Bakker et al., 2012; Davis-Kean & Ellis, 2019; Havron et al., 2020). Although small subsamples of larger-sample infant research tend to yield similar results to the larger sample, the small samples also have a higher likelihood of ambiguous findings (e.g., marginal significance) as well as false positives and negatives (Oakes, 2017). Therefore, it is possible that the difference we see between target and non-target outcomes in the Mutual-Engagement condition is a false positive. However, given that this result coheres with much of the prior literature in this area, it is perhaps more plausible that the findings in one or both of the other two conditions could be false negatives. It is essential to replicate these condition differences with a larger sample.

Determining an appropriate sample size given the issue of basing power analyses on prior small samples is a challenging task. Some have argued that even increasing to 24 infants per cell as a standard (as opposed to the traditional 8–12) would help the problem (Oakes, 2017). Others have suggested setting effect size estimates very conservatively (e.g., using $d = 0.1$ as a starting point) while acknowledging the huge limitations this would place on labs given resource constraints and the time-consuming nature of collecting infant data (Davis-Kean & Ellis, 2019). Ideas to improve the robustness of infant research beyond increasing sample size have also been proposed, such as looking at multiple measures for evidence of a capacity (Havron, 2022; Lobue et al., 2020), or increasing the amount of data collected from each infant (Byers-Heinlein et al., 2021; DeBolt et al., 2020). In line with these ideas, we conducted planned exploratory analyses in our study to probe for additional insight into infants' differential processing of the three conditions. Our looking pattern analyses did not unambiguously map onto the condition difference in overall looking time; however, these findings can inform future work aimed at designing methods to investigate reliable within-infant responses to communicative events.

6 | CONCLUDING REMARKS

Our study suggests that 6-month-old infants' early understanding of the communicative function of speech may be supported by viewing third-party interlocutors engaged in a face-to-face interaction. It is important to note, however, that although the effect sizes from this research paradigm tend to be large—and the basic findings have been replicated both directly and conceptually in multiple labs (e.g., Colomer & Sebastian-Galles, 2020; He et al., 2016; Krehm et al., 2014; Martin et al., 2012; Tauzin & Gergely, 2018; Vouloumanos, 2018; Vouloumanos et al., 2014)—the current study and many others have tested small samples which are likely underpowered. Considering the likely continued challenges of large scale, in-person research, as well as resource-intensive nature of studying young infants, future work on the early development of communicative expectations would benefit from collaborative efforts such as those of The ManyBabies Consortium (2020).

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CONFLICTS OF INTEREST

Authors declare no conflicts of interest with regard to the funding source for this study.

DATA AVAILABILITY STATEMENT

The data are publicly available on the Open Science Framework (https://osf.io/4v7cb/).

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REFERENCES

Augusti, E. M., Melinder, A., & Gredebäck, G. (2010). Look who's talking: Pre-verbal infants' perception of face-to-face and back-to-back social interactions. *Frontiers in Psychology*, *1*, 161. https://doi.org/10.3389/fpsyg.2010.00161

Baillargeon, R., & Barrett, J. (2005). Baby. An experimental software program for infant looking time experiments.

Bakker, M., Van Dijk, A., & Wicherts, J. M. (2012). The rules of the game called psychological science. *Perspectives on Psychological Science*, *7*(6), 543–554. https://doi.org/10.1177/1745691612459060

Baldwin, D. A., Bill, B., & Ontai, L. L. (1996). Infants' tendency to monitor others' gaze: Is it rooted in intentional understanding or a result of simple orienting? *Infant Behavior and Development*, *19*, 270. https://doi.org/10.1016/S0163-6383(96)90324-0

Baldwin, D. A., Markman, E. M., Bill, B., Desjardins, R. N., Irwin, J. M., & Tidball, G. (1996). Infants' reliance on a social criterion for establishing word-object relations. *Child Development*, *67*(6), 3135–3153. https://doi.org/10.1111/j.1467-8624.1996.tb01906.x

Beier, J. S., & Spelke, E. S. (2012). Infants' developing understanding of social gaze. *Child Development*, *83*(2), 486–496. https://doi.org/10.1111/j.1467-8624.2011.01702.x

Bergelson, E., & Swingley, D. (2012). At 6–9 months, human infants know the meanings of many common nouns. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(9), 3253–3258. https://doi.org/10.1073/pnas.1113380109

Byers-Heinlein, K., Bergmann, C., & Savalei, V. (2021). Six solutions for more reliable infant research. *Infant and Child Development*, e2296. https://doi.org/10.1002/icd.2296

Carpenter, M., & Liebal, K. (2011). Joint attention, communication, and knowing together in infancy. In A. Seemann (Ed.), *Joint attention: New developments in psychology, philosophy of mind, and social neuroscience* (pp. 159–181). MIT Press.

Clark, H. H. (1996). *Using language*. Cambridge University Press. https://doi.org/10.2277/0521561582

Clark, H. H., & Carlson, B. T. (1982). Hearers and speech acts. *Language*, *58*(2), 332–373. https://doi.org/10.2307/414102

Colomer, M., & Sebastian-Galles, N. (2020). Language background shapes third-party communication expectations in 14-month-old infants. *Cognition*, *202*, 104292. https://doi.org/10.1016/j.cognition.2020.104292

Corkum, V., & Moore, C. (1998). The origins of joint visual attention in infants. *Developmental Psychology*, *34*(1), 28–38. https://doi.org/10.1037/0012-1649.34.1.28

Csibra, G. (2010). Recognizing communicative intentions in infancy. *Mind & Language*, *25*(2), 141–168. https://doi.org/10.1111/j.1468-0017.2009.01384.x

Davis-Kean, P. E., & Ellis, A. (2019). An overview of issues in infant and developmental research for the creation of robust and replicable science. *Infant Behavior and Development*, *57*, 101339. https://doi.org/10.1016/j.infbeh.2019.101339

DeBolt, M. C., Rhemtulla, M., & Oakes, L. M. (2020). Robust data and power in infant research: A case study of the effect of number of infants and number of trials in visual preference procedures. *Infancy*, *25*(4), 393–419. https://doi.org/10.1111/infa.12337

D'Entremont, B. (2000). A perceptual-attentional explanation of gaze following in 3- and 6-month-olds. *Developmental Science*, *3*, 302–311. https://doi.org/10.1111/1467-7687.00124

D'Entremont, B., Hains, S. M. J., & Muir, D. W. (1997). A demonstration of gaze following in 3- to 6-month-olds. *Infant Behavior and Development*, *20*(4), 569–572. https://doi.org/10.1016/S0163-6383(97)90048-5

Farroni, T., Csibra, G., Simion, F., & Johnson, M. (2002). Eye contact detection in humans from birth. *Proceedings of the National Academy of Sciences of the United States of America*, *99*(14), 9602–9605. https://doi.org/10.1073/pnas.152159999

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Fillmore, C. (1981). Pragmatics and the description of discourse. In P. Cole (Ed.), *Radical pragmatics* (pp. 143–166). Academic Press.

Gredebäck, G., & Melinder, A. (2010). Infants' understanding of everyday social interactions: A dual process account. *Cognition*, *114*(2), 197–206. https://doi.org/10.1016/j.cognition.2009.09.004

Gustafsson, E., Brisson, J., Mailloux, D., Mainville, M., Beaulieu, C., & Sirois, S. (2016). Do infants recognize engagement in social interactions? The case of face-to-face conversation. *Infancy*, *21*(5), 685–696. https://doi.org/10.1111/infa.12135

Hamlin, J. K., & Wynn, K. (2011). Young infants prefer prosocial to antisocial others. *Cognitive Development*, *26*(1), 30–39. https://doi.org/10.1016/j.cogdev.2010.09.001

Handl, A., Mahlberg, T., Norling, S., & Gredebäck, G. (2013). Facing still faces: What visual cues affect infants' observations of others? *Infant Behavior and Development*, *36*(4), 583–586. https://doi.org/10.1016/j.infbeh.2013.06.001

Havron, N. (2022). Why not both? Using multiple measures to improve reliability in infant studies. *Infant and Child Development*, e2336. https://doi.org/10.1002/icd.2336

Havron, N., Bergmann, C., & Tsuji, S. (2020). Preregistration in infant research—A primer. *Infancy*, *25*(5), 734–754. https://doi.org/10.1111/infa.12353

He, J., Jin, X., Li, Z., Zheng, L., Sun, Z., Zhang, M., & Shen, M. (2016). Infants' understanding of information transmission in the context of communication involving multiple agents. *Infancy*, *21*(2), 228–240. https://doi.org/10.1111/infa.12105

Krehm, M., Onishi, K., & Vouloumanos, A. (2014). I see your point: Infants under 12 months understand that pointing is communicative. *Journal of Cognition and Development*, *15*(4), 527–538. https://doi.org/10.1080/15248372.2012.736112

Legerstee, M., Barna, J., & DiAdamo, C. (2000). Precursors to the development of intention at 6 months: Understanding people and their actions. *Developmental Psychology*, *36*(5), 627–634. https://doi.org/10.1037/0012-1649.36.5.627

Liberman, Z., Woodward, A. L., & Kinzler, K. D. (2017). Preverbal infants infer third-party social relationships based on language. *Cognitive Science*, *41*(S3), 622–634. https://doi.org/10.1111/cogs.12403

LoBue, V., Reider, L. B., Kim, E., Burris, J. L., Oleas, D. S., Buss, K. A., Perez-Edgar, K., & Field, A. P. (2020). The importance of using multiple outcome measures in infant research. *Infancy*, *25*(4), 420–437. https://doi.org/10.1111/infa.12339

Martin, A., Onishi, K. H., & Vouloumanos, A. (2012). Understanding the abstract role of speech in communication at 12 months. *Cognition*, *123*(1), 50–60. https://doi.org/10.1016/j.cognition.2011.12.003

Molina, M., Van de Walle, G., Condry, K., & Spelke, E. (2004). The animate-inanimate distinction in infancy: Developing sensitivity to constraints on human actions. *Journal of Cognition & Development*, *5*(4), 399–426. https://doi.org/10.1207/s15327647jcd0504_1

Oakes, L. M. (2017). Sample size, statistical power, and false conclusions in infant looking-time research. *Infancy*, *22*(4), 436–469. https://doi.org/10.1111/infa.12186

Papeo, L., & Abassi, E. (2019). Seeing social events: The visual specialization for dyadic human–human interactions. *Journal of Experimental Psychology: Human Perception and Performance*, *45*(7), 877–888. https://doi.org/10.1037/xhp0000646

Papeo, L., Stein, T., & Soto-Faraco, S. (2017). The two-body inversion effect. *Psychological Science*, *28*(3), 369–379. https://doi.org/10.1177/0956797616685769

Pruden, S. M., Hirsh-Pasek, K., Golinkoff, R. M., & Hennon, E. A. (2006). The birth of words: Ten-month-olds learn words through perceptual salience. *Child Development*, *77*(2), 266–280. https://doi.org/10.1111/j.1467-8624.2006.00869.x

Senju, A., & Csibra, G. (2008). Gaze following in human infants depends on communicative signals. *Current Biology*, *18*(9), 668–671. https://doi.org/10.1016/j.cub.2008.03.059

Spelke, E. S., & Kinzler, K. D. (2007). Core knowledge. *Developmental Science*, *10*(1), 89–96. https://doi.org/10.1111/j.1467-7687.2007.00569.x

Striano, T., & Stahl, D. (2005). Sensitivity to triadic attention in early infancy. *Developmental Science*, *8*(4), 333–343. https://doi.org/10.1111/j.1467-7687.2005.00421.x

Tauzin, T., & Gergely, G. (2018). Communicative mind-reading in preverbal infants. *Scientific Reports*, *8*(1), 1–9. https://doi.org/10.1073/pnas.1816709116

The ManyBabies Consortium. (2020). Quantifying sources of variability in infancy research using the infant-directed-speech preference. *Advances in Methods and Practices in Psychological Science*, *3*(1), 24–52. https://doi.org/10.1177/2515245919900809

Thorgrimsson, G., Fawcett, C., & Liszkowski, U. (2015). 1- and 2-year-olds' expectations about third-party communicative actions. *Infant Behavior and Development*, *39*, 53–66. https://doi.org/10.1016/j.infbeh.2015.02.002

Tincoff, R., & Jusczyk, P. W. (2012). Six-month-olds comprehend words that refer to parts of the body. *Infancy*, *17*(4), 432–444. https://doi.org/10.1111/j.1532-7078.2011.00084.x

Tomasello, M. (2001). Perceiving intentions and learning words in the second year of life. In M. Bowerman & S. Levinson (Eds.), *Language acquisition and conceptual development (language culture and cognition)* (pp. 132–158). Cambridge University Press. https://doi.org/10.1017/CBO9780511620669.007

Vouloumanos, A. (2018). Voulez-vous jouer avec moi? Twelve-month-olds understand that foreign languages can communicate. *Cognition*, *173*, 87–92. https://doi.org/10.1016/j.cognition.2018.01.002

Vouloumanos, A., Druhen, M. J., Hauser, M. D., & Huizink, A. T. (2009). Five-month-old infants' identification of the sources of vocalizations. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(44), 18867–18872. https://doi.org/10.1073/pnas.0906049106

Vouloumanos, A., Martin, A., & Onishi, K. (2014). Do 6-month-olds understand that speech can communicate? *Developmental Science*, *17*(6), 872–879. https://doi.org/10.1111/desc.12170

Vouloumanos, A., & Werker, J. F. (2007). Listening to language at birth: Evidence for a bias for speech in neonates. *Developmental Science*, *10*(2), 159–164. https://doi.org/10.1111/j.1467-7687.2007.00549.x

Yamashiro, A., & Vouloumanos, A. (2018). How do infants and adults process communicative events in real time? *Journal of Experimental Child Psychology*, *173*, 268–283. https://doi.org/10.1016/j.jecp.2018.04.011

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