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Infants follow the gaze of same-age peers, young children, and adults

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Abstract

Gaze following – infants' orienting towards an object attended to by their social partner – has been linked to a range of socio-cognitive skills. Despite considerable research on when infants follow the gaze of their social partners, studies have typically examined infants' following of adults' gaze. Therefore, little is known about whether or how gaze following is modulated by the characteristics of the model, such as their age. The current study examined infants' following of the gaze of an actor that varied in age: an adult, a young child, and an infant. In an eyetracking study, 49 infants, aged 6–14 months, were presented with videos in which the actor (either an adult, a child or an infant) first looked down towards a neutral point on the table, then to the participant with a friendly facial expression, and then to one of two novel objects to the left and right of the table. The age of the actor did not predict participants' gaze following behaviour, with participants following the gaze of the adult, child and same-aged peer. Thus, gaze following is not constrained to interactions with an adult. Furthermore, participants showed high interest in the actors' faces which was the strongest for the infant actor followed by the child actor, and the adult actor. These results shed insight into the interaction between infants' gaze following behaviour and their attentional preferences for different social partners. We discuss the implications of these findings for theories of development: Beyond adults, other infants and children are also perceived as interesting social partners and, potentially, valuable sources of information.

KEYWORDS
adults, children, gaze following, interesting social partner, peers

1 | INTRODUCTION

Gaze following – monitoring and following the gaze of others – emerges early in development (Brooks & Meltzoff, 2005): by preferentially attending to aspects of the world (e.g., an object) that another person attends to, this behaviour offers valuable opportunities for learning. While humans are not the only species capable of attending to and following the gaze of others (Bugnyar et al., 2004; Okamoto-Barth et al., 2007; Tomasello et al., 1998), gaze following is assumed to influence many more complex and uniquely human cognitive processes and social functions (Corkum & Moore, 1998; Tomasello, 2010), such as language learning, emotional development, social learning, communication and cooperative behaviour (Çetinçelik et al., 2021; Tomasello et al., 1998). Research on whose gaze infants follow has mostly focused on adults, and thereby, excluded other children and peers as potentially valuable social partners. Here, we investigate the extent to which infants between 6 and 14 months follow the gaze of adults as well as older children and same-age peers.

The ability to follow gaze develops during the first year of life (see Del Bianco et al., 2019, for a review). Some studies suggest that even newborns display a rudimentary form of gaze following behaviour, by looking towards objects cued by eye-gaze (Farroni et al., 2004). Others report evidence for gaze following between 3 and 4 months (Butterworth & Jarrett, 1991; Gredebäck et al., 2010) with more robust effects being reported from around 5 months of age (Gredebäck et al., 2018; Morales et al., 2000; Senju & Csibra, 2008; Szufnarowska et al., 2014), also in cultures with limited parent-child face-to-face interaction (Hernik & Broesch, 2019). While some studies suggest that young infants need additional "ostensive" cues to follow gaze, for example, infant-directed speech (Hernik & Broesch, 2019; Senju & Csibra, 2008), others find evidence of gaze following in young infants without such ostensive cues (Gredebäck et al., 2018). Furthermore, infants show increased processing (indexed in a stronger neuropsychological response) of objects that adults previously attended to (Reid et al., 2004). Around 6–12 months, gaze following seems to stabilize (Gredebäck et al., 2010; Morales et al., 2000).

Despite the explosion of research on how, when, and why infants follow the gaze of their social partners, there is limited work examining how and to what extent infants follow the gaze of social partners other than adults, for example, other infants or older children. Some studies suggest that infants' gaze following is susceptible to social constellations, for example, infants follow the gaze of a stranger more robustly than the gaze of someone familiar (Gredebäck et al., 2010; Striano & Bertin, 2005). Del Bianco et al. (2019) attribute this difference to the novelty of the stranger, with novelty triggering more fixations on the strangers' face, and familiarity leading to infants fixating the targets more. Other studies highlight the contingency of the social interaction, finding that children's following of the gaze of a social robot is influenced by their prior communication and interaction with the robot (Meltzoff et al., 2010; Sivridag & Mani, 2024) and gaze following is predicted by the perceived agency of the actor (Johnson et al., 1998) In keeping with this suggestion, Kishimoto et al. (2008) find that 2- to 3-year-olds follow the gaze of their same-aged peers in live interactions: One child, the leader, was instructed to look at a doll, while the reaction of another child, the follower, was coded. Children followed the gaze of their peer in approx. 90% of the trials, suggesting that they used their peers' gaze to reorient their attention to a common target. Taken together, this research suggests that there may be important differences in the extent to which – how robustly and how quickly – infants follow the gaze of different social partners.

Indeed, children's interactions with their social partners in other domains of social development are influenced by the pedagogical status of their interaction partners. Most of this work suggests that infants and children learn more and imitate behaviour more robustly in interactions with adults relative to their peers. For instance, 15-month-old children only imitated actions performed by an adult (Seehagen & Herbert, 2011), while 3- and 4-year-olds selectively learned the rules of a game from an adult relative to a peer (Rakoczy et al., 2010). Indeed, children imitate even unnecessary or irrelevant actions when these were previously performed by an adult, suggesting that children may follow adults seemingly indiscriminately, without questioning or assessing the validity of their behaviour (Bonawitz et al., 2011). Such results are often taken to suggest that imitating peer behaviour might play more of a social function rather than a pedagogical function (Zmyj et al., 2012). Nevertheless, some studies also report improved learning from peers, especially with regards to familiar actions (Zmyj et al., 2012), also showing improved retention only of actions performed by peers relative to adults (Ryalls et al., 2000). Taken together, these studies suggest differences in children's interactions with different social partners, especially when comparing partners differing in age, for example, adults, same-age peers, and other children.

Studies finding improved learning and action imitation from interactions with adults are in keeping with theories of early development that highlight the role of adults as "benevolent experts" whose actions, behaviours and gaze may be of particular importance to young infants (Baron-Cohen, 1995; Csibra & Gergely, 2009). Such findings are also in line with learning-based accounts suggesting that infants may learn to follow *any* partner's gaze over time based on whether following gaze has, in their experience, led to information gain (Corkum & Moore, 1998; Silverstein et al., 2021). These accounts would similarly predict a stronger tendency to follow the gaze of an adult, as adults may be more likely to attend to information that is useful for infants (Bonawitz & Shafto, 2016; Shafto et al., 2012; see Zmyj & Seehagen, 2013 for a review).

On the other hand, socio-cognitive theories of development emphasise the valuable impact of slightly older peers on early learning (Vygotsky, 1962). Indeed, the importance of peers in early development is the basis for the principles underlying mixed age group Montessori classrooms (Montessori, 1949) facilitating learning from older and more knowledgeable peers (Randolph et al., 2023). Furthermore, while children may consider adults as knowledgeable social partners, peers may be interesting for other reasons given the greater similarity between the peer's and a child's own (motor) skills and interests (Zmyj & Seehagen, 2013). Thus, while age may be a relatively good proxy to evaluate whether another person might be a knowledgeable teacher, children may also learn to accept peers and, especially, older children, as valuable social partners.

Against this background, we examined the extent to which 6- to 14-month-old infants follow the gaze of an adult, a child, and an infant. We analysed how robustly and how quickly infants follow the actor's gaze and fixate on the target object attended by the actor, as well as how much time infants spend looking at the face as indices of their social engagement and interest in actors of different ages. If infants follow adults' gaze faster and more robustly than younger actors, this would provide support for theories that assume adults to be infants' "natural" teachers (Csibra & Gergely, 2011). If, however, infants similarly attend to and follow adults', children's and other infants' gaze, it would support learning accounts that value learning from informative or interesting social partners, regardless of their age (e.g., Corkum & Moore, 1998; Zmyj & Seehagen, 2013).

1.1 | Research questions and hypotheses

1.1.1 | Do infants follow the gaze of infant, child, and adult actors?

We used three measures of gaze following. First, we examined the proportion of time infants spent looking at the target object, that is, the object fixated by the actor, relative to the distractor object, from the moment when the actor turned to fixate this object to the end of the trial. We predict that infants will follow the gaze of an adult, a child, and an infant, as indexed by increased looking towards the target object relative to the distractor object in all conditions. At the same time, we predict that infants will be more likely to follow the gaze of the adult relative to same-aged peers and older children.

Second, we examined the frequency of infants' first fixations to the target as opposed to the distractor in all three conditions. We predicted that infants would fixate the target object first more often than the distractor in all three conditions. However, we predict that the frequency of infants' first fixations to the target would be greater when the actor was an adult relative to when the actor was a child or infant.

Third, with a focus on the dynamics of infants' gaze following behaviour, we also examined the time that infants took to fixate the target object (latency of gaze following) across the three conditions and predict that infants show shorter latencies to fixate the target when following the adult actor, relative to the child or infant actor[1].

1.1.2 | Do infants spend more time looking at adult, child, or infant actors?

We examined whether infants showed a greater preference for looking at the adult, child, or infant actor. We predict that infants will fixate the adult's face more than the child or infant's face, as evidenced by studies of infants' preferences for adult and child faces (Heron-Delaney et al., 2017; but see Heron-Delaney et al., 2018, for 5- to 6-year-old children preferring child over adult faces).

2 | METHODS

2.1 | Participants

We tested 49 German 6- to 15-month-old infants (M = 10.13; SD = 66.55; range = 6 m 9 d–15 m 5 d; f = 26). Infants were recruited through the database of the lab. Additional infants were excluded due to piloting (N = 3) and technical failure (data were not recorded; N = 14). Each session lasted about 30 min and participation was rewarded with an age-appropriate book and a certificate. Ethics approval was granted by the ethics committee of the institute.

The sample size was determined by an a-priori power analysis based on Outters et al. (2020) using G*Power software and resulted in a minimum sample size of n = 46 to reach the desired power of .80, with an alpha-level of .05 for a repeated-measures ANOVA (within factors). We took this as a minimum guideline sample size although the original study (Outters et al., 2020) does not report the results of generalized linear mixed models fit to the data.

2.2 | Stimuli

For the present study, we showed infants 10-s videos, where an actor and two objects were presented in each video. The actors were a 20-year-old female in the adult condition, a 5-year-old girl in the child condition and an 11-month-old boy in the infant condition (see Figure 1). The videos were recorded with the help of a large cardboard that had one hole on either side and was placed on a table in front of the actor. For the videos of the adult actor, the filming person kept track of the timing and instructed the actor to look up and to the side at specific points within the trial. For the child and infant video, one experimenter sat below the table and addressed the child to guide their gaze towards the centre and downwards. Then, a second experimenter, who stood behind the camera, addressed the child to make the

FIGURE 1 Example display of the stimuli. Each video was 10 s long. The actor would look down for 2 s (L), then towards the participant for 2 s (M), and then to one of two objects for the remaining 6 s (R). Each participant saw four videos per actor. For data protection purposes, the child actors' faces were blurred to be included in the manuscript.

child look straight to the camera. Next, the first experimenter presented a toy from below the table through one of the two holes of the cardboard to guide the gaze of the child to either the right or the left position on the table. We then picked the video that was most similar to the adult version in design and timing, and mirrored the video to have a video with the infant or the child looking towards each side. Thus, we ensured high consistency in the behaviour across the actors.

The novel objects used in the videos were obtained from the Novel Objects and Unusual Names (NOUN)-Database (Horst & Hout, 2016) and sorted into 12 unique pairs according to their similarity in colour and shape. The objects were added to the videos and were placed on the left and right side of a table in front of the actor. Each video consisted of three phases. In the beginning, the actor looked down for 2 s. Then the actor lifted their head and looked up at the camera with a neutral-friendly expression, mimicking eye-contact, to catch the participant's attention, also lasting for 2 s. Next, at 4 s into the trial, the actor turned their head for 1 s, looked at the object either to the right or the left and kept their eyes locked on the object for the remaining 5 s of the video. The videos were cut and edited with the video editing software DaVinci Resolve 18.

In total, 144 videos were created. It was ensured that each object of the 12 object pairs appeared on both sides of the screen (side: left, right) and that the actor's gaze was directed to both sides (gaze: left, right). Each of these 48 object combinations was then combined with each of the three actors.

2.3 | Experimental design

Each participant was presented with 12 trials. Trials were presented in two blocks, with each block consisting of one list of six videos presenting two videos from each condition. Twenty-four lists of videos were created, such that two different lists (i.e., two blocks) were presented to each participant. These lists ensured that no object appeared more than once for each participant. Lists were assigned to participants following a Latin square design. A moving cartoon image of a flower was displayed in the centre of the screen between trials as an attention getter. If the infant's attention shifted away from the screen, the next video was only started once the infants' attention shifted back to the attention getter on the screen. The videos within one block appeared in random order and the direction of the actors' gaze was counterbalanced within blocks (one left and one right per actor). Before, between and after blocks, infants were presented with a colourful image of balloons combined with a music clip to keep them engaged in the task.

2.4 | Procedure

Testing took place in a dimly lit, quiet room, where infants were seated approximately 65 cm away from a screen in a car seat or on the lap of their parent. The parent was present for the entire duration of the experiment. A remote eye tracker (Tobii X 120) set beneath the screen and recorded gaze date at 60 Hz. A 5-point calibration procedure was conducted in Tobii Pro. If more than two points could not be calibrated, single points were selected and recalibrated until the desired accuracy was reached. The experiment was run using PsychoPy and lasted approx. 3 min.

3 | ANALYSIS PLAN

The study and analysis plan were preregistered (https://doi.org/10.17605/OSF.IO/9ZPN4). The first set of linear models examined whether infants followed the gaze of an adult, child or infant actor (RQ1). The dependent variable for the first analysis was the **proportion of target looking** (PTL). This was calculated as the duration of time spent looking at the target divided by the total time spent looking at the target and the distractor from 4 to 10 s when the actor looked towards the target. The dependent variable for the second analysis was whether the **first look** after the actor began to turn their head was towards the target or the distractor object. A further exploratory analysis investigated whether the **latency** of infants' gaze following differed across the three actors. The dependent variable was the speed with which participants fixated the target from 4 s on when the actor turned towards the target.

The dependent variable for the analysis examining whether infants spent longer looking at the adult's, child's, or infant's face (RQ2), was the total amount of time spent looking at the actor's face from 2 to 10 s in the trial compared to total looking time during this time window. This time window differed from the other analyses because we wanted to consider the time when the actor looked to the participant (from 2 s on) before the actor looked to one of the objects.

3.1 | Statistical models

All linear models included the same predictor structure: The *actor* (adult, child, infant), *age* of the participating child in days (centred to a mean of 0), and the *direction* of the target (left, right) were included as predictors. Random intercept of *child id* and a random slope for *actor* and *direction* in *child id* were included. Random intercept of *object pair id* and a random slope for *actor* and child *age* in *object pair id* were included. A random intercepts effect of *target object* and a random slope for *actor* and child *age* in *target object* was preregistered but not included in the final analysis because of convergence issues. All statistical models were run in R (version 4.3.0 or higher; R Core Team 2023).

If a model failed to converge, we inspected the estimated parameters for correlations among random intercepts and slopes. If the majority were close to −1 or 1 for a grouping variable (e.g., child ID), we excluded them and refitted the model. If the exclusion did not improve model fit (Matuschek et al., 2017), we excluded all correlation parameters. We will report for each model individually which steps were taken.

We ran a full-null model comparison using a likelihood ratio test (Dobson, 2002) to evaluate the influence of *actor*. Therefore, we ran a reduced null model that excluded *actor* in the fixed effect's part. If the difference between the full and the null model was significant, this would suggest that *actor* predicted the robustness of infants' gaze following and face viewing. To allow for such a likelihood ratio test, models were fitted using maximum likelihood. To obtain significance values of the individual effects, we refitted the full model using restricted maximum likelihood and then used the Satterthwaite approximation to degrees of freedom (Luke, 2017; function lmerTest of the package lmerTest, version 3.1-3 or higher; Kuznetsova et al., 2017).

Full model:

Response ~ glmer(Actor + child age + direction +
(1 + Actor + direction | childID) +
(1 + Actor + child age + direction | object pair ID),
data = data)

TABLE 1 Results of the generalised linear mixed effects models evaluating infants' gaze following (PTL) from an adult, a child, and a baby.

	PTL					PTL: Intercept model				
Predictors	Estimates	Std. error	CI	Statistic	*p*	Estimates	Std. error	CI	Statistic	*p*
Intercept	1.13	.14	.88 – 1.44	.95	.342	1.26	.08	1.11 – 1.44	3.46	**.001**
Actor: child	1.27	.21	.91 – 1.76	1.41	.159	1.27	.21	.92 – 1.75	1.44	.151
Actor: baby	1.04	.18	.74 – 1.45	.21	.833	1.03	.17	.75 – 1.41	.19	.852
z.age	1.02	.07	.90 – 1.16	.33	.741	1.02	.07	.90 – 1.16	.35	.730
Direction: right	1.04	.14	.80 – 1.34	.29	.770	1.05	.17	.77 – 1.44	.31	.753

Abbreviations: CI, confidence level; Std. error, standard error.

TABLE 2 Results from t-tests and Bayes Factor analyses, comparing infants' target looking in each condition against chance level = .5. Significant values ($p < .05$) are highlighted in bold.

	PTL: *t*-tests and Bayes Factors				
Predictors	Mean	*t*	*df*	*p*	BF
Actor: adult	.56	1.73	48	.09	.62
Actor: child	.61	3.08	47	**.004**	9.53
Actor: baby	.58	1.83	45	.07	.74

4 | RESULTS

4.1 | Do infants follow the gaze of infant, child, and adult actors?

4.1.1 | Proportional target looking

This model examined the extent to which infants fixated the target as opposed to the distractor object and whether there were differences in the proportion of target looking towards the object fixated by an adult, child, or infant actor (RQ1, Table 1). The dependent variable included values of 0 and 1. Therefore, we centre-log-transformed the response and ran a beta model using the function glmmTMB without any optimizers. A full model including all correlations between random slopes and intercepts did not converge. Therefore, we reduced the correlations among random intercepts and slopes stepwise. A model excluding all correlations converged and did not show overdispersion and good stability.

The full-null model comparison revealed no significant difference between actors ($p = .35$). Inspection of the coefficients of the full model showed no significant effects of any of the predictors. An intercept model, with the predictors *actor* and *direction* centred, revealed that infants showed above-chance target looking across actors ($p = .001$). These results suggest that infants followed the gaze of an adult, a young child and another baby.

The intercepts of the individual factor levels indicated that target looking was highest for the child condition (see Table 1, Figure 2). One sample *t*-tests and Bayes Factors of infants' proportional target looking in each condition with the chance level at .5 suggested that infants' target looking differed significantly from chance for the child condition ($p = .004$, BF = 9.53), but not for the adult or baby condition (see Table 2 and Figure 3). This would suggest that gaze following was highest in the child condition compared to the adult and infant condition. Note, however, that the results of the frequentist and Bayesian *t*-tests need to be interpreted with caution, given the non-significant full-null model comparison reported above as well as the reduced structure of a *t*-test in comparison to the provided linear model.

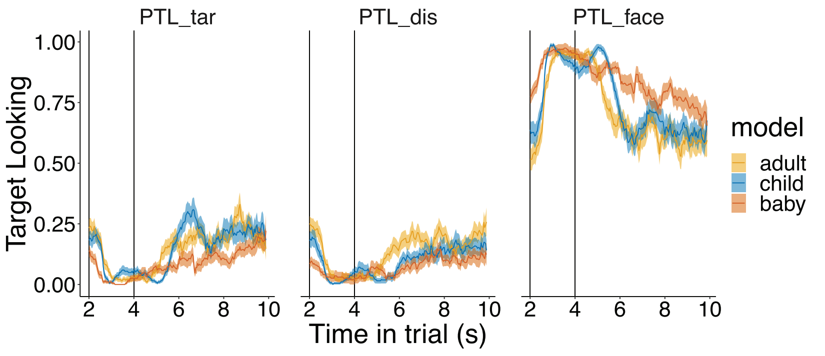

FIGURE 2 Infants' looking towards the target (PTL_tar), the distractor (PTL_dis) and the actor's face (PTL_face) across time from 2 to 10 s. The yellow band reflects looking when a young adult was presented, blue when a 5-year-old child was presented, and red when a 10-month-old infant was presented. The actor looked up towards the participant at 2 s into the trial and directed the gaze towards one of two objects at 4 s into the trial and their gaze remained on the respective object until the end of the trial.

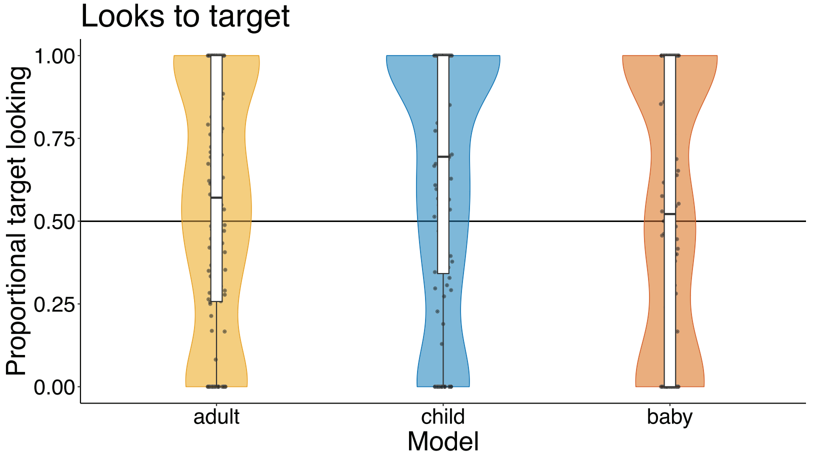

FIGURE 3 Violin plots of infants' proportional target looking, calculated as the time spent looking at the target divided by their looking towards the target and the distractor, when an adult, a 5-year-old child, or a 10-month-old baby were looking at one of two objects.

Furthermore, we note that these analyses considered target looking averaged across the duration of the trial, while the time course of infants' target looking (see Figure 2) indicates that infants followed the gaze of all three actors with subtle, non-significant differences in timing and amplitude (see also the following analyses).

4.1.2 | First look

A one-way (actor: baby, child, adult) ANOVA revealed no significant differences between infants' first look to the target across actors ($p = .35$). A follow-up *t*-test, examining whether infants looked more often to the target ($M = .58$) than chance level (chance = .5) across actors, was significant, $t(48) = 3.36$, $p = .002$. The according linear model examined whether infants' first look after the actor turning their head towards the target was more frequently towards the target (coded as 1) relative to the distractor (coded as 0) across actors (Table 3 and Figure 4). The number of trials

TABLE 3 Results of the generalised linear mixed effects models evaluating whether infants' first look was towards the target or the distractor when following the gaze of an adult, a child, and a baby.

	First look					First look: Intercept model				
Predictors	**Odds ratios**	**Std. error**	**CI**	**Statistic**	***p***	**Odds ratios**	**Std. error**	**CI**	**Statistic**	***p***
Intercept	1.02	.35	.52 – 2.00	.05	.959	1.56	.23	1.17 – 2.08	3.04	**.002**
Actor: child	1.73	.69	.80 – 3.78	1.38	.166	1.74	.69	.80 – 3.81	1.39	.165
Actor: baby	1.13	.40	.56 – 2.25	.33	.739	1.13	.40	.56 – 2.26	.34	.733
z.age	1.16	.18	.85 – 1.59	.95	.344	1.16	.19	.85 – 1.59	.94	.350
Direction: right	1.54	.68	.65 – 3.66	.98	.326	1.55	.68	.65 – 3.68	.99	.321

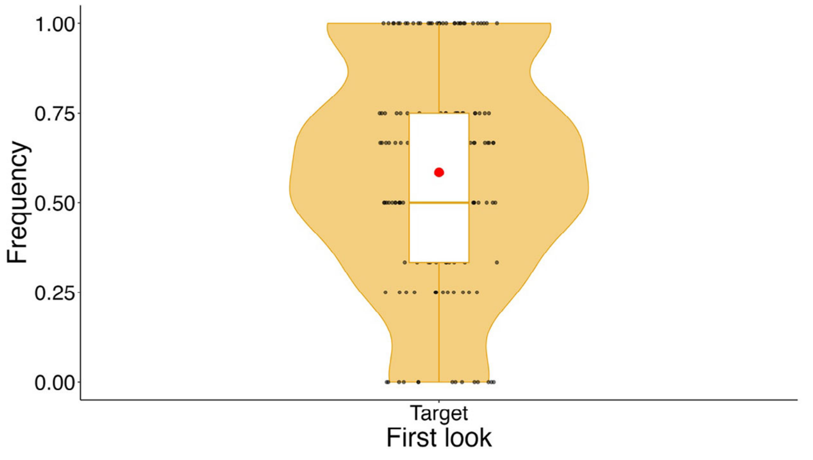

FIGURE 4 Violin plot of the frequency of infants' first look after the actor turned their head towards the target object. The red dot represents the mean.

TABLE 4 Results of the generalised linear mixed effects models evaluating infants' latency when following the gaze of an adult, a child, and a baby. Std. Error = standard error; CI = confidence level.

	Latency				
Predictors	**Estimates**	**Std. error**	**CI**	**Statistic**	***p***
Intercept	6.47	.28	5.93 – 7.02	23.54	<.001
Actor: child	–.22	.31	–.84 – .40	–.70	.482
Actor: baby	.14	.26	–.37 – .64	.53	.597
z.age	.07	.12	–.17 – .31	.57	.567
Direction: right	.22	.23	–.24 – .67	.94	.349

Abbreviations: CI, confidence level; Std. Error, standard error.

where the participant shifted towards the correct (target) and incorrect (distractor) image was fed in as a matrix and a binomial model was fitted using the function glmer of the package lme4 (version 1.1-33 or higher; Bates et al., 2014) with the optimizer "nloptwrap" and optCtrl = list(maxfun = 100000). A full model with all correlations converged, did not show overdispersion and good stability.

The full-null model comparison revealed no significant difference between actors ($p = .47$). Inspection of the coefficients of the full model showed no significant effects of any of the predictors (see Table 3). An intercept model, with the predictors *actor* and *direction* being centred, revealed that infants showed above-chance target looking across actors. Thus, infants' first look was more often to the target compared to the distractor across actors.

4.1.3 | Latency

This model examined whether the speed with which infants fixated the target (after the actor began to turn their head towards the target) differed across actors (Table 4). We ran a generalized linear mixed model using the function lmer with the optimizer "nloptwrap" and optCtrl = list(maxfun = 100000). A full model with all correlations converged, did not show overdispersion and good stability.

TABLE 5 Results of the generalised linear mixed effects model evaluating infants' looking towards the face when presented with an adult, a child, or a baby.

	Actor preference				
Predictors	**Estimates**	**Std. error**	**CI**	**Statistic**	***p***
Intercept	3.47	.46	2.69 – 4.50	9.47	<.001
Actor: child	1.26	.12	1.04 – 1.52	2.33	.020
Actor: baby	2.00	.25	1.56 – 2.56	5.46	<.001
z.age	1.03	.10	.85 – 1.25	.34	.733
Direction: right	1.01	.09	.86 – 1.19	.11	.910

Notes: Baby-child comparison was computed using the same model, but changing the order of levels of the factor actor. This model is not reported here separately.
Abbreviations: CI, confidence level; Std. error, standard error.

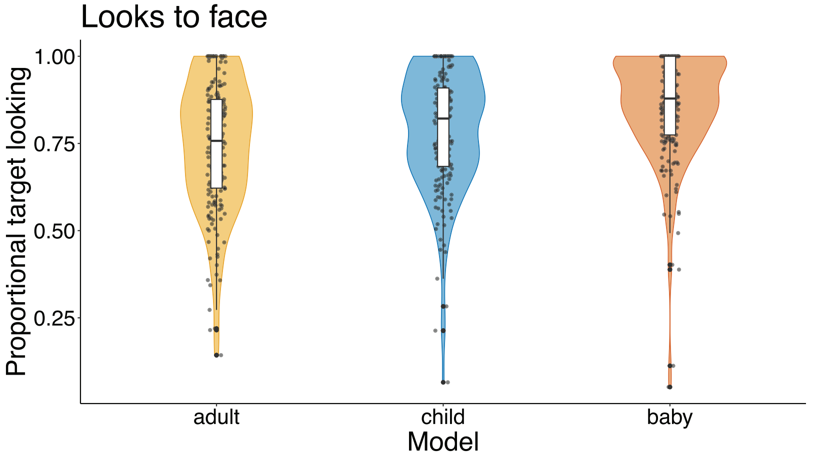

FIGURE 5 Violin plots of infants' looks to the face of a young adult, a 5-year-old child, and a 10-month-old baby.

The full-null model comparison revealed no significant difference between actors ($p = .54$). Inspection of the coefficients of the full model showed no significant effects of any of the predictors which would indicate differences in latency between actors (Table 4). Thus, infants' latency to look to the correct target did not differ significantly across actors.

4.1.4 | Do infants spend more time looking at adult, child or infant actors?

Next, we run a model investigating whether infants looked preferably to one of the three actors (RQ2, see Table 5 and Figure 5). The variable included values of 0 and 1. Therefore, we center-log-transformed the response and ran a beta model using the function glmmTMB without any optimizers. A full model with all correlations did not converge. Therefore, we reduced the correlations among random intercepts and slopes stepwise. A model without any correlations converged and did not show overdispersion and good stability.

The full-null model comparison revealed a significant difference between actors ($p < .001$). Inspection of the coefficient estimates of the full model showed that infants looked significantly more to the baby than to the adult ($p < .001$), more to the child than to the adult ($p = .02$), and more to the baby than to the child ($p < .001$). These results suggest that infants preferred looking towards the baby's face compared to the child's and adult's face, and more towards the child's face relative to the adult's face.

5 | DISCUSSION

In the current study, we examined the extent to which infants followed the gaze of an adult, a child, and an infant actor. Furthermore, we examined whether infants spent longer looking at the face of the adult, the child, or the infant actor. The results suggest that infants followed an infant's, a child's, and an adult's gaze. Their first look was significantly more often to the target than the distractor, independent of the actor, and there was no difference in infants' latency of looking to the target across actors. Furthermore, infants were highly interested in all three faces and looked significantly more to the baby than the child face and more to the child face than the adult face. These results suggest that infants between six and 15 months follow the gaze of different social partners, and are highly interested in faces, especially the faces of same-age peers.

We suggested that there may be two potential outcomes regarding infants' gaze following behaviour. On the one hand, infants might follow an adults' gaze more robustly relative to a child or infants' gaze. Some theoretical perspectives such as the natural pedagogy account (e.g., Csibra & Gergely, 2009), suggest that adults are ideal teachers for young children, and that infants may be innately tuned to follow the gaze and learn from such benevolent experts relative to other infants and children. On the other hand, other perspectives on child learning predict gaze following behaviour to be attuned to prior experiences of the child and the, respectively, expected information gain (Corkum & Moore, 1998). Thus, this too could be taken to speculate that infants may follow adults' gaze more robustly relative to infants' and children's gaze, given likely differences in past gains in interactions with adults relative to children or infants. However, positive learning experiences with other children can lead to an increased value of gaze following in peer interactions. Furthermore, accounts that highlight the role of adults, as well as other children and peers as valuable and potentially informative social partners (Zmyj & Seehagen, 2013) suggest that infants would also follow the gaze of an informative child, especially given the social function of gaze following.

Our findings provide no support for theories that accord adults a special role in early development with regards to gaze following. Support for such theories predominantly comes from findings suggesting a boost in early gaze following when gaze cues provided by an adult are accompanied by ostensive cues such as infant-directed speech (Hernik & Broesch, 2019; Senju & Csibra, 2008). In contrast, in the current study, a direct gaze with a friendly facial expression was used to keep the cue constant across actors. Our findings suggest that infants were agnostic with regards to the pedagogical status of their social partner in such conditions, and followed the gaze of an adult, a child, or another infant. Indeed, the results of the frequentist and Bayesian *t*-tests could be tentatively taken to conclude that infants followed the gaze of the child most robustly. It is possible that the absence of strong ostensive cues in the current design may have led to infants not prioritising adult gaze. Nevertheless, the current findings question the special status of adults in early development, at least with regards to social communicative interactions.

In keeping with theories suggesting that peers and older children can be valuable social partners, our findings suggest that adults, children, and infants alike may be social role models whose interests, for example, the objects that capture their attention, may drive early attention and, potentially, learning. Social constructivist theories like Vygotsky's "Zone of Proximal Development" (Vygotsky, 1962) particularly emphasize the importance of collaborative interactions and imitation between children and older peers for learning. A similarly important role for peers in learning and imitative behaviour was proposed in Piaget's work (Piaget, 1932), suggesting that the similarity in the cognitive abilities of peers may lead to children imitating peer behaviour more, due to children assuming that they may be able to do something that a peer can do. Indeed, social comparison theories suggest that older adults may be considered too different from the infant, leading to infants considering children to be more appropriate social models (Bandura, 1977; Festinger, 1954). Such a pattern would be in keeping with results in younger and older adults showing that gaze following behaviour also varies across adulthood, with younger – but not older – adults being biased towards same-aged peers (Slessor et al., 2010). Bringing together the pedagogical accounts and the social learning accounts reviewed above, children's gaze following behaviour may follow a more social function in tasks not emphasising learning progress, while benefiting from a pedagogical assumption in tasks where children can update their models of the world in a specific regard. This may especially be so later in development, when the desired and expected learning progress is more quantifiable for a child herself, given the development of children's metacognitive abilities (de Eccher et al., 2024).

Some evidence for the possibilities discussed in the paragraph above come from two findings of the current study. The intercepts in the PTL model of the individual factor levels indicated that target looking was highest for the child condition (despite the non-significant result for differences between actors). Similarly, the frequentist and Bayesian t-tests suggested that robust evidence for gaze following was found only in the child condition but not in the adult and infant condition. This might speak to a potential prioritisation of older peers in early development, with older peers striking the ideal balance between knowledgeability and similarity. Future research should, therefore, explore the role that older peers may play in driving learning progress in the zone of proximal development. Second, we note that infants looked longest towards the baby face relative to the other actors, and more towards the child face relative to the adult face. Similarly, the time-course graph suggests that infants spent more time looking at the face of the baby than to the child or adult, and that they seemed to direct their attention less to the objects in the baby condition compared to the child and adult condition (although this difference was not significant when collapsing the data across time).

Infants' interest in faces is in line with research showing that humans quickly detect faces in complex scenes and show a preference for faces over other objects (e.g., Kelly et al., 2019). Similarly, infants' increased interest in infant faces relative to older children and adult faces has also been reported in studies that directly contrast still images of faces of different age groups (Damon et al., 2016, 2021). At the same time, this finding contrasts with other work suggesting that children show a preference for adult faces between 3- and 9-months of age (Heron-Delaney et al., 2017; Macchi Cassia et al., 2014). Such differences are typically explained in terms of children's prior experiences, with studies showing that increased exposure to child faces may lead to children showing a preference for child faces relative to adult faces (Macchi Cassia, 2011; Macchi Cassia et al., 2012, 2014; but see Rhodes & Anastasi, 2012). Thus, on the one hand, infants' preference for infant and child faces may be explained by the prior familiarity of adult faces and the relative novelty of infant and child faces (Del Bianco et al., 2019; Gredebäck et al., 2010; Striano & Bertin, 2005). On the other hand, the preference for infant and child faces may be due to multiple factors such as infants' preference for specific kinds of faces, their familiarity with adult faces, and the power of gaze in driving communicative behaviour.

Note that, in the current design, the face of the actor and the novel objects competed for the attention of the infant, and thus, infants' attention to the different areas on the screen cannot be explained independently of each other. Furthermore, the degree of their interest in the actor faces differed across conditions. Given that infants were highly interested in looking at the infant face (compared to the other actors), this could interfere with their gaze following behaviour: because of their attention to the infant face, infants might show less gaze following from infants or they might be less interested in following the gaze of the infant, and therefore, might look more to the face. Importantly, even though infants' attention to the faces was high, they showed gaze following from all three actors. This mirrors the competition in the real world, with infants balancing their attention to people's faces relative to the objects or the environment that other people and the children themselves are interested in.

We note that the results presented here were obtained using videos of white, German actors and testing white German infants growing up in a mostly middle-class university town. Therefore, we cannot generalize our findings to other cultural or familial backgrounds. In particular, we cannot speak to the universality of infants' gaze following of other children and infants in cultures where caregiver-child and peer interactions may vary. We note also that some studies show increases in gaze following behaviour across the age range tested in the current study (e.g., Tang et al., 2024). In contrast, both the current study and Outters et al. (2020), do not find differences in gaze following across early development in the paradigm tested here. Indeed, we included age as a control factor in all our analyses to evaluate potential differences across development and found that age did not modulate any of the measures reported here. One reason for the differences across studies may be related to differences in the paradigm, given that Tang et al. (2024), for instance, had infants interacting with a real person during the experiment. Furthermore, the current study presented infants with a female adult and child actor and a gender-neutral infant (where it was not clear whether this was a male or a female infant), in keeping with previous studies of infant gaze following behaviour (Outters et al., 2020; Senju & Csibra, 2008). In further exploratory analyses, the gender of the participant was not a significant predictor of infants' gaze following in any of the analyses. We note, however, that infants' attention in such tasks can be influenced by the gender of the actor, which may lead to differences across participants in future studies.

The current study finds that infants follow the gaze of an adult, a child, and a baby, and show high interest in faces, particularly same-age faces. These results have important implications for ongoing theoretical and empirical development on adult-child interaction, which have, thus far, largely ignored the possibility that peers and older children might play just as important a role in the development of infant's social-cognitive skills. Our study highlights how infants make plentiful use of their social environment, using the gaze of others to redirect their own attention, independent of the age of the social partner. In the context of theories on social learning, these results suggest that infants perceive not only adults, but also their peers and slightly older children as valuable social partners whose gaze might be worth following.

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CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

DATA AVAILABILITY STATEMENT

The data are available on request.

ETHICS STATEMENT

The study was reviewed and approved by the ethics committee of the Georg-Elias-Müller-Institute for Psychology, University of Göttingen.

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ENDNOTE

[1] Note that in the preregistration for this study, we had erroneously predicted both that we do not expect differences across conditions and that, should there be differences across conditions, we predict increased gaze following with adults as opposed to children and same-aged peers. As pointed out by a reviewer, this allowed us to predict both directions of effects. We, therefore, make our predictions more concrete here by specifying our more direct hypothesis of increased gaze following with the adult actor relative to the other actors.

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