# Gaze-Following as a Process:
## Its Emergence in 3- to 5-Month-Olds

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**Abstract**

'Look at that!' — an adult's sudden turning away and showing her profile may initially be an unwanted interruption of intimate mutual attention for young infants. However, over time the infant comes to follow the adult's gaze. How does this transition take place? Two experiments were undertaken to explore the effect of target objects on gaze following behaviors between 3 and 5 months of age. More infants successfully shifted their gaze to targets with eyes which simulated unbroken mutual gaze (a facing doll), than to targets without eyes (a ball or a doll showing its back). It is argued that this developmental transition from dyadic to triadic interaction is achieved as part of a continuous process in development rather than as a sudden change.

**Keywords**: gaze-following; 3- to 5-month old infants; target objects; targets with eyes; mutual gaze

### Introduction

The successful following of gaze and participation in joint visual attention is seen as a key transition point between dyadic and triadic attention and serves as a predictor for subsequent developments in language and other social-cognitive skills (Brooks & Meltzoff, 2005, 2008; Carpenter, Nagell, & Tomasello, 1998; Cetincelik, Rowland, & Snijders, 2021; Flom, Lee, & Muir, 2007; Tomasello & Todd, 1983; Yu, Suanda, & Smith, 2019). However, few studies specifically examine how this developmental transition from the dyadic to triadic interaction is achieved — whether it emerges as a "revolution" (Tomasello, 1999) or as a "developmental continuity" (Reddy, 2005, 2008, 2011). The experiments reported in this paper focus on observing precursor behaviors of gaze-following, and exploring the supporting situations which help infants' gaze-following behaviors to appear between 3 and 5 months of age.

Converging data has suggested that the period of 3 to 5-months of age is crucial for the emergence of gaze-following. In Butterworth's 2001 overview, he reported that, in typical development, infants have been shown to demonstrate fragile gaze-following behaviors around three months, and by about ten months, robust gaze-following to objects with adults (Butterworth, 2001). The early fragile gaze-following Butterworth identified is occasionally described as a reflexive body movement or attention shifting. Research by Brooks and Meltzoff has brought up evidence of "body following" rather than gaze-following in 9-month-olds (Brooks & Meltzoff, 2002, 2005; Meltzoff & Brooks, 2007), and D'Entremont, Yazbek, Morgan, and MacAulay (2007) discussed how an adult's head-turn might reflexively stimulate a shift of attention in infants of 3- to 6-months. They suggested that the adult's head-turn stimulates the infants to shift their attention to one side, but infants' completion of the turn depends on "their ability to disengage attention from a central stimulus, their ability to initiate saccadic movements, and whether there are peripheral cues to help pull their attention away from the central stimulus" (p.83).

What cues can help infants succeed, then, in gaze-following? Butterworth and Jarrett (1991) found that gaze shifting by adults when supported by pointing helped infants in their first 18 months to successfully locate the more peripheral of a pair of targets, whereas an adult's change of head direction and shifted gaze alone resulted in the infants only locating the more central target of the pair. Later, research by Deák, Flom, and Pick (2000) suggested three possibilities for why this should be the case. First, pointing is "an intentional request" to direct another person's attention, whereas gaze-shifting alone is not necessarily intended to direct attention. Second: pointing is "a better geometric cue" than head re-direction. The arm, stretched out in front of the infants, gives them a clear directional indicator to follow. Finally: raising and stretching out one's arm is a large movement, more easily noticed by infants than a simple head-turn.

These conjectures may also be applied to the observations in the D'Entremont et al. (2007) findings above; young infants' motor and attentional skills are immature and whether truly understanding or not, they may need clear, reinforced signals to notice an attention-directing cue. Further research by Flom, Deák, Phill, and Pick showed that 9-month-olds can follow gesture combinations that redundantly specify where an adult is looking; an adult both pointing and looking at a target is giving a more compelling cue than just by gaze-shifting alone (Flom, Deák, Phill, & Pick, 2004). Postural cues may also have assisted. Akhtar and Gernsbacher (2008) have pointed out, "in naturalistic interactions, changes in gaze direction are almost always accompanied by changes in body posture," and it is likely that such reinforcing bodily clues play an important role in supporting the onset of gaze-following.

Certain cues may serve to dissuade gaze-following, especially in the early period of 3 to 5 months of age. Many researchers have confirmed through experiments that infants prefer to look at adults' faces with their gaze directed to them (Hains & Muir, 1996; Hood & Macrae, 2007; Johnson & Farroni, 2007; Symon, Hains, & Muir, 1998). From birth, human infants look longer at a face with direct rather than averted eye gaze (Farroni, Massaccesi, Pividori, & Johnson, 2004). In Hood, Willen, and Driver's (1998) study, for example, 3-month-olds turned their gaze to a target if a face disappeared from the screen, but 61% of them continued looking at the face if it did not disappear, that is, remained visible along with the target (Hood et al., 1998). Similarly, 3- and 4-month old infants demonstrated difficulty disengaging from a face and failed to notice pointing alone as a cue to shift attention in an experiment in which the adult pointed to a target while still maintaining face-to-face contact. The majority of the infants instead maintained eye contact with the adult (Amano, Kezuka, & Yamamoto, 2004).

An experiment by Amano, Kezuka, and Yamamoto (2005) also showed evidence of this difficulty disengaging from face and eyes when they demonstrated that 3-to 5-month-olds are likely to turn their heads and follow an adult's moving head in order to keep a face with eyes within view. In their experiment, after face-to-face interaction, when an adult turned her head and eyes to an object, about half of the infants kept still and stared at the adult's profile and then looked down, or followed the adult's moving head, continuing to stare at the adult's profile rather than looking at the object. Furthermore some infants tried to get into a position from which they could look again at both the adult's both eyes by moving their own heads (Amano et al., 2005).

Gaze-following experiments with infants are mostly carried out in a context of social interaction; an adult engages in a face-to-face interaction with an infant before giving a gaze "cue" of turning away. From the infants' point of view, the adult's sudden turning away (and showing her profile), even if it is accompanied with a gentle verbal invitation to share something interesting to them, may initially be an

unwanted interruption of their intimate mutual attention. Under the condition of mutual infant-adult gaze, infants are calm and conserve energy, whereas the absence of eye contact may elicit considerable infant crying (Blass, Lumeng, & Patil, 2007). This is a developmental point at which scaffolding may help provide a bridge for transiting from infant confusion at loss of eye-contact, to understanding and following cues to shift gaze.

So, then, what targets can be useful scaffolds for stimulating infants' transiting from dyadic to triadic conditions, i.e., useful in eliciting infant gaze-following and shared attention to an object with an adult? Trembly, and Rovira (2007) and Moore (2008) have pointed out that until recently the nature of the target for joint attention has received little interest from researchers. Moore traces this to the influence of the initial research on joint visual attention, done by Scaife and Bruner (1975), in which visual targets were absent from the reported investigation (Moore, 2008). Since then, however, researchers have found that absence of a target dissuades gaze-following during the first year of life (Moore & Corkum, 1994; Moore, 1999; Moore & Povinelli, 2007). Varied locations of targets (Flom et al., 2004), and variations on the type of target (Deák et al., 2000) also make differences in successful gaze-following. Flom et al. (2004) have reported that 9-month-old infants follow adults' focus of attention more frequently when the target objects are distinctive and complex. However, as yet we still know little about what targets elicit gaze-following in this early period of 3 to 5 months of age.

Therefore in this paper we explore the effects of two different target objects (doll or ball) on the timing of infants' gaze-following/head-turn; during an adult's head-turn or during an adult's showing of their profile, and on the form of infant gaze-following/head-turn; direct (straight to target) or indirect (via pointing hand).

## Experiment 1

### Method

**Participants.** Ninety-nine infants (thirty eight 3-month-olds, range 14–17 weeks, 19 males and 19 females; forty 4-month-olds, 18–21 weeks, 21 males and 19 females; twenty one 5-month-olds, 22–26 weeks, 10 males and 11 females) were recruited from babies who attended a regular health check-up. All the infants were healthy and born at term. An additional 7 infants (one 3-month-old and six 4-month-olds) were eliminated from the final list. When the experimenter turned her head away from them, these seven infants started to cry, and did not show signs of willingness to re-engage in the experiment with the experimenter.

**Materials.** The experimental materials were two toys; a red ball (6 cm in diameter) and a doll in pink rompers (14 cm high, in a sitting pose). The size of the doll's face was about the same size as the red ball.

**Procedure.** The infants were each seated on their mothers' laps across the table from the experimenter. The table between them was lined on its surface at every 30 degrees radially from the position of the infants (see Figure 1). Prior to the experiment, the experimenter asked each mother her child's name (and nickname) and his/her date of birth for reference. Then three yellow markers were placed in a triangle on the top of the infants' heads to assess their gaze directions. The experimenter's head had already been marked similarly with red markers. The experimenter next introduced and manipulated "her" toy. In the case of the ball, it was rolled and bounced lightly on the table, and in the case of the

doll, it was made to bow saying, "hello," and to wave "goodbye." Then she moved it 50 cm from the center to the right or to the left, setting it down on the 60 degree line, outside of the infant's range of peripheral vision if the infant was looking straight forward, at the experimenter[1]. She then manipulated the second toy and moved it to the opposite side from the first, also at 60 degrees and also just out of the infant's immediate range of vision. The doll was always placed facing the infants.

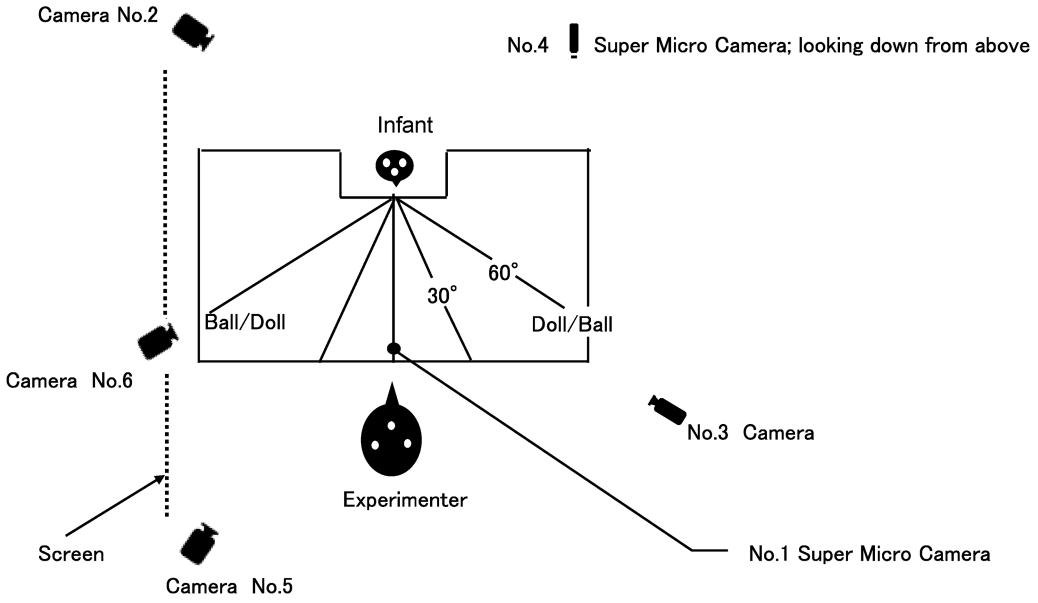


**Figure** 1 Bird's-Eye View of the Experimental Setting
The table (60×120 cm) was cut out to make a space (15×30 cm) for the infants to fit in.
Camera No.3 was about 70 cm away from the table, and camera No.5 was about 90 cm away from the table.

In a short face-to-face interaction with the infant, the experimenter asked the infant: "Where has the ball gone (or the doll)? Let's look at the ball (or the doll)! Where is it?" Then she turned her head and body to face the target, pointing to it as well, and simultaneously answered herself aloud, "Here it is!" (From the infant's point of view, her face changed from a frontal view to a profile with only one eye visible.) She stayed still for about 2 seconds presenting her profile. Then she turned back to re-engage with the infant, and then repeated the same steps with the other toy. The experimenter always pointed with the arm closest to the target, to avoid crossing the field of her profile from the point of view of the infants.

**Coding and reliability.** The experimental setting and the arrangement of cameras are shown in Figure 1. The images captured by the four cameras (No.1, 2, 3 and 4) were integrated into one. The first camera focused on the infant's face. The second focused on the face of experimenter, the third shot

1 Infant's range of vision and peripheral vision is much narrower compared to older children and adults (see Tronick, 1972; Dobson, Brown, Harvey, & Narter, 1998).

from the infant's left side, and the fourth recorded a bird's-eye view of the experimenter and the infant. There were two more cameras, one (No.5) focused on the infant's diagonal front and the other (No.6) on the infant's right side. The infant's head-turning and gaze direction to the experimenter's face, hand and the object were checked by examining the video pictures of six different angles frame by frame (1/30 s). The target objects were placed at the tip of the 60 degree line, the experimenter's head was at the 30 degree line when her gaze was turned to the target object, and her pointing hand was always between the 30 and 60 degree line from the point of view of the infants. The triangle atop of the infant's head showed which degree line the infant's gaze direction followed, confirming the images taken by the cameras which were recording the infant's eye direction directly. If the direction of the triangle on the infant's head intersected with the direction of the experimenter's triangle when the experimenter looked at the target object, (from the vantage of the bird's-eye view camera), this showed joint visual attention at that stage. Initial agreement of the two coders, calculated for two infants at each age group (total six infants), was 97.0% (Cohen's kappa＝.92). In a few cases of discrepancy between the two coders, all the pictures were reviewed frame by frame.

## Results

The effects of two target objects were examined in two stages; during the experimenter's head-turning towards an object (in action), and during the presenting of her profile for 2 seconds (at pause).

**The effects of target objects during the experimenter's head-turning.** Infants' responses to the experimenter in action were classified into three categories: Turning to the same direction as the experimenter's head-turning, Turning to the opposite direction, and No-turning. "Turning" included all infants' head movements without regard for their scale. Therefore, there were cases of both disengaging and non-disengaging from the experimenter's face in "Turning." In the latter case, the infants kept watching the experimenter's face and as a result their heads were moving slightly at the same time as the experimenter's head was turning and her body was inclining towards the target. Table 1 shows the percentages of infants who were classified into the three categories.

**Table** 1 Infants' Head-Turning During the Experimenter's Head-Turning to a Target (%)

| | | Turning (same) | Turning (opposite) | No-turning |
|---|---|---|---|---|
| 3 months (n ＝38) | Doll | 47.4 | 2.6 | 50.0 |
| | Ball | 39.5 | 2.6 | 57.9 |
| 4 months (n ＝40) | Doll | 77.5 | 0.0 | 22.5 |
| | Ball | 62.5 | 2.5 | 35.0 |
| 5 months (n ＝21) | Doll | 71.4 | 0.0 | 28.6 |
| | Ball | 76.2 | 0.0 | 23.8 |

In order to statistically test whether infants' head-turning differed by target objects, the categories were collapsed into a dichotomous variable consisting of "Turning" (to the same direction) versus "Others" (Turning to the opposite direction and No-turning).

The McNemar's test was used to examine whether each infant's head-turning differed in relation to the target objects. No significant relationship between head-turning and the target objects was found at the .05 levels, in all three age groups. These results indicated that the experimenter's head-turning

(gaze-shifting) stimulated infants' head-turning, but whether the target was the ball or the doll did not influence their turning at these ages.

Next a chi-square analysis was used and a significant relationship between head-turning and age group was found for both target objects; $\chi^2=8.28$, $df=2$, $p=.019$, for the doll, $\chi^2=8.38$, $df=2$, $p=.016$, for the ball. Post hoc comparisons with a Bonferroni adjusted alpha level of .017 (.05/3) revealed a significant difference between the 3-month-olds and the 4-month-olds for the doll, $\chi^2=7.58$, $df=1$, $p=.006$, and the 3-month-olds and the 5-month-olds for the ball, $\chi^2=7.31$, $df=1$, $p=.007$. The experimenter's head-turn (gaze-shifting) did not fulfill its function as a cue to look in the same direction for the 3-month-olds. Additionally, a few of the 3- to 4-month-olds turned to the opposite direction from the experimenter; these younger infants noticed the experimenter's head-turn, but they appeared uncertain of which way she was moving. None of the 5-month-olds showed this confusion.

**The effects of target objects with the experimenter showing profile at pause (the final static head orientation).** In the latter stage, during the presentation of the experimenter's profile for 2 s (at pause), each infant's recorded gaze was classified into four categories: Target object (they shifted their gaze to the target object), Hand (they shifted their gaze to the experimenter's hand), Face (no gaze-shift from the experimenter's face), and Looking away (they disengaged from the face but failed to find any other objects including the experimenter's hand.) Table 2 shows the percentages of infants in each of these categories.

**Table 2** Infants' Gaze-Shifting Targets While the Experimenter Paused for 2 s. (%)

| | | Target object | Hand | Face | Looking away |
|---|---|---|---|---|---|
| 3 months (n =38) | Doll | 39.5 | 10.5 | 15.8 | 34.2 |
| | Ball | 18.4 | 10.5 | 21.1 | 50.0 |
| 4 months (n =40) | Doll | 62.5 | 5.0 | 7.5 | 25.0 |
| | Ball | 40.0 | 7.5 | 12.5 | 40.0 |
| 5 months (n =21) | Doll | 81.0 | 0.0 | 4.8 | 14.3 |
| | Ball | 42.9 | 4.8 | 9.5 | 42.9 |

In order to statistically test the relationship between target objects and gaze-shifting, gaze-shifting categories were collapsed into a dichotomous variable consisting of "Target object" versus "Others" (Hand, Face and Looking away).

The McNemar's test was used to examine whether each infant's gaze-shifting differed by the target objects. There were significant differences in gaze-shifting between the two target objects at the .05 level in all age groups (the 3-month-olds: $\chi^2=5.33$, $df=1$, the 4-month-olds: $\chi^2=4.77$, $df=1$, the 5-month-olds: $\chi^2=8.00$, $df=1$.) The effect of target objects on infants' successful gaze-shifting was clear; the infants found the doll more easily than the ball in all age groups.

Next a chi-square analysis of age-group by dichotomous gaze-shifting revealed a significant relationship between age-group and gaze-shifting for the doll ($\chi^2=10.19$, $df=2$, $p=.006$), and a marginally significant relationship for the ball ($\chi^2=5.50$, $df=2$, $p=.064$). Post hoc comparisons using a Bonferroni correction adjusted alpha level of .017 (.05/3) revealed that a significant difference was found between the 5-month-olds and the 3-month-olds for the doll ($\chi^2=9.38$, $df=1$, $p=0.002$) with 81.0% of the 5-month-olds shifting to the target vs. only 39.5% of the 3-month-olds. For the ball, only 18.4% of the

3-month-olds were able to shift to the target, compared to 40.0% of the 4-month-olds, and 42.9% of the 5-month-olds, however, these proportional differences were not statistically significant (the 3-month-olds vs. the 4-month-olds: $\chi^2=4.36$, $df=1$, $p=0.037$, the 3-month-olds vs. the 5-month-olds: $\chi^2=4.09$, $df=1$, $p=0.043$.) The results indicated that for the 3-month-olds it was more difficult to shift their gaze to the target objects than for the 4- and 5-month olds, whether the target was the doll or the ball. The 3-month-olds' gaze often remained on the experimenter (her profile or her hand), or they appeared to be at a loss.

**The effects of target objects on the nature of infant gaze-following/head-turn; direct (straight to target) or indirect (via pointing hand).** In successful gaze-shifting from the experimenter's face to the targets, two ways of shifting were observed; one was a direct shifting from the face to the objects, and the other was indirectly, by way of the pointing hand. Table 3 shows when the target was the ball, the percentages of infants who took the indirect way increased. Taking all the three age groups' data together, a marginal significant difference was found between the doll and the ball ($\chi^2=3.15$, $df=1$, $p=.076$). This result indicates that the experimenter's pointing hand may have helped the infants shift their gaze to the target when they couldn't immediately find the target object.

**Table 3** Percentages of Infants Who Shifted Directly From the Face to the Object, vs. Infants Who Shifted Indirectly via the Pointing Hand

| | 3 months | | 4 months | | 5 months | |
|---|---|---|---|---|---|---|
| | Doll | Ball | Doll | Ball | Doll | Ball |
| | (n =15) | (n =7) | (n =25) | (n =16) | (n =17) | (n =9) |
| Direct shift | 73.3 | 57.1 | 84.0 | 62.5 | 70.6 | 55.6 |
| Indirect shift | 26.7 | 42.9 | 16.0 | 37.5 | 29.4 | 44.4 |

## Discussion

In the early study of gaze-following by Scaife and Bruner (1975) in which visual targets were absent, the directions in which infants turned their heads were taken as an index of joint visual attention. However, the present experiment indicates that head-turning to the same direction as the experimenter, and subsequent gaze-shifting to the target may possibly be based on potentially distinguishable motivations. Turning in the same direction as the experimenter in action did not necessarily result in successful gaze-shifts to the target, even in the oldest group. Their head-turns appeared to be a part of contingently interactive behavior with a communicative partner: they might have followed the experimenter's moving face (face-following) or the experimenter's postural change (body following). Among the 3-month-olds who turned with the experimenter, the majority failed to gaze-shift to the target object.

In our observations, the 3-month-olds in particular were likely to show distress when the experimenter shifted her gaze from them. The number of infants who shifted their gaze from the face to the target object increased rapidly from 4-months-old; some infants (20.0% of the 4-month-olds, and 28.6% of the 5-month-olds) were observed taking alternating looks between the experimenter's profile and the object as if to determine what she was looking at. Perra and Gattis (2010, 2012) have also reported observing 3 and 4-month-olds shifting gaze back and forth between experimenter and target within their immediate visual field.

To get young infants to notice and recognize a target object, research thus far indicates that it is necessary for adults to bring their own gaze close to the object (Amano et al., 2004) or to hold the object near to their own face (D'Entremont, Hains, & Muir, 1997; Striano, Stahl, Cleveland, & Hoehl, 2007; Perra & Gattis, 2010, 2012). Adequate help from adults appears to support understanding of this intended link between an adult's gaze and an object.

In this study, we found features of the target objects facilitating this developing understanding as well. Flom et al. (2004) have reported that infants follow adults' focus of attention more frequently when the target objects are distinctive and complex. Our results lead us to concur and note that while red is distinctive, the infants more often turned their heads and shifted their attention to the pink-clothed doll rather than the red ball, suggesting that the social elements represented by the doll carry psychological distinctiveness. As shown in Table 2, many infants ignored the ball when it was the experimenter's visual target, and looked at the experimenter's profile instead. Even if they turned their heads to the 60-degree line on which the ball was placed, they overlooked the ball itself or stopped with their gaze on the pointing hand near the ball.

We suggest two possibilities as to why the infants were so attracted to the doll in comparison to the ball. As reported in many studies, infants prefer objects active in a contingent manner (Johnson, Slaughter, & Carey, 1998; Molina, Van de Walle, Condry, & Spelke, 2004). The attraction may have been the infants' response to the human-like actions of the doll (in the introduction stage of the experiment we had made the doll perform typical greeting and parting actions). The other possibility is the fact that the doll had eyes and a face, known to be among the most attractive stimuli to young infants (Farroni, Csibra, Simion, & Johnson, 2002; Farroni, Massaccesi, Pividori, & Johnson, 2004; Frank, Vul, & Johnson, 2009; Jayaraman, Fausey, & Smith, 2015).

As a further investigation the following additional experiment was undertaken in which the experimenters exchanged the red ball for another doll, this one showing its back, as one of the targets. As there were no significant differences between the 4-month-olds' and the 5-month-olds' responses in Experiment 1, this second experiment targeted infants of 3 and 4 months only.

## Experiment 2

The aim of Experiment 2 was therefore to examine if 3-and 4-month-olds could, after face-to-face interaction with an experimenter introducing and manipulating toys, shift their gaze to a doll showing its back as well as to a doll facing them. The prediction was that they would not shift their gaze as readily to the doll showing its back, because they would not be able to see its eyes.

### Method

**Participants.** Forty infants (19 males and 21 females: range 15–20 weeks) were recruited from babies who attended a regular health check-up at the same location as in Experiment 1. All infants were healthy and born at term. An additional six infants were eliminated from the final list due to crying or technical troubles.

**Setting and materials.** The experimental setting and the arrangement of cameras was the same as in Experiment 1. The experimental materials were two dolls (14 cm high), identical to the doll used in Experiment 1.

**Procedure.** The procedures were identical to Experiment 1; while speaking with the infant, the experimenter introduced and manipulated her first doll (it was made to bow, saying "hello," and to wave "goodbye") and moved it from the center to the right or to the left, then did the same with her second doll. One doll "retreated back" and was placed facing the infant, and the other doll was turned around and "went away" to the opposite side from the first doll, and was set down with its back to the infant.

The infants' head-turning and gaze direction to the experimenter's face, hand, and the objects were checked by examining the video pictures of the six different camera angles frame by frame (1/30 s). Initial agreement of the two coders calculated for four infants was 93.8% (Cohen's kappa=.88).

## Results and Discussion

Each infant's gaze-shifting was classified into the same four categories as Experiment 1: Target object (they shifted their gaze to the target object); Hand (they shifted their gaze to the experimenter's hand); Face (they did not disengage from the experimenter's face); and Looking away (they disengaged from the face, but failed to find any other objects, including the experimenter's hand.). Figure 2 shows the percentages of infants who were classified into each of these categories.

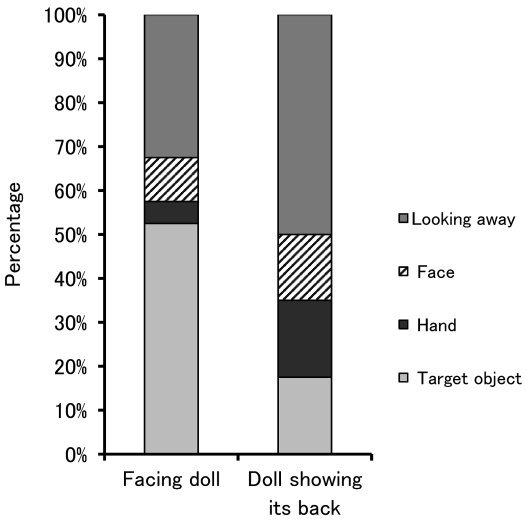


**Figure** 2 Infants' Gaze-Shifting Targets

In order to statistically test whether infants' gaze-shifting differed by the target objects, the four categories were collapsed into a dichotomous variable consisting of "Target object" versus "Others" (Hand, Face and Looking away). The McNemar's test was used and it revealed a significant difference between the facing doll and the doll showing its back ($\chi^2=9.80$, $df=1$, $p=.002$), with 17 infants succeeding in shifting their gaze to the facing doll, but failing to shift their gaze to the doll showing its back. In contrast, only three infants shifted their gaze to the doll showing its back, but failed to shift their gaze to the doll facing them.

The difference between the infants' attention to the target objects was quite clear: the infants gazed at the doll facing them more frequently than to the doll showing its back. These findings support the observations from Experiment 1 that infants were more attracted by the doll placed facing them than by the ball, and strengthen the possibility that it was the presence of eyes on the doll that most effectively caught the attention of the infants in both experiments.

## General Discussion

As mentioned in the discussion section in Experiment 1, the youngest infants were likely to attend to the attention-directing cues in themselves, without showing understanding of the intended meaning, i.e., that they were being encouraged to shift their gaze to the indicated object. From around four months, the infants in this study began to grasp the meaning of the adult's profile (after the adult's sud-

den turning away) as an attention-directing cue, not as a sign of interruption of their communication, and searched for the target of the adult's gaze.

The nature of the target objects had an effect on following cues to shift gaze. The results of the two experiments were consistent in showing that infants in the first half of the first year were more likely to shift their attention to a doll facing them than another object when the experimenter turned her attention and gaze to a visual target. Infants did not shift their attention as readily to other objects (the ball and the doll showing its back). The facing doll in particular attracted and sustained the young infants' attention, and we suggest this was because it was placed with its eyes toward the infants.

Farroni et al. found in their 2005 experiment that even newborns preferred direct gaze and looked at upright faces longer than at inverted faces (Farroni et al., 2005). Since the features were identical in both types of faces in their study, our infants' preference for a "facing" doll rather than a doll "turned away" may also have been determined by the simulation of "mutual gaze," rather than simple complexity. As noted above, infants prefer objects active in a contingent manner (Johnson et al., 1998; Molina et al., 2004). The "mutual gaze" simulated by the doll's eyes facing the infants may be the simplest example of action in a contingent manner. The doll showing its back, which had "turned its back" and "left" the infants, had, from the infants' point of view, made a sudden interruption of "mutual gaze".

The youngest infants appeared to most want to keep communicating with an adult through face-to-face interaction, and this held true through both experiments. Tremblay and Rovira (2007) examined 3-month-olds' gaze distribution during adults' speaking with another person or with an object the adult was pretending to "converse" with. In the PPP condition (infant-adult-adult), infants distributed their visual attention equally between the two adults. In the PPO condition (infant-adult-object), infants looked significantly more often and longer at the adult than at the object. They produced twice as many socially directed behaviors oriented toward both adults in the PPP condition than toward the adult and the object in the PPO condition. The results of our two experiments support Tremblay's finding, and indicate that it seems to be a strong desire of infants to share communicative activity with adults, and to understand the meaning of adults' actions.

Reddy (2011) proposed a model which includes infants themselves among the "objects" others attend to. Her model elucidates the developmental continuity between dyadic and triadic interaction; she writes that "the developing awareness of attention does not occur as a 'discovery' of attention at the age of nine to twelve months but as a developing awareness of different 'objects' that others can be meaningfully appreciated as attending to (p. 145)." In accordance with her model, we could say that our infants lost and searched for the adult's gaze, and then found the doll's gaze "attending" to them. People's faces (Tremblay & Rovira, 2007), people's hands (Amano et al., 2004; Fausey, Jayaraman, & Smith, 2016), and objects with eyes which simulate unbroken mutual gaze in this present study, then, may be "objects" infants are capable of attending to early on and jointly with others.

In conclusion, our findings suggest that when infants experience loss of mutual gaze and then search in the direction of an adult's gaze, if they can find something easily recognizable, relevant, or attractive to them, that "belongs" to the adult, they will also pay attention to it, and this is a beginning of gaze-following and shared attention to an object. Objects "belonging to the adult" from the infants' point of view in these experiments were the adult's hand, or an object of the adult's which the adult was grasping, pointing to, or attending to, and particularly, an object of the adult's with eyes which simulat-

ed unbroken mutual gaze. For infants, it represents transiting the bridge from dyadic to triadic interactions and enables a new stage of communication between infants and adults. Infants' motivation to share communicative activity with adults seems to play an essential role in this developmental process.

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