
Infant shifting attention from an adult’s face to an adult’s hand: a precursor of joint attention

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Abstract

Two experiments were designed to investigate shifting attention from an adult’s face to an adult’s hand by 3- and 4-month-olds. In Experiment 1, 24 infants were presented with five types of hand gestures by their mothers and a stranger. Experiment 2 was given to 22 infants with the same procedures, except for the addition of a head inclining while pointing to objects. The results were: (1) after encountering an averted head repeatedly, the infants shifted their attention from the adult’s face to the moving hand and objects; they oriented to what the adult was attending to. (2) The moving head improved the rate of infants turning their heads to the same direction as the adult. The conclusion was averted head and eyes play a major role in infants’ orienting to an adult’s hand. A hand was a shared visual target during the adult’s object performance, indicating that infants’ orientation to the adults’ hand is a precursor stage of joint visual attention.

Keywords: Three- and four-month-olds; Shifting attention from face to hand; Adult–infant interaction; Moving head; Orientation to the hand; Joint attention

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Young infants get information by relating to adults’ faces, hands and objects. They are not yet able to gather information about surrounding objects by themselves through their own acts of handling. They depend on adults’ hands to bring objects or information into their range. Adults’ hands are not only able to transfer objects into infants’ visual fields; they introduce new meanings into infants’ surroundings.

In the second half of the first year, infants’ interest extends from face-to-face interaction with an adult to object exploration. They are especially interested in the objects that belong to adults; an infant attempts to grasp a string of beads as the mother dangles it, tries to touch a button on her shirt, or to explore things

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in a chest pocket when held in his/her father’s arms. We noticed an 11-month-old infant replacing her mother’s fingers on the piano keys by herself, after she had been sitting on her mother’s lap, watching her playing the piano for some time. Infants look at and/or reach for an adult’s pointing finger (Murphy & Messer, 1977; Butterworth, 1998), a hand giving and taking, the hands of arms extended to hold the baby, and objects such as pens, spoons, knives, or the like in the hands of adults. When an infant tries to reach for the spoon in a caregiver’s hand during a meal, she will put it into the infant’s hand and try to coordinate in joint engagement; both of them attending to the same object. This sharing attention might be a precursor of joint attention.

Amano and Kezuka (1994, 1996) made several experiments to find if infants in the second half of the first year pay attention to an adult’s hand during object performance. Experimental materials were a small red box (9 cm × 6 cm × 4 cm) with a lid, fastened on by a small red stick (15-cm long) through two rings attached to the edges of both sides of the box. A plastic toy strawberry of actual size was placed inside the box. The lid was designed to spring open for an infant to find the strawberry in the box, whenever the stick was pulled out sideways through the two rings.

The experimenter (or the mother) put the strawberry into the box, put the lid on and put the stick through the two rings to fasten it, and then asked the infant to find the strawberry. When the infant could not do it alone, the adult demonstrated how to get it by pulling the stick out sideways through the rings so that the lid would open. Then, the adult tried coordinated joint engagement with the infant. The whole procedure was repeated until the infant met with success or grew tired of it.

The results were that many of the participating infants at the ages of 7, 10 and 12 months tried to put their hand on the hand of the adult, or on the stick next to the adult’s hand, when the adult started pulling the stick sideways. Some infants in the 10- and 12-month-age groups, when the demonstration was given with the adult’s right hand, touched the part of the stick where the adult’s hand had been with their right hand, although it was located on their left (as the adult and the infants were sitting across a table from each other). In another experiment by Amano and Kezuka (1998), we confirmed that 12-month-old infants are likely to try to touch a strange object when it is held by an adult’s hand.

Woodward’s experiments (1998, 1999) focused on infants selectively attending to the aspects of an actor’s behavior that are relevant to his or her underlying intentions. She found that infants looked longer at an object contacted by a hand (regardless of the experimental condition or their age). However, infants quickly lost interest in the event when the object (a white bear or a multi-colored ball) was contacted by a rod. She stated that this tendency to watch an object grasped by an actor appeared most clearly at 9 months of age.

In daily life and/or experimental situations, the responses of infants to an adult’s hand are widely recognized. Looking at and/or reaching for an adult’s pointing finger is considered to be a sign of an infant’s having a misunderstanding of the adult’s hand gesture (Murphy & Messer, 1977; Butterworth, 1998, 2001). Such infant’s errors, however, could be positively regarded as a precursor of joint attention.

The scenes of joint attention are triadic social interaction in which the child and the adult are jointly attending to the same object, and to one another’s attention to that third thing. Six-month-old infants are considered to interact only dyadically with objects or other persons. At around 9–12 months of age, a new set of behaviors begins to emerge. Unlike early behaviors, they are not dyadic, but are triadic in the sense that they involve a coordination of their interactions with objects and people, resulting in a referential triangle of child, adult, and object to which they share attention (Tomasello, 1999).

Using the exclusion paradigm, however, Nadel and Tremblay-Leveau (1999) have recognized a triadic interaction in a person–person–person system (P–P–P) among infants younger than 6 months old.
suggested that this system appears earlier than the person–object–person system (P–O–P). Our proposal involves another type of triadic interaction system: person–person(object)–person (P–P(O)–P). This interaction can be observed when an adult holds an object in his/her hand, and an infant looks at and/or reaches for it. Here, P(O) refers to an adult’s hand holding an object. During a meal, for instance, a spoon on the table does not attract much attention from an infant. When an adult takes it up and begins to eat with it, however, the infant immediately attends to it, and wants to use it as the adult does. As observed in several other examples described in the earlier part of this paper, when infants at this age show interest in an object, it generally has some relevance to an adult’s performance.

In our view, the P–P(O)–P system seems to emerge prior to the P–O–P system. How does the early dyadic interaction move to a triadic one, i.e. the P–P(O)–P system? What triggers infants to orient to an adult’s hand and/or an object in his/her hand?

There are four possible reasons underlying infants orienting to adults’ hands. The first is that infants are trying to confirm if their hands are the same as adults’. In White’s study (1964), infants around 2–2.5 months old would hold their hands in front of their faces to look at them (i.e. hand regard). After infants discover their own hands, they begin to attend to others’ hands; looking at, reaching for, placing their hands on an adult’s hand and/or placing their hands near an adult’s. These actions might be interpreted as infants’ attempts to understand others as something “like me”; some researchers point out that there seems to be some relationship between infants’ understanding of their own actions and their trials in relating them to the actions of others (Meltzoff & Moore, 1999; Tomasello, 1999).

The second possible reason is that a hand is a moving object, which can be recognized easily even by young infants. Infants tend to orient to moving objects that are standing out against other objects in their visual field (Nagata & Danemiller, 1990). A hand moves over space, more rapidly than a head. A moving hand is probably a salient object for infants. But when the infants cannot yet follow a moving hand, they remain looking at an adult’s face during object performance. Obviously the infant’s ability to pursue moving objects plays a role. Aslin (1981), and Aslin and Johnson (1996) reported that 4 month olds are able to pursue a visible target moving horizontally without being distracted by surroundings.

The third possible reason is that hands bring new sights or information into the infant’s visual field. Leslie (1982, 1984) studied infant perception of causality, using a habituation recovery technique with filmed stimuli. Young infants (28-week-olds) viewing a hand picking up a doll recovered interest in a test trial more than infants viewing a doll transported by an object. These results suggest to us that infants can discern a change made by an adult’s hand, and that hands are seen from an early age as agents of change. Adults often bring an object into the sight of infants, or indicate it by pointing to it if they cannot reach it, resulting in infants orienting to the adult’s hands. Infants would come to expect that something new will happen when adults move their hands and so they then orient to the adult’s hands.

The fourth reason, thus far undiscussed in the literature, for infants’ orientation to adults’ hands is that it emerges as a reaction to an adult’s head and eyes. After face-to-face interaction between an infant and an adult, if the adult becomes engaged in object performance, the adult’s eyes are directed to their own hands and/or the object. Then, even if the infants keep looking at the adult’s face, they would be left just finding the averted head and eyes of the adult. In such a case, they will be at a loss, because they have lost the communicative signal. If the infant is able to follow the adult’s gaze line, he/she will try to look at the same object the adult is looking at, i.e. the adult’s hand and/or the manipulated object.

Many studies have focused on an averted head and eyes in the context of social contingency. Murray and Trevarthen (1985) found that the visual attention and positive affect of 6- to 12-week-olds elicited during mother–infant interactions declined when the mother turned away to interact with another adult.
Hains and Muir (1996) examined infants’ sensitivity to adults’ eye directions and experimented with infants from 14 to 26 weeks of age. Their idea was that if the infant expects the person whose head is oriented toward them to interact, provided the eyes are visible, then smiling and attention should be elicited by the gaze-toward condition, while less interactive behavior should occur during the averted head and eyes closed conditions. If eye direction is a cue to interaction, however, interactive behavior should decrease whenever eyes are averted. They then compared the infants’ responses to the adults’ faces under three experimental conditions: head averted, normal head position but eyes averted, and eyes down; with normally gazing eyes as a control group. The results from their experiments suggest that after infants have experienced an adult’s eyes averting away, the recovery in the infant’s gaze is not significant even when the adult changes her body position to turn towards them. An adult’s eye contact appears to give cues to infants to engage in communicative exchanges.

Caron, Caron, Roberts, and Brooks (1997) presented infants with a prerecorded video display of a female adult displaying positive interactive behavior under five conditions (normal, eyes forward; eyes averted; head and eyes averted; head averted, eyes forward; and eyes closed). The results indicated that 3-month olds are sensitive to a moving head but not to eye orientation. They smiled and gazed less when the adult’s head was averted or her eyes appeared to be closed. However, they did not differentiate between adult eye directions, while 5-month olds were sensitive to both moving head and eye orientation.

Mutual attention is essential for young infants to communicate with adults. Infants in the first half of the first year are sensitive to adults’ eyes; infants want to keep adults’ eyes on themselves. They want to be looking at adults’ face all the time. During an adult’s object performance, he/she focus his/her gaze on his/her hand and/or the object, and infants, by looking at the adult’s averted head and eyes while the adult’s hand(s) are moving, eventually develop the ability to connect an adult’s averted head and eyes with his/her visual target. What can make infants realize this connection between an adult’s averted head and eyes and his/her hand (or an object in his/her hand)?

Among the four reasons described above, the second and the fourth are related to each other. When adults handle an object, they look at their moving hand and/or the object in their hand. Therefore, if infants follow the adult’s gaze, they will see the adult’s moving hand. Taking this into consideration, we conducted two experiments with infants at 3 and 4 months to examine infants’ responses to adults’ hand gestures, i.e. various types of moving hand. Our concern was the emergence of the change of orienting from face to hand. We chose 3- and 4-month-olds as the participants, because they are still at a stage of face-to-face interaction. We intended to find what can trigger them to orient to an adult’s hand? If infants in this period are capable of shifting attention, what can trigger this shift from attention to the face, which is commonly observed among 3- and 4-month-olds, to attention to an adult’s hand? The purpose of this study was to determine this point.

1. Experiment 1

The experiments were designed using five common and easily discernable hand gestures: (a) a “twinkling” hand, (b) hands manipulating an object, (c) a hand transferring an object, (d) a hand withdrawing from an object, and (e) a hand pointing to an object. In the case of (a) a “twinkling” hand, the adult’s face averted slightly from the infant’s to the side, as she regarded her own moving hand, and in (b) hands manipulating, the face was in the “looking downward” position. An adult’s “profile” was presented to the infants in (c) a hand transferring, (d) a hand withdrawing and (e) a hand pointing. We intended to
determine in which cases the infants could find the relationship between an adult’s averted head and eyes and an adult’s moving hand most easily. Lasky and Klein (1979), Kurzweil (1988), Roe (1991) and many other investigators have already reported that young infants showed different visual responses to their mothers and to strangers, not only in the case of face-to-face interaction but in various other cases. In this experiment, infants’ own mothers and a female “stranger” (the experimenter herself) were engaged in the above types of hand gestures and head–eye positions.

1.1. Method

1.1.1. Participants

Twenty-four infants (14 males and 10 females, medium age: 17 weeks, range: 16–20 weeks) were recruited from the babies who attended a regular health check at Tamamura Health Center located in Gunma Prefecture near Tokyo. All of them took part in the experiment, but three were eliminated from the final list, as they did not participate in all the sessions. When their mothers turned their heads away from them, these three infants started to cry and it was impossible for them to recover face-to-face interaction with the adults.

1.1.2. Setting and materials

Infants were observed in a partitioned-off area of the health center, and the mother–infant interaction was kept natural in both action and in the conversation directed to the infants. The experimental materials were two types of ordinary toys; a red ball (6 cm in diameter) and a doll in pink clothes (10 cm high). The size of the head of the doll was about the same as that of the red ball.

1.1.3. Hand gestures

The following five types of hand gestures were designed.

1. A “twinkling” hand; the adults showed their own hand, and rotated their wrist around several times to make a “twinkling” action in front of the infant’s face.
2. A hand manipulating an object; a red ball was bounced lightly and rolled on the table, and a doll in pink clothes was patted on the head.
3. A hand transferring an object; after manipulating one of the two toys, the adults moved it 50 cm to the right from the center with their right hand or 50 cm to the left with their left hand. The doll was always facing the infants.
4. A hand withdrawing from an object; leaving an object at the prescribed place, the adult withdrew her own hand.
5. Directing; after face-to-face interaction, directions were given in the following three ways. (a) Pointing with gaze: The adult pointed at one toy (the ball or doll), turning her eyes to it simultaneously, and then did the same toward the other toy. Her head and eyes were oriented approximately 60° to the right or the left from the infant’s face to fixate on the toys placed on both sides of the table. (b) Pointing without gaze while maintaining eye contact: The adult pointed to the left and to the right, towards each object, while maintaining unbroken eye contact with the infant. (c) Turning head: The adult turned her head to the ball and the doll without pointing to either of the two. Again, the adult’s head and eyes were reoriented approximately 60° to the right or the left from the infant’s face to fixate on the
toys placed on both sides of the table. While carrying out these actions, the adult spoke to the infant (in Japanese), “Where’s the ball?” “Here it is!” or “Where’s the doll?” “There it is!” Then they kept their faces still and neutral for about 2 s.

1.1.4. Procedure
Experiment 1 was carried out under the following two situations for each infant.
First, the experimenter made the hand gestures. The infant was sitting on his/her mother’s lap across the table from the experimenter.
Second, the mother presented the hand gestures in the same way as the experimenter had. The infant was sitting on the experimenter’s lap across the table from his/her mother.
Prior to the experiment, the experimenter asked each mother her child’s name (and nickname) and his/her date of birth for reference. The hand gestures were presented in the sequence shown in Fig. 1. The order of the presentation, (the ball or the doll first) and the direction for placing the objects (left or right)

Fig. 1. Flowchart of Experiment 1: adult’s face during performance as seen by infants. At the first interaction, when the adult called the infant’s name, she could gain the infant’s eye contact immediately. After the adult showed her profile, however, the infant did not regain eye contact easily. In one of the cases it took more than a minute to get back to face-to-face interaction. It took 10–15 min to finish the whole sequence.
were chosen at random, yet counterbalanced in total. Before each hand gesture, except in the case of the withdrawing hand, the adult called the infant by name or nickname to attract the infant’s attention, and to confirm the infant gazing upon her in face-to-face interaction, without touching the infant’s body.

After completion of the whole process by the experimenter, the mothers took their turn in the experiment. Prior to their turn in the experiment, they were given detailed instructions for the demonstration and on how to interact with their child.

To assess the infant’s visual target, four video recorders (SONY Handycam Video 8, TR-3) were used to record the infant’s face, the face of the adult, her right hand and her left hand. These four videotapes were integrated into one (by SONY Betacam A.B Roll Editing System), so that the infant’s orientation to the adult’s face and hand could be analyzed frame by frame (by SONY Video Cassette Recorder EVO-9720). The infant’s behavior, every episode of the infant’s orientation to the adult’s face and hands and to the objects, was checked. Each episode was coded from the video records by two trained coders. Initial agreement of the two coders, calculated for two infants, was 0.935. For cases of the infants’ responses on which the coders disagreed, the two coders met to review the response and resolve recording discrepancies.

1.2. Results

The infants could realize the relationship between an adult’s averted head and eyes, in the turning slightly and looking downward position (see sequences 1, 2 and 5 in Fig. 1), and the adults’ moving hand. In the case of an adult’s profile (see sequences 3, 6, 8, etc. in Fig. 1), however, it was more difficult for them to connect the averted head with the moving hand.

1.2.1. Effects of types of hand gestures

All the infants in this experiment paid attention to the adult’s hand when it was presented by itself (a “twinkling” hand) (Table 1). The adult’s hand in motion in front of the infants was more attractive than her face.

The proportions of the infants who oriented to each hand gesture (manipulating, transferring and withdrawing) are shown in Table 2. Every episode was scored as follows: 1 point for objects by themselves, 0.5 points for hands by themselves or holding an object, and no points for an arm, a face and any other responses (AOR). ANOVAs (two adults × two objects) were performed over every hand gesture to examine possible differences between the adults (experimenter and the infant’s own mother), and between objects (the doll and the ball).

The results of these analyses found no significant difference in either manipulation or transfer. There was no significant difference between the infants’ responses to the hand gestures of the mothers and to those of the experimenter. Also, there was no significant difference between the responses to the two

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Infants’ orientation when presented with the twinkling hand (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Face</td>
</tr>
<tr>
<td>Experimenter</td>
<td>94.1</td>
</tr>
<tr>
<td>Mothers</td>
<td>73.1</td>
</tr>
</tbody>
</table>

Note. AOR = any other responses.
Table 2

<table>
<thead>
<tr>
<th></th>
<th>Manipulation</th>
<th>Transfer</th>
<th>Withdrawal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Face</td>
<td>Hand</td>
<td>AOR</td>
</tr>
<tr>
<td>Experimenter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doll</td>
<td>50.0</td>
<td>100.0</td>
<td>20.8</td>
</tr>
<tr>
<td>Ball</td>
<td>62.5</td>
<td>87.5</td>
<td>20.8</td>
</tr>
<tr>
<td>Mothers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doll</td>
<td>27.3</td>
<td>100.0</td>
<td>13.6</td>
</tr>
<tr>
<td>Ball</td>
<td>45.5</td>
<td>95.5</td>
<td>40.9</td>
</tr>
</tbody>
</table>

Note: Hand = hand or object in hand, AOR = any other responses (e.g. looking down, looking away), Obj. = objects.

objects in the adult’s hand. The infants always focused their attention more on an adult’s hand holding an object than to their face.

When the objects were placed alone, however, the infants reacted differently to each of them. As for the withdrawing hand from the object placed, a tendency to be a significant difference was found between the two objects, $F(1, 80) = 3.844, P = 0.0534$. Infants attended more frequently to the doll than to the ball. Adult × object interaction also showed a tendency to be a significant difference, $F(1, 80) = 2.943, P = 0.0910$. A significant difference in the infants’ responses to the face was found between the mothers’ performance and the experimenter’s ($\chi^2 = 0.0126$, d.f. = 1, $P < 0.05$). When mothers were withdrawing their hand from the ball, 45.5% of the infants looked at it, while 22.7% of them looked at her face. In the case of the experimenter, however, only 25% of them looked at the ball; 58.3% of them were watching her face, instead.

Fig. 2 shows the responses of the infants who pursued the hand transferring an object, when the object was then left on the table. Not all of them appeared to recognize the object left on the table. Some infants looked at the adult’s hand withdrawing from the object. In the case of the ball, compared to that of the doll, the infants oriented more often to the hand withdrawing regardless of the person (the experimenter or the mother) who transferred the object. Additionally they returned frequently to the experimenter’s face during her performance with the ball.

Fig. 2. Responses of the infants who pursued the hand moving with an object, when the object was set in place.
Table 3
The directions of infants’ orientation in Experiment 1 (%)

<table>
<thead>
<tr>
<th>Pointing with gaze</th>
<th>Pointing without gaze</th>
<th>Turning head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face</td>
<td>Arm</td>
<td>Hand</td>
</tr>
<tr>
<td>Experimenter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doll</td>
<td>90.5</td>
<td>28.6</td>
</tr>
<tr>
<td>Ball</td>
<td>85.7</td>
<td>23.8</td>
</tr>
<tr>
<td>Mothers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doll</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>Ball</td>
<td>66.7</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Note. Object = direction of the object, opp. = opposite direction, AOR = any other responses.

1.2.2. Effects of types of directions

The proportions of the infants oriented to the directions are shown in Table 3. Every episode was scored as follows: 1 point for the same direction, 0.5 points for a hand, and no points for an arm, a face, opposite orientation and AOR. Then an ANOVA (two adults × two objects × three conditions) was performed over the infants’ responses to the two adults (the experimenter and his/her own mother), for directing to the objects (a doll and a ball) in the three conditions (pointing with gaze, pointing without gaze while maintaining eye contact, and turning head towards object).

A significant difference was found among the conditions, $F(2, 240) = 6.877, P < 0.005$. While infants looked in the same direction as adults most frequently under the condition of “pointing with gaze,” under the condition of the “pointing without gaze while maintaining eye contact,” they often remained looking at the adult’s face. They paid less attention to the adult’s hand or arm when eye contact was maintaining than when the adult gazed at her own hand and the object she was indicating. Under the condition of the turning head, they looked at the adult’s profile for a while, and then looked down or looked away (Fig. 3). Another significant difference was found between the doll and the ball, $F(1, 240) = 16.488, P < 0.0001$. The infants were always oriented to the doll more frequently than the ball. There was a significant difference between the cases of the experimenter and that of their mothers; infants tended to be oriented to the same direction as their mothers more often than with the experimenter, $F(1, 240) = 9.274, P < 0.005$.

Moreover the adult × condition interaction was proved significant, $F(2, 240) = 3.281, P < 0.05$. In the case of their mother’s pointing hand, the infants directed their attention to the indicated direction even while mothers maintained eye contact and told the infants to look at the object she was indicating by hand movement alone. When the indicated object was the ball, whether it was their mothers’ or the experimenter’s, more infants paid attention to the adults’ arms and/or hand than paid attention to the direction of the ball.

There were significant differences between the experimenter and the mothers in the proportion of infants looking at the adult’s face, in the case of pointing at the doll with gaze ($\chi^2 = 14.538, \text{d.f.} = 1, P < 0.001$), and without gaze while maintaining eye contact ($\chi^2 = 11.455, \text{d.f.} = 1, P < 0.001$). When the experimenter pointed to the doll, the infants tended overwhelmingly to look at the experimenter’s face. When the adult’s head was turning to the ball, the difference was significant again between the experimenter and the mothers in the proportion of infants looking at the adult’s face ($\chi^2 = 9.024, \text{d.f.} = 1, P < 0.005$). When the experimenter indicated the ball by turning her head, they tended to
simply keep their gaze fixed on the experimenter’s face. In the case of their mothers, however, the infants often looked to the opposite direction, i.e. to the doll they had been looking at previously.

2. Discussion

After face-to-face interaction between an adult and an infant, during object performance, 3- and 4-month-olds paid attention to the moving object in front of them. They shifted attention from the adult’s face to her hand gestures and to objects in the adult’s hand. When the adults shifted their gaze from the infant’s face horizontally to another direction, the infants could not catch communicative signals from the averted head and eyes, and showed distress. But when the adults repeatedly returned their gaze to the infant from the other direction at intervals between every hand gesture, some infants turned their head in the same direction as the adult, and seemed to begin to understand the meaning of the adult’s averted head and eyes.

In what way did the infants relate to the adult’s averted head and eyes, her hand and an object? Infants in the first half of their first year try to communicate with adults through their eyes. When the adult was facing the infants, they directed their attention to the adult’s face. If the adult maintained eye contact with the infant while moving her hand without gaze, the hand did not attract the infant’s attention except for the mother’s. In the case of an adult’s averted head and eyes, however, we could see that while the infants were looking for such interactive eyes, their gaze encountered the adult’s stretching or withdrawing arms and her line of regard. The hand and/or the arm mediated the infant’s attention between the averted head...
and eyes and the object in the direction the adult was pointing at. The adult’s hand often guided the infant’s gaze to the object she was indicating, although it failed to do so in some cases, discussed in the following. Generally speaking, a mother’s face/hand is naturally more familiar to infants than an experimenter’s face/hand. While the experimenter’s face was a visual target for infants to search, they probably did not search their mother’s face due to familiarity with it. They easily switched their attention to a visual target other than their mother’s face. Therefore, the mother’s performance increased the infants’ curiosity towards a new object to a greater extent than the experimenter’s. While there was no significant difference in the infants’ responses to the doll, whether presented by the experimenter or their mothers, when the ball was separated from the hand, a difference was found in the infants’ responses. In the case of their mother doing the indicating, they looked at the ball more often than with the experimenter. One infant noticed her mother’s hand withdrawing from the ball, then she returned her attention to the ball, from the withdrawing hand. The infant distinguished “a hand itself” from “a hand holding a ball,” and “a ball” from “a ball held in the hand.” The infants never responded in this way to the experimenter’s hand. They tended simply to fix their eyes on the experimenter’s face.

The differences between the responses to the doll and to the ball can also be explained by the concept of familiar (a doll which has a “face”) or unfamiliar (a ball). In the case of an unfamiliar object, the infants did not appear to recognize it when it was placed on the table by itself. The infants seemed to recognize it only when it was in an adult’s hand. It did not constitute a figure by itself. The infants did not seem to recognize the object unless it was mediated by an adult’s hand; in other words, they could distinguish the object in the adults’ hand (the figure) from the surroundings (the ground). For the infants, human acts (the expressions of face, hand, and body) would be what they are most familiar with. An object in an adult’s hand attracts infants; adults’ hands put an emphasis on a certain object for infants, distinguishing it from its surroundings.

3. Experiment 2

Moore, Angelopaulas, and Benette (1997) and Corkman and Moore (1998) ascertained from their experimental results that infants in the second half of the first year are able to understand an adult producing a head-turn movement to the side. Therefore an adult’s head turn, when noticed by infants, can determine the direction of the infant’s gaze. But in Experiment 1, with 3- and 4-month-olds, the adult’s head turn was not yet meaningful for more than half of the infants. It did not yet seem to play any role in attracting their attention to an object. Most of them remained looking at the adult’s face (profile) even with the adult’s hand pointing at an object. The aim of Experiment 2, therefore, was to examine if 3- and 4-month-olds could, after gazing at a face, pursue an adult’s head moving towards an object as well as or better than they could pursue an adult’s hand moving towards an object. Furthermore we wished to learn whether they would shift their gaze to a new object if it were near the adult’s face.

3.1. Method

3.1.1. Participants

Twenty-two infants (9 males and 13 females, medium age: 18 weeks, range: 16–19 weeks) from another group recruited from the same Health Center as in Experiment 1, took part in this experiment. Two infants were omitted from the final list because they cried and could not complete the session.
3.1.2. Setting and materials
The setting and materials were the same as in Experiment 1, but this time with infants seated continuously on their mothers’ laps, and with refinement in the “directing” stage of the experiment.

3.1.3. Hand gestures
The hand gestures (1–4) were the same as in Experiment 1. The fifth (“directing”) was changed as follows (to focus on infant responses to a moving head):

(a) Pointing with gaze: The experimenter pointed and gazed at the ball and the doll, keeping her face still and neutral for about 2 s.
(b) Moving head: The experimenter indicated the objects by inclining towards them while gazing at them, and kept her face still and neutral for about 2 s.
(c) Pointing and moving head: The experimenter indicated the objects by inclining her body towards them, fixing her gaze them, and pointing, and kept her face still and neutral for about 2 s.

3.1.4. Procedure
The experimenter presented and manipulated the two toys. The infant sat on his/her mother’s lap across the table from the experimenter.

After completing the four types of hand gestures, the experimenter indicated the object to the infant in three ways (pointing with gaze, moving head, and pointing and moving head) while talking to the infant: “Where’s the ball?” “Here it is!” And, “Where’s the doll?” “There it is!” Then she told the infant to look at the ball and the doll again, more carefully.

To assess the infant’s visual target, three yellow markers were placed in a triangle on the top of the infant’s head. Similarly, the experimenter was marked with red markers, and the table was lined on the surface at every 30°, with the ball and the doll placed on the 60° lines.

Six video cameras were set up for recording (Fig. 4). The first camera (Super Micro Camera ELMO QN-401) focused on the infant’s face. The second (SONY Handycam CCD-TR3) focused on the face of experimenter, the third (SONY Handycam CCD-TR3) shot from the experimenter’s right side, and the fourth (SONY CCD Color Camera DXC-LS1) took a bird’s eye view of the experimenter and the infant. The pictures taken by the four cameras were integrated into a single videotape recorder (by a Four Video Separate Unit, SONY YS-Q 400). There were two more cameras, one focused on the infant, the other on the experimenter’s left hand. The tapes could be analyzed frame by frame (by SONY Video Cassette Recorder EVO-9720).

Every episode of the infant’s behavior directed to the experimenter’s face, hand, and the objects was checked. The bird’s eye view of the experimenter and the infant, with the lines marked on the table, made it possible to capture the experimenter’s movements and infant’s movements accurately. The coding discrepancy between the two coders was insignificant.

3.2. Results
The infants’ responses to the hand gestures, and the differences noted between the ball and doll were similar to the results found in Experiment 1.

The directions to which the infants oriented are shown by proportion in Table 4. Every episode was scored as follows: 1 point for the same direction to 60 and 30°, 0.5 points for a hand, and 0 points
for the experimenter’s face, an opposite direction and AOR (any other responses). An ANOVA (two objects \times three conditions) was performed for the infants’ responses to the experimenter directing to the objects (a ball and a doll), for all three conditions (pointing with gaze, moving head, and pointing and moving head). A significant difference was found among the conditions, $F(2, 114) = 4.160$, $P < 0.05$.

The difference between the “pointing with gaze” condition and the “moving head” conditions was quite clear. In the condition of the “moving head,” infants looked in the same direction as the experimenter most frequently (80%: doll, 45.5%: ball), in contrast to the “pointing with gaze” in which only 25% of the infants looked in the indicated direction. The moving head attracted the 3- and 4-month-old infants’ attention more than a pointing hand. In response to the experiment’s final step, a difference between “the moving head” and “the pointing and moving head” was not clearly evident, however, indicating that the “moving head” made more of a difference for the infants than the hand motion.

Table 4
The direction of infants’ orientation in Experiment 2 (%)

<table>
<thead>
<tr>
<th>Pointing with gaze</th>
<th>Moving head</th>
<th>Pointing and moving head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face</td>
<td>Hand</td>
<td>Object</td>
</tr>
<tr>
<td>30°</td>
<td>60°</td>
<td></td>
</tr>
<tr>
<td>Doll</td>
<td>95.0</td>
<td>35.0</td>
</tr>
<tr>
<td>Ball</td>
<td>95.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Note. Object = direction of the object, opp. = opposite direction, 30° = turning to 30° and 60° = turning to 60°.
No significant differences were found between the two objects, nor in object × condition interaction. The following difference was observed, however. When the experimenter moved her head towards the doll, many infants followed the moving head (16/20), and then turned their eyes to the doll (14/16). In the case of the ball, however, although 10 infants pursued the moving head to the 60° line, not all of them turned their eyes to the ball. Four infants kept their eyes on the experimenter’s profile, and two pursued the moving head to the end, but paid no attention to the ball, passing it by instead and looking in an irrelevant direction. Only four looked at the ball.

Out of the remaining infants who did not pursue the moving head to the 60° line, four pursued the experimenter’s moving head to the 30° line, gazed at her profile a brief time, and then looked down, or looked away from the target. Six did not try to pursue the moving head. A tendency to withdraw from the task was observed in these six infants.

3.3. Discussion

The differing results from Experiment 1 and Experiment 2 make clear that 3- and 4-month-olds are on the verge of being able to follow an adult’s hand, and that if, in addition to or instead of a hand, they are provided with a moving head, the task of finding the object indicated by the adult becomes easy for the infants. This further confirms our hypotheses that from 3 and 4-months of age infants are ready to attain an ability to participate in triadic social interaction and that infant interest, in the ensuing stage, in an adult’s pointing finger is not a failure but is rather a necessary step in bridging the gap between dyadic and triadic social interaction.

In this second experiment, focusing on infant responses to a moving head, we could confirm that in the case of the moving head towards an object, infants, attracted to gaze at a face, easily turned their heads to the same direction as an adult, and gazed at the object indicated. The number of infants who could pursue the adult’s head, however, declined in proportion to the adult inclining her body toward an object over the 30° line. While doing this, the adult’s face gradually went into profile, resulting in making the infants look at the adult’s profile.

Based on our observations, it seems infants do not pursue a moving head simply because it is a moving target. Rather, the moving head probably indicates that they can find some object in that direction. And when they can recognize something they are already familiar with or interested in, they will look at the same object that the adult is regarding. This could be interpreted as joint visual attention. This joint visual attention begins with infants pursuing the adult’s moving head. When an adult is looking at some object, infants also want to see it. The infants expect some object of interest to them to be in the direction to which the adults are turning their eyes. If infants at 3 and 4-months of age cannot find any object to attract their attention nearby the adult’s head, it results in their gaze remaining on the adult’s profile.

When the adult inclined her body towards the doll, many infants switched their gaze to it. As in Experiment 1, they appeared to find that the doll was similar in shape to the adult, but somewhat different, and they gazed long at it. When the adult was inclining towards the ball, even if the ball was near her face, many infants did not switch their gaze to it. They seemed to find the ball to be an unfamiliar or uninteresting object, and continued looking at the adult’s face.

Moreover, the infants might have learned through the experimental session how to distinguish the direction in which they could find the most pleasing view. If the infants had pursued the moving head without any intention, the same results would have been obtained with both the doll and the ball. However, the tally of their responses indicates that many of them rejected following the moving head to
the ball with their gaze, as if the infants had decided that there was nothing of interest to them in that direction.

4. General discussion

The four previously proposed reasons underlying infants’ orienting to the adults’ hand will now be discussed.

First, that infants may be trying to confirm if the adult’s hand is the same as their own hand. During our two experiments, no case was observed where infants looked at their own hands (except when looking down after having been presented with the adult’s profile), or compared the adult’s hand with their own. They did compare, however, the adult’s face with the adult’s hand and the adult’s hand with the object. Therefore, no evidence was found to base discussion of this proposal upon, in this study.

Second, infants could be interested in the adult’s hand as a moving object. Certainly infants attend to moving objects. But in Experiment 1, the infants responded differently to the mothers and the experimenter. Also the infants responded differently to the two objects, a ball and a doll, even though the objects were handled in the same way. If the infants had pursued the adults’ moving hands simply because they were moving, the same results would have been obtained from both the mothers’ and experimenter’s cases, and while using either object. We could see that the infants were highly motivated by familiar people and objects.

This, in contrast, provides evidence for the third possible reason for infants to begin to pay attention to adult’s hands. Our results suggest that infants at the ages of 3 and 4 months begin to see hands as agents of change. Hands bring new sights or information into the infant’s visual field. Infants can expect that something new will happen when adults move their hands and so they then orient to the adult’s hands.

Fourth, and until now undiscussed in the literature on infant development, we could observe during the course of the experiments that the infants’ orientation to an adult’s hand emerges when the infants looks at an averted head and eyes. We confirmed that infants at 3 and 4 months are ready to develop the ability to connect the adult’s averted head and eyes with his/her visual target, i.e. his/her own hand or an object. The evidence supports the fourth possible reason: that the adult’s averted head and focus on his/her own hand plays a major role in infants orienting to the adult’s hand. We also confirmed our interpretation of infants’ shifting attention to the adult’s hand as a precursor of joint attention with the following observations.

When adults turned their eyes from the infant’s face to an object, the infants looked at the adult’s averted head and eyes, and showed distress. There were five infants in total who were excluded from our final experimental participants as they started to cry at this point. But there were some infants who turned their eyes to the same direction as the adults during the experiment. They may have recognized the meaning of the adult’s averted head; a new communicative signal that can introduce a third person (or object) to their until now, exclusively dyadic communications. As adults often bring an object into the sight of infants, or indicate it by pointing if they cannot easily reach it, infants develop the ability to orient to the adult’s hand. As the adult’s line of regard follows her moving hand (in the process of stretching out), the infants pursue the adult’s moving hand and their line of regard will join with the adult’s line of regard. After this positive experience infants will tend to look in the direction the adult is pointing, which can be interpreted as the beginning of adult–infant joint attention.

Nadel and Tremblly-Leveau (1999) proposed that a baby can share attention with an adult toward a third person more precociously than toward an object, and communicating with others in the P–P–P system is their first experience using a triadic interactive skill.
In our two experiments of the triadic interaction system: P–P(O)–P, infants at the period of 3 and 4 months were able to shift their attention toward a third object in an adults’ hand. However, it was more difficult for them to shift their attention toward an object placed on the table. Based on this result, we find that the P–P(O)–P system emerges earlier than the P–O–P system. Also whether infants were able to shift their attention or not depended on the character of the third object. Shifting to the ball was more difficult than to the doll. Shifting to a person may be yet easier; this is a possible subject for future research.

In the context of this study, we did not examine the relationship between the P–P–P system and the P–P(O)–P system. In another study, unrelated to the “P–P–P exclusion experiments” (Nadel & Tremblay-Leveau, 1999), however, infants at the age of 3 and 4 months could shift their attention to a third person. One of the adults (Experimenter 1) sitting facing an infant across a table, made a “still” face after face-to-face interaction, and another (Experimenter 2) standing beside Experimenter 1 called the infant’s name. The infant attended to Experimenter 2, and then switched the gaze back to the Experimenter 1 (Kezuka, Amano, and Yamamoto, 2002). After the P–P–P system which appears at first in a triadic interaction, the P–P(O)–P system follows, and at last the P–O–P system appears at the second half of the first year of life.

As mentioned in the beginning, the process of young infants getting information is primarily through adults’ faces, hands and objects. As young infants have only the most limited experience of handling things themselves, adults’ hands introduce new meanings into infants’ surroundings. By learning to shift attention from an adult’s face to hand, infants are able to step up to the next stage of development.

References


