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Brief report

Sensitivity to triadic attention between 6 weeks and 3 months of age

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Abstract

In Study 1, 6-week- and 3-month-old infants gazed more to an adult when she alternated attention between an object and the infant versus when attention was directed only to the object. In Study 2, 6-week-olds did not discriminate between triadic situations with face-to-face interaction controlled.

Keywords: Triadic attention; Joint attention; Cognitive development; Ontogeny; Infancy

A sensitivity to triadic attention, or an interaction involving the infant, another person, and an outside object or event, is necessary for a wide range of human social cognitive skills, such as social referencing (Moses, Baldwin, Rosicky, & Tidball, 2001) and language learning (Baldwin, 1993; Morales, Mundy, & Rojas, 1998; see also Tomasello, 1999). It has been argued, however, that a sensitivity to others' triadic attention does not emerge until the latter half of the first postnatal year (see e.g., Tomasello, Carpenter, Call, Behne, & Moll, 2005). Such theories are not consistent with evidence showing that by 3 months of age infants follow others' visual attention toward external objects (D'Entremont, Hains, & Muir, 1997; Hood, Willen, & Driver, 1998; see also, Hains & Muir, 1996) and even show evidence of processing information about the objects (Reid, Striano, Kaufman, & Johnson, 2004). Also at around this age, infants distinguish between an adult engaging in triadic attention – i.e., looking at an external object and immediately back to the infant versus looking at an external object, away from the infant and then at the infant. It appears then that the underpinnings of a sensitivity to joint attention may be emerging early in ontogeny (see also Reddy, 2003; Striano, 2004).

In Study 1, we assessed whether infants at 6 weeks and 3 months of age can distinguish between two types of triadic attention. The goal was to replicate findings showing a sensitivity to triadic attention at 3 months of age (see Striano & Stahl, 2005), and to extend this paradigm to a younger age group to establish the developmental trajectory of infants' sensitivity to triadic (person, person, object) relations.

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1. Study 1

1.1. Participants

Twenty-six infants participated in the study. The final sample included twelve 6-week-old infants ($M = 44.9$ days, S.D. = 4.38, range = 36–51 days, 9 females and 3 males) and 14 3-month-old infants ($M = 98.4$ days, S.D. = 10.57, range = 86–119 days, 6 males and 8 females). An additional 7 infants were tested, but not included in the final sample: one infant was not included because of illness and 6 infants were not included because of fussiness. All infants were White and from a small city in the east of Germany. Infants were given a gift for their participation.

1.2. Procedure

Testing took place in a carpeted room within an area surrounded by white curtains to eliminate any possible distractions. Sessions were videotaped with 3 digital video cameras (Sony DCR-TVR 11E). One captured a front close-up view of the infants, another one a profile view of the infants and a third an overview of the entire setting. As shown in Fig. 1, the female experimenter held up two identical objects (either two colorful balls or two hand puppets), one in each hand, about 12 cm to the left and right of the infant's face. The experimenter began by engaging the infant in a normal interaction for 60 s. Mothers sat behind the infant, out of view, and watched the procedure over a video monitor. A second experimenter timed the interaction and cued E1 when to start and stop each condition. Infants interacted with E1 for 5 min. Minutes 1, 3, and 5 consisted of normal interaction (NI) and minutes 2 and 4 consisted of a *joint attention* or a *look away* episode. In the joint attention condition, the experimenter looked away at the object and smiled for 3–4 s and said phrases, such as "Oh, that is nice" or "It is pretty" with a positive tone of voice. She then turned back to the infant, achieved eye contact, and repeated the same procedure for 1 min. In the look away condition, the experimenter looked away at the object and smiled when she spoke and said phrases for 3–4 s, such as "Oh, that is nice" or "It is pretty" (the experimenter spoke these phrases in German) with a positive tone of voice. The experimenter then paused for 1–2 s before speaking the phrases again, with the phase lasting a total of 1 min. The durations of the adult's smiling and vocalizations were the same across the conditions, and the experimenter used the same phrase types in both conditions. What differed across conditions was that the adult coordinated visual attention with the infant in the joint attention condition and not in the look away condition. The order of the joint attention and look away conditions and object to which the adult directed her attention was counterbalanced across infants.

1.3. Coding

Sessions were scored from videotapes by an observer who was blind to the research hypotheses. Gazing, smiling, and gaze following were coded off-line by using a computerized coding system from video-records. Gazing was defined

Fig. 1.

as any look to the experimenter's face, and was coded as a percentage of the entire 1-min phase. Smiling was scored when the cheeks were raised and the lips were turned upward, with our without the mouth open, and was coded as a percentage of the entire interaction time. Gaze following was defined as the number of looks to the target object (the object to which the experimenter looked) minus the number of looks to the other object (the object to which the experimenter was not looking). To assess inter-observer reliability, a second naïve observer scored a random 20% of the sessions. The agreement between the two observers was Cohen's kappa 0.84 for gazing and 0.81 for smiling.

In preliminary analyses, repeated measures ANOVAs were performed for each measure in order to check for significant order, side, or object effects. There were no significant interactions or main effects; therefore, these variables were collapsed in subsequent analyses. Because of the unequal distribution of male and female infants between the two age groups, gender was included as a covariate. If gender did not result in a significant effect (main effect or interaction), the variable was not included in the final analysis. A 5 (episode: normal, joint attention, normal 2, look away, normal 3) × 2 (age: 6 weeks or 3 months) mixed design ANOVA was performed on the percent of time that infants gazed at E, smiled at E, and gazed at the target object.

1.4. Gazing

The ANOVA yielded a significant main effect of episode for gazing at the experimenter, $F(4, 88) = 5.335$, $p < .001$. At both ages, infants gazed more at the experimenter during the Normal interaction and joint attention condition compared to the look away condition ($p < .001$). There was a significant gender effect $F(1, 22) = 6.839$, $p = .016$ such that females gazed more than males (marginal $M = 70.2$ s and marginal $M = 48.0$ s, respectively). There were no other significant main effects or interactions (all p-values >.31).

1.5. Smiling

There was a significant effect of episode for smiling, $F(4, 96) = 4.750$, $p = .002$. Infants smiled reliably more in the joint attention condition compared to the look away condition ($p = .016$). Infants also smiled more in the three normal interaction episodes compared to the look away episode (all p-values $\leq .03$). There was no significant main effect for age, $F(1, 24) = 2.493$, $p = .127$. The interaction between smiling and age group was almost significant, $F(4, 96) = 2.391$, $p = .056$. Given a possible transition in social and cognitive behavior at around 2 months of age as described in the introduction, we further inspected this interaction effect to establish any potential developmental transition. We found no significant effect for episode for 6-week-olds ($p = .123$) and a significant effect of episode for 3-month-olds, $F(4, 52) = 5.477$, $p = .001$. Three-months-olds smiled more in the joint attention episode ($p = .01$) and the three Normal interaction episodes (all p-values $\leq .05$) compared to the look away episodes.

1.6. Gaze following

There was no significant effect of episode for gaze following, $F(4, 96) = 1.51$, $p = .205$). The ANOVA yielded a significant main effect for age group, $F(1, 24) = 13.152$, $p = .002$. As shown in Table 1, the gaze following score was significantly larger for 3-months-olds compared to 6-week-olds. There were no other significant main effects or interactions.

Infants at both ages distinguished between a joint attention interaction and a look away interaction. Although this finding suggests a sensitivity to joint attention by 6 weeks of age, it is also possible that infants at this age were primarily influenced by the facial cues directed toward them in the joint attention condition. Prior studies have shown that by 3 months of age infants can discriminate between joint attention cues with or without relevant affect. Specifically, 3-month-old infants smiled and gazed more to an experimenter when she alternated gaze between the infant and an object versus when she broke contact by gazing above the infant's head for 1 s before turning to the object (Striano & Stahl, 2005). In the Striano and Stahl study, the two conditions were identical in terms of vocalizations and positive affect; the only difference between the two conditions was the break in eye contact before the experimenter turned to the object, such that the experimenter's smiling and vocalization would not be interpreted as being about the object to which she then directed gaze. Therefore, in Study 2 we tested whether 6-week-old infants are similarly sensitive to the relevance of affect accompanied by triadic social cues.

Table 1
Study 1 means and standard deviations for infant behavior at 6 weeks and 3 months of age

Age	Behavior	N 1	(S.D.)	JA	(S.D.)	N 2	(S.D.)	LA	(S.D.)	N 3	(S.D.)
1.5 months	Gaze (% time)	67.9	(34.91)	84.0	(27.06)	86.0	(28.03)	61.9	(32.24)	60.7	(37.97)
($N = 12$)	Smile (% time)	3.3	(5.03)	9.7	(20.98)	5.9	(11.31)	0.7	(1.40)	2.0	(2.93)
	Gaze follow (# looks to same object − # looks to different object)	0.1	(0.51)	0.1	(0.29)	−0.2	(0.72)	−0.2	(1.11)	−0.4	(1.24)
3 months	Gaze (% time)	59.1	(25.03)	70.1	(19.81)	58.1	(32.38)	41.4	(26.05)	48.5	(23.68)
($N = 14$)	Smile (% time)	15.2	(16.14)	8.6	(9.17)	14.8	(17.11)	1.7	(3.39)	8.0	(10.76)
	Gaze follow (# looks to same object − # looks to different object)	4.0	(5.10)	3.6	(4.65)	2.4	(5.67)	6.1	(5.27)	3.6	(4.94)

N1, normal interaction 1; JA, joint attention condition; N2, normal interaction 2; LA, look away condition; N3, normal interaction 3.

2. Study 2

2.1. Participants

Twenty-two infants were included in the final sample (12 males, 10 females). Infants ranged in age from 35 to 49 days ($M = 42.6$ days, S.D. = 3.9). One additional infant was tested, but excluded due to fussiness.

2.2. Procedure

The experimental design was similar to that of Study 1, with several exceptions. E1 interacted with the infant over a total of 2 min: one 60 s condition, followed by a period of 5–10 s in which E1 stopped to obtain eye contact from the infant. Following this, a second 60 s condition took place. A second experimenter (E2) stood behind a curtain and cued E1 with the beeping of a stopwatch when each 60 period ended. The two conditions were as follows, and were counterbalanced for order across subjects:

2.3. Joint attention

E1 began the interaction after establishing eye contact with the infant. As in Study 1, the experimenter looked away at the object and smiled for 3–4 s and said phrases, such as "Oh, that is nice" or "It is pretty" with a positive tone of voice. She then turned back to the infant, achieved eye contact, and repeated the same procedure, alternating gaze while speaking in a positive tone, between the object and the infant, for 1 min.

2.4. Affect only

The affect only condition was identical to the joint attention condition, except that E1 broke eye contact with the infant for 1 s before looking to the object. After looking at the infant while talking and smiling for 2 s, E1 looked above the infant's head for 1 s and then turned her gaze immediately to the object for 3 s. The purpose for this change in procedure was that, with the break in face-to-face interaction, E1's smiling and talking would not be interpreted as being about the object that E1 was looking to. This was because when E1 turned to look at the object it was not following eye contact with the infant, but rather following a break in contact with E1 looking above the infant's head. At the same time, we were able to control for the amount of face-to-face interaction directed at the infant.

Coding was conducted as in Study 1. With respect to inter-observer reliability, Cohen's Kappa for smiling was 0.96 and 0.84 for gazing.

In preliminary analyses, repeated measures ANOVAs were performed for each measure in order to check for significant order, age or side effects. These analyses revealed no significant interactions or main effects; therefore, these variables were collapsed in subsequent analyses. Because of the unequal distribution of male and female infants between the two age groups, gender was included as a covariate. If gender did not result in a significant effect (main effect or interaction), the variable was not included in the final analysis.

2.5. Gazing

A repeated measures ANOVA with condition entered as the within-subject factor revealed no significant effect of condition ($F(1, 20) = 0.034$, $p = 0.855$). The mean for the joint attention condition was 9.0 s (S.D. = 12.68) and 8.4 s (S.D. = 9.58) for the affect only condition.

2.6. Smiling

Analyses for smiling were not performed due to insufficient sample size. Only one infant exhibited smiling during the experiment.

Triadic attention is a necessary component of many human social cognitive skills – including some that may be unique to humans, such as language. The ontogeny of infants' sensitivity to triadic attention is an important question that has received scant attention. Prior studies assessing infants' sensitivity have focused on gaze following or dyadic interaction paradigms (Hains & Muir, 1996; Striano, 2004; see also Nadel & Tremblay-Leveau, 1999, for evidence of dyadic and triadic relations with older infants). One exception is a recent study comparing 3- 6-, and 9-month-old infants' sensitivity to triadic attention (Striano & Stahl, 2005), showing that by 3-months of age, infants are sensitive to various degrees to others' triadic attention.

In the current study, we extended these findings to a younger age group in order to gain a better understanding of the developmental course of this effect. We compared 3-month-old and 6-week-olds' sensitivity to an adult who coordinated attention between an object and the infant or who looked at an object while talking. Results revealed that even by 6 weeks of age, infants are sensitive to relevant aspects of dyadic social interaction. They did not show a classic "still-face" effect with less gazing and smiling to the adult during the joint attention condition. By 6 weeks of age, infants are sensitive to the presence of social cues directed toward them as shown in Study 1. They were not, however, sensitive to the triadic relevance (i.e., signals as these relate to objects) of these communicative signals, as demonstrated in Study 2. This finding is consistent with other studies demonstrating a transition in infants' sensitivity to the relevance of communicative signals between 1 and 3 months of age (see Striano, Henning, & Stahl, 2005). Prior research shows that by 3 months of age, infants can distinguish between relevant and non-relevant dyadic (Striano, Henning, & Stahl, 2006) and triadic social cues (Striano & Stahl, 2005).

In Study 1, infants gazed reliably more at the adult when she engaged in a normal interaction or in a triadic interaction (i.e., joint attention condition) than when she looked away at an object while talking (i.e., look away condition). Similar results were found for smiling, although this effect may have been modulated somewhat by age as revealed by the marginal interaction with age and episode. This effect should be investigated with a larger group of infants, and ideally on a longitudinal basis in order to assess the developmental course. Gaze following results were not significant or as robust as in prior studies (see Striano & Stahl, 2005), but followed the same general pattern (i.e., more gaze following in the look away condition than in the joint attention condition). This may be due to lower sample size as well as the addition of a second object (left and right side of the infant), which may have competed for the infants' attention.

The current study demonstrates that infants as young as 6 weeks of age are sensitive to some aspects of triadic attention, such as movement cues and facial expressions. The function of the sensitivity to triadic attention remains open and does not necessarily imply an awareness of intentions or goals in others. The current study suggests that there may be a link between early dyadic (face-to-face) interaction and triadic social skills (i.e., joint attention). For instance, infants gazed and smiled less at both ages, and showed less smiling at 3 months of age when an adult broke dyadic or triadic contact. One major function of dyadic and triadic interactions may thus be to share attention with others (see Hobson, 2000; Reddy, 2003; Striano, 2004). This drive likely does not undergo a radical change when infants begin to shift attention more flexibly. Future research is needed to track the developmental course of infants' sensitivity to others' dyadic and triadic attention (see Nadel & Tremblay-Leveau, 1999; Striano & Rochat, 1999) and to establish when and if these social sensitivities parallel or index an understanding of others' mental states.

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