Cognitive Development 24 (2009) 23–33

Contents lists available at ScienceDirect

Cognitive Development

One-year-olds' understanding of nonverbal gestures directed to a third person

Maria Gräfenhain[a,b,*], Tanya Behne[a,c], Malinda Carpenter[a], Michael Tomasello[a]

[a] *Max Planck Institute for Evolutionary Anthropology, Department of Developmental and Comparative Psychology, Deutscher Platz 6, D-04103 Leipzig, Germany*
[b] *University of Leipzig, Department of Psychology, Seeburgstr. 14-20, D-04103 Leipzig, Germany*
[c] *School of Psychological Sciences, University of Manchester, Oxford Road, Manchester M13 9PL, UK*

ARTICLE INFO

Keywords:
Preverbal development
Communicative intentions
Overhearing
Nonverbal gestures

ABSTRACT

We investigated whether infants comprehend others' nonverbal communicative intentions directed to a third person, in an 'overhearing' context. An experimenter addressed an assistant and indicated a hidden toy's location by either gazing ostensively or pointing to the location for her. In a matched control condition, the experimenter performed similar behaviors (absent-minded gazing and extended index finger) but did not communicate ostensively with the assistant. Infants could then search for the toy. Eighteen-month-old infants were skillful in using both communicative cues to find the hidden object, whereas 14-month-olds performed above chance only with the pointing cue. Neither age group performed above chance in the control condition. This study thus shows that by 14–18 months of age, infants are beginning to monitor and comprehend some aspects of third party interactions.

In most cultures, infants grow up within complex social environments, surrounded by siblings, peers, and various extended family members. In these environments, infants often encounter the ongoing communicative interactions of other individuals. Research on language acquisition has raised the question of whether young children benefit from overhearing these third-party conversations and learn language from them (Akhtar, 2005a). Some observations suggest that they do. In some cultures, for example, young children are not directly addressed as often as they are in Western cultures. Observations of learning in those cultures suggest that children do benefit from overhearing others'

* Corresponding author. Tel.: +49 341 35 50 406; fax: +49 341 35 50 444.
E-mail address: graefenhain@eva.mpg.de (M. Gräfenhain).

0885-2014/$ – see front matter © 2008 Elsevier Inc. All rights reserved.
doi:10.1016/j.cogdev.2008.10.001

conversations (Lieven, 1994; Schieffelin & Ochs, 1986), and recent experimental research in Western cultures has supported this claim. Akhtar et al., for instance, showed that two-year-old children were able to learn new object labels and, to some extent, new action verbs by overhearing these words in two adults' conversation (Akhtar, 2005b; Akhtar, Jipson, & Callanan, 2001; Tomasello & Barton, 1994). Even 18-month-old infants were able to benefit in this overhearing context (Floor & Akhtar, 2006), although their performance was rather fragile, affected by memory demands. Eighteen-month-olds have also been found to use overheard emotional information in an imitative learning task (Repacholi & Meltzoff, 2007).

It is an interesting question whether younger infants, too, could benefit from overheard communicative information. To our knowledge, only one previous study has addressed this question. Moll, Carpenter, and Tomasello (2007) found that 14-month-old infants had difficulties judging which of three objects an experimenter knew about after observing her interacting with some of the objects with a third person. In contrast, after having been directly involved in joint engagement with the experimenter and those objects, the infants were able to judge correctly. This suggests that infants younger than 18 months may have difficulty comprehending and using information from third-party interactions.

In the current study, we tested 14- and 18-month-olds using a different, more direct test of infants' overhearing skills. We adapted the method Behne, Carpenter, and Tomasello (2005) used to study infants' understanding of others' nonverbally expressed communicative intentions toward infants themselves. In that study, an adult established a hiding–finding game by hiding toys for infants, at first in such a way that infants could see into which of two containers the adult placed the toys. Then, for the test, the adult hid the toys without letting infants see where they were hidden, called the infant's name and nonverbally indicated the toy's location with one of two communicative cues: pointing or ostensively gazing at that container. Infants as young as 14 months of age used both types of communicative cue, searching in the correct location more often than expected by chance. In a control condition, the adult performed similar surface behavior, but in a non-communicative manner, for example gazing absent-mindedly at the baited container. In this context, in contrast, infants' performance dropped to chance level, suggesting that they were using an understanding of the adult's communicative intention – and not some lower-level orienting cue – to choose the correct container in the experimental condition.

Although at first glance this task seems trivially easy – the adult clearly "told" infants where the toy was in the experimental condition – many similar tests with apes have shown that they do not use the experimenter's communicative cues to find the hidden reward (Call, Hare, & Tomasello, 1998; Tomasello, Call, & Gluckman, 1997). To succeed on this task, infants not only had to follow the adult's point or gaze direction to the correct container (something apes can do); they also needed to recognize why the adult indicated this particular location. They needed to know that the adult was trying to help them find the hidden toy communicatively (something apes apparently do not do).

To test whether infants could also recognize the adult's communicative intention in an overhearing context, we used the same general method as Behne et al. (2005), but this time the experimenter directed her communicative gestures to an assistant standing next to her instead of to infants. Thus, in order to solve the task, infants not only had to monitor the adults' interaction; they also had to recognize that the experimenter was trying to communicate to the assistant where she had hidden the toy. We also included a control condition to investigate whether infants solved the task using an understanding of the content of the ongoing communicative interaction or instead simply followed the direction of the experimenter's head turn or the direction of the outstretched index finger (i.e., had their attention attracted in that direction more automatically by those cues). Thus, in this condition, the experimenter performed a similar surface behavior as in the experimental condition, but did not attempt to communicate ostensively with the assistant (i.e., she gazed absent-mindedly at the correct location or held out her index finger in its direction purposelessly).

We considered the present task to be somewhat less demanding than previous overhearing tasks. Our two communicative cues (ostensive gaze alternation and pointing) were nonverbal and the communicative cues remained visible until the infant had chosen a container, and therefore they required less in the way of memory skills from the infants. For these reasons, and given the findings of Floor and Akhtar (2006), and Repacholi and Meltzoff (2007), we predicted that 18-month-old infants should

be able to comprehend the experimenter's communicative intention to indicate the toy's location in the experimental condition. In the control condition, in contrast, we expected infants to choose the containers at chance level, as the experimenter provided no ostensive communicative behavior on which the infants could rely.

For the younger infants it was more difficult to make predictions. On one hand, given Moll et al.'s (2007) finding that 14-month-olds had difficulty using information from third-party interactions, we might expect 14-month-olds to have difficulty with the current task as well. On the other hand, the reduced memory and social-cognitive demands of the current task might make it easier and within the capabilities of 14-month-olds.

1. Method

1.1. Participants

Forty-three 14-month-old infants (21 boys; mean age 14;18, range 14;01 to 15;02) and forty-six 18-month-old infants (25 boys; mean age 18;04, range 17;19 to 18;19) participated in the study. They were recruited from a database of parents who had agreed to participate in studies of infant development. Infants were randomly assigned to conditions following a between-subjects design. Specifically, 21 14-month-olds and 25 18-month-olds participated in the experimental condition, and 22 14-month-olds and 21 18-month-olds participated in the control condition. Additional infants were tested but not included in the final sample. Eleven 14-month-olds (five from the experimental condition) and four 18-month-olds (two from the experimental condition) did not participate in at least three of four trials for at least one of the two types of cue (see below) due to fussiness, loss of interest, or reluctance to search for the toy. Analyses including the few test trials in which these infants did participate revealed the same pattern of results as the analyses reported below. Still, to be conservative, we only included infants who participated in at least three trials.

1.2. Materials

A large, crescent-shaped box (length = 95 cm, height = 28 cm, maximum width = 32 cm), covered with cloth, served as a low table for the hiding procedure. On each trial two identical opaque containers were used as possible hiding locations. The containers had lids that could be propped up to occlude the experimenter's (E's) hands from the infant's sight during the hiding process. The inside of the containers was cushioned with material to prevent any noise when E deposited a toy in them. In order to prevent perseveration errors across trials (Behne et al., 2005), we used four different pairs of identical containers, each pair of different size, shape and color. Each pair of containers was used in one warm-up trial, one gaze trial and one pointing trial.

The toys E hid in the containers in the warm-up trials could make noises (e.g., rattling or squeaking), so that E had the opportunity to catch infants' attention without explicitly referring to them (i.e., without calling their name or establishing eye contact with them). The toys during the test trials were such things as small cars, toy animals, or balls, thus, highly attractive objects to infants, in order to motivate them to search for the toys. Two cameras recorded the entire test session.

1.3. Design and procedure

Infants first participated in four warm-up trials designed to familiarize them with the procedure. In these trials infants learned that they were allowed to approach the table and open the containers during the response phase, even though they had not been directly addressed and no adult gave them explicit permission to do so.

Fig. 1 depicts the general set-up. Infants sat on their parent's lap on the floor facing E, who knelt behind the table. (Infants were approximately 1.50 m away from the table.) For the warm-up trials, which were the same in both the experimental and control condition, an assistant (E2) sat on the floor next to the parent. At the start of each warm-up trial, E put two identical, open containers on the left and right ends of the table. E then addressed E2, holding the toy in front of her with both hands

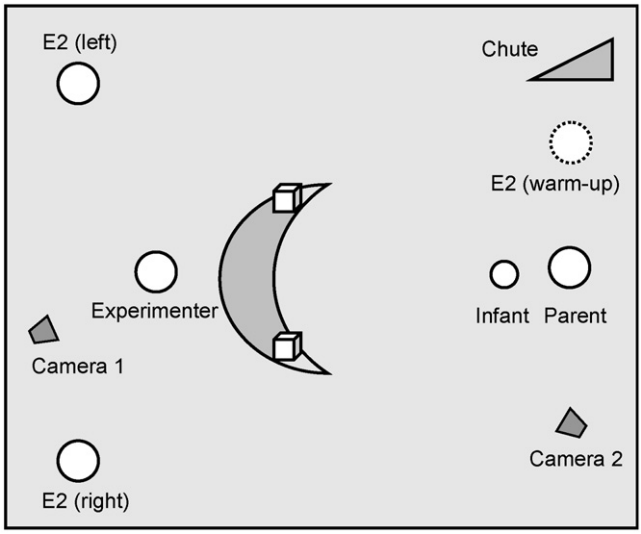

Fig. 1. Schematic depiction of the experimental set-up for both warm-up and test trials.

together and said, "Look, [E2's name], I'm going to hide the toy!" Then E lowered both hands, parted them in mid-air, taking the toy in one hand, and placed each hand in one of the containers, thereby depositing the toy in one of them. Note that in the warm-up trials, everyone could always see the toy in E's hand and therefore knew in which container she put it. Then, E closed the lids of the containers and said to E2, "[E2's name], I hid the toy!" At the beginning of the session, parents were instructed to keep their infant on their lap until this point. Now, the infant was allowed to approach the table and to retrieve the toy. If infants did not approach, parents were instructed to nonverbally encourage infants by helping them to rise from their lap. If infants still did not approach, E2 verbally encouraged them to help her get the toy.

Throughout the warm-up trials, even while infants were searching for the toy, E avoided interacting with them, looking at and addressing only E2. After infants retrieved the toy, E exclaimed in a surprised and happy way, "Oh look, [E2's name], (s)he has already found the toy!" E2 asked the infant to show her the toy and both played with it briefly while E was preparing the next trial. E2 then directed the infant to a chute in a corner of the room and encouraged the infant to let the toy slide down the chute, where it remained enclosed in a box at the bottom of the chute.

The procedure of the test trials in the experimental condition was similar to that of the warm-up trials, but with two main differences: First, it was even clearer that E was only addressing E2. Whereas in the warm-up trials, E2 had sat on the floor next to the parent, E2 stood slightly behind and to the side of E in the test trials; thus, for half of the infants, she was on the left side and for half of the infants on the right side (see Fig. 1). Therefore, E had to turn away from the infant to address E2. Throughout the test trials, E2 bent forward in E's direction in order to emphasize their mutual interaction.

The second crucial difference between warm-up and test trials was that in the test trials the toy was hidden in such a way that neither E2 nor the infants could see where it was. That is, E put two containers in the middle of the table and showed a toy to E2. E then announced to E2 that she was going to hide the toy, and E2 closed her eyes and lowered her head so she could not see.[1] E closed both hands around the toy and lowered her hands behind the table, where – out of the infant's sight – she quickly and inconspicuously moved the toy to one hand. She then lifted her closed fists and placed each simultaneously into one of the containers, depositing the toy silently in one of them. Next, E closed the lids and slid the containers to the ends of the table. Thus, the containers were equidistant from her,

[1] See Brooks and Meltzoff (2002) for evidence that infants at this age know that closed eyes prevent seeing.

Fig. 2. Examples of the communicative cues in the experimental condition: (1) ostensive gaze alone to the left container, (2) pointing with gaze gesture to the right container.

and sufficiently far apart that the infant later could not open both containers simultaneously. E then announced to E2 that she had hidden the toy, upon which E2 lifted her head and opened her eyes. E immediately started to give one of two deictic cues to E2:

Experimental condition – Gaze alone. E first established eye contact with E2 and then repeatedly turned her head to alternate gaze between the baited container and E2's face. In doing so, E emphasized her communicative intent with ostensive cues such as raised eyebrows and wide-open eyes and called E2's name occasionally to emphasize that she was talking to E2 and to indirectly attract infants' attention.

Experimental condition – Pointing with gaze. E established eye contact with E2 and then pointed across her body, holding her hand at the midline of her body, with the index finger extended, to avoid local enhancement of one of the table's sides. While doing this, E alternated gaze between E2 and the correct container but did so only about half as often as in trials with Gaze alone. She used the same ostensive cues as in trials with Gaze alone. Fig. 2 shows an example of each communicative cue in the experimental condition.

Throughout both deictic cues, E never looked at the infant, and E2 stayed in her place, looking at E's face, never at the containers. E2 simply continued to look inquiringly at E as if not having properly understood her.

In the control condition, the set-up and the hiding procedure were the same as in the experimental condition except that the experimenters' interaction was not as communicative, both during the hiding and during the test phase. Therefore, E2 was not bending forward toward E as in the experimental condition, but stood upright pretending to read something on a file, which she held in front of her face. When E turned to E2 and announced that she was going to hide the toy (and later that she had hidden it), E2 briefly looked at E, nodded absent-mindedly and turned back to her file. Thus, E2 briefly reacted to E's calling but did not engage in a communicative interaction with her, and E in turn seemed to wait for E2 to finish reading the file. The condition was implemented in this way in order to render E's absent-minded behavior (see below) meaningful in the current context. Then, as in the experimental condition, after having announced that the toy was now hidden, E immediately started to give one of two non-communicative cues.

Control condition – Absent-minded gaze alone. After announcing to E2 that the toy was hidden, E sat with one leg bent up, rested her elbow on her knee and let her gaze wander distractedly over to the baited container. She then rested her head on her hand and stared absent-mindedly at the container as if waiting for E2 to become available. As in the experimental condition, E alternated gaze between E2 and the correct container occasionally, but in a distracted way, without ostensive cues. She also called E2's name to emphasize that she was talking to E2 and to indirectly attract infants' attention. In response to E calling her name, E2 briefly looked up, nodded distractedly and then looked back at her file. As soon as E2 had broken eye contact with E, E recommenced staring at the container.

Fig. 3. Examples of the similar-looking but non-ostensive cues in the control condition: (1) absent-minded gaze alone to the right container, (2) outstretched index finger with gaze to the left container.

Control condition – Non-communicative 'pointing' with gaze. E stretched out her index finger as in the experimental condition, but rested her hand on her knee or her other arm. For the rest of the trial, she pretended to examine her outstretched index finger. While doing this, E occasionally alternated gaze non-ostensively between E2 and the correct container and called E2's name. Fig. 3 depicts an example of each similar-looking but non-ostensive cue in the control condition.

In both the experimental and control condition, as soon as E had announced to E2 that she had hidden the toy and started to give the respective cue, parents allowed infants to get up and search for the toy. E continued giving the cue until the infant had approached the table and had made a choice. If infants' first choice of a container was correct, E2 immediately turned to the infant. As in the warm-up trials, she always asked the infant to show her the retrieved toy and then directed the infant to the chute in the corner of the room. If infants' first choice of a container was incorrect, they were allowed to open the other container, retrieve the toy, and put it in the chute. This was done to ensure that infants who were unsuccessful did not quickly lose interest in the game. However, if an infant opened the incorrect container first, E stopped giving her cue, continued looking at E2, and waited until the infant had found the reward. As in the warm-up trials, in all test trials E avoided addressing the infant but expressed surprise that the infant had already found the toy.

Each infant participated in eight test trials, that is, four gaze trials (i.e., Gaze alone or Absent-minded gaze alone cue, depending on the condition) and four pointing trials (i.e., Pointing with gaze or Non-communicative 'pointing' with gaze cue, depending on the condition). The cues were blocked, with half of the infants first receiving the gaze and then the pointing cue and the other half receiving the opposite order. Infants were randomly assigned to one of these sequences. The locations of the hidden toy (left vs. right) were counterbalanced for each test block. Their predetermined sequence was random, except that the toy was never hidden on the same side more than twice in a row.

1.4. Coding and analyses

Infants' responses were coded from videotape. If an infant chose the container E was pointing or gazing at, this was scored as a correct response; choosing the other container was scored as an incorrect response. Infants' choice was coded as the first container they approached and opened or clearly attempted to open and then went on to open with the assistant's help. Just touching a container without trying to open it did not count as a choice, as it was not a clear attempt to retrieve the hidden toy.

Three independent coders who were naïve to the hypothesis of the study coded the recordings of four randomly chosen infants from each age group in each condition. Excellent interrater agreement

was obtained: Cohen's kappas = 1 for the 18-month-olds in both conditions and the 14-month-olds in the control condition, and Cohen's kappa = .81 for the 14-month-olds in the experimental condition.

Infants were included in final analyses if they had participated in at least three of four trials in at least one of the test blocks. Because some infants in the final sample did not participate in all eight trials due to fussiness (26 infants), experimenter error (4 infants), or parental interference (1 infant), mean proportions of correct choices were used in most analyses. Infants who did not complete all test trials were not included in most analyses of individual performance. The number of participants included is therefore reported for each analysis.

2. Results

Preliminary analyses showed that neither the order of cue blocks (i.e., gaze first vs. pointing first) nor the assistant's position (left vs. right), nor infants' gender affected search performance – either singly or in combination with the main experimental variables. These factors were therefore not included in any of the following analyses. All p values are two-tailed unless otherwise indicated.

2.1. Effects of type of cue, age and condition

Fig. 4 presents infants' search performance as a function of age, condition, and type of cue. In the first analysis, we were interested in whether infants' performance varied as a function of condition and age and whether the type of cue affected infants' search behavior. The 80 infants who had completed both test blocks using the criterion of completing at least three of four trials in each test block were included in this analysis (20 in each age group and condition). A repeated-measures ANOVA, with type of cue (gaze alone vs. pointing with gaze trials) as within-subject factor and age group (14 and 18 months) and type of condition (experimental vs. control) as between-subjects factors, revealed a significant effect of condition, $F(1,76) = 8.74$, $p < .01$, $\eta^2 = .10$. We found no effect of age, and no interaction of these two factors. Further, we found no effect of type of cue, and no interaction of type of cue with any other factor (all p values $\geq .12$). Thus, overall, 14- and 18-month-old infants performed better when E communicatively gazed or pointed with gaze to the correct container for E2 in the experimental condition than when E performed similar-looking but non-communicative actions in the control condition.

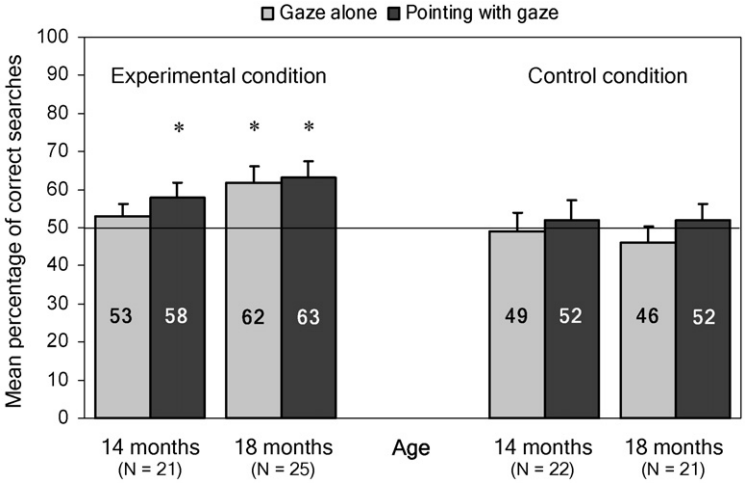

Fig. 4. Search performance on 'Gaze alone' and 'Pointing with gaze' trials for the experimental and control conditions. Asterisks indicate a significant difference to chance level (one-sample t-tests, p values < .05, two-tailed).

2.2. Comparisons against chance

In order to assess whether infants in each age group chose the correct container more frequently than expected by chance (i.e., in more than 50% of the trials), we conducted one-sample *t*-tests comparing infants' mean search performance in each condition against this chance level. In the experimental condition, 18-month-olds performed significantly above chance in both gaze and pointing trials (gaze alone: $t(20) = 2.79$, $p < .05$; pointing with gaze: $t(23) = 2.67$, $p < .05$). However, 14-month-olds only performed significantly above chance on pointing trials (gaze alone: $t(20) = 0.96$, $p = .35$; pointing with gaze: $t(19) = 2.27$, $p < .05$). In the control condition, infants in both age groups performed at chance levels in both types of trials (absent-minded gaze alone: $t(20) = 0.97$, $p = .34$ and non-communicative 'pointing' with gaze: $t(19) = 0.67$, $p = .51$ for 18-month-olds; absent-minded gaze alone: $t(19) = 0.17$, $p = .87$ and non-communicative 'pointing' with gaze: $t(21) = 0.44$, $p = .66$ for 14-month-olds). Thus, infants in both age groups reliably searched in the correct container when E pointed with gaze at the hidden toy's location but searched randomly when she showed similar-looking but non-communicative behavior. However, when E gazed ostensively without pointing, only the 18-month-old infants, not the 14-month-olds, reliably searched in the correct container.

Analyses of infants' individual performance revealed that in the experimental condition, 3 of the 16 18-month-olds who participated in all test trials performed significantly above chance individually (binomial test, at least seven of eight trials correct, $p < .05$, one-tailed), whereas no 18-month-old in the control condition performed significantly above chance individually. No 14-month-old performed significantly above chance individually in either condition.

2.3. Analysis of training effects

Next, we investigated the possibility that infants might have learned to respond correctly over the course of the eight test trials. Table 1 presents infants' search performance in each trial. On their very first experimental trial, infants at both ages did not perform better than expected by chance. Only 61% of 18-month-olds and 50% of 14-month-olds in the experimental condition searched in the correct container on their first trial (binomial tests: $p = .41$ and $p = 1.00$, respectively). This might suggest that especially in the experimental condition, infants learned to use the communicative cues over the course of the test session. In order to examine whether infants' search performance varied systematically, that is, whether at least some of the eight test trials differed significantly from each other, we calculated Cochran's *Q* tests for each condition and age group separately. No significant effects were found for either condition or age group (p values $\geq .19$). The same pattern of results was found for each cue separately.

However, these analyses only included infants who had completed all eight trials (in the experimental condition: 16 18-month-olds and 15 14-month-olds; in the control condition: 14 18-month-olds and 13 14-month-olds). For a more representative analysis, for each infant in the experimental condition, we additionally calculated the mean of the Spearman correlations between each infant's individual performance in each test trial and the order of that test trial (i.e., first through last). If infants' search performance improved over the course of the test session, we should find significant correlations between their performance and the order of the respective test trial. That is, mean correlations should

Table 1
Percentage of correct responses in each of the test trials as a function of condition and age (the *n* for each cell ranges from 19–24).

Condition	Age	Trial							
		1	2	3	4	5	6	7	8
Experimental	14	50	56	33	75	50	45	63	60
	18	61	65	61	63	53	62	81	55
Control	14	68	65	48	40	65	35	37	50
	18	47	57	42	43	58	42	60	47

differ significantly from zero if infants' correct search performance substantially correlated with the last test trials. In contrast, mean correlations should be close to zero if the search performance did not improve over the course of the test session. One-sample *t*-tests comparing the mean correlation coefficients to zero revealed that infants' search performance did not vary systematically with test trials (14-month-olds: $t(20) = .22$, $p = .83$; 18-month-olds: $t(24) = .38$, $p = .71$). Thus, although infants' performance was quite variable across test trials, it varied unsystematically. In sum, there is no evidence that infants in the experimental condition searched in the correct container because they had simply learned how to respond to the cues across repeated trials.

3. Discussion

Overall, as a group, infants aged 14 and 18 months showed some understanding of nonverbally expressed communicative intentions directed to another person, that is, they recognized the relevance of 'overheard' gestures that an adult directed to a third person and they used them to find a hidden toy. Eighteen-month-olds reliably used both types of communicative cue provided (i.e., pointing with gaze and ostensive gaze alternation alone), whereas 14-month-olds only reliably used pointing with gaze and their performance was more fragile overall. This suggests that in the first half of their second year of life, infants start to extract relevant information from the ongoing communicative interactions they encounter in their social environment, even when these interactions do not include them directly.

One could argue, however, that infants might have succeeded in this task for other, less sophisticated reasons. For example, perhaps infants were just cued to the correct location because of E's gaze or finger direction. However, if this were the case, then in the control condition, when E also gazed or extended her index finger at the baited container, infants should also have chosen the correct container, but they did not. Although they did search in the control condition, they chose the correct container significantly less often than in the experimental condition. Thus, the findings of the experimental condition cannot be explained by simple following of E's gaze or finger direction. Instead, we believe that infants in this condition were using the communicative cues directed at another person to find the hidden toy.

This finding is in line with work by Gergely and Csibra (2005), who claim that from very early on, infants are sensitive to others' ostensive and referential communicative behavior and see it as conveying new and relevant information, for example, when choosing what actions of others to imitate. A similar effect may have occurred in the current study, but in a third-person context. That is, in the experimental condition, E's ostensive-communicative behavior may have prompted infants to infer that E's gestures were relevant in the current context, whereas infants in the control condition made no such inference.

However, infants in the experimental condition did not show strong evidence of making this inference from the beginning of the test session. They were not immediately successful in their very first trial. This might suggest that they learned to use the communicative cues over the course of the test session. However, there are two strong pieces of evidence against this interpretation. First, in the experimental condition, infants' search performance did not improve systematically over the course of the test session (i.e., there were no training effects). The 18-month-olds, for example, were generally correct but their performance was quite variable across trials (the percentage of 18-month-olds who responded correctly ranged from 53% to 81% across the eight test trials). Second, infants in the control condition performed at chance in the beginning of the test session and continued to do so in the subsequent trials even though they could have easily learned to associate the direction of the experimenter's gaze or index finger with the correct container. We therefore believe that infants came into the study with some understanding of third persons' communicative interactions instead of acquiring this ability over the course of our study.

Another possible explanation is that infants succeeded in this task simply because they mistakenly thought the experimenter was communicating directly with them. This is unlikely because of the set-up, with E remaining completely turned away from them when giving the communicative cues to E2. (Note that even very young infants have been shown to be sensitive to the presence of eye contact and the directedness of ostensive-communicative cues, e.g., Farroni, Mansfield, Lai, & Johnson, 2003; Senju, Johnson, & Csibra, 2006.) Further, if this were true, one would expect infants to perform as well in this 'overhearing' situation as in a situation in which infants were addressed directly. However, it is clear

that infants did not solve this 'overhearing' task at high rates. A comparison to the version of the task in which the experimenter directly addressed the infants to indicate the reward's location (Behne et al., 2005, Study 1) shows that the 'overhearing' context is more demanding for both 14- and 18-month-old infants. Whereas direct cues were comprehended in 77% (18-month-olds) and 64% (14-month-olds) of trials in the Behne et al. study, these percentages fell to 61% and 56%, respectively, in the current study. The weaker (but still successful) search performance of infants in the 'overhearing' context thus suggests that they really did see the communicative cues as directed to the assistant, not to themselves.

The relatively weak performance of the 14-month-olds in the current study extends recent findings that 14-month-olds have difficulty comprehending third-party interactions in a different setting (Moll et al., 2007). How much infants need the scaffolding provided by direct joint engagement thus seems to depend on the nature and difficulty of the task. When social-cognitive and/or memory skills are more demanding (as in the tasks used by Moll et al., 2007, and Floor & Akhtar, 2006), or when there is less information present, as in the current study's gaze alone cue, young infants apparently depend more on direct joint engagement and do not benefit from witnessing third-party interactions. A similar pattern can be observed when looking at toddlers' word-learning abilities. For example, Akhtar et al. (2001) showed that 24-month-olds were able to acquire object labels from observing third-person interactions, but they were less able to do so for the presumably more demanding task of learning action words.

The present study therefore is the first to show that recognizing others' nonverbally expressed communicative intentions in an 'overhearing' context is challenging but nevertheless possible, at least to some extent, even for infants as young as 14 months of age. The question remains, then, how infants were able to discern the meaning of E's gestures even though she did not address them directly. We and others have previously argued and presented evidence that to comprehend communicative intentions, infants rely on some kind of joint attentional frame to ground the referential act in their shared experience with the communicator. This shared experience then helps them to recognize why the communicator thinks this referential act is relevant for them (Baldwin, 1995; Behne et al., 2005; Moore, Angelopoulos, & Bennett, 1999). Following this interpretation, in the current 'overhearing' context infants had to somehow understand the communicative interaction of the two adults as based on joint attention and reference, even if from their observer's outside perspective. That is, they had to understand E's gesture as relevant – either to themselves or to the assistant. If, despite our efforts, infants understood the gestures simply as relevant to themselves and their own goal to find the toy, this would indicate that infants mainly monitor third-party interactions with regard to their own individual goals. In contrast, if infants saw E's gestures as relevant to the assistant given that the two adults were jointly focused on finding the toy, this would suggest that from early on infants understand joint attentional activities not from an egocentric first-person view (with the assistant viewed from a third-person perspective) but rather from a "bird's-eye view" (Tomasello, 1999). Future research is thus needed regarding what perspective infants take when monitoring third-party interactions.

In sum, our findings complement those of Akhtar et al. (2001) and others (Barton & Tomasello, 1991; Floor & Akhtar, 2006; Oshima-Takane, Goodz, & Deverensky, 1996; Repacholi & Meltzoff, 2007) demonstrating 18-month-olds' ability to understand communicative interactions in overhearing contexts. Furthermore, they extend those findings, first, to nonverbal gestures, and second, to even younger infants, 14-month-olds. The ability to understand nonverbal gestures in overhearing contexts is undoubtedly important in young children's early social-cognitive and linguistic development, perhaps especially in cultures in which infants experience less direct, one-on-one interaction with adults than they do in Western, middle-class cultures.

Acknowledgements

This study was partially supported by a grant of the Deutsche Forschungsgemeinschaft to the first author as part of the DFG-Graduate Colleague 1182. The authors would like to thank Christiane Schwier, Susanne Grassmann, and Ulrike Zeissler for their help with data collection. We especially thank all parents and infants who volunteered to participate in this study.

References

Akhtar, N. (2005a). Is joint attention necessary for early language learning? In B. D. Homer & C. S. Tamis-LeMonda (Eds.), *The development of social cognition and communication* (pp. 165–179). Mahwah, NJ: Lawrence Erlbaum.

Akhtar, N. (2005b). The robustness of learning through overhearing. *Developmental Science*, *8*, 199–209.

Akhtar, N., Jipson, J., & Callanan, M. A. (2001). Learning words through overhearing. *Child Development*, *72*, 416–430.

Baldwin, D. A. (1995). Understanding the link between joint attention and language. In C. Moore & P. J. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 131–158). Hillsdale, NJ: Lawrence Erlbaum.

Barton, M., & Tomasello, M. (1991). Joint attention and conversation in mother-infant-sibling triads. *Child Development*, *62*, 517–529.

Behne, T., Carpenter, M., & Tomasello, M. (2005). One-year-olds comprehend the communicative intentions behind gestures in a hiding game. *Developmental Science*, *8*, 492–499.

Brooks, R., & Meltzoff, A. N. (2002). The importance of eyes: How infants interpret adult looking behavior. *Developmental Psychology*, *38*, 958–966.

Call, B., Hare, B., & Tomasello, M. (1998). Chimpanzee gaze following in an object-choice task. *Animal Cognition*, *1*, 89–99.

Farroni, T., Mansfield, E. M., Lai, C., & Johnson, M. H. (2003). Infants perceiving and acting on the eyes: Tests of an evolutionary hypothesis. *Journal of Experimental Child Psychology*, *85*, 199–212.

Floor, P., & Akhtar, N. (2006). Can 18-month-old infants learn words by listening in on conversations? *Infancy*, *9*, 327–339.

Gergely, G., & Csibra, G. (2005). The social construction of the cultural mind: Imitative learning as a mechanism of human pedagogy. *Interaction Studies: Social Behaviour and Communication in Biological and Artificial Systems*, *6*, 463–481.

Lieven, E. V. (1994). Crosslinguistic and crosscultural aspects of language addressed to children. In C. Gallaway & B. J. Richards (Eds.), *Input and interaction in language acquisition* (pp. 56–73). New York: Cambridge University Press.

Moll, H., Carpenter, M., & Tomasello, M. (2007). Fourteen-month-olds know what others experience in joint engagement with them. *Developmental Science*, *10*, 826–835.

Moore, C., Angelopoulos, M., & Bennett, P. (1999). Word learning in the context of referential and salience cues. *Developmental Psychology*, *35*, 60–68.

Oshima-Takane, Y., Goodz, E., & Deverensky, J. L. (1996). Birth order effects on early language development: Do secondborn children learn from overheard speech? *Child Development*, *67*, 621–634.

Repacholi, B. M., & Meltzoff, A. N. (2007). Emotional eavesdropping: Infants selectively respond to indirect emotional signals. *Child Development*, *78*, 503–521.

Schieffelin, B. B., & Ochs, E. (1986). *Language socialization across cultures*. New York: Cambridge University Press.

Senju, A., Johnson, M. H., & Csibra, G. (2006). The development and neural basis of referential gaze perception. *Social Neuroscience*, *1*, 220–234.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.

Tomasello, M., & Barton, M. (1994). Learning words in nonostensive contexts. *Developmental Psychology*, *30*, 639–650.

Tomasello, M., Call, J., & Gluckman, A. (1997). Comprehension of novel communicative signs by apes and human children. *Child Development*, *68*, 1067–1080.