Developmental Science 8:6 (2005), pp 492–499

REPORT

One-year-olds comprehend the communicative intentions behind gestures in a hiding game

Tanya Behne, Malinda Carpenter and Michael Tomasello

Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Abstract

This study explored infants' ability to infer communicative intent as expressed in non-linguistic gestures. Sixty children aged 14, 18 and 24 months participated. In the context of a hiding game, an adult indicated for the child the location of a hidden toy by giving a communicative cue: either pointing or ostensive gazing toward the container containing the toy. To succeed in this task children had to do more than just follow the point or gaze to the target container. They also had to infer that the adult's behaviour was relevant to the situation at hand – she wanted to inform them that the toy was inside the container toward which she gestured. Children at all three ages successfully used both types of cues. We conclude that infants as young as 14 months of age can, in some situations, interpret an adult behaviour as a relevant communicative act done for them.

Introduction

Infants begin to follow the gaze direction of others to nearby targets within their visual field as early as 3 to 6 months of age (D'Entremont, Hains & Muir, 1997), and by around 1 year of age they follow gaze to more distal targets as well (e.g. Corkum & Moore, 1995). They also reliably follow adults' pointing gestures to moderately distal targets by around their first birthdays (e.g. Carpenter, Nagell & Tomasello, 1998).

But following gazing or pointing gestures does not necessarily mean that the infant understands that the adult intends to direct her attention, that is, it does not necessarily mean that the infant understands the adult's communicative intent. A better situation for assessing whether infants understand communicative intent is one in which the infant follows an adult gesture to an otherwise uninteresting target and *in addition* makes some inference about why the adult took the trouble to direct her attention to this boring object. Following Sperber and Wilson (1986), we must look for situations in which the infant asks herself: Why did the adult do this for me? Why is this object to which he is gesturing *relevant* to our interaction?

One possible task with this structure is the so-called object choice task. In the context of a hiding game, Tomasello, Call and Gluckman (1997) had an adult indicate which of three distinct containers contained a reward by (a) pointing to the correct container; (b) placing a small wooden marker on the correct container; or (c) holding up an exact replica of the correct container. Children aged 2.5 and 3.0 years not only followed the adult's indication to one of the containers, but they also inferred that the hidden reward could be found there (as evidenced by their search behaviour). They treated each communicative attempt as an expression of the adult's intention to direct their attention in ways relevant to the current interaction/game. In contrast, in the same situation great apes did not infer the location of the hidden food. This was not because they cannot follow the direction of pointing or gazing (they can; see Call & Tomasello, 2005, for a review), but because they did not tune in to the adult's communicative intention and infer why he was directing their attention to this location. They did not understand that the gesture was made for their benefit, and so they did not seek or find the relevance of this act in this context.

Three-year-old children can also use gaze direction by itself as a cue in this kind of hiding game. Povinelli, Reaux, Bierschwale, Allain and Simon (1997) found that 3-year-olds successfully located hidden rewards, both when the adult pointed and when she gazed at the baited container. Younger children between 2 and 2.5 years of age reliably used pointing gestures to guide their search, but they did not perform above chance when the experimenter

Address for correspondence: Tanya Behne, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, 04103 Leipzig, Germany; e-mail: behne@eva.mpg.de

only gazed at the baited container. Importantly, in contrast to pointing, gaze direction by itself is not typically used to express communicative intentions in interactions with infants. Great apes in this study once again showed evidence for following gaze direction and pointing, but no evidence of understanding the human's communicative intentions.

Very little is known about the ability to infer communicative intent from such gestures by 1-year-old infants, at the time when language is first beginning to emerge. There is some evidence from children's early word learning, but these studies do not target the comprehension of communicative intentions directly. For example, a number of word learning studies have shown that infants between 18 and 24 months perceive the speaker's intention and follow her attention in various ways in order to identify the referent of a novel word (see Baldwin, 1995, and Tomasello, 2000, for reviews). But these studies all presuppose that infants recognize that the adult expressed a communicative intention. Other studies show that infants at 18 months of age (perhaps even at 13 months) are able to learn a word or sound for a novel object when they hear it produced by a person attending to the object with them, but not when it is coming from a person out of sight or from a loudspeaker (Baldwin, Markman, Bill, Desjardins, Irwin & Tidball 1996; Campbell & Namy, 2003). Infants at 17 months of age can also use both familiar and novel naming frames to identify the intended referent of a novel word (Namy & Waxman, 2000). These results suggest that infants only learn new words when they come from a person visible to them within certain kinds of linguistic frames, but, again, they do not address the more specific question of infants' understanding of communicative intent.

And so the question is whether infants just beginning to learn language possess an understanding of communicative intentions – especially as expressed in non-linguistic gestures. In the current study we assessed this understanding in a hiding-finding game with infants at 14, 18 and 24 months of age. The game was based on the object-choice tasks conducted with older children and great apes (similar to those of Tomasello *et al.*, 1997, and Povinelli *et al.*, 1997). An experimenter hid a desirable toy in one of two opaque containers and then indicated its location by giving a communicative cue – either pointing or ostensive gazing toward the correct location. The question was whether children at these different ages (including prelinguistic and/or barely linguistic children) would understand that this was a communicative cue given for their benefit that had relevance for them in this situation – specifically, that it indicated the container in which the hidden toy could be found. Our prediction was that children – at least in the older age group(s) – would use the adult's communicative cues to guide their search for the hidden toy.

Method

Participants

Participants were 60 children from a medium-sized German city. There were three ages: 20 children (8 boys, 12 girls) were 14 months old (mean age = 14;15, range = 14;2 to 15;2), 20 children (11 girls, 9 boys) were 18 months old (mean age = 18;2, range = 17;20 to 18;15) and 20 children (7 boys, 13 girls) were 24 months old (mean age = 24;2, range = 23;17 to 24;13).

In addition five 14-month-olds, nine 18-month-olds and three 24-month-olds took part but were not included in the final sample because of experimental errors ($n = 2$), because the children did not participate in the game ($n = 2$), or because they lost interest and did not complete all experimental trials ($n = 13$). Children were recruited from a database of parents who had volunteered to participate in studies of child development.

Materials

A crescent-shaped box (length = 95 cm, height = 28 cm, max. width = 32 cm), covered with material, served as a low table on which the hiding took place. On each trial two identical opaque containers were used as possible hiding locations. Findings from a pilot study with 2-year-olds showed that some children tended to search in the container the toy had been in on the previous trial. In order to minimize this perseveration error, a new pair of hiding containers was used on each subsequent trial. Four pairs of containers, each of different colour, material and shape were used as hiding locations. Each pair of containers was used for one gaze trial and one point trial.

For the 18- and 24-month-olds, a screen (60 cm × 80 cm) was used to conceal the hiding process. For the 14-month-olds, the hiding procedure was different (see below) and no screen was used. Instead, boxes with lids that could be propped up to occlude the experimenter's (E's) hands served as hiding locations. Again four different pairs were used, all of them lined with material to muffle any sounds that might be made when depositing a toy. Two cameras were used to film the hiding game, one facing the child and one facing E.

Design and procedure

The design and experimental procedure were the same for all three age groups, with the one exception that the

hiding process was slightly modified for the 14-month-old infants (see below).

All children first participated in a warm-up task to familiarize them with the containers used for hiding. E placed a pair of containers on the floor in front of her, showed the child an attractive toy and said the German equivalent of, 'Look, I'll hide it.' She then placed the toy in one of the containers, ensuring that the child was watching her, and closed both containers. The child was then encouraged to retrieve the hidden toy. This visible 'hiding' procedure was carried out for all four pairs of containers.

For the experimental trials, E kneeled behind the low table facing the child, the parent and the assistant, who were all sitting about half a metre away. At the start of each trial, a pair of open, empty containers was placed on the table, one at either end of the table. E presented a toy and if the child showed interest in it, she placed the screen in front of the table while saying, 'Look, now I'll hide the [toy].' She then lowered the toy behind the screen, quickly pushed both containers towards each other, hid the toy in one, and pushed the containers apart again (roughly 70 to 80 cm from each other), so that they were positioned at equal distance to E. This distance between the containers ensured that the child could not grab both containers but had to choose which one to go to. After removing the screen, E established eye contact with the child and indicated the hiding location giving a communicative cue. Two types of deictic cues were used:

(a) ostensive gaze: E repeatedly turned her head, gazing at the baited container and back at the child. While gaze alternating, E also expressed her communicative intent through facial gestures such as raised eyebrows.
(b) point: E pointed across her body, holding her hand with extended index finger at the midline of her body, in order to control for distance cues. While pointing, E looked at the baited container and back at the child, expressing her communicative intent also through facial gestures such as raised eyebrows.

The parent and assistant ensured that the child stayed with them (and in the centre with equal distance to the two containers) until E had started giving her communicative cue. Then the child could go to retrieve the toy and the assistant encouraged her by saying, 'Where's the [toy]? Can you go and get the [toy]?' If a child clearly tried unsuccessfully to open one of the containers, the assistant helped (either by holding it at its base or by loosening the lid slightly), so that the child could then open it and retrieve the toy. If a child did not find the hidden toy, E opened the container and showed the child the toy for her to retrieve. This was done to ensure that children who were unsuccessful did not quickly lose interest in the game due to frustration.

All children participated in four point trials and four gaze trials. For each age group, the order of cue presentation was counterbalanced across children, that is, half of the children participated in four point trials followed by four gaze trials and for the other half the order was reversed. The hiding locations (i.e. left or right container) were counterbalanced for each child and each communicative cue. The predetermined order of left or right hiding location was random, except that the toys were never hidden more than twice in succession on the same side.

Procedural modifications for 14-month-olds

For 14-month-olds, the procedure was the same as for the older children, except for the hiding process itself. No screen was used to occlude the hiding process, as pilot results indicated that the use of a screen prolonged the hiding phase and seemed to distract the 14-month-olds. Instead, the boxes remained stationary and the lids of the boxes were propped up to conceal the hiding process. E showed the child a toy, then covered it with both hands and lowered her hands behind the table. There, out of the child's sight, she concealed the toy in one closed hand, moved her hands apart, lifted them and put each hand into one of the boxes simultaneously, thereby depositing the toy in one of the boxes. She then closed the lids of the boxes, one with each hand, and indicated the location of the toy as described above. The assistant sitting with the child checked that there were no visible or audible signs to the toy's location during hiding.

Scoring and data analyses

Children's responses were coded from videotape. If a child 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. A child's choice was coded as the first container she approached and opened, or clearly attempted to open and then continued to do so with the assistant's help. Just touching one container in passing without picking it up or attempting to open it did not count as a choice, because this type of response could have reflected an interest in the container instead of a search for the object inside (see Introduction). (Rarely, i.e. on 3% of gaze trials and 2% of point trials, children choose neither container.) To assess inter-observer reliability, data from four randomly chosen children in each age group (i.e. 20% of all trials) were independently coded from tape by a second person.

For all three age groups there was 100% agreement between the two coders on whether or not children chose the correct container.

For each participant the mean percentage of correct and incorrect responses was calculated for all trials, as well as for the gaze and pointing trials separately. (A small percentage of trials, 12 out of a total of 480 trials, had to be excluded because of experimental error or parental interference. Thus, for one 24-month-old, five 18-month-olds and six 14-month-olds analyses were based on seven not eight experimental trials. These children were not included in statistical analyses of individual performance using binomial tests.)

Results

Preliminary analyses showed that order of pointing and gazing trials did not affect children's search performance. A two-way ANOVA on the mean percentage of correct responses showed no main effect of order of presentation (gazing vs. pointing trials first), $F(1, 54) = 0.37$, $p = .54$, and no interaction with age (14, 18 and 24 months), $F(2, 54) = 2.12$, $p = .13$. Thus order of cue presentation was not included as a variable in any subsequent analyses.

Comparisons to chance

Children at all three ages reliably chose the correct location when searching for the hidden toy, suggesting that they used the communicative cues provided (paired *t*-test comparing correct versus incorrect search location for both cues combined: 14-month-olds, $t(19) = 5.25$, $p < .001$; 18-month-olds, $t(19) = 8.46$, $p < .001$; 24-month-olds, $t(19) = 12.93$, $p < .001$). On average, 24-month-olds chose the correct container on 88% of trials, 18-month-olds on 77% of trials, and 14-month-olds on 64% of trials. Analyses of individual performances illustrate the improvement with age: 84% of 24-month-olds and 60% of 18-month-olds, but only 7% of 14-month-olds were significantly better than chance individually (Binomial tests, at least 7 out of 8 trials correct, $ps < .05$, one-sided).

Analyses of infants' performance on their first experimental trial also corroborated this pattern: nearly all 24-month-olds (19 out of 20 children) and most 18-month-olds (15 out of 20) chose the correct container on their first trial (Binominal tests, $ps < .05$ for both age groups). For the 14-month-olds, 12 out of 20 infants searched correctly; thus in this age group search performance did not differ significantly from chance on the first trial.

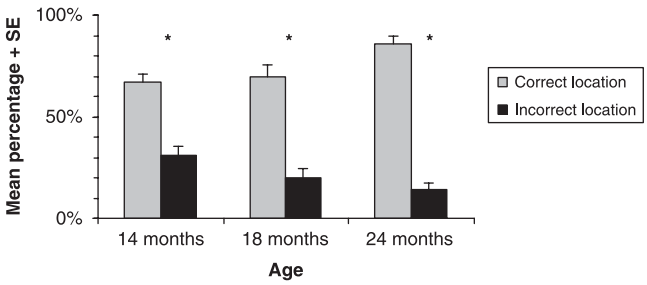

Figure 1 *Search performance on gaze trials. At all ages children reliably chose the correct location (paired* t*-test comparing correct versus incorrect search location, 14-month-olds,* t*(19) = 4.51,* p *< .001; 18-month-olds,* t*(19) = 5.26,* p *< .001; 24-month-olds,* t*(19) = 10.72,* p *< .001).*

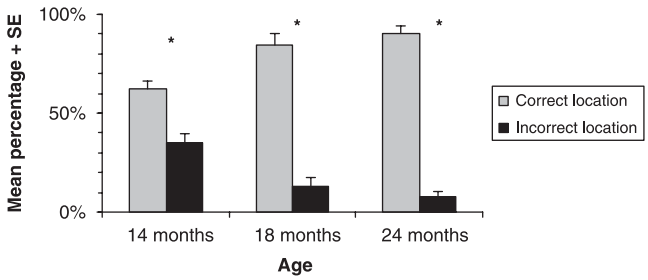

Figure 2 *Search performance on point trials. At all ages children reliably chose the correct location (paired* t*-test comparing correct versus incorrect search location, 14-month-olds,* t*(19) = 2.87,* p *= .01; 18-month-olds,* t*(19) = 7.02,* p *< .001; 24-month-olds,* t*(19) = 12.57,* p *< .001).*

Figures 1 and 2 present children's search performance separately for the two different types of cues. Children at all ages performed significantly above chance on both point and gaze trials, suggesting that they used both types of cues to identify the correct hiding location (see Figures 1 and 2 for means and statistical analyses).

Effects of age and type of cue

Effects of age and type of cue on percentage of correct searches were analysed using a repeated-measure ANOVA with cue type (point vs. gaze trials) as within-subject factor, and age (14, 18 and 24 months) as between-subject factor. A significant effect of age was found, $F(2, 57) = 10.42$, $p < .001$. Children's search performance improved significantly with increasing age (pairwise comparisons, 14 vs. 18 months: $p = .02$, 18 vs. 24 months: $p = .04$). There was no main effect of type of cue, but there was a marginally significant interaction between age and type of cue, $F(2, 57) = 3.14$, $p = .051$.

Post-hoc analyses (Fisher LSDs) revealed the following age patterns for the two cues. On point trials, the two older age groups (18 and 24 months) did not differ from one another, but performed significantly better than the 14-month-olds (pairwise comparisons, 24 vs. 18 months: $p = .38$; 24 vs. 14 months, $p < .001$; 18 vs. 14 months, $p = .001$). On gaze trials, however, 24-month-olds performed significantly better than both 18- and 14-month-olds, who did not differ from each other (pairwise comparisons: 24 vs. 18 months, $p = .01$; 24 vs. 14 months, $p = .003$; 18 vs. 14 months, $p = .55$). In other words, children's performance improved with age and this improvement occurred earlier for point as opposed to gaze cues.

Children's search performance on point and on gaze trials was also compared within each age group. At the age of 18 months, children performed significantly better on point trials than on gaze trials (pairwise comparison, $p = .01$). For the other two age groups no differences between the two types of cues were observed (pairwise comparisons, 14-month-olds, $p = .39$; 24-month-olds, $p = .44$).

In summary, 24-month-olds showed a very high success rate on both point and gaze trials; 18-month-olds were very successful on point trials, but less so on gaze trials; and 14-month-olds made a number of errors on both types of trials. At all ages, however, children performed significantly above chance in finding the hidden toy with both types of cues.

Discussion

These results show that infants at all three ages reliably chose the correct hiding location, indicating that they were using the adult's communicative cues to find the hidden toy. The current results are not easily explained by such things as local or stimulus enhancement. The search task was set up so that when the adult indicated the location of the hidden toy, the distance between her and the two containers was equal. Furthermore, when giving the communicative cue, the adult did not handle or touch either container.

Nevertheless, it may be argued that infants' correct searches may have been the result of some kind of attentional highlighting. That is, perhaps infants followed the adult's point or gaze direction to its target, and then – when given the opportunity to search for the hidden toy – they approached the container which they had just been looking at. In order to check whether infants' search performance simply reflected such an orientation bias induced by low-level attentional cueing processes, the following control study was conducted.

Study 2

The aim of this second study was to explore infants' search performance when the adult did not provide *communicative* cues, but when she produced similar surface behaviour in an absent-minded, non-communicative manner. So, as a control for the gazing condition, instead of ostensively gazing at the correct hiding location (that is, using communicative signals such as raised eyebrows and re-establishing eye contact), the adult now looked at the hiding location absent-mindedly. As a control for the pointing condition, the adult held her hand in the same position as in the pointing trials but without accompanying this cue with communicative looking behaviour; instead she now looked down, examining her hand. Thus, in this study the adult's behaviour – though similar in surface structure – did not express any communicative intent. If infants' search success in the first study was simply based on low-level attentional cueing processes, then their search performance in this study should be similar to that observed in Study 1. In contrast, however, our prediction was that infants' search performance would not differ significantly from chance, when – as in this study – the adult's cues did not express a communicative intent.

Method

Participants

Forty new infants participated in this control study. Twenty children (6 girls, 14 boys) were 14 months old (mean age = 14;25, range = 14;18 to 15;4) and 20 children (9 girls, 11 boys) were 18 months old (mean age = 18;3, range = 17;19 to 18;16 days). In addition, eight 14-month-olds and five 18-month-olds took part but were not included in the final sample, because of experimenter error ($n = 2$), because the children did not want to participate in the game ($n = 2$) or because they lost interest and did not complete all experimental trials ($n = 9$).

Materials

The materials used were the same as those described above for Study 1.

Design and procedure

The only difference between Study 1 and 2 was the type of cues E gave during the experimental trials. Apart from this, the design of the study and the experimental procedures were the same as in Study 1. Thus, the warm-up task, the set-up of the experimental trials and the

hiding procedures were the same as those described above.

The crucial difference in procedure was that instead of providing a communicative cue, E produced similar surface behaviours but did so in a non-communicative way. Thus after hiding the toy, she called the child's name and briefly established eye contact with the child, and then provided a 'cue' with a distracted, absent-minded and withdrawn demeanour. Again two types of cues were used, which closely paralleled the two communicative cues employed in Study 1:

(a) absent-minded gaze: E gazed at the baited container with an absent-minded facial expression (i.e. her eyes were unfocused, her facial expression was neutral and she did not raise her eyebrows or widen her eyes). (Occasionally she glanced back towards the child, but without establishing eye contact.) By resting her chin in her hand E underlined her absent-minded, non-communicative expression.
(b) distracted 'point': E held her hand with extended index finger at the midline of her body, in the same position as for the communicative point cue. But instead of looking at the child and the baited container, she looked down at her hand. Her facial expression suggested that she was preoccupied with inspecting her hand or wrist watch.

All subsequent procedural details (e.g. the assistant's questions encouraging the child to retrieve the toy, help with opening the containers, etc.) were the same as in Study 1. The design of this study also paralleled that of the previous study. That is, each child participated in eight experimental trials, four of each type, and the order of cue presentation and hiding location were counterbalanced the same way as described above.

Scoring and data analyses

The scoring and analyses of data were carried out in the same way as in Study 1. Inter-observer reliability was high for both age groups (for 14-month-olds: 97% agreement, Kappa = 0.94; for 18-month-olds: 100% agreement).

Results

Preliminary analyses showed that the order of cue presentation had no significant effect on the percentage of correct searches. A two-way ANOVA with order of presentation and age as between-subject factors yielded no significant effects.

Infants' search performance did not differ significantly from chance at either age (paired *t*-test comparing correct versus incorrect searches for both cues combined: 14-month-olds, $t(19) = -1.37$, $p = .19$; 18-month-olds, $t(19) = 0.29$, $p = .77$). On average, 14-month-olds chose the correct container on 47% of trials and 18-month-olds on 50% of trials. Analyses of individual performances confirm this picture: search performances did not differ significantly from chance for any 14- or 18-month-old child. The same pattern of results was observed when search performance was analysed separately for the two types of non-communicative 'cues' (see Figures 3 and 4 for means and statistical analyses). An analysis of the effects of age and type of cue on the percentage of correct searches did not yield any significant findings either. (Infants searched in one of the containers just as frequently as they did in the first study – the percentage of trials in which infants chose neither container was as low as in Study 1 – they just did not reliably choose the correct container.)

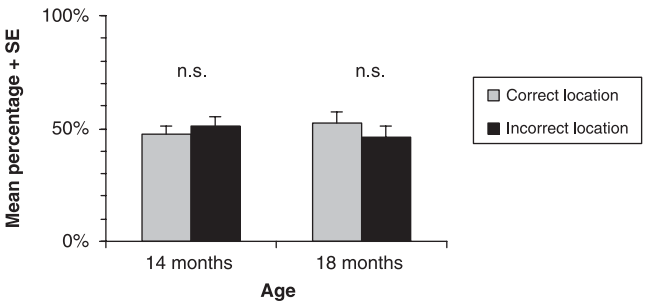

Figure 3 *Search performance on absent-minded gaze trials. Children's performance was at chance level at both ages (paired* t*-test comparing correct versus incorrect searches, 14-month-olds,* t*(19) = –0.48,* p *= .63; 18-month-olds,* t*(19) = 0.63,* p *= .54. Rarely, i.e. on 1% of trials, infants chose neither container).*

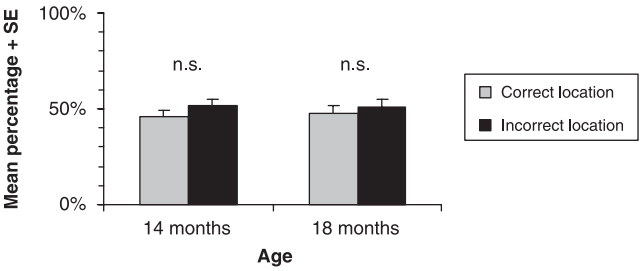

Figure 4 *Search performance on distracted 'point' trials. Children's performance was at chance level at both ages (paired* t*-test comparing correct versus incorrect searches, 14-month-olds,* t*(19) = –0.88,* p *= .39; 18-month-olds,* t*(19) = –0.4,* p *= .69. On 2% of trials infants chose neither container).*

Discussion

Infants' search performance was at chance level both when E gazed absent-mindedly at the baited container and when she distractedly held her hand so that her index finger pointed towards the baited container. This pattern of results was found for both age groups, 14- and 18-month-olds, applying to both group level and individual level of performances.

These findings indicate that low-level attentional cueing processes cannot account for infants' search performance. When, for example, the adult simply gazed at one of the two containers without providing communicative cues, children did not reliably choose this container. Hence low-level gaze-following mechanisms did not seem to determine infants' choice between the two potential hiding locations. Infants' choices were at chance level when not given a *communicative* cue to guide their search.

General discussion

Based on this set of results we conclude that infants as young as 14 months of age understand that some adult acts express communicative intentions. That is, when an adult ostensively gazed to or pointed to a container, children not only followed her attention there, but also inferred – based on the hiding routine already established – that she intended to inform them that this was the location of the hidden toy. Children knew that this behaviour was intended for them, and that it was meant to be relevant to the ongoing interactive situation. In contrast, when the adult produced behaviours with a similar surface structure, but did so in a non-communicative manner, infants' search performance dropped to chance levels.

At first glance, the results of Study 1 appear to be inconsistent with findings by Povinelli *et al.* (1997), since in their study 2-year-old children did not perform above chance when the adult gazed at the baited container. It is possible that the more challenging set-up of their task (the experimenter was positioned closer to the 'incorrect' container), and/or the small sample size in their study (12 children with one gaze trial each) may account for this discrepancy. In light of the findings from our second study, a more likely explanation is that the gaze cue of Povinelli *et al.* was not specifically communicative in nature (the experimenter turned his head to look to the correct container, but he did not alternate his gaze between child and container), making it more difficult for children to infer that the adult was informing them about the location of the hidden reward.

For successful search performance children needed to attend to the adult's communicative cue, identify its referent and infer its relevance in the context of the game. Children's different types of errors illustrate these different aspects. In Study 1, children occasionally had difficulties finding the hidden toy because of problems identifying the referent of the communicative cue. For example, some children went to the correct side of the room and searched behind the table or followed the cue past the container, looking back at the adult questioningly while searching. Thus even though they attended to the cue and inferred its relevance, they had difficulties finding the toy due to problems identifying the container as referent. The reverse kind of error was also observed. A few times children attended to the cue and successfully identified its referent, but did not infer its relevance. These children turned their head to look at the intended target, and even moved a few steps towards it while following the adult's point or gaze, but then approached the other container and opened it.

This last example – and the results of Study 2 – illustrate that successful search performance involved more than the ability to follow another person's gaze or point to its target, the container. Following the adult's gazing or pointing led to an object that was not particularly interesting in itself (especially as there was a second identical container that was just as noticeable). In order to find the hidden toy children needed to infer why the adult was gazing or pointing at this container. Thus, they had to (a) realize that the adult's behaviour was done for their benefit, and (b) assume that it was relevant in the context of the joint activity. Our results suggest that infants as young as 14 months are able to do so.

Our findings also show that infants' ability to infer communicative intent is not restricted to linguistic interactions. Infants were able to infer communicative intent when it was expressed non-verbally. In this context the great apes' repeated lack of success on such tasks is revealing. Chimpanzees possess several of the prerequisite skills needed to solve these tasks. They can follow others' gaze and they understand something about others' intentional action (Call, Hare, Carpenter & Tomasello, 2004). They are also capable of using some cues in an object choice situation: they perform above chance when the location of the hidden food can be inferred by other, non-communicative means (Call, 2004; Hare & Tomasello, 2004). For example, when a competitive experimenter reached towards one of two containers, chimpanzees reliably chose this container, presumably because they were able to infer his goal of retrieving some food from that location. In the cooperative scenario, however, when the experimenter indicated the location of hidden food by pointing, chimpanzees did

not seem to perceive this as a cue given for them and failed to infer its relevance. Human children, in contrast, even those as young as 14 months of age, are able to infer another person's communicative intent in the context of a joint activity. This ability is essential for the acquisition and development of language and for other forms of cultural learning and shared cooperative activities.

Acknowledgements

We thank Angela Loose for her help with data collection and coding, and Hannes Rakoczy for helpful comments on the manuscript. We also thank the parents and children who participated in the study.

References

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

Baldwin, D.A., Markman, E.M., Bill, B., Desjardins, R.N., Irwin, J.M., & Tidball, G. (1996). Infants' reliance on a social criterion for establishing word–object relations. *Child Development*, **67** (6), 3135–3153.

Call, J. (2004). Inferences about the location of food in the great apes (*Pan paniscus, Pan troglodytes, Gorilla gorilla and Pongo pygmaeus*). *Journal of Comparative Psychology*, **118**, 232–241.

Call, J., Hare, B., Carpenter, M., & Tomasello, M. (2004). 'Unwilling' versus 'unable': chimpanzees' understanding of human intentional action. *Developmental Science*, **7** (4), 488–498.

Call, J., & Tomasello, M. (2005). What do chimpanzees know about seeing revisited: an explanation of the third kind. In N. Eilan, C. Hoerl, T. McCormack, & J. Roessler (Eds.), *Issues in joint attention* (pp. 45–64). Oxford: Oxford University Press.

Campbell, A.L., & Namy, L.L. (2003). The role of social-referential context in verbal and nonverbal symbol learning. *Child Development*, **74** (2), 549–563.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*, **63** (4), serial no. 255.

Corkum, V., & Moore, C. (1995). Development of joint visual attention in infants. In Chris Moore & Philip J. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 61–83). Hillsdale, NJ: Erlbaum.

D'Entremont, B., Hains, S.M.J., & Muir, D.W. (1997). A demonstration of gaze following in 3- to 6-month-olds. *Infant Behavior and Development*, **20** (4), 569–572.

Hare, B., & Tomasello, M. (2004). Chimpanzees are more skilful in competitive than in cooperative cognitive tasks. *Animal Behaviour*, **68**, 571–581.

Namy, L.L., & Waxman, S.R. (2000). Naming and exclaiming: infants' sensitivity to naming contexts. *Journal of Cognition and Development*, **1** (4), 405–428.

Povinelli, D.J., Reaux, J.E., Bierschwale, D.T., Allain, A.D., & Simon, B.B. (1997). Exploitation of pointing as a referential gesture in young children, but not adolescent chimpanzees. *Cognitive Development*, **12** (4), 327–365.

Sperber, D., & Wilson, D. (1986). *Relevance: Communication and cognition*. Cambridge, MA: Harvard University Press.

Tomasello, M. (2000). Perceiving intentions and learning words in the second year of life. In M. Bowerman & S. Levinson (Eds.), *Language acquisition and conceptual development* (pp. 132–158). Cambridge: Cambridge University Press.

Tomasello, M., Call, J., & Gluckman, A. (1997). Comprehension of novel communicative signs by apes and human children. *Child Development*, **68** (6), 1067–1080.

Received: 28 June 2004
Accepted: 9 February 2005