

Infants Determine Others' Focus of Attention by Pragmatics and Exclusion

Henrike Moll, Cornelia Koring, Malinda Carpenter,
and Michael Tomasello

Max Planck Institute for Evolutionary Anthropology

In the studies presented here, infants' understanding of others' attention was assessed when gaze direction cues were not diagnostic. Fourteen-, 18- and 24-month-olds witnessed an adult look to the side of an object and express excitement. In 1 experimental condition this object was new for the adult because she was not present while the child and someone else played with it earlier. Children responded to this as if they assumed that the adult was excited about this new object as a whole. In the other condition the object was one with which the infant and this adult had just previously played for a minute. In this case children appeared to assume that the adult could not be excited about this object in itself. They responded either by attending to a specific part of the object or, more frequently, by looking around the room for another object. These results suggest that 1-year-olds can determine what others are attending to based on a pragmatic assessment of what is new and what is old for them combined with a form of reasoning by exclusion.

There is much evidence that infants from 12 to 14 months of age understand that others see things. For example, they know that an adult will not be able to see a target when he or she has his or her eyes closed or is wearing a blindfold (Brooks & Meltzoff, 2002; Caron, Butler, & Brooks, 2002). They also understand that an opaque screen blocks someone's vision (Butler, Caron, & Brooks, 2000; Caron, Kiel, Dayton, & Butler, 2002; Dunphy-Lelii & Wellman, 2004) and that when an adult is looking to a location behind a barrier or behind the infant's body, that adult is seeing something that the infant is not (Deák, Flom, & Pick, 2000; Moll & Tomasello, 2004). In all of these cases, infants are able to determine what others

see by following their head or eye direction and line of regard, taking into account various kinds of obstacles and other special circumstances.

But there are also situations in which a person sees many things but attends only to some part of them. Understanding selective attention of this type would seem to be much harder for infants to learn about or understand than simply seeing because people may attend to something in their visual field without any observable behavioral cue, such as gaze direction, that might single out their focus of attention. If attention is thought of as intentional perception (Tomasello, 1999), then in the theoretical proposal of Tomasello, Carpenter, Call, Behne, and Moll (in press), understanding that others attend to things selectively is analogous to understanding that in pursuing their goals behaviorally actors actively choose one behavioral means over others for a reason. That is to say, in both cases an actor has multiple possibilities (things he or she can see or could do) and from these chooses only one or a few (to attend to or enact), and he or she does this for rational reasons that in some cases an observer can understand (Gergely, Bekkering, & Kiraly, 2002; Gergely & Csibra, 2003).

One reason an actor may have to attend to one thing over others is that it is new to him or her. Young children's understanding of novelty has been investigated very little, but there are a few relevant studies in the area of pragmatics of language acquisition. Some of them have demonstrated that young children understand that people usually talk about what is new in the current discourse context. Young children themselves not only tend to talk about what is new (Baker & Greenfield, 1988; Greenfield & Zukow, 1978; O'Neill & Happé, 2000) but also assume that a novel word they hear refers to the new aspect in that situation (e.g., Akhtar, 2002; Tomasello & Akhtar, 1995). However, in these studies the novel aspect of the situation was equally new for both the adult and the child, so it remains unclear whether these children assessed what was new for the *other*, or whether they simply relied on what was new to them.

Akhtar, Carpenter, and Tomasello (1996) disentangled these two possibilities to investigate whether children really know that people get excited about and attend to new things, not old things, in the immediate context. They had an adult look excitedly in the direction of four objects and exclaim, "Look, I see a gazzer! A gazzer! I see a gazzer in there!" and then ask the child to give her the gazzer. Just prior to that, in the experimental condition, the adult had played with three of these objects but was out of the room while the child played with the fourth. Two-year-old children knew that what the adult wanted was not any of the three objects she and the child had played with previously (people do not normally get excited about things they have just previously been playing with). Rather, they knew that what the adult wanted was the object that was new to her—the one with which she was not familiar from past experience (because she was out of the room when it was introduced) even though children themselves were familiar with it. Two-year-old children thus understood what was new from the adult's perspective.

O'Neill (1996) conducted a similar study, also with 2-year-olds, in which she found that children adjust their linguistic and gestural requests to their parent depending on whether the parent either witnessed or did not witness a hiding event in which something interesting for the child was placed in an out-of-reach container.

There is only one study of younger infants' understanding of others' selective attention based on what is old and what is new for the adult. Adapting the method of Akhtar et al. (1996), Tomasello and Haberl (2003) had infants at 12 and 18 months of age play with an adult and two new toys, in turn. For a third toy, however, the adult left the room while the child and another adult played with it. The first adult then returned, looked at all three toys clustered together on a tray, and exclaimed excitedly "Oh, look! Look at that one!" which she then followed immediately with the request "Can you give it to me?" To retrieve the one the adult wanted, children had to (a) know that people generally attend to and get excited about new, not familiar, things, and (b) identify what was new for the adult even though it was not new for them. Results showed that children at both ages were able to identify the object that was new for the adult, whereas in a control condition in which the adult stayed in the room for the third object, so that all three objects were old for her, infants handed over objects randomly.

Tomasello and Haberl's (2003) study shows infants' understanding of selective attention, in the sense of focusing on one out of several objects based on an understanding of which objects someone is and is not familiar with. In the studies presented here, we investigate whether infants know that others are focused on an object as a whole versus a specific part or feature of it—again, depending on their past experience. Given the salience of whole objects for young children, as evidenced by their *whole object bias* in word learning (Markman, 1991; Markman & Wachtel, 1988; Soja, Carey, & Spelke, 1991), one might expect that understanding this would be even more difficult. We tested this with 14-, 18-, and 24-month-old infants using a modification of the Tomasello and Haberl (2003) procedure. In one condition an adult and child played for some time with an object that had a salient part, but without drawing particular attention to that part. The adult then left for a moment and on returning looked at the object from the part side and exclaimed something like "Oh, great, look!" while looking attentively. The hypothesis was that in this case infants would not think that the adult was excited about the object as a whole because they had just shared it in play with the adult a few moments before. Instead, infants would think that there must be something new about the object, something not previously noticed or attended to, that had now caught the adult's attention. The expectation was thus that in this condition, in which the object was familiar to the adult (object familiar condition), the infant would look to the part side of the object to see what was new. A small sticker inconspicuously stuck to the back of the object served as a target of the experimenter's attention in this condition. This was in contrast to a second condition (object new condition), in which the adult and infant did not play with the object before the adult's entry and

exclamation so that the entire object was new for the adult. In this case, although the experimenter's regard was directed at the exact same place as in the object familiar condition (the back of the object containing the sticker), we expected that the infant would assume the adult was attending to the whole object because the whole object was new for the adult. Infants might thus do various things to the object as a whole in this condition (e.g., look at it, grasp it, point to it, or give it to the adult), but none targeted in particular at the part. In Study 1, 18- and 24-month-olds were tested, and in Study 2, 14-month-olds were tested with a slightly modified method.

STUDY 1

Method

Participants. Participants were 50 children 18 and 24 months of age from a middle-size German city. Twenty-five children (12 girls, 13 boys) were 18 months old ($M = 17;29$, range = 17;17–18;14), and 25 children (14 girls, 11 boys) were 24 months old ($M = 24;0$; range = 23;17–24;15). An additional 7 children (four 18-month-olds and three 24-month-olds) were dropped from the study because they were fussy or uncooperative. Children were obtained from a database of children whose parents had volunteered to participate in studies on child development.

Materials and design. Materials were six toys that could be manipulated in a variety of ways on their front side but had only one little sticker (approximately 1.5×1.5 cm) on their otherwise blank backside. A few were conventional toys such as a drum, a bunk bed, and a box. The others were more abstractly shaped, unfamiliar objects with various attachments on them. Figure 1 presents a sample of two of the toys. The sticker was the specific part of the object that was looked at by Experimenter 1 equally in both conditions. Objects were placed on a low wooden bench (70 cm long, 42 cm wide, 50 cm high) and were always within reach of the children. To make playing more interesting for the children, a small wooden doll that looked like a “grandpa” was used to act on the toy in various ways.

Each child received a total number of six trials—three trials in each of two different conditions (see following)—with a different toy in each trial. Order of toys was counterbalanced using a Latin squares design and was different for every child. The two experimental conditions were alternated on every trial, with the initial condition being counterbalanced across participants within each age group.

Procedure. Children came with a parent for one session of approximately 20 min. Testing took place in a quiet room (4.30×4.30 m) within a child observation laboratory. Prior to the experiment, both experimenters played with the child in a

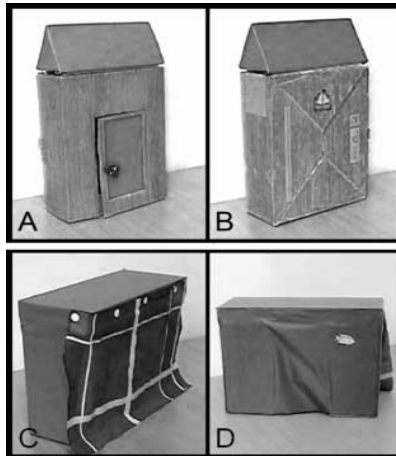


FIGURE 1 Sample of the toys used in Study 1. A and C show two toys from their front side. B and D show these toys' backsides including the sticker (the target part).

warm-up area until the child was sufficiently acclimatized. Then the two experimenters, the parent, and the child entered the testing room. The only objects in the room were a chair for the parent, a low wooden bench serving as a table, and a box on the floor containing the toys. Experimenter 1, Experimenter 2, and the child took preset positions around the table: The child stood in front of the table, and Experimenter 1 and Experimenter 2 sat at 90° angles to the sides of the table. The parent sat in the chair behind the child and was instructed not to interfere but to ensure that the child returned to his or her position at the beginning of each response phase in case he or she moved away during play. This was to guarantee that all children had the same starting position in every trial.

Then the experiment started with either the object familiar or the object new condition. In the object familiar condition, Experimenter 2 brought out the first toy from the box. She put it on the table, saying, "Look at this!" Experimenter 1 and the child then played with the toy together for 70 sec. Neither the parent nor Experimenter 2 engaged in the play. Playing was very similar across objects, but a script determined for each object separately how it should be manipulated. For all objects, the experimenter placed the doll on various sides and performed simple actions such as walking and jumping, and with each specific toy some special actions were performed, for instance, sleeping in the case of a bunk bed toy and drumming with the drum. Every object was placed with the back facing the child at least once to ensure that children saw the special target side with the sticker at least once. Although all children thus saw the backside, they hardly ever noticed or paid particular attention to the sticker during this initial play (and Experimenter 1 never did so). After the 70 sec, Experimenter 2 signaled to Experimenter 1 that the time had

elapsed. Experimenter 1 then terminated the play and, placing the object on the table, got up, saying, "I am going over here." Experimenter 1 then went to the light switches next to the door, where she remained with her back turned to the child. While she was there, Experimenter 2 placed the toy on a fixed position on the table, saying, "I'll put this here." The distance from the child to the toy was approximately 50 cm. The backside of the object (the side with the sticker) 90° to the child's right, facing Experimenter 1. Experimenter 1 returned from her position near the door, approached the toy, and leaned forward toward it with her head at a distance of approximately 80 cm from the toy. From this position, looking straight at the sticker on the object's backside, she exclaimed in an excited tone, "Oh, great, look!" looking briefly at the child afterward. If the child was not paying attention, Experimenter 1 repeated the utterance up to two more times. She sustained her gaze on the object with a facial expression of excitement for approximately 7 sec. Then the response phase terminated.

In the object new condition essentially the same thing happened, but Experimenter 1 left at the beginning before seeing the toy. Experimenter 1 got up, saying, "I am going outside now. Bye-bye!" and waved goodbye to the child. Experimenter 2 responded by waving back and saying goodbye as well. Experimenter 1 left the room. When she was gone, Experimenter 2 took the assigned toy out of the box and placed it on the table in front of the child, saying, "Look at this!" As in the object familiar condition, they played with the toy for 70 sec; the parent did not engage in this interaction. In both conditions, the linguistic expressions used by the experimenters were identical. Also, they played with the toys in very similar fashion because they always followed the same script with a given toy. When the time had elapsed, Experimenter 2 took the toy and put it in the same fixed location and position on the table, saying, "I'll put this here!" Then Experimenter 1 came back into the room. She approached the toy and leaned forward toward it exactly as in the other condition, looking at the sticker on the backside of the toy. The response phase was then identical to that in the other condition.

Thus, the procedure was identical in both conditions except that Experimenter 1 played with the toy in the object familiar condition and Experimenter 2 played with the toy (in the same way as Experimenter 1) in the object new condition. It is important to note that in both conditions, during her exclamation, Experimenter 1 looked at and sustained her gaze at exactly the same spot. She fixated on the sticker on the back of the toy in both conditions, the only difference being that the toy as a whole was new to her in the object new condition, whereas it was familiar from past experience in the object familiar condition.

Coding and reliability. All trials were coded from the videotapes by the second author. Piloting revealed two general kinds of actions: actions that were directed toward the toy as a whole and actions that were not directed toward the toy as a whole. Of those actions that were not directed at the toy as a whole, there were two types.

First, there were part-directed actions, which were references to a specific part of the toy (including the sticker on the backside of the toy as the most rational candidate). Second, there were searching looks, which seemed to be attempts to identify some other object to which the experimenter might be referring. Both part-directed actions and searching looks were expected to be more frequent in the object familiar condition than in the object new condition. The following list shows in more detail the behaviors coded as part-directed actions and searching looks.

Part-directed actions.

1. *Name the part:* This was coded if a child named what the sticker depicted; if the child said “heart” or “star” for example, and the sticker really was heart or star shaped.

2. *Point at the part:* The child clearly pointed at the sticker on the object’s backside.

3. *Move/lean around table to Experimenter 1’s side to see the part:* The child walked around the table 90° to his or her right (or clearly leaned his or her head/body around the table to this side); that is, the child took Experimenter 1’s perspective and then clearly looked at the object’s backside from this position. If the child walked around to this side but then went on or did not look at the toy at least once from this position, this response was not coded.

4. *Take and check object:* The child took the object and clearly inspected it for something particular, including the side containing the sticker.

5. *Attend to other parts:* The child attended to a part of the object other than the target part (sticker) by either naming or pointing at it or inspecting it closely.¹

Searching looks. These were coded if the child either looked around the room or near the toy with several shifts in gaze direction. The difference between this and the part-directed actions was that no part of the object was targeted. Instead, children seemed to look for something other than the toy.

The following list of actions constituted the category of object-directed actions, which we expected to occur more often in the object new condition than in the object familiar condition.

Object-directed actions.

1. *Name the object:* The child uttered a word that described the toy as a whole.

2. *Point at the object:* A point to the whole toy was defined as a point in the direction of the toy with no orientation to a specific part. Thus, if a child pointed from

¹These “other-part actions” were included because they were clear references to specific parts, not the object as a whole. Even though these were references to parts other than the target part (the sticker), they were attempts to localize something specific on the toy. Our primary interest was whether children would assume different attentional foci depending on the condition and not whether the children’s final assumptions were correct or incorrect.

some distance toward the toy so that no specific part was in the line of his or her point, then a “point to whole toy” was coded.

3. *Share the object*: The child manipulated the object while alternating gaze with Experimenter 1. This included repeating the actions that had been done during the play phase and handing the object over to Experimenter 1.

For each trial, the first relevant response was coded. Mean proportions were calculated because a few trials could not be completed or were excluded from the analysis due to children’s fussiness or experimenter error.

To assess interrater reliability, all 50 children were recoded by an independent second rater who was unaware of the hypotheses of the experiment. Excellent levels of reliability were obtained. For the part-directed actions and the searching looks, the raters agreed in 97% ($\kappa = .93$) and 95% ($\kappa = .85$) of trials, respectively. For the object-directed actions, agreement was achieved in 97% of the trials ($\kappa = .82$).

Results

Preliminary analyses revealed that order of conditions had no significant effect on any of the three dependent variables (part-directed actions, searching looks, and object-directed actions), so this factor was disregarded.

For the part-directed actions and the searching looks, we conducted a doubly multivariate analysis of variance (MANOVA) for repeated measures, with age as between-participant factor and condition as repeated measure. This procedure allows testing for possible effects on two related variables simultaneously. For the object-directed actions, a two-way analysis of variance (ANOVA) with age as between-participant factor and condition as repeated measure was conducted. Figure 2 presents the mean proportions of part-directed actions, searching looks, and object-directed actions for the 18-month-olds (2a) and the 24-month-olds (2b) for the two conditions separately.

For the part-directed actions and searching looks, there was no significant age effect, $F(2, 47) = 0.87, p = .42$, and no significant interaction between age and condition, $F(2, 47) = 0.26, p = .78$. As we predicted, children showed more of these actions in the object familiar condition than in the object new condition, as indicated by a significant condition effect, $F(2, 47) = 13.20, p < .001$. Eighteen-month-olds showed part-directed actions in a proportion of .29 ($SE = .05$) of the trials in the object familiar condition and in .21 ($SE = .06$) of the trials in the object new condition. For the 24-month-olds, these numbers were .36 ($SE = .07$) and .27 ($SE = .06$), respectively. Similarly, 18-month-olds used searching looks in a proportion of .34 ($SE = .07$) of the trials in the object familiar condition and in .15 ($SE = .05$) of the trials in the object new condition. For the 24-month-olds, the numbers were .29 ($SE = .08$) and .04 ($SE = .02$), respectively. Individually, 23 of the 18-month-olds

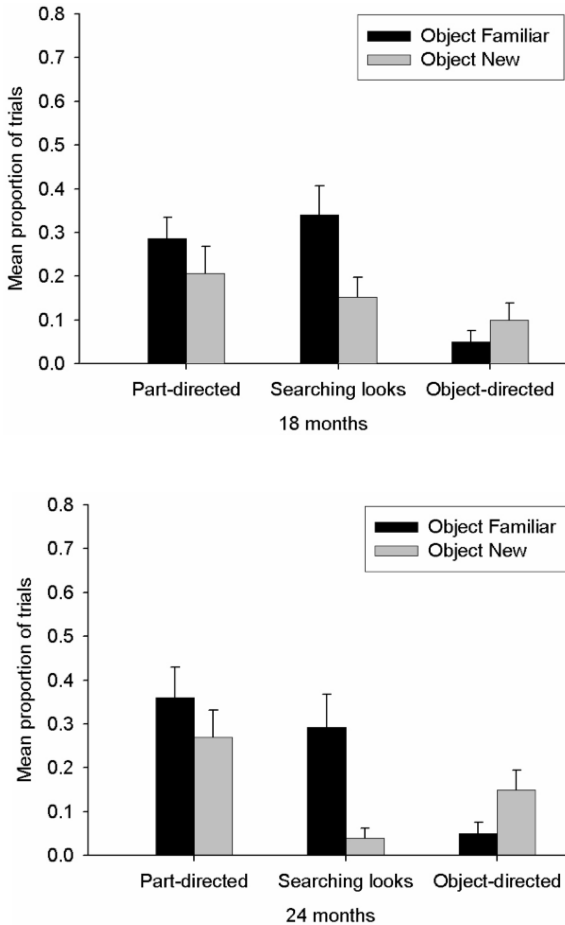


FIGURE 2 Mean proportions (+SE) of part-directed actions, searching looks, and object-directed actions as a function of condition (a) for the 18-month-olds and (b) for the 24-month-olds in Study 1.

(92%), and 22 of the 24-month-olds (88%) showed a part-directed action or a searching look in at least one of the object familiar trials.

The significant condition effect of the MANOVA allowed us to conduct two univariate ANOVAs for the part-directed actions and the searching looks, separately. Thus, a univariate ANOVA was conducted with only the part-directed actions as the dependent measure. There was a marginally significant effect of condition, with children producing more part-directed actions in the object familiar condition than in the object new condition, $F(1, 48) = 3.96, p = .052$. The factor

age, $F(1, 48) = 0.83, p = .37$, as well as the interaction, $F(1, 48) = 0.02, p = .88$, remained nonsignificant. In addition, a separate univariate ANOVA with only searching looks as the dependent variable was conducted. As indicated by a significant effect of condition, children showed more searching looks in the object familiar condition than in the object new condition, $F(1, 48) = 20.02, p < .001$. Again, the factor age, $F(1, 48) = 1.63, p = .21$, and the interaction, $F(1, 48) = 0.46, p = .50$, were not significant.

As expected, there was a significant main effect for condition, $F(1, 48) = 5.94, p = .019$, revealing that children displayed more object-directed actions in the object new condition than in the object familiar condition. The 18-month-olds showed object-directed actions in a proportion of .05 ($SE = .03$) of the trials in the object familiar condition and in .10 ($SE = .04$) of the trials in the object new condition. For the 24-month-olds, the numbers were also .05 ($SE = .03$) and .15 ($SE = .05$), respectively. Because of low mean proportions (see Figure 2a and 2b), we looked at effect sizes using Cohen's (1977) measure. We observed a small effect size for the 18-month-olds ($d = .33$) and a medium effect size for the 24-month-olds ($d = .55$). There was no significant main effect for age, $F(1, 48) = 0.63, p = .43$, and no significant interaction between the factors age and condition, $F(1, 48) = 0.55, p = .46$.

Discussion

The results of this study show that both 18- and 24-month-olds distinguished whether a person was attending to an object as a whole or to a certain part of it depending on this person's prior experience. More concretely, children showed more actions directed at something other than the whole object when an experimenter reacted excitedly while looking at a toy that she had interacted with before than when she had had no experience with the toy and saw it for the first time. On the contrary, when the object was new to the experimenter, children referred more to the object as a whole than when the experimenter knew the toy from previous experience. The results thus add to existing evidence that children in this age range can take into account another person's past experience to determine (Tomasello & Haberl, 2003) or influence (O'Neill, 1996) his or her attentional focus in pragmatically appropriate ways. This study shows that children this age know that people usually do not get excited about the same thing over again, and therefore that when a person seemingly gets excited about something he or she is already well familiar with, then the person may really be attending to something different. They would thus seem to be reasoning by exclusion in the sense that they have concluded that the adult cannot be focused on the object as a whole because it is old news.

The main purpose of this study was to investigate whether children this age would assume different attentional foci depending on an adult's past experience. How precisely they can actually identify that focus was of secondary concern to us. Of interest, the children were not very precise in their attempts to identify the target

in the object familiar condition. For instance, only approximately 21% of the part-directed actions were clear references to the sticker. But the sticker was simply one likely candidate: a potentially interesting item located in the experimenter's direct line of sight. The children did not even completely consider the possibility that the experimenter attended to any part of the toy, as indicated by the fact that the difference between conditions for the part-directed actions reached only marginal significance. Rather, they mostly looked around the room—presumably for another object. This is a surprising finding because Experimenter 1 clearly oriented and gazed toward the target toy, and no other toys were located nearby that could have easily led to a misinterpretation of Experimenter 1's gaze direction. On the other hand, this behavior fits well with the idea that children have a whole object bias (for an overview, see Markman, 1992)—an issue to which we return in the General Discussion section.

Supporting this interpretation, children in both age groups showed significantly more object-directed actions, such as naming or pointing at the toy or handing it to Experimenter 1, in the object new condition than in the object familiar condition. This indicates that the children understood that in this condition, what the experimenter attended to was the object as a whole, and as a consequence, the children also started engaging with the object as a whole more than in the other condition.

The results of this study therefore suggest that 18- and 24-month-old children are able to determine when objects are new and when objects are familiar for an adult, thus supporting the findings of Tomasello and Haberl (2003) using a different experimental method and response measure involving just a single toy. In addition, the results presented here suggest that 18- and 24-month-old children also operate with some kind of whole object bias and use this to reason by exclusion about what object an adult might be focused on.

STUDY 2

The aim of the second study was simply to see if 14-month-old infants behave in the same way as the older infants in this same experimental procedure. To adapt the task to infants this young, however, a few methodological changes had to be made.

Method

Participants. Participants were 30 infants (14 boys, 16 girls) 14 months of age ($M = 13;28$, range = 13;17–14;14). Five additional infants were dropped from the study because they were uncooperative (3) or because of experimenter error (2). Infants were recruited from the same database as participants in Study 1.

Materials, design, and procedure. Several changes were made to Study 1. First, the doll was no longer used because some children got attached to it in a way that seemed to influence their responses. For example, some children were looking for “grandpa” during the response phase or became distracted from the task when the doll was taken away. The experimenters simply manipulated the toys with their hands, in a fashion similar to the way they did with the doll in Study 1. Second, the toys were slightly changed, such that they no longer had any openings at the front side, such as doors. This was because some of the toys used in Study 1 had doors or windows and we noticed that children sometimes looked inside these openings instead of looking at the sticker. Thus, the toys in this study were quasi-novel toys with parts to manipulate but no doors or the like on their front side, and, as in Study 1, only a little sticker on their backside. Finally, as another improvement, the box from which the toys were retrieved was no longer used. This was done to clear the area near the target object from any distractors that might be misinterpreted by the infants as the target of Experimenter 1’s attention. Instead, the toys were brought out from a drawer of a cabinet located behind Experimenter 2. The order of toys was determined by a Latin square design such that, across all infants, each toy appeared equally often in both conditions.

The procedure also was slightly modified to adjust the task demands to the younger age group. First, to ensure that infants paid attention to Experimenter 1 in the crucial moment when she expressed excitement toward the toy, Experimenter 2 pointed to Experimenter 1 for the infant, saying, “Look, [*name of Experimenter 1*]!” when Experimenter 1 returned. Infants’ attention was thus drawn to Experimenter 1 at the beginning of the response phase, immediately before Experimenter 1 started reacting toward the toy. Second, when gazing at the object, Experimenter 1’s eyes were level with the infants’. Instead of simply leaning forward, in this study Experimenter 1 knelt down in front of the toy at a distance of approximately 50 cm, such that her eyes were approximately on the same level as the infants’ to make it easier for infants to identify Experimenter 1’s gaze direction. Third, we increased both the intensity of Experimenter 1’s excitement in her voice and the number of utterances in which she expressed excitement. On every trial, she repeated variations of the sentence, “Oh, great, look!” a total of four times, making eye contact with the infant twice. During the first of these two eye contacts, Experimenter 1 also called infants by name to keep them attending. Finally, the duration of the play with each object was reduced from 70 to 50 sec to adjust it to the attention span of infants of this age.

Coding and reliability. The first author, who was unaware of the condition, coded all trials. Basically, the same coding criteria were applied as in Study 1. However, some of the action types coded in that study were not displayed by the 14-month-olds in this sample. The only kind of object-directed actions scored in this study were object manipulations and some instances of pointing near the ob-

ject. However, it was impossible to code these points reliably: It was often unclear exactly where infants were pointing. The only actions *not* directed at the whole object shown by any infants were searching looks, directed either around the object or around the room. Therefore, the target actions that we focused on in this study were only searching looks and object manipulations.

To assess interrater reliability, 7 infants (23%) were coded by an independent research assistant, who was also unaware of the condition. For the searching looks, both raters agreed in their judgments in 88% of the trials ($\kappa = .72$). For the object manipulations, the raters agreed on 98% of the trials ($\kappa = .95$).

Results

Figure 3 presents the mean proportions of searching looks and object manipulations for each of the two conditions. As in Study 1, the two different types of responses were analyzed separately. As expected, infants showed a significantly higher proportion of trials with searching looks in the object familiar condition ($M = .32, SE = .07$) than in the object new condition ($M = .12, SE = .04$), $t(29) = 2.58, p < .01$, one-tailed. Fifteen of the 30 infants (50%) displayed searching looks at least once in the object familiar condition. Of these searching looks, 73% were not directed at the object but elsewhere in the room, with the remaining 27% directed around the object itself. Infants had a tendency to manipulate the target toy in a higher proportion of trials in the object new condition ($M = .48, SE = .08$) than in the object familiar condition ($M = .35, SE = .06$), $t(29) = 1.65, p = .055$, one-tailed.

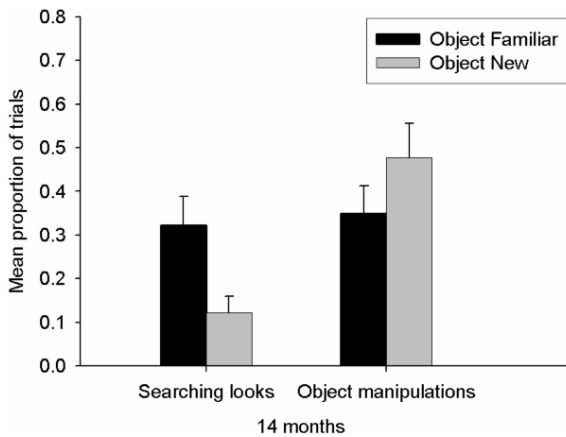


FIGURE 3 Mean proportions (+ SE) of searching looks and object manipulations as a function of condition for the 14-month-olds in Study 2.

Manipulation check. It thus appears as though 14-month-olds, too, distinguished whether the adult was attending to the whole object or to something else based on the adult's familiarity with the object. However, there is a possible alternative explanation that could account for these results that does not involve any understanding of other people's past experiences. Even though experimenters acted according to a predefined script and were trained to act similarly to each other and to be consistent across trials, it is conceivable that infants were inadvertently provided with differential cues in the two conditions. For example, experimenters might have played more enthusiastically in one condition than in the other during the play period, and thus might have directed the infants' attention differently to the toy. This is a justified concern because infants played with different experimenters in the two conditions (Experimenter 1 in the object familiar condition, Experimenter 2 in the object new condition), and, despite having been trained to use the same script while playing, different experimenters might have different modes of expression. Or, in the response period, Experimenter 1 might have accidentally expressed more enthusiasm or excitement in one condition than the other, thus selectively drawing infants' attention to the toy in a different way. This is plausible because Experimenter 1, of course, could not be unaware of the condition. We thus investigated for differential experimenter behaviors in both the play and the response periods. An independent coder who was ignorant with regard to the purpose of the experiment rated the experimenters' level of enthusiasm on a 5-point Likert scale ranging from 1 (*not enthusiastic*) to 5 (*extremely enthusiastic*) for a sample of 8 infants (27% of the total sample). The subsample was matched with regard to order of conditions but was randomly chosen otherwise. The coder rated Experimenter 1 and Experimenter 2's level of enthusiasm in the play period as well as Experimenter 1's level of enthusiasm in the response phase, when Experimenter 1 exclaimed excitedly while looking at the toy. The coder's judgments were based on a holistic impression including facial and vocal parameters. The means for enthusiasm in the play period were identical in the two conditions ($M = 3.08$ in both conditions, $t(23) = 0$, $p = 1$), and so were the means for enthusiasm in the response phase (again, $M = 3.08$ in both conditions, $t(23) = 0$, $p = 1$). Thus, neither in the familiarization nor in the response period did experimenters provide differential cues in terms of different levels of enthusiasm.

Another possible alternative explanation involves not the experimenters but the children. Perhaps for some reason children allotted their attention differently in the two conditions during the play period. To investigate for differences in children's attention to the toy between the two conditions, the same independent rater coded the same sample for children's attention to the toy. Specifically, she determined for each trial the percentage of time during which infants visually attended to the toy. The results showed that infants visually attended to the toy equally across the two conditions, $t(22) = .11$, $p = .91$. On average, infants attended to the object on 82%

of the trial in the object familiar condition and on 81.5% of the trial in the object new condition.

A further possible alternative explanation involves infants' searching looks. In the object familiar condition, immediately before Experimenter 1 started reacting toward the toy, she stood for a moment near the light switch next to the door. Perhaps infants' attention was drawn to this area and this could explain the finding of increased searching looks in this condition. To investigate for this possibility, the same independent rater again coded the same sample of infants and determined for the response phase of every trial the duration with which infants fixated on the area near the light switch, where the experimenter had been standing just previously in the object familiar (but not the object new) condition. The result was that per trial, infants fixated on this area on average for 0.3 and 0.4 sec in the object new condition and the object familiar condition, respectively. This difference was not significant, $t(23) = .43, p = .67$. Only on three trials did we find a substantial fixation (for 2 sec or more) on the area near the light switch (two trials in the object familiar condition and one trial in the object new condition), but in none of these trials was a searching look coded. Thus, it is unlikely that our findings could be explained by infants' curiosity about a certain area in the room being raised in one condition but not the other.

Discussion

Infants of only 14 months of age, like the older infants from Study 1, acted differently when they saw an adult attending to an object with excitement depending on whether this adult had previously experienced the object. More concretely, the infants in this study searched significantly more often for another referent for the experimenter's excitement when she had previously experienced the toy than when she had not experienced it. The infants seemed to be puzzled by the strange behavior of the experimenter in this condition, and they were trying to make sense of it. Just like the older children in Study 1, the 14-month-olds looked primarily for other possible whole object referents rather than for different parts of the target object itself in this condition. When they looked, they did so on average in more than two thirds of the cases for a different object somewhere near the target toy or even relatively far away from it.

In contrast, infants tended to manipulate the object more often when it was new for the experimenter than when it was familiar for her. This differential behavior indicates that they perceived her excitement as referring to the toy as a whole in this condition. Possible alternative explanations involving the experimenter's behavior and the children's differential attention to the toy were not supported. And so even these infants, many of whom were prelinguistic, also seemed to be operating with something like a whole object bias and used this to reason by exclusion about what object the adult might be focused on.

GENERAL DISCUSSION

In the studies presented here, children from 14 to 24 months of age clearly knew when an object was familiar or unfamiliar for an adult, and thus, at some level, what she was attending to when expressing excitement toward a toy. When the adult looked at and vocalized to the target object excitedly when it was new for her, children acted on the object as a whole. But when they had previously witnessed the adult interacting with the target object, the children made attempts to localize something different, either something specific on the object or another object nearby. These children thus assumed different attentional foci between the conditions even though the person was behaving in the same way and looking at the exact same spot in both conditions.

In these studies, we replicated the findings of Tomasello and Haberl (2003) using a different response measure (looking and acting on an object instead of handing an object over), and we extended their findings to situations in which the adult is attending to two different things within the same object (instead of attending to just one out of several objects). Infants not only know something about what others see, or have visual access to; they also know something about what people attend to selectively within their visual fields. In these two studies this knowledge is based on which referents, or which parts of referents, are exciting and interesting because they are experientially new for the adult—a key skill in learning to communicate in pragmatically appropriate ways. In addition, Moll and Tomasello (2005) also replicated Tomasello and Haberl's (2003) findings in an extension aimed at determining precisely what kinds of interactions with objects adults must engage in before infants know that those objects have become familiar for the adult. It thus seems, contrary to general beliefs in the field, that 1-year-old infants know what others “know,” in the specific sense that they know which entities another person has or has not experienced previously. In addition to their understanding of this type of knowledge and ignorance in others, they also know how this influences other people's attentional focus in some situations.

Of interest, one can look at this task as a perceptual analog to the Gergely et al. (2002) rational imitation procedure. In that procedure, infants assumed that when an adult used her head to illuminate a light even though she could have used her hand, the adult must have had a reason for her unusual action, and so they copied the unusual action. In the studies presented here, too, to be successful children apparently assumed that when the adult reacted excitedly toward an object she was familiar with, there must be a reason—something they had not previously noticed—and so they searched for it. The difference in this case, then, is that the underlying reason in this study is more mental than physical. The important point is that in both studies the children seemed to understand something about how people's actions are influenced by reasons, potentially based on a wide variety of factors both in that person's history and in the environmental sit-

uation. Human infants are apparently good at both of these by around 14 months of age.

Infants can also use some other cues to infer others' attentional focus. For example, in word-learning contexts, 18-month-old infants have shown an ability to discern an adult's attentional focus based on knowledge of her goal in the context of a finding game. Specifically, Tomasello, Strosberg, and Akhtar (1996) found that 18-month-old infants initially inferred from an adult's searching actions which one of several objects she was seeking, and then later when she asked for it ambiguously while facing several candidate objects, the infant knew which one she was attending to and wanted. There are thus several kinds of social-pragmatic cues in addition to excitement combined with newness, such as goal-directed searching, that help infants solve the problem of reference under ambiguous conditions. Children thus use, among other things, adults' goals and experiences to figure out what the adults are referring to, even in nonlinguistic situations.

The results presented here also provide evidence for how 14- to 24-month-old children use their knowledge of what is new and old for others in their social reasoning. Most important, and surprising for us, children in the object familiar condition did not reliably assume that the adult was focused on the target part of the key object, even though this was the natural assumption from an adult's point of view, because the experimenter was bending down and clearly focused on the object. Instead, their most common response was to look around the room for another object (although they sometimes looked to parts of the target object as well). In the word-learning theory of Markman (1992), when children experience an adult using a novel word, their assumptions are that it refers to (a) something they do not yet know a word for (mutual exclusivity), and to (b) a whole object (whole object bias). So when they hear an adult use a novel word for a familiar object whose name they already know, this sets up the inference that the novel word must refer to a different object.

Something very similar occurred in our study, and indeed this study is very similar to Study 3 of Markman, Wasow, and Hansen (2003) with 15- to 18-month-olds. In that study, a single, highly familiar object was placed on a table by a single experimenter, who then subsequently talked about it with either (a) its familiar name (e.g., "spoon"), or (b) a novel name (e.g., "toma"). Assuming that infants knew that this highly familiar object is conventionally called a spoon, when they heard it being called a "toma" they should have been puzzled and looked around the room for some other object that might be the intended referent; that is, they should have employed the mutual exclusivity assumption for naming. And indeed this is what they did, apparently operating not only with a kind of exclusion reasoning but also with a whole object bias, as they appeared to be searching for another object and not for a certain feature or part of the only object nearby.

From the point of view of language acquisition, the nonlinguistic and linguistic versions of *exclusion reasoning* in these tasks tap into some common principles in

the pragmatics and the semantics of language, respectively. In our nonlinguistic version, 1-year-old children have shared experience with the adult about an object, and on the basis of this they know that the object is not new for the adult and so she is not likely to be excited about it in the current context. This is pragmatic knowledge in the sense that it is an assessment of what the partner knows and does not know in the current context. In Markman et al.'s (2003) linguistic version, 1-year-old children knew some object label conventionally (a kind of generalized sharing), and on the basis of this knew that the label is the one the experimenter could be expected to know and use for the same referent as well. This is semantic knowledge in the sense that it consists of linguistic conventions that apply generally across contexts, mostly independently of the particular knowledge and experience of particular listeners on particular occasions. The fact that 1-year-old infants understand both forms of sharing—nonconventional and conventional—and use them in exclusion reasoning of different kinds is both surprising and impressive.

Overall, the results presented here add to a growing body of results suggesting that 12- to 18-month-old infants possess a much more sophisticated set of social-cognitive skills and knowledge than previously suspected. It is unlikely that they understand abstract mental states such as beliefs. But even before they have made it very far in the acquisition of language, infants understand that others have goals and intentions (e.g., Behne, Carpenter, Call, & Tomasello, 2005; Csibra, Gergely, Bíró, Koós, & Brockbank, 1999; Gergely et al., 2002), that others like and dislike things (Repacholi & Gopnik, 1997), that others see things (e.g., Moll & Tomasello, 2004), and even that others know—in the sense of “are familiar with”—things (Tomasello & Haberl, 2003; this study, pp. 413). They then use this understanding on particular occasions to help them to discern what other people are doing and, to some degree, why they are doing it.

ACKNOWLEDGMENTS

This research project was supported by a Grant (#xxx) from the Studienstiftung des Deutschen Volkes. We thank Eva Leermann, Angela Loose, and Jennifer Kittel for assistance in data collection. Finally, we are grateful to the infants and parents who participated in this study.

REFERENCES

- Akhtar, N. (2002). Relevance and early word learning. *Journal of Child Language*, 29, 677–686.
- Akhtar, N., Carpenter, M., & Tomasello, M. (1996). The role of discourse novelty in early word learning. *Child Development*, 67(2), 635–645.

- Baker, N. D., & Greenfield, P. M. (1988). The development of new and old information in young children's early language. *Language Sciences, 10*, 3–34.
- Behne, T., Carpenter, M., Call, J., & Tomasello, M. (2005). Unwilling versus unable: Infants' understanding of intentional action. *Developmental Psychology, 41*(2), 328–337.
- Brooks, R., & Meltzoff, A. N. (2002). The importance of eyes: How infants interpret adult looking behavior. *Developmental Psychology, 38*(6), 958–966.
- Butler, S. C., Caron, A. J., & Brooks, R. (2000). Infant understanding of the referential nature of looking. *Journal of Cognition and Development, 1*(4), 359–377.
- Caron, A. J., Butler, S. C., & Brooks, R. (2002). Gaze following at 12 and 14 months: Do the eyes matter? *British Journal of Developmental Psychology, 20*, 225–239.
- Caron, A. J., Kiel, E. J., Dayton, M., & Butler, S. C. (2002). Comprehension of the referential intent of looking and pointing between 12 and 15 months. *Journal of Cognition and Development, 3*(4), 445–464.
- Cohen, J. (1977). *Statistical power analysis for the behavioral sciences* (Rev. ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Csibra, G., Gergely, G., Bíró, S., Koós, O., & Brockbank M. (1999) Goal attribution without agency cues: The perception of 'pure reason' in infancy. *Cognition, 72*, 237–267.
- Deák, G. O., Flom, R. A., & Pick, A. D. (2000). Effects of gesture and target on 12- and 18-month-olds' joint visual attention to objects in front of or behind them. *Developmental Psychology, 36*(4), 511–523.
- Dunphy-Lelii, S., & Wellman, H. M. (2004). Infants' understanding of occlusion of others' line-of-sight: Implications for an emerging theory of mind. *European Journal of Developmental Psychology, 1*(1), 49–66.
- Gergely, G., Bekkering, H., & Kiraly, I. (2002). Rational imitation in preverbal infants. *Nature, 415*(6873), 755.
- Gergely, G., & Csibra, G. (2003). Teleological reasoning in infancy: The naive theory of rational action. *Trends in Cognitive Sciences, 7*(7), 287–292.
- Greenfield, P. M., & Zukow, P. G. (1978). Why do children say what they say when they say it? An experimental approach to the psychogenesis of presupposition. In K. Nelson (Ed.), *Children's language* (Vol. 1, (pp. xx-xx). New York: Gardner.
- Markman, E. M. (1991). The whole-object, taxonomic, and mutual exclusivity assumptions as initial constraints on word meanings. In S. A. Gelman & J. P. Byrnes (Eds.), *Perspectives on language and thought: Interrelations in development* (pp. 72–106). New York: Cambridge University Press.
- Markman, E. M. (1992). Constraints on word learning: Speculations about their nature, origins, and domain specificity. In M. R. Gunnar & M. Maratsos (Eds.), *Modularity and constraints in language and cognition. The Minnesota Symposia on Child Psychology* (pp. 59–102). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meaning of words. *Cognitive Psychology, 20*, 121–157.
- Markman, E. M., Wasow, J. L., & Hansen, M. B. (2003). Use of the mutual exclusivity assumption by young word learners. *Cognitive Psychology, 47*, 241–275.
- Moll, H., & Tomasello, M. (2004). 12- and 18-month-old infants follow gaze to spaces behind barriers. *Developmental Science, 7*(1), F1–F9.
- Moll, H., & Tomasello, M. (2005). How 14- and 18-month-olds know what's new for others: Joint and individual engagement with objects. Manuscript submitted for publication.
- O'Neill, D. K. (1996). Two-year-old children's sensitivity to a parent's knowledge state, missing info. ??vol, issue, xx-xx??.
- O'Neill, D. K., & Happé, F. G. E. (2000). Noticing and commenting on what's new: Differences and similarities among 22-month-old typically developing children, children with Down syndrome and children with autism. *Developmental Science, 3*(4), 457–478.

- Repacholi, B., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology*, 33(1), 12–21.
- Soja, N. N., Carey, S., & Spelke, E. S. (1991). Ontological categories guide young children's inductions of word meaning: Object terms and substance terms. *Cognition*, 38(2), 179–211.
- Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.
- Tomasello, M., & Akhtar, N. (1995). Two-year-olds use pragmatic cues to differentiate reference to objects and actions. *Cognitive Development*, 10(2), 201–224.
- Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (in press). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences*, vol #, pp. XX–XX?
- Tomasello, M., & Haberl, K. (2003). Understanding attention: 12- and 18-month-olds know what's new for other persons. *Developmental Psychology*, 39, 906–912.
- Tomasello, M., Strosberg, R., & Akhtar, N. (1996). Eighteen-month-old children learn words in non-ostensive contexts. *Journal of Child Language*, 23(1), 157–176.