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How 14- and 18-Month-Olds Know What Others Have Experienced

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Fourteen- and 18-month-old infants observed an adult experiencing each of 2 objects (experienced objects) and then leaving the room; the infant then played with a 3rd object while the adult was gone (unexperienced object). The adult interacted with the 2 experienced objects in 1 of 3 ways: by (a) sharing them with the infant in an episode of joint engagement, (b) actively manipulating and inspecting them on his or her own as the infant watched (individual engagement), or (c) looking at them from a distance as the infant played with them (onlooking). As evidenced in a selection task, infants of both ages knew which objects had been experienced by the adult in the joint engagement condition, only the 18-month-olds knew this in the individual engagement condition, and infants at neither age knew this in the onlooking condition. These results suggest that infants are 1st able to determine what adults know (have experienced) on the basis of their direct, triadic engagements with them.

Keywords: social cognition, joint attention, joint engagement, knowledge–ignorance

Recent research has established that infants know much more than previously supposed about other persons. Much of this research has focused on what infants understand about goal-directed action (e.g., Gergely, Bekkering, & Király, 2002; Woodward, 1998, 2003). A related question is what infants understand about the perception, attention, and even knowledge of others.

Research on what children understand about what other persons see and know has mostly focused on preschoolers. For example, one of the best researched questions concerns children's understanding at around 3–4 years of age of others' beliefs about the world (see Wellman, Cross, & Watson, 2001, for a review). Also, children from age 2 to 4 come to understand the visual perspective of others in sophisticated ways (see Flavell, 1992, for a review). Children's understanding of whether an individual is knowledgeable or ignorant about some piece of information also develops substantially during this same developmental period (see Flavell, 1999, for a review).

Two well-known studies concern toddlers just past their second birthdays. First, O'Neill (1996) had an experimenter place a desired object in one of two opaque containers out of a child's reach. To obtain the desired object, the child had to request help from her parent. In one condition, the parent witnessed the hiding and so knew the location of the hidden object. In another condition, the parent either left the room or closed his or her eyes before the hiding and so was ignorant of the object's location. The question was whether children would communicate differently depending on the parent's knowledge state. The finding was that children at 2–2½ years gestured to their parent more in general and more specifically to the location of the object when the parent was ignorant of the object's location than when he or she was knowledgeable. (Similar results were obtained by Moore & D'Entremont, 2001, but see Dunham, Dunham, & O'Keefe, 2000, for some cautionary findings.)

Second, Akhtar, Carpenter, and Tomasello (1996) addressed a similar question using a word-learning paradigm. They had children at around their second birthday play with three toys successively with an experimenter and a parent. The parent then left the room. When the parent was gone, a fourth object was brought out, and the experimenter and the child played with it for the same duration as for the first three. Then the parent returned and looked at all four objects, arranged in a row on a shelf, and exclaimed: "Oh, a gazzer! Wow, a gazzer! Look at the gazzer!" Children inferred that the parent wanted the object that he or she was seeing now for the first time (had not experienced), even though the children themselves had had the same amount of experience with all four objects.

In a certain sense, then, toddlers know what others know—at least in the sense that they know what objects or events others have experienced a few minutes previously. The question thus arises whether infants show the same understanding. It is clear that infants know that others have some kinds of psychological relations to objects. For example, in looking time studies, infants in the middle of the 1st year understand another person's grasping actions as object or goal directed (Woodward, 1998), by 1 year of age they know which actions follow certain emotional expressions (Phillips, Wellman, & Spelke, 2002), and at around the same age they understand some things about seeing, as evidenced by the results of both looking-time and gaze-following studies (e.g., Brooks & Meltzoff, 2002; Moll & Tomasello, 2004; Woodward, 2003). But very few studies have investigated specifically what infants understand about what others know, that is, by manipulat-

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ing which objects others have and have not experienced previously.

There have been two key studies. First, using a violation-of-expectation paradigm, Onishi and Baillargeon (2005) had 15-month-old infants observe an adult either witnessing or not witnessing an object being moved from one location to another. As evidenced by their increased looking times when the actor searched in the correct location even when the actor had not witnessed the movement, infants seemed to know whether the actor did or did not witness the moving event a few moments before. Regardless of whether this study showed that infants have an understanding of false beliefs, as claimed by the authors, it certainly showed that infants have an understanding of what others have and have not perceived (Perner & Ruffman, 2005).

Second, using a nonlinguistic version of Akhtar et al.'s (1996) basic method, Tomasello and Haberl (2003) had infants of 12 and 18 months of age play with an adult and two novel toys successively. The adult left the room while the infant and an assistant played with a third toy. The first adult then returned, looked at all three toys aligned on a tray, and exclaimed excitedly, "Oh, look! Look at that one!" The adult then followed immediately with the request, "Can you give it to me?" As in Akhtar et al.'s (1996) study, to retrieve the object the adult expressed interest in, infants had to both know that people tend to be interested in new things and also to identify what in this specific situation was new for the adult (which object the adult had not experienced), even though the object was not new for them. Results showed that infants at both ages were able to identify the new object, that is, the one the adult had not experienced previously.

An important question, addressed by none of these studies, is under what conditions infants come to know what others have and have not experienced. In what way does an adult need to engage with an object so that an infant perceives that person as having experienced it?

One obvious possibility is that infants merely need to witness others observing an object in order to understand that the others have experienced it. However, there are empirical reasons to assume that this might be difficult for infants. Most importantly, there is no clear evidence that children below 2 years of age understand that others can have a current visual perspective that differs from their own (i.e., Level 1 perspective taking has not been found before 2–2½ years of age; Flavell, Shipstead, & Croft, 1978; McGuigan & Doherty, 2002; Moll & Tomasello, 2006)—raising the question of whether they know the content of what the other sees at all.

A second possibility is that infants need to perceive the other person acting on and reacting to an object in some way, for instance by manipulating, inspecting, and reacting to it verbally or emotionally, before they can understand that the person has experienced it. This is the way infants themselves explore objects and come to understand the world (Piaget, 1952), and so it is possible that they need to see another agent acting as well in order to register him or her as experiencing the object. Relevant to this hypothesis are studies with infants showing that the object directedness of grasping actions is understood several months before the object directedness of visual relations (Woodward, 1998, 2003).

A third plausible hypothesis is that infants need to be directly engaged with another person and an object simultaneously in joint engagement to register that the other person has experienced the object. Given the importance of judgments of what is given or new for the listener in linguistic communication, it might be the case that interactions analogous to the back-and-forth of conversation provide a privileged context for judging the knowledge states of others. Indeed it has been demonstrated that infants best register what adults are attending to—as measured by their acquisition of new referential words—when they are in a joint attentional interaction with the adults (e.g., Dunham, Dunham, & Curwin, 1993; Tomasello & Farrar, 1986). Theoretically, Barresi and Moore (1996) have argued that the perspective of other persons becomes especially salient when self and other are both interacting simultaneously with the same object. The theoretical proposals of Tomasello, Carpenter, Call, Behne, and Moll (2005) could also be read in this way because collaborative interactions in which adult and child form a shared focus of attention require the child to focus on the role or perspective of the partner continuously and in special ways.

One possible developmental hypothesis is the following: It may be that joint engagement is a particularly powerful way for very young infants (around 1 year, say) to learn that an adult has experienced an object. Later, possibly from around 18 months of age, infants may become able to judge another person's relation to an object on the basis of less socially infused observations. This developmental prediction is suggested by findings that by 18 months of age infants learn novel words even if they are not mutually engaged with the speaker (Floor & Akhtar, 2005) and even when they are focused on a different object from the referent when the speaker names it (Baldwin, 1993). Furthermore, Carpenter, Nagell, and Tomasello (1998) found that the positive effect of joint attentional interactions on language development decreases after about 15 months of age.

To test this developmental hypothesis, we used the basic paradigm of Tomasello and Haberl (2003). An infant observed an adult experiencing each of two objects (experienced objects) and then leaving the room while the infant played with a third object (unexperienced object) along with an assistant. The adult experienced the first two objects in one of three different ways. The first was a situation of *joint engagement* in which infant and adult played with an object together (joint engagement condition), very similar to the experimental condition of Tomasello & Haberl (2003). The second was a situation of *individual engagement* in which the infant observed the adult actively manipulating, inspecting, and reacting to an object by herself (individual engagement condition). The third was a situation of *onlooking* in which the infant observed the adult simply observing an object as the infant played with it (onlooking condition).

We tested 18-month-olds (Study 1) and 14-month-olds (Study 2) in these three conditions, using as a dependent measure the object they selected when the adult returned to the room and said, excitedly, "Oh, look! Look at that! Can you give it to me?"—presumably asking for the one introduced while she (all experimenters in these studies were women) was gone. Our prediction was that the joint engagement condition would enable infants of both age groups to determine that the first two objects had been experienced by the adult, thus making the unexperienced one stand out as the target of the adult's excitement. In the individual engagement condition we predicted success only for the 18-month-olds, who, in language studies, have seemed less dependent on joint attentional interactions to determine an adult's referential

intentions. We did not expect infants of either age to know that the adult had experienced an object only by observing the adult observing it in an uninvolved manner (i.e., in the onlooking condition).

Study 1

Method

Participants. Participants were obtained from a database of parents from a middle-sized German city who had volunteered for studies of child development. Participants were 84 German-speaking infants (38 boys and 46 girls) of 18 months of age (M = 17.29, range = 17.03–18.28). An additional 37 infants were excluded or failed to complete the study because they failed the pretest criterion (15); showed no clear response in the test, that is, either did not make a choice at all or handed over two or three toys simultaneously (9); were uncooperative (9); or because of experimenter error (4).

Materials and design. In the pretest (see below) three familiar toys were used: a ball, a teddy bear, and a toy car. In the experimental procedure three modified unusual objects were used: a gardening utensil, a birdcage item, and a slide rule. All objects were easily distinguishable by color and shape and were about the same size. They all made a special sound when being manipulated in a certain way. A previously conducted preference test showed that the infants had no significant preferences among these objects.

Each infant was randomly assigned to one of three conditions, yielding 28 infants in each condition (mean age in each condition: joint engagement = 18.05, individual engagement = 17.29, onlooking = 17.24). One of the three novel toys was designated to be the target for a given infant on the basis of a counterbalanced schedule. The target's position in the tray (left, middle, or right) was also counterbalanced. Each infant received only a single experimental trial. Sessions were conducted in German (with the English glosses below being rough translations—exact scripts may be obtained upon request).

Procedure. Participants visited a child laboratory with a parent for one session of approximately 15–20 min. Prior to the study, the experimenters (E1 and E2) played with each infant in a playroom until he or she was comfortable with the situation. The experiment took place in a testing room (4.30 × 4.30 m) with the infant, the parent, and the two experimenters sitting at a square table. The infant was seated on the parent's lap and sat 90° to E2 and 180° to E1. A pretest was conducted in order for us to see whether infants generally understood the question that would be asked of them in the final test. In this pretest, the experimenters and the infant played with the ball, the teddy bear, and the toy car (always in this order), one at a time for 50 s. Then E2 placed the toys in a tray (randomizing the positions) and held it straight in front of the infant. E1 then asked the infant to hand her the toys successively by name, looking at the infant only (thus avoiding any gaze cues). A previous pilot test had demonstrated that infants of this age generally knew the names for these objects. In order to pass the pretest, participants had to select correctly (without needing to be corrected) at least one of the first two requested toys and hand it to E1. If infants did not hand the requested toy over to the experimenter in either the first or the second request, they were excluded from the final test.

At this point the experimental procedure began. In all three conditions, infants played with the three novel toys one at a time with one of the two experimenters (depending on condition), with the target object coming last. Play with each toy followed a standardized script, which was identical across conditions, toys, and experimenters. The parent never engaged in the interaction. The experimenter demonstrated how to manipulate the object such that it would make a certain sound. The infant and the experimenter then took turns manipulating it. During this time, the experimenter commented on both the object and the play in a very general fashion, saying, "Look what you can do with this!" and "That's nice!" as she emoted positively. The three conditions differed in the first part of the procedure in the following way (the final part was the same for all; see below):

In the joint engagement condition, E2 brought out the first toy and handed it to E1, saying, "Look, what I've got here!" Then, E1 and the infant played with this toy together for 60 s. The joint engagement took place solely between E1 and the infant, who sat opposite from one another at the table. After the 60 s, E2 took the toy and placed it on the tray, saying, "I'll put this here!" She then brought out the second toy, and the same procedure was then repeated for this toy.

In the individual engagement condition, immediately after the pretest was finished, E1 exclaimed, "I'm going over there!," pointing near the camera for the infant, making sure that he or she noticed her going over there. E1 stood up and went over to the camera, which was located next to the door. When the infant looked up from the table, he or she could see E1 in front of her at a distance of about 2 m. E2 retrieved the first toy, saying, "Look, what I have got here!," brought it to E1, and returned to her seat at the table immediately. E1 then manipulated the toy for 30 s, commenting on it and emoting about it. While doing this, she never looked at the infant but was entirely focused on the object. The infant watched E1 investigating the toy. If the infant stopped watching her, E2 said, "Look!," pointing to E1 to keep the infant attending to this event. After the 30 s, E2 came, took the toy from E1, and returned with it to the table. E2 and the infant then played with the toy for another 30 s. During this time, E1 remained at the camera, not following the others' interaction but focusing on the camera. After the 30 s, E2 placed the toy on the tray, took out the second object, and brought it to E1 again, who was still standing near the camera. The same procedure was repeated for the second toy.

In the onlooking condition, just as in the individual engagement condition, E1 went to the camera immediately after the pretest, exclaiming, "I'm going over there!" and pointing for the infant. She stood next to the door, oriented toward the table and the infant, at a distance of about 2 m. E2 pointed to E1 for the infant and explained to him or her, "E1 is over there. She can see us," and finally, "We'll keep playing!" E2 and the infant played with the first toy in a joint engagement for 60 s. While they shared the toy, E1 looked on the table and fixated the toy. She never established eye contact either with E2 or with the infant. As in the other conditions, the procedure was repeated for the second toy. Table 1 schematically depicts the procedures from the first experimenter's point of view in the three conditions.

In all three conditions, the final procedure with the third toy was identical. After the play with the second toy was finished and E2 had placed it on the tray, E1 announced, "I am going outside now.

Table 1
E1's Actions as a Function of Condition and Temporal Position of Toy

Condition	Toy 1	Toy 2	Toy 3
Joint engagement	share	share	leave
Individual engagement	manipulate	manipulate	leave
Onlooking	onlook	onlook	leave

Note. E1 = Experimenter 1.

Bye-Bye!" and left the room emphatically. After her leaving, E2 pointed to the door, saying to the infant: "E1 is outside. She cannot see us. We'll keep playing!" She then brought out the third toy, which was the target toy, and she and the infant played with it for 60 s, following the script. After the 60 s, E2 put the third toy on the tray next to the other two (at the previously determined position), saying, "I'll put this here," as she had done for the other two. At this point, E1 returned to the room, at which point E2 picked up the tray and held it straight in front of the infant, with all objects equidistant from her. From a distance of approximately 2 m, E1 looked at the tray and exclaimed in a tone of excitement: "Oh, look! Look there! Look at that there!," pointing in the rough direction of the tray with the whole arm. She then added "Give it to me, please!" approaching the table and holding out her hand toward the middle of the tray. She repeated her request up to five times if necessary, looking in the infant's face only now that she stood close to the objects.

Coding and reliability. The primary experimenter judged which toy the infant handed over live, recording it on a score sheet immediately after the infant's choice. To assess interrater reliability, a research assistant, unaware of condition, coded 18 infants of the final sample from the video material (21%, 6 infants from each condition). Agreement between the two raters was 100%, for a Cohen's kappa of 1.

Results

Figure 1 presents the number of infants who chose the target toy in each condition. When we compared each of the conditions with chance using the binomial procedure, we found that more infants than expected by chance (.33) handed over the target object in both the joint engagement condition, $p = .046$, and the individual engagement condition, $p = .02$ (both one-tailed). This was not true of the onlooking condition, which did not differ from chance significantly, $p = .94$ (one-tailed; note that number of targets chosen was slightly below the chance value).

For comparisons between conditions, we used a Fisher exact test. Significantly more infants handed over the target object in the joint engagement condition as compared with the onlooking condition, $p = .01$ (one-tailed). Infants in the individual engagement condition also chose the target significantly more often than infants in the onlooking condition, $p < .01$ (one-tailed). Infants in the joint engagement and the individual engagement conditions chose the target object equally often, $p = .50$ (one-tailed). Thus, in both the joint engagement and the individual engagement conditions, infants reliably chose the target object more often than chance and more often than in the onlooking condition, in which infants chose the target at chance levels.

Manipulation check. One alternative explanation, which could account for these results without granting infants any understanding of adults' past experiences, is that infants simply did not visually attend to E1 sufficiently in the onlooking condition to register her experiencing the objects. To test this possibility we checked whether (a) infants in the joint engagement condition visually attended to E1 more than did infants in the onlooking condition and (b) infants who looked to E1 more were more successful in identifying the target object.

In order to address the first question, an independent coder determined the percentage of time during which infants (the entire sample of $N = 28$) looked at E1 in the joint engagement and the onlooking conditions. To assess interrater reliability, another independent coder scored a random sample of 6 (21%) infants of each condition. For both conditions, strong correlations between the two raters' judgments were obtained (Pearson's correlations, rs $\geq .98$). The result was that, on average, infants focused on E1 for 9.4% of the play periods in the joint engagement condition and for 6.9% of the play period in the onlooking condition. This difference is not statistically significant, $t(54) = 1.60$, $p = .12$ (two-tailed), $N = 28$. To address the second question, we also looked at whether the percentage of time infants spent looking at E1 was positively correlated with successful performance in the test (using Pearson's correlation). It was not. For the joint engagement condition, infants' performance in the test did not correlate with the amount of visual attention to E1, $r = -.03$, $p = .87$ (two-tailed), $N = 28$. Interestingly, in the onlooking condition, a moderate negative correlation between infants' performance and the time they spent looking to E1 was obtained, $r = -.41$, $p = .03$ (two-tailed), $N = 28$.

Discussion

The current results replicate those of Tomasello and Haberl (2003) for their 18-month-olds. In both studies, infants of this age knew which of three objects another person was excited about and attending to when making a request based on which objects the

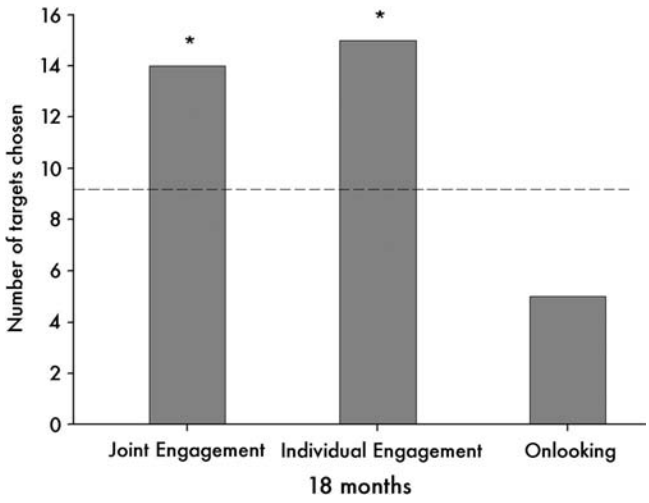

Figure 1. Number of 18-month-olds ($N = 28$) who chose the target object as a function of condition. The dashed line indicates chance level, and asterisks indicate significant difference from chance.

person had and had not experienced previously. This performance requires the general understanding that people tend to express interest in new things, not just-experienced things, and, in addition, knowledge about which of the three objects the adult had and had not experienced previously.

Our new question was whether the way in which the experimenter engaged with the object mattered. More specifically, what do infants need to see the adult doing with a toy to know that he or she has experienced it? The main result was that 18-month-olds registered the adult's experiencing of the objects equally well in the joint engagement and the individual engagement conditions—and both of these better than in the onlooking condition. These findings thus disconfirm a strong sharing hypothesis according to which infants need to be part of an adult's engagement with an object in order to know that he or she has experienced it. It was sufficient that they simply watched the adult manipulate, examine, and comment on it by herself.

On the other hand, if the adult merely watched the infant and the other experimenter play with the toy, infants did not register the adult's experience with the object. They do not know that seeing by itself, without action and reaction, leads to knowing. This was so, even though infants in the onlooking condition visually attended to the adult while she looked at the experienced objects as much in this condition as in the joint engagement condition (and, in any case, increased looking times to E1 were not positively related to success in the task in either of these two conditions). This result provides further evidence that it is relatively hard for infants to understand visual experiences of adults when they are simply passively viewing the world (see introductory paragraphs and General Discussion for more on this point).

The knowledge of 18-month-old infants about which objects an adult has and has not experienced thus depends on how they experience the adult interacting with those objects. But 18-month-old infants apparently do not need to be personally engaged with an adult in order to attend to and register his or her experiencing of an object. On the basis of language acquisition research and theoretical proposals about the importance of sharing experience, however, we may hypothesize that it is still possible that this might change with age and that younger infants would need to participate with an adult and an object jointly in order to register his or her experience with it (e.g., Carpenter et al., 1998). In a second study, therefore, we adapted the methods of this study for use with 14-month-olds.

Study 2

In this study, we ran a modified version of the procedure of Study 1 with 14-month-olds. Our hypothesis was that infants this young would register the adult's experience with objects only during joint attentional interactions in which they were jointly engaged. Because infants this young are not so competent at handing over objects upon request, we had to modify our criteria for excluding infants on the basis of their pretest and test behavior.

Method

Participants. Participants were 84 infants (44 girls, 40 boys) of 14 months of age (M = 13.26, range = 13.15–14.15) obtained from the same database as the infants in Study 1. An additional 23 infants were tested but dropped because they did not pass the pretest (13), they failed to make a clear response in the test (3), they were fussy or uncooperative (4), or because of experimenter error (3).[1]

Materials, design, and procedure. The materials, design, and procedure were the same as in Study 1. Each infant was randomly assigned to one of three conditions, yielding 28 infants in each condition (mean age in each condition: joint engagement = 13.29, individual engagement = 13.25, onlooking = 13.24).

On the basis of the experience of Tomasello and Haberl (2003) with 12-month-olds, as well as our own pilot testing with 14-month-olds, we concluded that 14-month-old infants are not so motivated and/or proficient at handing over objects to adults. We thus had to modify our criteria for inclusion. In this study, for an infant to pass the pretest, he or she had to identify at least one of the first two requested objects immediately without any corrections from the experimenter (in Study 1, the 18-month-olds had to identify *and hand over* at least one). Identifying the object correctly meant that infants had to either touch it, take it for themselves, or hand it to E1. We also had to adjust the criteria for deciding which object an infant had chosen in response to the adult's request in the test. Although the procedure was identical to that of Study 1 and infants were still asked to give a toy, in Study 2 infants were not excluded for not handing over a toy if they clearly chose one by taking it for themselves or putting it on the table. Ten of the infants of the final sample of 84 participants selected a toy this way, without handing it to the experimenter (4 infants from both the joint engagement condition and the onlooking condition and 2 infants from the individual engagement condition). Again as in Study 1, however, if the choice was unclear because the infant touched several toys simultaneously or the infant did not touch any of the objects, the infant was excluded.

Coding and reliability. To assess interrater reliability, a second coder, who was unaware of condition, coded a sample of 18 infants from the video material, 6 from each condition (21%). She agreed with the primary coder in 100% of her judgments, leading to a Cohen's kappa of 1.

Results

Figure 2 presents the number of infants who chose the target toy in each condition. When we compared each of the conditions to chance using the binomial procedure, we found that more infants than expected by chance (.33) handed over the target object in the joint engagement condition, p = .02 (one-tailed). This was not true of either the individual engagement condition, p = .39, or the onlooking condition, p = .45, which did not differ from chance (both one-tailed).

To compare between conditions, we used a Fisher exact test. Infants chose the target toy more often in the joint engagement

[1] In both studies, infants were excluded statistically equally in the different conditions (chi-square goodness of fit nonsignificant in both cases). Moreover, the performance of the excluded children was uniformly poor, as expected, and not very different among conditions. The proportion of excluded children handing over the target object (summed across both studies) was .20 for joint engagement, .13 for individual engagement, and .25 for onlooking. Note also that these figures are uncorrelated (in either direction) with the performance of included children.

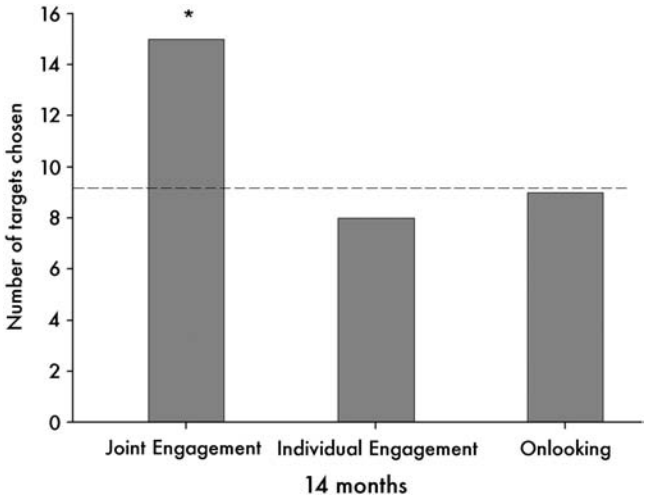

Figure 2. Number of 14-month-olds ($N = 28$) who chose the target object as a function of condition. The dashed line indicates chance level, and asterisks indicate significant difference from chance.

condition as compared with the individual engagement condition, $p = .05$ (one-tailed), and tended to choose the target object more often in the joint engagement condition as compared with the onlooking condition, $p = .088$ (one-tailed). Infants' target choices in the individual engagement condition did not differ significantly from their choices in the onlooking condition, $p = .50$ (one-tailed). Thus, it was only in the joint engagement condition that infants reliably chose the target object.

Comparisons across studies. We compared the performance of the 14-month-olds from this study with that of the 18-month-olds from Study 1 for each of the three conditions separately using the Fisher exact test. In the joint engagement condition, 14- and 18-month-olds chose the target equally often, $p = .50$ (one-tailed). The number of 14- and 18-month-olds choosing the target in the onlooking condition also did not differ, $p = .18$ (one-tailed). However, significantly more 18-month-olds than 14-month-olds selected the target toy in the individual engagement condition, $p = .05$ (one-tailed).[2]

Manipulation check. As in Study 1, we addressed the possibility that differences in infants' attention to E1's experiencing of the objects might account for the results. An independent coder determined (for the whole sample of $N = 28$ per condition) the percentage of time during which infants looked to the experimenter. To assess interrater reliability, another coder scored a random sample of 6 (21%) of the infants from each condition. The raters' judgments correlated highly in both conditions (Pearson's correlations, $rs \geq .89$). The key comparison here was between the joint engagement and individual engagement conditions. We found that, on average, infants in the joint engagement condition looked to E1 for 9.8% of her play with the experienced objects. In the individual engagement condition, in which infants were asked to watch E1 manipulate the toy on her own, infants looked to E1 for 41.3% of this same time period. Infants' looking times to E1 in the individual engagement condition were thus significantly higher than in the joint engagement condition, $t(54) = 18.51$, $p < .001$ (two-tailed), $N = 28$.[3] Infants' success in the test did not correlate with their amount of visual attention to E1 either in the joint engagement condition, $r = -.09$, $p = .66$, $N = 28$, or in the individual engagement condition, $r = -.08$, $p = .68$, $N = 28$ (both Pearson's correlations, two-tailed).

Discussion

The main aim of this study was to see whether 14-month-olds would show a similar or a different response pattern from that of the 18-month-olds in Study 1. The hypothesis was that the response pattern would change such that only in the joint engagement condition would infants register the adult's experience with the experienced objects.

The results confirm this hypothesis. Like the 18-month-olds in Study 1 and like the 12-month-olds in Tomasello and Haberl's study (2003), the 14-month-old infants in this study clearly attended to and registered the adult's experience of the experienced objects in the joint engagement condition. Also like the 18-month-olds in Study 1, they did not register the adult's experiencing the objects in the onlooking condition. But unlike these older infants in Study 1, they did not register her experience with the objects in the individual engagement condition. This finding cannot be explained by positing that infants simply did not pay enough attention to E1 in the individual engagement condition because in fact they actually attended more to E1 in this condition than did those in the joint engagement condition (and again performance in the test did not correlate positively with visual attention to E1 in either of the two conditions). Possible reasons for this difference in performance by the 14-month-olds are discussed in the General Discussion section.

General Discussion

The results of the current study add to a growing body of literature indicating that infants understand not just what others are doing and not just what others are seeing but also what others know. But the word *know* has many meanings in English, and what the research indicates precisely is that infants know what others know in the sense of what the other has experienced previously—perhaps most accurately conveyed by the first members from the following pairs of verbs in other languages: *kennen–wissen* (German), *conocer–saber* (Spanish), *connaître–savoir* (French), which

[2] When the same comparison was done without those ten 14-month-old infants who did not hand over the chosen object in the test (thus excluding those 14-month-olds who did not match the inclusion criterion of the 18-month-olds), the pattern of results stayed the same. The differences between the 14- and 18-month-olds remained nonsignificant for the joint engagement and onlooking conditions, $ps > .26$ (both one-tailed), and the 18-month-olds still tended to choose the target toy more often than did the 14-month-olds in the individual engagement condition, $p = .077$ (one-tailed). Excluding these infants changed the odds ratio only slightly, from 2.9 to 2.6, which shows that the increase of the p value was mainly due to the smaller sample size.

[3] A small amount of infants' looking to E1 during this time occurred within those 30 s in which E1 was onlooking while E2 and the infant played at the table. When these 30 s are disregarded and the analysis is restricted to those 30 s in which E1 individually examined the object, infants still fixated E1 for 36.6% of the time. Again, this was significantly more than in the joint engagement condition, $t(54) = 16.53$, $p < .001$.

are best translated into English as "be familiar with" or "be acquainted with" from past experience. There are now four studies that have shown that infants below 18 months of age know what others know in this sense, at least in some contexts. The first was the study by Tomasello and Haberl (2003), on which the current studies are based. The second was the study by Onishi and Baillargeon (2005), in which 15-month-olds expected a person to look for an object where he or she saw it previously. The third study was that of Moll, Koring, Carpenter, and Tomasello (2006), in which 14-month-old infants reacted to an adult's excited gaze direction differently (i.e., identified his or her focus of attention differently) depending on what he or she had previously experienced. And the fourth study is the current study. In these four studies, an actor either had or had not witnessed an interesting object or event, and infants had to know not only what another person did and did not know but also how his or her knowledge or ignorance determined his or her actions.

In this regard, the findings of these four studies differ from those of previous studies in which the issue is infants' understanding of how an actor intentionally acts upon, perceives, or shows interest in two objects differentially (e.g., Phillips et al., 2002; Woodward, 1998, 2003)—because in these latter studies there was no manipulation of which objects an actor had and had not experienced previously.

The new findings of the current studies are that (a) infants register an adult's experiencing of an object only under specific circumstances and (b) these circumstances change with age. First, infants at both 14 and 18 months of age failed to register that an adult had experienced an object when they only observed her onlooking as they played with it. Although infants follow gaze direction from the middle of the 1st year (e.g., D'Entremont, Hains, & Muir, 1997), and by 1 year of age they can take into account barriers to do so (Moll & Tomasello, 2004), they do not seem to be able to understand the content of what another sees, when this differs from what they see, until 2 years of age. That is to say, so-called Level 1 perspective taking has not been demonstrated before 2–2½ years of age (Flavell, Shipstead, & Croft, 1978; McGuigan & Doherty, 2002). Moll and Tomasello (2006) found that 18-month-old infants did not know which of two objects, both visible from the child's point of view, could not be seen from an adult's perspective. This suggests that in the current study it was not that infants noted the adult's experiencing of the object but later did not recall it; they very likely never noted it in the first place. So it seems that even at age 18 months, mere visual relations of other people to objects are not well understood—whether the other's visual experience is past, as in the current study, or present, as in Level 1 perspective-taking tasks. However, infants of the same age can understand that others have experienced something when they have observed them engaging with the object more actively (e.g., in the current individual engagement condition). Interestingly, studies using looking-time measures have revealed a similar décalage between understanding visual (looker–object) versus more active, manual (actor–object) relations in younger infants (Woodward, 1998, 2003).

One alternative interpretation might be that infants in the onlooking condition did indeed register the adult as experiencing the experienced objects, but they assumed that her interest in them was not satiated by merely looking at them—and so they did not differentiate experienced and unexperienced objects at test. This is possible. However, in two follow-up studies, we have found that at test 14-month-old infants do not know which of the three objects the adult is excited about after witnessing him or her actively and excitedly exchange the experienced objects with another person (without the infant being directly involved in this interaction). In contrast, infants do know which object the adult is excited about after witnessing the adult merely looking at, but not manipulating, the experienced objects if that looking consists of shared visual experience with the infant. These two findings suggest, in line with our overall sharing hypothesis, that for 14-month-old infants the determining factor is not the adult's satiation of interest in the objects.

At first sight, the negative findings in the onlooking condition seem to contradict the results of Tomasello and Haberl's (2003) control condition. In that condition, the adult engaged with the infant jointly for the experienced objects but remained inside the room for the third object, watching the infant and the other adult play with the third toy. In this condition, infants handed over objects randomly, suggesting that they had registered the adult experiencing the third object just as well as the first two. But in this condition, because the adult had previously shared the other two toys and then remained in the room for the third, it is possible that the sharing or the joint engagement was not really terminated, at least from the infants' point of view, when the third object was brought out. Also, in our study, the design was such that the contrast was always between the adult experiencing the experienced objects in some way and being totally absent from the room. It is possible that for the contrast between experienced and unexperienced objects to be strong enough for the infant, the adult's absence is a necessary (though not sufficient) condition.

Infants at both ages in the current study registered that an adult had experienced an object when they had previously interacted with the adult and object in a bout of joint attentional engagement. This finding is reminiscent of Tomasello and Farrar's (1986) study of word learning, in which infants between 12 and 18 months of age learned new words best if they were exposed to them inside a joint attentional interaction with the speaking adult (see also Dunham et al., 1993). Episodes of joint attentional interaction can thus be thought of as hot spots for language learning because they lead infants to focus on the adult's referents more often and/or in special ways. The current results are fully consistent with, and perhaps generalize, this hypothesis. The simplest generalization is that inside joint attentional interactions infants are more attentive to adults' intentional actions and perceptions, including their communicative actions. In the word-learning literature, this dependence on joint attentional scaffolding for helping infants identify the adult's reference to the world begins to decline somewhere after 15 months of age (Carpenter et al., 1998). And at around 1½–2 years of age, infants start to learn words even when they are not mutually engaged with the speaker and when they are engaged with a different object than the referent (Akhtar, 2005; Akhtar, Jipson, & Callanan, 2001; Baldwin, 1993; Floor & Akhtar, 2005)—perhaps because from this age on linguistic communication itself begins to form the basis of joint attentional interactions.

It thus may be significant that in our individual engagement condition the adult not only manipulated and inspected the object actively but also reacted to it and made verbal comments about it. This may have created for the older but not the younger infants a kind of joint attentional interaction by itself. Eighteen-month-olds

might simply cast a wider net than do 14-month-olds in defining a shared activity to include an adult talking and reacting, even if they are not directly addressed as in the classic joint attentional episode. Then by 2 years of age, as evidenced by Moll and Tomasello (2006), young children even register others' visual experience in the absence of any verbal comments and other reactions directed at an object.

One other possibility for why young infants knew what the adult knew only in joint engagement might be that infants generally attend better to what is going on around them because the joint engagement puts them in a state of higher arousal. But note that this hypothesis of heightened attention to the adult's experiences in joint attentional episodes does not mean that infants are looking longer at the adult, which the control analyses demonstrated was not the case (see the *Manipulation check* sections of both studies). Instead, we believe that the nature of infants' attention to the adult and his or her experiences is qualitatively different inside joint attentional interactions. Both partners focusing on the same thing at the same time makes the experiences of the other more salient in contrast to one's own (Barresi & Moore, 1996). When the infant is truly jointly engaged with another, he or she has formed with that partner some kind of joint goal and joint plans of action, which require continuous monitoring of the other's intentions and attention, even though the infant may look to the face of the other only occasionally (Tomasello et al., 2005). In these interactions infants register naturally and readily important aspects of what the partner is experiencing, and they recall naturally and readily what they have jointly experienced with specific partners.

Overall, the current studies contribute to the growing body of evidence suggesting that 1-year-olds have much more sophisticated social–cognitive skills than previously suspected. They not only understand what goals others have (Carpenter, Call, & Tomasello, 2005; Gergely, Nádasdy, Csibra, & Bíró, 1995) and what preferences others have (Repacholi & Gopnik, 1997); they also know what others know, in the sense of what they have and have not experienced in the immediate past. The current study establishes that infants' knowledge of other people's experiences changes with age, with joint attentional engagement playing a particularly crucial role in the months immediately after the first birthday and later becoming less important. This developmental pattern supports the view that infants' understanding about others' attentional states, perhaps the least observable aspects of human activity, develops initially inside of joint attentional engagements with others and only later extends to the activities of others performed individually. Why it takes children another 2–3 years to understand such things as false beliefs (see Wellman et al., 2001) is a pressing question for future research.

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