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PAPER

Fourteen-month-olds know what others experience only in joint engagement

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Abstract

We investigated how 14-month-old infants know what others know. In two studies, an infant played with each of two objects in turn while an experimenter was present. Then the experimenter left the room, and the infant played with a third object with an assistant. The experimenter returned, faced all three objects, and said excitedly 'Look! Can you give it to me?' In Study 1, the experimenter experienced each of the first two toys in episodes of joint visual engagement (without manipulation) with the infant. In response to her excited request infants gave the experimenter the object she did not know, thus demonstrating that they knew which ones she knew. In Study 2, infants witnessed the experimenter jointly engage around each of the experienced toys with the assistant, from a third-person perspective. In response to her request, infants did not give the experimenter the object she had not experienced. In combination with other studies, these results suggest that to know what others have experienced 14-month-old infants must do more than just perceive others perceiving something; they must engage with them actively in joint engagement.

Introduction

Several recent studies have reported the surprising finding that human infants, even before they have learned much language, know what others 'know'. For example, Onishi and Baillargeon (2005) found that 15-month-old infants were surprised when a person searched for an object where it really was instead of where she had seen it being hidden just previously. Regardless of whether this is interpreted as evidence for the understanding of false belief, it is evidence that infants know what others have and have not witnessed in the immediate past (see Perner & Ruffman, 2005, for a similar interpretation).

In addition to this looking time study, several other recent studies using more active response measures have also reported that by around their first birthdays prelinguistic infants know which things in the world others have and have not experienced – what they 'know' in the sense of what they are 'acquainted with' or 'familiar with' from the immediate past. The first study of this type was that of Tomasello and Haberl (2003). They had 12- and 18-month-old infants play with an experimenter and an assistant with two novel toys successively at a table for 1 minute each. Then the experimenter left the room. While she was gone, the infant and the assistant played with a new, third toy for 1 minute. All three toys were then placed on a tray and held in front of the infant, while at the same time, the absent experimenter returned to the room. Looking at the tray – and without providing any gaze cues – she exclaimed excitedly 'Oh look! Look there! Look at that one there! Can you give it to me?' Impressively, both 12- and 18-month-old infants reliably handed over the toy that was new for the experimenter, even though all three toys were equally old for them (and they did this more than would be expected by chance and more often than in a control condition in which the experimenter stayed inside the room during play with all three objects). To do this, infants must have (1) known that people tend to get excited about new, not old, things, and (2) identified which one of the three objects was indeed new for the experimenter in this specific situation. A second study was conducted by Moll, Koring, Carpenter and Tomasello (2006), who showed with a different procedure that 14-month-olds and older infants assumed different referents based on what an adult had and had not experienced in the immediate past. More specifically, when an adult reacted excitedly towards an object, infants interpreted her attention as being directed at the object as such when it was new for the adult, but they looked around the room

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for another possible referent when the object was not new, but familiar for the adult.

These studies together suggest that 1-year-old infants can attribute knowledge and ignorance to other people. The term 'knowledge' is very broad and comprises at least two types of knowledge for which there are different words in languages like German (*kennen* – wissen), French (*connaître* – savoir), and Spanish (*conocer* – saber). The first members of these pairs of words are best translated into English as 'being acquainted with' or 'being familiar with'. What is crucial about this kind of knowledge is that it is acquired by a direct experience-based contact between the 'knower' and an object, person, place, etc. In the tasks described above, infants need to understand that the actor knows or does not know an object in this sense. One important question then is: what do infants need to experience a person doing (on the object and in relation to the infant) in order for them to know that this person knows something in this specific sense?

The most straightforward answer is that infants just need to observe the adult observing objects in order to register her as knowing them ('seeing leads to knowing'). However, infants seem to have serious difficulties with the understanding of mere visual relations. Looking time studies, for instance, have shown that infants understand the directedness of seeing only several months after they understand the directedness of more active, manipulative behaviors (Woodward, 1998, 2003). Similarly, so-called level 1 perspective-taking, which requires children to understand what another person can and cannot see at a given moment, has not been shown in children younger than 2 years of age (e.g. McGuigan & Doherty, 2000; Moll & Tomasello, 2006). It thus seems unlikely that 1-year-old infants come to know what other people know simply by observing them observing things.

Moll and Tomasello (2007) approached this problem by manipulating how 14- and 18-month-old infants experienced an adult experiencing objects. Using a variant of the Tomasello and Haberl (2003) paradigm, in one condition (Joint Engagement condition) the first two toys were played with together, thus 'shared', just as in Tomasello and Haberl's (2003) study. Here, the experimenter looked at, manipulated, and commented on each of the first two toys while alternating gaze between the toy and the infant. In a second condition the experimenter and the infant did not experience the first two toys together (Individual Engagement condition). Instead, they played with them separately: the infant watched the experimenter look at, manipulate, and comment on them on her own at some distance (never looking at the infant), and the infant got a chance to play with them individually as well. In a third condition, the experimenter simply looked at the known toys from some distance, as the infant and the assistant played with them together (Onlooking condition).[1] Finally, in all three conditions the experimenter left the room while the infant and assistant played with the third object and then returned and excitedly asked the infant in a non-specific way to give her an object, as in Tomasello and Haberl's (2003) experimental condition. The main finding was a developmental difference. The 14-month-olds knew which object the adult was referring to only in the Joint Engagement condition. In contrast, the 18-month-olds knew this in the Individual Engagement as well as the Joint Engagement condition. Interestingly, neither age group knew which object the adult referred to when she had just looked at the first two objects. This is in line with previous findings which showed that mere visual relations are particularly challenging for infants.

Joint engagement thus seems to be an especially facilitative context in which infants come to understand things which they otherwise would not yet understand. Joint engagement has also been shown to be helpful for the development of a number of other social-cognitive skills, such as learning novel words (for an overview, see Dominey & Dodane, 2004; Tomasello, 2003). In the current studies, therefore, our aim was to investigate in more detail precisely which aspects of joint attentional engagement facilitate infants coming to know what others know. In the first study we predicted that joint engagement would help infants to understand even others' mere visual relations to objects, which otherwise is very difficult for them. To test this prediction, an adult established joint engagement with infants around two objects, as in Moll and Tomasello's (2007) Joint Engagement condition (with alternating attention and verbal acknowledgement), except that the adult explored these objects only visually, with no manipulation. This study thus tests the hypothesis that joint engagement in itself – in the absence of actually manipulating and exchanging the object of joint attention – is sufficient for infants to attend to and know what the other is experiencing.

In the second study, we attempted to determine if the back-and-forth structure typical of social interactions, including conversations, is sufficient by itself – even if the infant is not participating directly – to facilitate the infant's determination of what the other is experiencing. This study thus tests the hypothesis that it is sufficient for infants to witness an adult engage actively with *another* person around objects – from a third-person

[1] Infants did notice the experimenter's presence. Coding of infants' looks revealed that infants looked to the experimenter for the same amount of time in this condition as in the Joint Engagement condition.

perspective – in order to register the adult as knowing these objects. In this study, therefore, we had infants witness an adult pass the known objects back and forth with another person in episodes of joint engagement, with no direct involvement of the infant; she was an eavesdropper only. With the results of these two studies, we should be able to specify in much more detail what 14-month-olds need to experience in order to register another person as knowing objects from past experience.

Study 1

In this study we investigated whether 14-month-olds can identify which of several toys is unknown for an adult, when the adult only visually explores the known toys without examining them manually. Importantly though, instead of simply looking at them from afar as in Moll and Tomasello's (2007) Onlooking condition, the adult 'shared' her visual experience with the infant.

Method

Participants

The participants of this study were obtained from a database of parents who had volunteered to participate in studies on child development. Subjects were 56 (31 females, 25 males) German 14-month-olds (mean = 14;00, range = 13;17 to 14;14). Another 18 infants were dropped from the final sample, either because they were fussy ($n = 3$), because of experimenter error ($n = 2$), because they failed the pre-test ($n = 9$) or because they did not make a clear choice in the test ($n = 4$). This was the case if infants either did not select a toy at all or if they chose two or three toys simultaneously.

Materials and design

For the pre-test we used three familiar toys: a ball, a teddy bear and a toy car. In the experimental test, three unusual objects were used as toys. One of them was a piece of a gardening tool, the second was a modified bird-cage mirror and the third was a modified abacus. Each of the experimental toys was a different color and shape but was approximately the same size. Each of them made a distinctive sound when manipulated in a certain way. Figure 1 shows these three novel toys. A preference test conducted prior to the study revealed no significant preferences among these toys. A tray was used from which infants could select the toys in the response phase of the pre-test and the experimental test (see Figure 1).

Figure 1 *The three novel toys and the tray used in Study 1 and Study 2.*

Infants were assigned to one of two experimental conditions, in which they received a single trial. The order in which the toys were presented (first, second, third) and the toys' location on the tray in the response phase (left, middle, right) were counterbalanced.

Procedure

Infants were tested individually in a child research laboratory. The entire session lasted approximately 20 minutes. Prior to the test, the two experimenters (E1 and E2) played with infants in a play area until they were sufficiently comfortable with the situation. The experiment was conducted in a room (4.30×4.30 m) with E1 and E2, the infant and the parent sitting around a square table. The infant was seated on her parent's lap, at a 90 angle to E2 and a 180 angle to E1, who was seated with her back towards the door. The infant thus sat facing the door. This set-up is schematically depicted in Figure 2.

Following the procedure of Tomasello and Haberl (2003) and Moll and Tomasello (2007) a pre-test was conducted in order to exclude infants who were generally unable or unwilling to select a specific item upon request, because that was a prerequisite for the experimental test. In this pre-test, both experimenters and the infant played together with a ball, a teddy bear and a toy car in turn for 50 s each (always in this order). E2 then placed all three toys on the tray at randomized positions and held the tray out in front of the infant. E1 requested each toy successively from the infant, referring to it by name but without gazing at it. The order of requests was determined mainly by the parent's previous report about which object names her infant knew best. In order to pass the pre-test, infants had to select clearly and

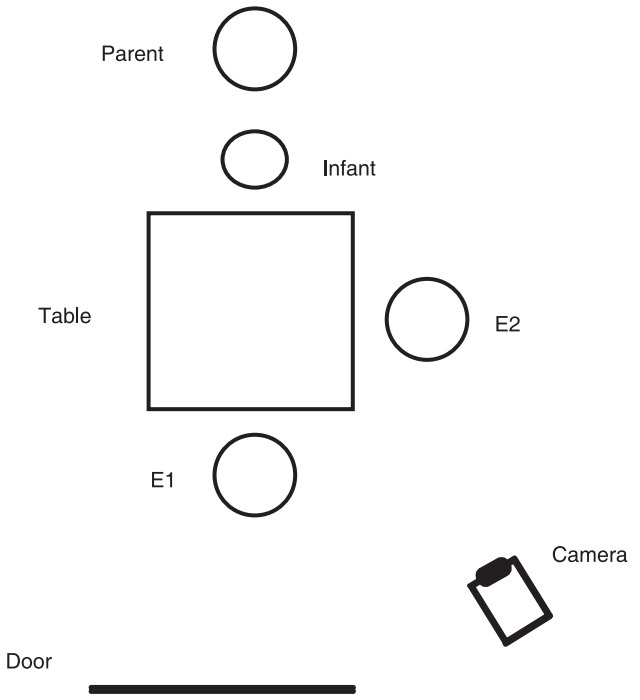

Figure 2 *Schematic depiction of the experimental set-up of Study 1.*

correctly either the first or the second requested toy by at least touching it. They did not necessarily have to hand it to E1, because in the experimental test (as in the previous studies) infants were also not excluded if they picked out a toy without then handing it to E1. Nine of the tested infants failed the pre-test.

At this point the main experiment began. The beginning of the procedure was identical in the two conditions. E2 brought out the first novel toy on the schedule and put it on the table. For the next 60 s, both experimenters commented interestedly about the toy and alternated gaze with the infant and sometimes with each other. Most of the social interaction took place between E1 and the infant. E2 held up the toy between them in order to make it their common perceptual focus, and she demonstrated the special way of manipulating it. E1 made more comments and more pronounced eye contact with the infant than E2. Importantly during this whole time, she had her arms folded naturally, resting on the edge of the table, so she never touched the toy. The infant and E2, however, manipulated and played with the toy. For all toys, this play followed a standardized script. Only very general comments were made like 'Look what you can do with this!' and 'Oh, isn't that nice!', and toys were neither named nor described specifically.

After 60 s of playing, E2 put the toy in its pre-assigned position on the tray – which was located out of reach but was potentially visible to the infant. E2 then brought out the second novel toy on the schedule and E1, E2, and the infant played with it as they had done with the first toy. Again, E1 never touched or manipulated the toy. She only had visual access to it, but commented on it according to the script and alternated gaze with the infant as before. The play time was again 60 s. When this time had elapsed, E2 placed the second toy on the tray at its assigned position.

This is when the experimental manipulation began. In the Experimental condition, E1 announced that she was going to leave. She emphasized her leaving by saying and waving good-bye several times. E2 responded by saying and waving good-bye to her as well. E1 then left the room. After she had gone, E2 said 'E1 is outside now. She cannot see us. We'll keep playing!' and then brought out the third toy and played with the infant with this toy for 60 s in the standard manner. When the 60 s were over, E2 placed the third toy next to the other two on the tray and put the tray on the table. At this moment E1 returned to the room. She turned around from the door and – gazing in the direction of the tray containing all three toys, without looking at a specific one – excitedly exclaimed 'Oh, look! Look there! Look at that one there!', which she followed immediately with the request 'Give it to me, please!' She approached the infant and held out her hand towards the middle of the tray while looking straight at the infant now that she stood closer to the toys. If necessary, she repeated her request.

In the Control condition, after having shared her visual experience with the first two novel objects, E1 simply stayed in the room for the third object. That is, she remained seated as E2 brought out the third toy. E1 then shared her visual experience of this object with the infant in exactly the same manner and for the same amount of time as she had done with the first two objects. After 60 s, E1 announced that she would go over to the door. She stood up and walked to the door where she remained with her head oriented towards the door (that is, away from the infant) for approximately 2 s when E2 exclaimed 'Look, [name of E1]!' At this point, E1 turned around and, exactly as in the Experimental condition, expressed excitement about the objects (without indicating specifically which object she was referring to), and requested the infant to hand her an object. The only difference between the conditions was thus that in the Experimental condition, E1 left the room for the third object and so this object was unknown to her upon her return, whereas in the Control condition, she remained in the room for the third object and was thus equally familiar with all three objects.

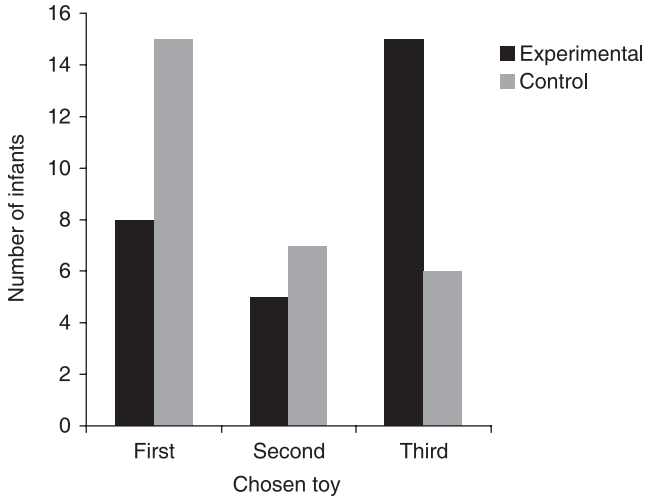

Figure 3 *Number of the 14-month-olds' toy choices in Study 1 as a function of condition (note that the target toy was the third toy).*

Coding and reliability

Based on a live judgment, E1 coded which of the three toys was taken or handed over by the child, recording it on a score sheet immediately after the test. If infants took a toy for themselves but then handed a different one to E1, the handed-over-toy was scored if the infant handed it within 40 s. To assess inter-observer reliability, an independent rater who was blind to the hypothesis of the study scored a random sample of seven of the 28 infants (25%) in each condition. Agreement between the two raters was 100%. In order to assess reliability on the pre-test, 14 infants from the final sample plus three infants who were dropped from the study for failing the pre-test were scored by the independent coder for passing or failing the pre-test. Again, the raters agreed in 100% of the cases.

Results

Figure 3 shows the number of infants' object choices separately for the two conditions, with 'first', 'second' and 'third' referring to the temporal position of the toy in the play sequence. The third object was the target toy, which was unknown to E1 in the Experimental but not in the Control condition. Using the binomial procedure, we compared the observed number of infants choosing the target object with target choices expected by chance (.33). As predicted, more infants than expected by chance chose the target object in the Experimental condition, $p = .04$, but not in the Control condition, $p = .27$. Interestingly, there was actually a primacy effect in the Control condition such that infants in this condition chose the first toy significantly above chance, $p = .04$. To compare the number of target choices between conditions, we used Fisher's Exact Test. As expected, significantly more infants chose the target object in the Experimental than in the Control condition, $p = .026$ (all *p*s two-sided).

Discussion

In the current study, infants of 14 months of age knew which of three objects an adult knew and did not know through visual experience when they were in joint engagement. When the adult reacted excitedly towards the group of objects in the response phase, infants handed her the object she did not know from past visual experience (Experimental condition). In contrast, when the adult had visually experienced all three objects (Control condition), infants handed her the first shared object significantly above chance. It is possible that this primacy effect in the Control condition reflects infants' understanding that people do not generally get excited about things they just have previously attended to and experienced, so in this situation, infants gave the adult the object which they shared at the very beginning (farthest away in time).

These results confirm those of previous studies showing that 14-month-old infants can determine which objects an adult does and does not know, in the sense of which objects she is and is not acquainted with from past experience (Moll & Tomasello, 2007; Moll *et al.*, 2006; Tomasello & Haberl, 2003). The new finding from the current study is that in order to make this determination, 14-month-old infants need not witness the adult actively manipulate the objects. Based on the results of Moll and Tomasello (2007) alone, one might surmise that active behavioral joint engagement between infant and adult around the object with physical manipulation is necessary, but it is not. Instead, here we show that physical manipulation by the adult is not necessary; onlooking is apparently enough as long as the adult also reacts and comments and shares visual attention with the infant around the object.

It is possible that in this study the adult simply adding overt reactions, comments, and gaze alternation in a back-and-forth manner to onlooking makes all the difference; these may count as 'evidence' that the adult has registered the object. Thus, one might suppose that it might be sufficient for infants to see an adult engage jointly with *another person* around objects in order to perceive the adult as knowing the objects – without the infant being directly addressed or involved, similar to the situation in experiments on 'overhearing' language

(for an overview, see Akhtar, 2005). But there are no empirical indications that this would be sufficient for 14-month-olds, as there are no published reports of overhearing studies with infants younger than 18 months of age (see Floor & Akhtar, 2006). We rather think that being *directly* involved in the other's activities as a partner in joint engagement is what is important at this young age. We thus did not expect that witnessing an adult interact socially with someone else around objects would suffice for infants this young to register the adult as knowing the objects. This possibility was tested in Study 2.

Study 2

In this study we investigated whether 14-month-old infants could determine what is known versus unknown to an adult by witnessing the adult engage jointly with a different person around objects. We thus put the infant in a position of experiencing a social interaction from a third-person, 'overhearing' perspective.

Method

Participants

Participants in this study were taken from the same database as those in Study 1. Subjects were 36 (18 females, 18 males) German infants of 14 months of age (mean = 14;06, range = 13;16 to 14;24; none had participated in Study 1). An additional 11 infants were tested but excluded from the sample because they were fussy ($n = 3$), because they failed the pre-test ($n = 6$) or because of experimenter error ($n = 2$).

Materials and design

The exact same materials were used as in Study 1. In the current study, there was only one experimental condition. The temporal position of the toys in the play sequence and their spatial position in the tray were perfectly counterbalanced. Each infant received one of 36 possible combinations.

Procedure

The same pre-test was conducted prior to the experiment, and the study took place in the same room as Study 1. The basic structure of the procedure was the same as that of the Experimental condition from Study 1, differing only with regard to the interaction around the first two toys. The final procedure from the moment when E1 left the room until the infant's response was identical.

After the pre-test was finished, E1 stood up and announced that she would go over to the camera, which was positioned next to the door (see Figure 2). When she arrived there, she turned and looked towards the table. At this position she was directly in the infant's line of regard. E2 then brought out the first novel toy on the schedule and played with it together with the infant for 30 s. Playing followed the same standardized script which was used for Study 1. E2 shared the toy with the infant, involving commenting on it, manually exploring it together and in turns, and alternating gaze between the toy and the infant. During this time, E1 simply looked at the toy from her position near the camera. After the 30 s, E2 went over to E1 near the camera. There, the two experimenters shared the toy for another 30 s as in the Joint Engagement conditions of Tomasello and Haberl (2003) and Moll and Tomasello (in press). That is, E1 and E2 alternated gaze, took turns manipulating the object and commented on it. Infants watched this event from their position at the table. Parents had been instructed before the experiment to simply point in the direction of the experimenters if their infant's attention noticeably shifted elsewhere. After the 30 s, E2 returned to the table and placed the toy on the tray. She brought out the second toy and played with it together with the infant, again for 30 s, and then went over to E1 next to the camera. As with the first toy, E1 and E2 now shared this toy for 30 s, at the end of which E2 returned to the table, sat down and placed this toy on the tray as well.

From this moment on, the procedure was identical to that of Study 1: E1 left the room and came back when E2 and the infant had finished playing with the third toy, at which point the response phase began (see Study 1).

Inclusion criteria and coding

The same criteria for inclusion and the same coding schema and procedure (i.e. the main coder coded infants' responses live) were applied as in Study 1.

Inter-rater reliability was assessed by having an independent rater, who was blind to the hypothesis of the study, score a random sample of nine of the 36 infants (25%). The two raters agreed on 89% of the trials (Cohen's Kappa = .82) – the one disagreement they had was between the two distractor toys (first and second toy). Thus, agreement was 100% if target versus distractor is scored.

Results

Figure 4 shows the number of infants' toy choices. Again, 'first', 'second' and 'third' refer to the temporal position of the chosen toy in the play and the third toy

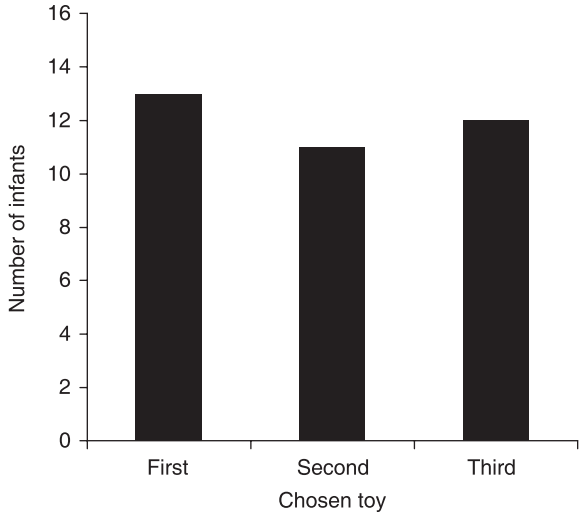

Figure 4 *Number of the 14-month-olds' toy choices in Study 2 (note that the target toy was again the third toy).*

is the target toy. As in Study 1, the binomial test was used to investigate whether the number of infants who chose the target object differs from the number expected by chance. As predicted, infants did not choose the target toy more than would be expected by chance, $p > .99$ (two-sided).

Manipulation check

One concern might be that infants attended less to E1 as she explored the known objects in this study than in Study 1. This concern seems reasonable given (1) that infants in the current study could perceive the adult examining the objects for only 30 s each, whereas infants in Study 1 had twice the amount of time (60 s) to register the adult as knowing the objects and (2) that infants were not directly involved. A coder who was ignorant with regard to the hypotheses of the current studies coded a randomly selected sample of 25% of the infants from the Experimental condition in Study 1 ($n = 7$) and Study 2 ($n = 9$). She determined the amount of time during which infants visually attended to E1 when she was visually sharing her experience of the object with the infant (60 s, Study 1) or when she was interacting with the object with E2 (30 s, Study 2). The result was that, on average, infants from Study 1 attended to E1 for 4.9 s, whereas infants from Study 2 attended to her experiencing the object for 27.4 s. Infants in Study 2 thus visually attended significantly longer to E1 than did infants in Study 1, $t(30) = 12.23$, $p < .001$ (two-sided), even though they had only half the time. This appears to be because in the Experimental condition of Study 1 (and also in the Joint Engagement condition in Moll and Tomasello, 2007) infants focused their visual attention mainly on the object, with only brief sharing looks to the interacting adult. In any case, infants in the current study did not fail to distinguish between the known and the unknown objects because they did not visually attend to E1 sufficiently as she explored the known objects.

Discussion

In this study, when the adult shared the known toys with someone else, and the infant witnessed this joint engagement from a third-person perspective, 14-month-old infants did not know which of three objects was known versus unknown for the adult. These results suggest that it is not just the social characteristics of joint engagement such as linguistic evidence, the contingent responding including talking and emoting or the back-and-forth structure that infants this age need in order to register what another person has experienced. Instead, infants this age need to be directly involved in the joint engagement: overhearing is not enough. And this is not because infants fail to pay attention to third-party interactions of this kind. In fact, infants in the current study actually spent a far greater percentage of time looking to the adult as she became acquainted with the objects than did infants in Study 1. It thus seems that what makes joint engagement so valuable for infants of this age in registering what others know is the fact that the infants themselves are simultaneously involved in the other person's actions and experiences.

General discussion

In the current studies, we determined the conditions under which 14-month-old infants are able to judge what other people do and do not know from past experience. Based on previous work we hypothesized that the sharing of experiences in joint engagement plays a pivotal role for this understanding. In a previous study, 14-month-olds knew what another person knew only when they were in joint attentional engagement with her (Moll & Tomasello, 2007). The current project aimed at taking a closer look at the relation of joint engagement and knowledge–ignorance understanding. More specifically, in Study 1 we investigated whether joint engagement helps 14-month-olds understand that others come to know things by mere visual contact, which is something that outside of joint engagement even 18-month-olds fail to understand (Moll & Tomasello, 2007). The aim of Study 2 was to determine the importance of direct involvement of the infant in the other's actions and experiences. We thus had infants observe an adult

engage socially around objects with another person. The results showed that only the 14-month-olds in Study 1 knew what the adult did and did not know – the 14-month-olds in Study 2 failed to make this distinction.

Generally the current findings add to growing evidence that shortly after their first birthdays infants can – at least under some conditions – understand others' psychological states: they not only understand that others have goals and perceive things but also that others know things from past experience (see Tomasello, Carpenter, Call, Behne & Moll, 2005, for a review). That infants this young are in principle able to make such assessments is surprising given that knowledge–ignorance distinctions have previously been demonstrated only for children after their second birthdays (Akhtar, Carpenter & Tomasello, 1996; Dunham, Dunham & O'Keefe, 2000; O'Neill, 1996). And so the question arises how the age of competence could be pushed down so dramatically. It seems that, in line with our hypothesis, part of the answer is that joint engagement has a strong influence on this type of social cognition.

This becomes clear from a comparison of the two current studies. In Study 1, in which infants were jointly engaged with an adult, they successfully determined which of three objects the adult did not know from past experience. In Study 2, in which they watched the adult interact jointly with another person but were not directly involved themselves, they failed to make such a distinction. Being directly addressed by the adult and involved in her actions thus seems to be a condition *sine qua non* for 14-month-olds to track her knowledge states. The procedures of the two studies were slightly different and so we cannot be sure that joint engagement is the only factor. However, our view is in accordance with previous findings which also suggest that joint engagement is what allows 14-month-olds to know what others know (Moll & Tomasello, 2007). Inside joint engagement, young infants are able to learn things and display skills they otherwise could not. Joint engagement facilitates not only word learning (e.g. Carpenter, Nagell & Tomasello, 1998; Dunham, Dunham & Curwin, 1993; Smith, Adamson & Bakeman, 1988; Tomasello & Farrar, 1986), it also influences the way infants subsequently attend to objects (Itakura, 2001), and results in more mature forms of play (Bigelow, MacLean & Proctor, 2004; Turkheimer, Bakeman & Adamson, 1989). In the current study, it enabled 14-month-olds to solve a task that 18-month-olds could not solve without the aid of joint engagement (Moll & Tomasello's, 2007, Onlooking condition).

The current Study 1 shows that it is not joint manipulation that makes the difference. Instead, as long as they were in joint engagement, mere onlooking was sufficient. And the current Study 2 shows that it is not simply the witnessing of a social interaction involving its typical back-and-forth structure that makes the difference. One might assume that this would suffice for infants to register the adult as knowing the objects. The pieces of information seem to be the same, whether the infant is a participant or just an observer of the interaction (as in Study 2): the infant perceives the adult commenting on the object, alternating gaze between the object and her social partner and so forth. However, it seems to be joint engagement directly perceived from the inside that is important – whether this sharing involves active manipulation or mere onlooking.

Interestingly, slightly older infants no longer depend on this direct form of joint engagement to the same extent. By 18 months of age infants can learn words without being directly involved in joint engagement with the speaker, by following a third-party conversation (Floor & Akhtar, 2006). Also by 18 months, infants can learn words even when they are focused on a different object from the speaker when the label is given (Baldwin, 1993). In Moll and Tomasello's (2007) study it was sufficient for 18-month-olds to witness an adult examine objects individually in order to register what the adult had and had not experienced. Thus, by 18 months at the latest, joint engagement is no longer a necessary condition for realizing what another person is attending to – or else by this age infants have a greater variety of ways by which they enter into joint attentional episodes. Onishi and Baillargeon's (2005) study might suggest that even 15-month-olds no longer depend on joint engagement in order to determine what others know. In their study, infants apparently registered whether an adult had experienced the location of an object even though there was no joint engagement between adult and infant (though note that this study involved manipulation by the adult, not just mere onlooking). One possible resolution is simply that 15 months of age is old enough to know what others know without direct joint engagement. The current results, in combination with others, simply suggest that the transition occurs somewhere between 14 and 18 months of age. Another possibility is that looking time studies tap into infant cognitive competencies in a different way than more active measures in which infants must make active choices based on what they experience in the experiment. Thus, there likely is a distinction to be made between more implicit knowledge supporting a discrimination among situations, as measured by looking studies, and more explicit knowledge of a kind that can support an infant's active behavioral decisions.

In any case, it seems that direct involvement in joint engagement is necessary in the very beginning of the

learning process, but shortly after, other types of engagement or the witnessing of joint engagement between others becomes sufficient (Carpenter *et al.*, 1998).

One important question then is, of course, what it is that makes the direct involvement in joint engagement so valuable for young infants. Somehow the other's knowledge state becomes 'transparent' in joint engagement (Eilan, 2005); but how? One possibility is that younger infants generally become more aroused in joint engagement and then are more motivated to pay attention to whatever happens around them. This seems fairly unlikely, however, given that in Moll and Tomasello's (2007) Onlooking condition, jointly attending to an object with an assistant did not help infants to understand that an adult standing a few steps away became familiar with this object. Thus, a general arousal effect is not plausible, because the joint engagement effect is restricted to the narrow spatial confines of the joint engagement episode.

Another possibility is that the adult's reacting to and commenting on the object provides evidence that she has registered it, and this evidence is needed for younger infants. However, this cannot be the full story. In our Study 2 the adult was reacting strongly towards the object by both acting manually and commenting on it, and yet infants did not register her as knowing the object.

Yet other possibilities are put forth by Barresi and Moore (1993, 1996) and Werner and Kaplan (1984). Barresi and Moore (1993) claimed that only by sharing a perspective can one become aware of both the similarities and the differences of that perspective between self and other. Werner and Kaplan (1984) characterized the 'primordial sharing situation' as one in which infant and adult begin to contemplate objects together versus simply acting on them individually. Examining an object together resembles an act of reference to this object and is like an invitation for the other to contemplate the object too. So maybe in joint engagement, both interactants make 'mutually manifest' that there is now a common object of contemplation. We would add to this view that in joint engagement, infant and adult form a shared goal together (e.g. playing with an object) and thereby act in a 'we'-mode in which they perceive their partner as 'you' instead of just 'he' or 'she' (see also Heal, 2005). Infants find it easier to determine what 'you' know than what 'he' or 'she' knows because the other's actions and experiences are directly tied to their own.

In any case, the current results help to specify the kinds of experiences 14-month-old infants must have in order to know what another person knows in a way that enables pragmatically appropriate social interactions with them. They need direct joint attentional engagement with them. And so we may hypothesize more generally that infants begin down the path of understanding other minds, culminating in their understanding of false beliefs at around 4 years of age through social interactions involving one or another form of shared intentionality (see Tomasello *et al.*, 2005). This suggests that theoretical accounts which neglect the social dimensions of the process, such as the theory theory in its most extreme form (see Stich & Nichols, 1998), cannot be fully adequate explanations. Children learn to read the minds of others initially in their 'deepest' social interactions with them, which is also intuitively plausible because that is how they will mainly use these skills later as they become ever more active participants in the social life around them.

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