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Brief article

Eighteen-month-old infants show false belief understanding in an active helping paradigm

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ABSTRACT

Recently, several studies have claimed that soon after their first birthday infants understand others' false beliefs. However, some have questioned these findings based on criticisms of the looking-time paradigms used. Here we report a new paradigm to test false belief understanding in infants using a more active behavioral response: helping. Specifically, the task was for infants to help an adult achieve his goal – but to determine that goal infants had to take into account what the adult believed (i.e., whether or not he falsely believed there was a toy inside a box). Results showed that by 18 months of age infants successfully took into account the adult's belief in the process of attempting to determine his goal. Results for 16-month-olds were in the same direction but less clear. These results represent by far the youngest age of false belief understanding in a task with an active behavioral measure.

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1. Introduction

There is currently much controversy about the age at which young children first understand that others may hold false beliefs. Classically, it was thought that young children first understand false belief at around 4–5 years of age, when they pass verbal tests such as the change-of-location (Sally-Anne) and change-of-contents (Smarties) tests (see Wellman, Cross, & Watson, 2001, for a review). But, as is well known, these tests have fairly strong demands on children's other cognitive skills (Bloom & German, 2000; Carlson & Moses, 2001). When these demands are reduced, children pass false belief tests at closer to 3 years of age (e.g., Carpenter, Call, & Tomasello, 2002).

Clements and Perner (1994) attempted to design a false belief test with an absolute minimum of extra cognitive demands. In this test, children saw a toy mouse leave its cheese at one location, then the cheese was moved when he was not looking, and children then heard the announcement that the mouse was coming back to get his cheese. The question was whether they would look to the place where the cheese really was, or rather to the old place where the mouse falsely believed it was. Children at 2;11, but not younger, seemed to anticipate that the mouse would act in accordance with his false belief. Recently, Southgate, Senju, and Csibra (2007) have used a similar anticipatory looking paradigm and found positive results with 25-month-olds.

More controversially, several recent studies have claimed false belief understanding in 15- and even 13-month-old infants (Onishi & Baillargeon, 2005; Surian, Caldi, & Sperber, 2007). The paradigm used in these cases is the violation-of-expectation paradigm. Infants looked longer at a scene in which a protagonist searched for an object in a place she could not know it to be (though it really was there) than to a scene in which the protagonist searched for an object where she had seen it hidden (but it no longer was). Some researchers have argued that in these tasks infants only need to notice that something is unusual; they do not need to attribute beliefs to the protagonist (e.g., Perner & Ruffman, 2005; Sirois & Jackson, 2007; see also Haith, 1998). Both for these skeptics and for researchers willing to interpret these new findings in

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the rich way advocated by their authors, converging evidence from studies using more active behavioral measures should be highly relevant – or even crucial.

In the current study, therefore, we used a new paradigm involving an active behavioral measure to assess infants' and young children's understanding of false belief. The procedure takes advantage of children's propensity from soon after the first birthday to help others with their problems in attaining goals (Warneken & Tomasello, 2006, 2007).[1] Children watched as a toy was switched from one box to another while an adult either witnessed the switch (true belief condition) or not (false belief condition). Then the adult attempted unsuccessfully to open the box the toy originally had been in. In the true belief condition, infants could follow their natural tendency to help immediately by opening the empty box for the adult. Since in this condition the adult had watched the moving of the toy from one box to the other, his attempt to get into the first box could not be to extract the toy. In contrast, in the false belief condition, if infants understood the adult's false belief and wanted to help, they should infer that he wanted the toy he thought was in there. In this case they should not simply go help him open the first box but rather go to the *other* box and extract the toy for him.

We began by trying the procedure with 2.5-year-olds in Study 1, then tested 16- and 18-month-olds in Study 2. To pass this test children must understand false beliefs in a way that goes beyond simply taking special notice of unusual events; they must understand *why* the person is doing what he is doing in terms of his beliefs about the world – in order to interpret his goal correctly and so to provide the appropriate help. They must use their understanding to respond appropriately in a real social interaction. If the 1-year-olds were successful, this would represent by far the youngest age of false belief understanding in a test with an active behavioral measure.

2. Study 1

2.1. Method

2.1.1. Participants

Participants were 24 German 2.5-year-olds (mean age = 31;3; range = 30;0–32;0; 12 girls). Seven additional children were tested but had to be excluded from analyses because of experimenter error (5), fussiness (1), or other complications (1).[2] Half of the children were randomly assigned to the false belief and half to the true belief condition.

2.1.2. Materials

Materials for the test were a stuffed caterpillar toy (25 cm long) and two wooden boxes (30 × 30 × 30 cm; one yellow, one pink; see Fig. 1),[3] each with a hinged lid and handle on top. The lids of the boxes could be locked shut by putting a wooden pin (3.5 × 15 cm) into a hole in front of the box.

2.1.3. Procedure

The child sat on a cushion equidistant to and 1 m from the two boxes, which were approximately 80 cm apart (the side the yellow box was on was counterbalanced). A pin was lying on the floor in front of each box. A female experimenter, E1, sat next to the child and a male experimenter, E2, sat between the two boxes facing the child and E1.

After warm-up play with unrelated toys, E2 noticed the boxes and explored them, one after the other, by lifting the lid twice with much interest. He then announced that he was going to go get another toy and left the room. While E2 was away, E1 taught the child how the boxes could be locked and unlocked with the pin. When the child had successfully opened each box twice in turn without E1's help, they returned to their position on the cushion between the boxes.

At this point E2 re-entered the room and excitedly showed the child and E1 the caterpillar toy for about 90 s. E2 then announced that he was going to put the caterpillar away and moved back to his starting position between the boxes. He looked at one box, then the other, and put the toy in the second box (which box this was fully counterbalanced), saying, "I'll put it in here." What happened next differed according to the experimental condition.

For children in the false belief condition, E2 said he had forgotten his keys outside, and thus left the room, closing the door. E1 pointed out to the child that E2 was not present and therefore could not see, and invited the child to "play a trick" on E2. E1 and the child approached the box with the toy inside. While alternating gaze systematically between the box, the child, and the door (to ensure that E2 was not there) throughout, E1 lifted the lid, took the toy out of the box, and closed and locked the box with the pin. She then moved the toy to the second box and closed and locked the box with the pin. She did this in a 'sneaky' way, giggling and gesturing casually "Shh" at the end to keep the child from telling E2 about the switch when he returned. Then they went back to the cushion, at which point E2 re-entered the room.

For children in the true belief condition, E2 stayed in the room during the switch and sat down, centered, behind the boxes. E1 pointed out to the child that E2 was present and therefore could see, and invited the child to join her. E1 and the child approached the box with the toy inside. While alternating gaze systematically between the box, the child, and E2 (to ensure that E2 was watching) throughout, E1 moved the toy to the other box exactly as in the false belief condition, but with no sneakiness. During each step of the switch, E2 said softly, "Aha," to emphasize that he was watching. However, he looked away briefly (to tie his shoes) each time a box was locked with a pin. After the toy had been moved and E1 and the child were on their way back to the cushion, E2 noticed that he had left the

[1] See Matsui and Miura (2008) for another, more complicated measure of false belief understanding using a helping paradigm with older children.

[2] This child was dropped because in effect she switched experimental conditions: she verbally informed E2 of the new location of the toy as he entered the room and, clearly assuming that his belief was updated, then acted according to what she assumed his "new" goal to be by opening the box he acted on. Note that including her or not did not affect the significance of results.

[3] For interpretation of color in Fig. 1, the reader is referred to the web version of this article.

Fig. 1. E2 pulling on the lid of the box he had put the toy in, right before the response period.

door ajar, got up to close it, and turned around so that he was in the same position as in the false belief condition at this point of the procedure.

In both conditions, E2 then approached from the door, stopped at a centered position between the boxes, and then looked at one box, then the other, very briefly, saying, "So." He approached the box he had looked at last – always the now-empty one he had put the toy in originally, before the switch – kneeled down behind it, and pulled on its handle for 1 s (two short pulls; see Fig. 1). He paused briefly, saying, "Hm," then sat in a centered position behind the boxes showing signs of disappointment, puzzlement, and resignation, and alternating gaze slowly between a spot on the floor in front of him and the child's face (never looking at either box). As soon as he was centered, the response period started and the child was allowed to approach the boxes. If the child hesitated to approach, the experimenters provided encouragement systematically, as needed: after 10 s, E1 said, "Go on, you can help him!", then repeated this after a further 5 s. After five more seconds, E2 asked if the child could help him. After five more seconds E1 offered to go with the child and "help together" (in this case she followed along behind the child). Finally, if needed, 5 s later E2 asked the child to "open a box."

The first author coded which box children opened (or else chose by touching) first. To assess reliability, a naive coder independently coded 100% of trials blind to condition. Perfect agreement was achieved. All p values reported are two tailed.

2.2. Results and discussion

All children chose a box, removed the pin, and opened the lid; most (75%) did so very quickly, either before any encouragement or else after E1's first encouragement cue. The box they chose differed significantly between conditions, $\chi^2(1, N = 24) = 8.22$, $p = .004$, see Fig. 2. In the true belief condition, 75.0% of children correctly opened the box E2 had just tried to open, apparently assuming that since he knew the toy was in the other box he must want to open this one for some reason. In contrast, in the false belief condition 83.3% of children correctly opened the *other* box, the one containing the toy, apparently assuming that E2 was trying to open the first box in order to get the toy – but had a false belief as to where the toy was.

These main choice results are corroborated by children's spontaneous communicative responses, which varied appropriately across conditions as well. In the false belief

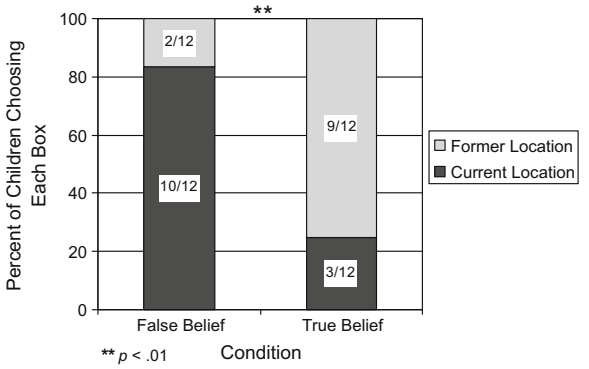

Fig. 2. Study 1: the percentage of 2.5-year-olds who chose each box – either the one with the toy in it (current location; correct in the false belief condition) or the one E2 had just acted on (former location; correct in the true belief condition) – in each condition. Numbers within the bars show the number of children who chose each box.

condition, as (or even before) E2 tried to open the box, seven children attempted to inform him about the new location of the toy (whereas in the true belief condition only one child did this). In the true belief condition, in contrast, three children talked to E2 about the pin, whereas only one child did this in the false belief condition. Two-and-a-half-year-old children thus showed clear evidence of false belief understanding in this pilot study by helping in different ways depending on whether the experimenter had a true or a false belief about where his toy was.

3. Study 2

In Study 2 we tested whether this procedure would work with infants. Since instrumental helping is really just beginning in infants at around 14 months of age (see Warneken & Tomasello, 2006, 2007), we chose to test 16- and 18-month-olds, but expected a relatively high attrition rate due to no-helping responses.

3.1. Method

3.1.1. Participants

Participants were fifty 18-month-olds (mean age = 18;0; range = 17;15–18;15; 24 girls) and fifty 16-month-olds (mean age = 16;3; range = 15;18–16;21; 24 girls). Additional infants were tested but not included because of parental (10) or experimenter error (8), fussiness (12), or because they wanted to take the caterpillar out of the second box during the switch and were therefore verbally prohibited by E1 to do so (which could have affected their future response behavior; six 18-month-olds, seven 16-month-olds).

A further ten 18-month-olds and twenty-two 16-month-olds participated but helped only with parental assistance. Because we could not be certain that parents did not subtly influence infants' responses in this case, below we present two sets of analyses, a main one without these infants included and one with them included. A further eighteen 18-month-olds, and twenty-six 16-month-olds did not help at all and therefore could not be analyzed.

3.1.2. Procedure

The procedure was the same as in Study 1 except that we included infants' parent in the encouragement procedure of the response phase. If infants did not help after the experimenters' encouragement, at the end of the response phase parents were prompted to say, "Go on, help him!" If infants still did not help for five more seconds, E2 suggested that they bring their parent and "help together." Parents then got up, offered a hand to infants, and let infants dictate where to go. The side of the yellow box and the side of the box E2 put the toy in before the switch were fully counterbalanced for the full sample of infants. Perfect inter-observer agreement was achieved (on 100% of the data).

3.2. Results and discussion

3.2.1. Eighteen-month-olds

All infants chose a box, at least by touching, if not opening it. As with the 2.5-year-olds, their performance differed significantly between conditions, $\chi^2(1, N = 50) = 15.91$, $p < .001$, see Fig. 3. In the true belief condition, 84.0% of infants correctly went to the box E2 had just tried to open whereas in the false belief condition 72.0% of infants correctly went to the *other* box, where the caterpillar toy was hidden. When analyzed separately, infants' performance differed from chance level in both conditions (binominal tests; true belief: $p = .001$; false belief: $p = .043$).

Similar results were found when infants who helped only with parental assistance were included, $\chi^2(1, N = 60) = 17.18$, $p < .001$: 23 out of 29 infants (79.3%) went to the box E2 had just tried to open in the true belief condition and 23 out of 31 infants (74.2%) went to the box with the toy in it in the false belief condition.

3.2.2. Sixteen-month-olds

All infants chose a box, at least by touching, if not opening it. Their performance, too, differed significantly between conditions, $\chi^2(1, N = 50) = 6.88$, $p = .009$, see Fig. 4. In the true belief condition, 56.0% of infants correctly went to the box E2 had just tried to open whereas in the false belief condition 80.0% of infants correctly went to the other box. When analyzed separately, infants' performance differed from chance level in the false belief condition (binominal test; $p = .004$), but not the true belief condition (binominal test; $p = .690$).

Similar results were found when infants who helped only with parental assistance were included, $\chi^2(1, N = 72) = 6.00$, $p = .014$: 17 out of 32 infants (53.1%) went to the box E2 had just tried to open in the true belief condition and 30 out of 40 infants (75.0%) went to the box with the toy in it in the false belief condition.

At both ages, these main choice results are corroborated by infants' spontaneous communicative responses, which differed across conditions as well. In the false belief condition, as (or right after) E2 tried to open the box, 10 infants (three 18-month-olds and seven 16-month-olds) communicated to E2 the actual location of the toy (mainly by

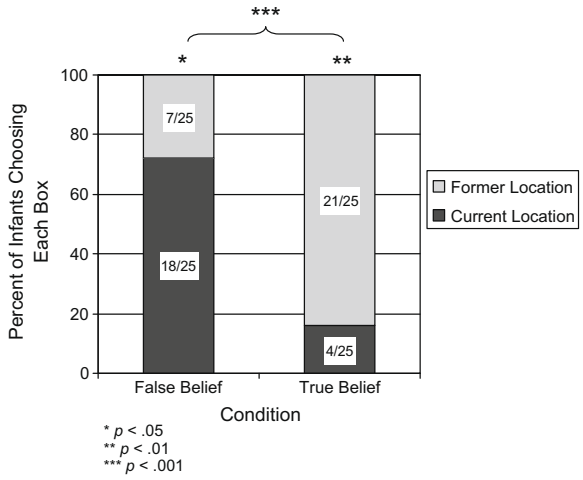

Fig. 3. Study 2: the percentage of 18-month-olds who chose each box – either the one with the toy in it (current location; correct in the false belief condition) or the one E2 had just acted on (former location; correct in the true belief condition) – in each condition. Numbers within the bars show the number of children who chose each box.

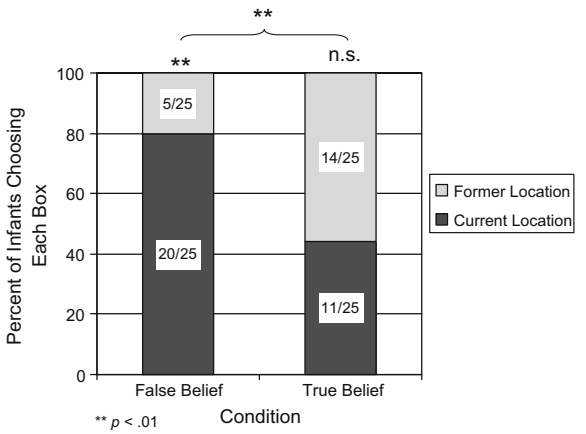

Fig. 4. Study 2: the percentage of 16-month-olds who chose each box – either the one with the toy in it (current location; correct in the false belief condition) or the one E2 had just acted on (former location; correct in the true belief condition) – in each condition. Numbers within the bars show the number of children who chose each box.

pointing), whereas in the true belief condition only four infants (two in each age group) did this. In the true belief condition, in contrast, six infants (five 18-month-olds and one 16-month-old) pointed toward the pin of the box E2 had just tried to open, whereas only two infants (one in each age group) did this in the false belief condition. Together, these results show that by 18 months and possibly by 16 months of age infants clearly make use of their understanding of others' false beliefs to help them appropriately.

4. General discussion

Classic tests of false belief understanding are convincing because successful children, in the most natural interpretation, must imagine the contents of an actor's mental states, and based on what they imagine those mental states to be, choose an appropriate behavioral response (e.g., naming or pointing to the box where the actor will go). The recent looking-time studies of younger infants investigate false belief understanding in a way that does not require them to act in response, that is, to choose an action based on their understanding; infants basically show different levels of interest in different situations. For many researchers, therefore, it would be useful to have studies with infants that employ more active and demanding behavioral measures. Using such active behavioral measures in a natural social context, the current studies provide the first evidence that infants as young as one-and-a-half-years can act appropriately based on an understanding of others' false beliefs.

Eighteen-month-olds showed clear evidence of this understanding, whereas the results for 16-month-olds were somewhat less compelling. Like the 18-month-olds, the 16-month-olds behaved differently in each condition, appropriately choosing the box with the caterpillar more often in the false belief condition than in the true belief condition. However, their results were not strong enough to reach significance against chance level in the true belief condition. It is possible that these younger infants possess an understanding of others' beliefs, but that task demands prohibited them from demonstrating this understanding fully in our study. For example, our dependent variable might have been too demanding for them, as instrumental helping behavior is just getting off the ground at this age (see Warneken & Tomasello, 2006, 2007), or they may have had difficulty inhibiting going for the caterpillar toy in the true belief condition. On the other hand, it is possible that the active use of false belief understanding is still developing at this age, and is only fully evident by 18 months of age. Future research is needed to investigate young infants' theory of mind abilities using a variety of different tasks.

The current study, in our opinion, requires the active imagining of others' beliefs, like the classic tests. It does not require *predicting* others' behavior based on imagining their mental states, as in the classic tests, but it does require interpreting and making sense of others' behavior in such terms, and making active use of this understanding in social interactions (as in studies of 3-year-olds' false belief understanding, e.g., Carpenter et al., 2002). More precisely, in the current study, when children were faced with the adult struggling to open a box, they had to imagine what the goal of this behavior was – in the sense of the adult's mental representation of the state of the world he desired – and they had to do so differently in the different conditions based on his beliefs about the current state of the world (i.e., whether or not he believed the toy was in the box).

In all studies of false belief understanding, a key interpretive challenge is to distinguish an understanding of false belief from an understanding of knowledge-ignorance. This challenge applies even to the standard verbal false belief task: the child in the false belief condition might reason that the returning protagonist is ignorant about the location of the toy (which was switched when she was out of the room) and so she will just go where she saw it last (which is the correct answer). However, several studies suggest that children are not using this strategy, either in the standard verbal tests or in other tasks (Garnham & Ruffman, 2001; Lohmann, Carpenter, & Call, 2005; Southgate et al., 2007), and a recent study by Song, Onishi, Baillargeon, and Fisher (2008) suggests that infants in the current age range do not use this strategy either.

We also do not believe the knowledge-ignorance interpretation is a plausible one for our study. The reason is that to respond appropriately the child must do more than simply imagine the experimenter with a blank thought bubble in his head (representing ignorance), but rather the child must imagine a thought bubble in E2's head that has actual cognitive content driving his behavior. The key moment is when E2 is trying unsuccessfully to get into the box, and clearly needs help. The child wants to help. What should she do? Apparently, the most natural thing is to help E2 get into that box – this is what children from 18 months on do at least ¾ of the time in the true belief condition when everyone has watched together as a toy was moved out of that box into a new one. But in the false belief condition, when E2 did not witness the moving of the toy, children did something different: most children went to the

other box and retrieved the toy. On what basis did they do this? Why did they not just help E2 open the box as in the other condition?

The most plausible explanation for this behavior, in our opinion, is that children imagined (as it were) a thought bubble in E2's head containing the desired toy in the box he put it in: he is trying to get into the box because he believes the toy is in there (he saw it go in there but did not see it go out), and so that must be what he wants. If children in this false belief condition were simply attributing to E2 a blank thought bubble of ignorance, then they would have no reason to go retrieve the toy – unless one thinks that somehow the toy is especially salient on its own. But then – flipping back to the true belief control – one must explain why they do not find the toy especially salient when everything is exactly the same but E2 was in the room when its location was switched. To override the tendency to simply help E2 open the box, which is their most frequent natural response (and a kind of 'pull of the real'), children in the false belief condition had to attribute to E2 the false belief that the toy was in there. Thus, the main logic of the current study – and what makes it a study of false belief, in our opinion – is that without an understanding of E2's false belief children cannot help him appropriately because they cannot know that he wants the toy.

The current study thus provides a simple, nonverbal – but still active, behavioral – measure of false belief understanding suitable (or adaptable) for use with other nonverbal populations. It provides much-needed converging evidence for the surprising findings of recent looking-time studies claiming false belief understanding in 1-year-old infants. It thus adds to an ever-growing body of evidence – also gained from a variety of active response measures – that early in the second year of life infants understand and interpret others' behavior in terms of an extensive collection of mental states, including their goals, intentions, desires, knowledge/ignorance, and, now, false beliefs (e.g., Behne, Carpenter, Call, & Tomasello, 2005; Buttelmann, Carpenter, Call, & Tomasello, 2008; Repacholi & Gopnik, 1997; Tomasello & Haberl, 2003). Whether their false belief understanding is of the same nature as that which 5-year-old children show in the classic, verbal tasks is an open question.

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