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Brief Report

Eighteen-month-olds understand false beliefs in an unexpected-contents task

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ABSTRACT

Recent studies suggest that infants understand that others can have false beliefs. However, most of these studies have used looking time measures, and the few that have used behavioral measures are all based on the change-of-location paradigm, leading to claims that infants might use behavioral rules instead of mental state understanding to pass these tests. We investigated infants' false-belief reasoning using a different paradigm. In this unexpected-contents helping task, 18-month-olds were familiarized with boxes for blocks that contained blocks. When an experimenter subsequently reached for a box for blocks that now contained a spoon, infants based their choice of whether to give her a spoon or a block on her true or false belief about which object the block box contained. These results help to demonstrate the flexibility of infants' false-belief understanding.

Introduction

"Theory of mind" is about predicting and explaining the actions of others by invoking their mental states such as goals and beliefs (Premack & Woodruff, 1978). For decades, it was thought that children first begin to understand that others can sometimes hold false beliefs at around 4 or 5 years of age (see

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Wellman, Cross, & Watson, 2001, for a review). This conclusion was based on studies using two different types of false-belief tests: (a) the change-of-location test, in which an object is moved in the absence of a story character (e.g., the "Sally–Anne" test; Baron-Cohen, Leslie, & Frith, 1985; Wimmer & Perner, 1983), and (b) the unexpected-contents test, in which a box does not contain what it is supposed to contain (the "Smarties" test; Hogrefe, Wimmer, & Perner, 1986; Perner, Leekam, & Wimmer, 1987). However, several recent studies have claimed false-belief understanding in 1-year-olds or even younger infants (see Baillargeon, Scott, & He, 2010, for a review).

The primary reason for the difference between these two sets of findings might be the explicit versus implicit methods used; the classic tests passed by preschoolers are explicit verbal tests, whereas the tests passed by infants use implicit measures such as looking time (e.g., Kovács, Téglás, & Endress, 2010; Onishi & Baillargeon, 2005; Surian, Caldi, & Sperber, 2007) and anticipatory looking (Clements & Perner, 1994; Southgate, Senju, & Csibra, 2007; Surian & Geraci, 2012; see Sodian, 2011, for a review). Researchers have also designed studies in which infants are asked to *act* based on their understanding of a protagonist's beliefs. For example, Buttelmann, Carpenter, and Tomasello (2009) presented 16- and 18-month-olds with an experimenter who put a toy into one of two boxes and left the room. In his absence, an assistant "sneakily" transferred the toy to the other box and locked both boxes. When the experimenter returned and tried to open the first box, infants helped him by going to the box that now contained the toy—inferring that because the experimenter believed the toy to be in the first box, he wanted his toy. In contrast, in a true-belief condition, in which the experimenter watched the switch of the toy but nevertheless then tried to open the empty box, infants went to the empty box and showed him how to open it—inferring that, because the experimenter knew the current location of the toy, he wanted to open the empty box for some other reason. Thus, infants interpreted the experimenter's goal differently depending on whether he believed his toy to be in the box he tried to open or not (see also Knudsen & Liszkowski, 2012a, and Southgate, Chevallier, & Csibra, 2010, for other behavioral tasks with 1-year-olds).

The literature on infants' understanding of false belief, however, has proved to be deeply controversial. Some researchers have argued that, in many of the implicit tests, infants do not necessarily need to attribute beliefs to the protagonist but might instead solve the tasks by matching observed test events to associations built during the familiarization phase or by using behavioral rules rather than mentalistic understanding (Apperly & Butterfill, 2009; Perner & Roessler, 2012; Perner & Ruffman, 2005; Rakoczy, 2012; Ruffman & Perner, 2005). One possible rule infants could employ is that *people look for objects where they last saw them.* Explanations such as this apply primarily to change-of-location tasks. For this reason, it is important to test infants in a variety of tasks, scenarios, and paradigms (Perner, 2010). If infants are able to pass multiple different tasks, an explanation based on belief understanding gains increased plausibility.

There are a few studies that are not based on the change-of-location paradigm, and still 1-year-olds show differences between conditions. For example, 18-month-olds seem to attribute false beliefs about an object's identity or properties (Scott & Baillargeon, 2009; Scott, Baillargeon, Song, & Leslie, 2010). Most relevant for the current study, Song and Baillargeon (2008) presented 14.5-month-olds with two objects: a stuffed skunk and a doll with blue pigtails. After familiarizing infants with the experimenter reaching for the doll, both objects were put into opaque boxes without the experimenter watching. Importantly, there was a tuft of blue hair protruding from the box containing the skunk. When the experimenter returned, infants looked significantly longer when she reached for the box containing the doll than when she reached for the box containing the skunk, demonstrating their expectation about the experimenter wanting the doll and being deceived by the tuft of blue hair. Although these studies do not use the change-of-location paradigm, they all use the same measure: looking time. Whereas looking time differences can clearly indicate, for example, a discrimination, an expectation, or a preference, behavioral measures go beyond this by showing that infants can translate their understanding into appropriate action. This is important because in real-world social interactions, children often need to actually respond to their partners (e.g., help or warn them about something; Buttelmann et al., 2009; Knudsen & Liszkowski, 2012a) based on the partners' false belief rather than just understand that they have one.

So far, all behavioral studies of infants' false-belief understanding have used change-of-location tests; thus, other types of tasks are needed. A further potential issue is that in most of the behavioral studies, there was a cue for infants that something unusual was going on, that is in the false-belief condition, an assistant transferred the object in a "sneaky" manner. This cue could have drawn infants' attention to the correct answer (the transferred object) in the false-belief condition, whereas it was not present in the true-belief condition (note that in the one behavioral study that did not involve sneakiness, there was no corresponding true-belief condition; Knudsen & Liszkowski, 2012b). Sneakiness has been shown to boost children's performance in verbal false-belief tests (Wellman et al., 2001), but this better performance does not necessarily reflect a better understanding of the others' mental states (Sodian, Hülsken, & Thörmer, 1999). Therefore, converging evidence from studies using different paradigms, and from procedures not involving sneakiness, is needed to investigate infants' flexibility in ascribing false beliefs to others.

In the current study, we presented 18-month-old infants with a new test modeled closely on the classic unexpected-contents (Smarties) test (Hogrefe et al., 1986; Perner et al., 1987) with no sneakiness. An assistant introduced infants to a series of boxes covered with pictures of children's building blocks. Together with an experimenter, infants experienced that each of these "block boxes" contained a block. However, right before the test, one of the boxes (the *target box*) surprisingly did not contain a block but rather contained a spoon. What differed between conditions was whether the experimenter was present during that experience and therefore knew about the surprising contents (true-belief condition) or whether she was absent and so would believe that there was a block in this box too (false-belief condition). In both conditions, the experimenter subsequently reached for the target box unsuccessfully. The assistant invited infants to help and get what the experimenter wanted by giving them access to two test objects: a block (correct in the false-belief condition) and a spoon (correct in the true-belief condition). To interpret the experimenter's goal correctly and help appropriately, infants must understand what the experimenter expected to find inside the box based on her belief about its contents. If they could do this, it would demonstrate their flexibility in attributing belief states to others and would rule out sneakiness as a possible explanation for their positive results in other behavioral studies.

Method

Participants

Participants were 36 18-month-olds (mean age = 18 months; 9 days, range = 17;18–18;27, 17 girls and 19 boys). Half of the infants ($n = 18$) were assigned to each condition in a between-participants design. An additional 21 infants were tested but not included in the main analyses because of parental or experimenter (E) error ($n = 4$), because they gave one of the test objects to their parents ($n = 4$) or only touched or took an object for themselves ($n = 7$) (which made it unclear whether their choice was related to what E wanted), or because they did not choose an object at all ($n = 6$). Infants were recruited from a database of parents who had agreed to participate in child development studies.

Materials

Materials were four identical brown cardboard boxes ($25 \times 17 \times 9$ cm), with pictures of plastic (Lego Duplo) blocks on four sides (front, left, right, and top). Three familiarization boxes each contained a plastic block (yellow, blue, or purple), and the fourth box (the target box) contained an orange plastic spoon. Before the test, another block and spoon (both red) were hidden under a piece of cardboard (100×50 cm) in fixed positions equidistant to the infants (see Fig. 1).

Procedure

After a warm-up period, E and the assistant (A) sat on the floor, and infants sat on a cushion 1 m away from E and A (parents sat on a chair in the corner) (see Fig. 1). There were four identical boxes on a shelf opposite infants.

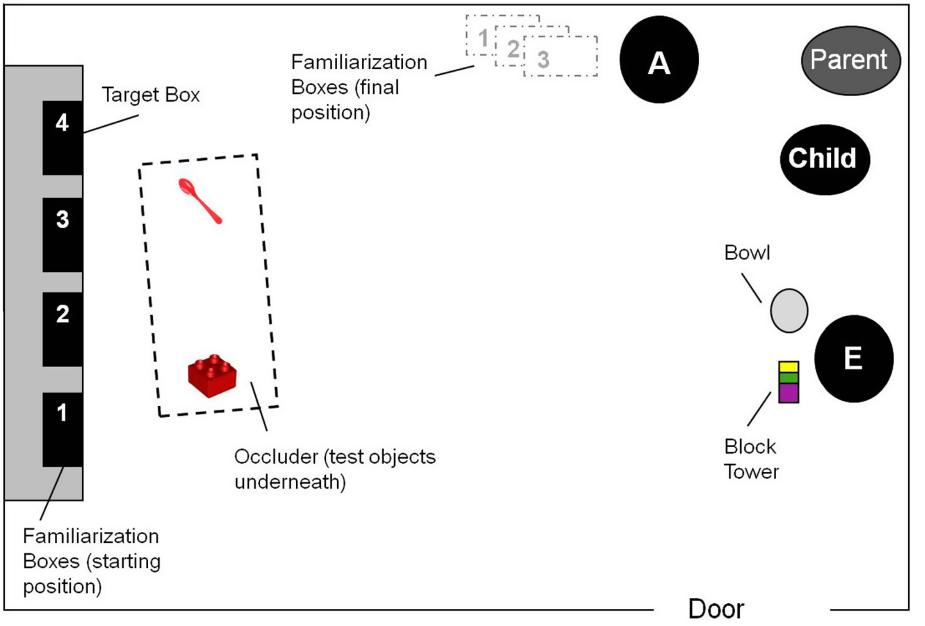

Fig. 1. Set-up of the study materials. Note that the test objects (i.e., spoon and block) were under an occluder and therefore not visible to anyone in the room before the test.

E and A began by wondering what to play, and A suggested getting a "block box." E agreed, and A went to the shelf. On her way there, again she mentioned getting a block box (this and the following repetitions of the term *block box* were designed to ensure that infants understood this was the accepted name for this box). She took the first box from the shelf and returned to infants. She mentioned that she now had a block box, pointed out the pictures of blocks on the box, and opened the box and found a block inside. She gave E the block and put the empty box aside. E put the block on the floor in front of her and then announced that she "wanted some more," so they repeated this procedure for the second and third boxes, resulting in a small block tower in front of E. What happened next differed according to condition.

In the *false-belief* condition, E left, saying that she needed to do something outside. Next, A said that she would get the fourth block box (the target box) despite E's absence, and she did so. After returning to infants, she pointed out that E was not present and therefore could not see. She opened the box such that infants were the first to see the unexpected contents (a spoon, not a block) and then turned the box around and discovered the unexpected contents herself. She expressed her surprise to infants about the contents by looking at the pictures on the box and comparing them with the actual contents, mentioning that this is a block box that does not contain a block but rather contains a spoon ("a spoon in the block box!"). Then she put the target box back onto the shelf and wondered aloud where E might have gone.

In the *true-belief* condition, E stayed in the room when A got the target box. Next, A pointed out to infants that E was present and therefore could see and then opened the box, and all three discovered the unexpected contents. As in the other condition, A commented on the discrepancy between the pictures on the box and the contents, but in this condition E conveyed that she was paying attention throughout with short remarks (e.g., "Hm!", "That's strange!"). After A had put the box back on the shelf, E left, saying that she needed to do something outside. After 2 s, A wondered aloud where E might have gone.

In both conditions, E then returned with an empty plastic bowl in her hand. She brought the bowl to make it plausible for infants that at test she could want either another block to put on the block tower or a spoon to use with the bowl. After sitting down again, she placed the bowl next to the block tower and mentioned that she had found the bowl outside. She looked at a centered spot in front of her (between the bowl and block tower), touched the bowl and block tower simultaneously (pretending to adjust them), and said, "Now I'm looking for . . .," with her voice trailing off without naming anything. While saying this, first she looked around the room, and then looked at the target box and reached toward it. During this time, A pretended to be busy, leaning away from E and infants. Then E addressed A, telling her "I need it" (ambiguously) while still reaching for the target box. Then, A looked up, alternating gaze between E's reaching hand and the target box, but did not respond. E, disappointed about A's lack of help, stopped reaching, looked down, and showed signs of disappointment, puzzlement, and resignation. As soon as E looked down, A told infants to look and got up and removed the occluder covering the two test objects (a spoon and a block), saying, "I have it here too," looking at both objects together. She sat down and encouraged infants to "go and get it for [E's name]" twice and then looked away again.

Parents had previously been instructed to pick infants up and silently put them on their feet at this point in order to increase the likelihood that infants would approach the test objects. If infants hesitated to approach, A provided encouragement systematically as needed. After 10 s, she repeated, "Go on, get it for [E's name]!" After an additional 10 s, A offered to go with infants and "get it together for [E's name]" (in this case following infants to ensure that she did not assist them). After a further 5 s, parents were signaled to read aloud a sentence from a sign on the wall ("Come on, [infant's name], go and get [E's name] what she wants!"). If infants still did not help after 5 s, A suggested that they bring their parents and "go and get it together." Parents then got up, offered their hands to infants, and followed behind them, letting them lead. If infants still did not get an object for E after an additional 10 s, the trial was over.

As soon as infants started to approach the test objects, E rested her right hand on her knee and held it open for infants to put something in it. We coded which test object (spoon or block) infants gave to E, either directly or by putting the block onto the tower or the spoon into the bowl. To assess reliability, a naive coder independently coded 25% of trials (randomly chosen) in each condition while blind to condition. Perfect agreement was achieved. All p values reported are two-tailed.

Results

The object that infants gave to E differed significantly between conditions, $\chi^2(1, 36) = 4.00$, $p = .046$, $\omega = .33$ (see Fig. 2). In the true-belief condition 66.7% of infants correctly gave E the spoon, whereas in the false-belief condition 66.7% of infants correctly gave E the block. Most infants (86%) responded

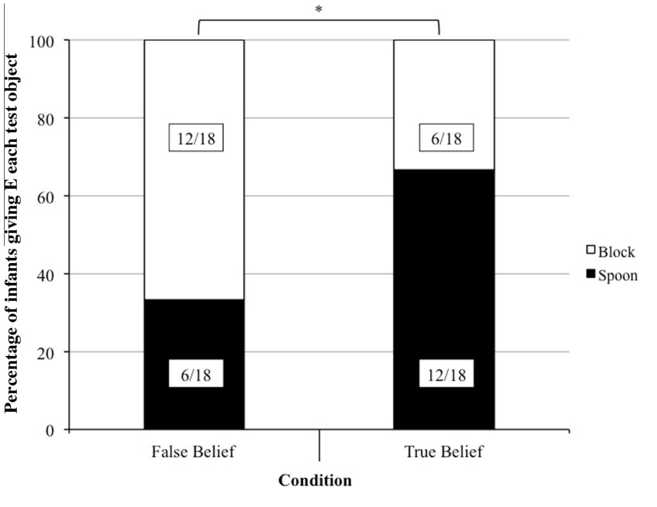

Fig. 2. Percentage of infants who gave E each test object in the two conditions. Numbers within the bars show the number of infants who gave each object. *$p < .05$, chi-square test.

after only A's encouragement alone without any adults following them. Very similar results were found when excluding the 5 infants who were accompanied by adults; in the true-belief condition 64.7% of infants gave E the spoon, whereas in the false-belief condition 71.4% gave E the block, $\chi^2(1, 31) = 4.01$, $p = .045$, $\omega = .36$. (In addition, for what it is worth, including the 11 excluded infants who chose an object for themselves or their parents gives a similar pattern of results, $\chi^2(1, 47) = 2.84$, $p = .092$, $\omega = .26$.)

Discussion

These results demonstrate false-belief understanding in infants using an unexpected-contents helping task. In the true-belief condition, in which the experimenter knew that there was a spoon in the target box, most infants gave her the spoon, whereas in the false-belief condition, in which the experimenter falsely believed that there was a block in the target box, most infants gave her the block (despite needing to set aside their own knowledge that the target box she was reaching for actually contained a spoon). Importantly, infants passed even though there was no sneakiness involved in this study. On discovering the unexpected contents of the target box, the assistant was surprised, but in both conditions she was equally surprised. Thus, although sneakiness might help children to focus on the mental states of the protagonist in behavioral studies (Wellman et al., 2001), it is clearly not necessary. Using a novel task, our results contribute new evidence that infants track the true and false beliefs of others and use these beliefs to determine how best to help them.

Our results extend those of previous infant false-belief studies by demonstrating the flexibility of infants' understanding. Infants' abilities are not tied to one specific paradigm (change-of-location tests); infants also successfully infer false beliefs in an unexpected-contents paradigm (see also Song & Baillargeon, 2008, for a type of unexpected-contents looking time study). The unexpected-contents task used in the current study, like the classic Smarties test, is more complex than the change-of-location task in the sense that infants must understand that the current content of the box violates people's general expectations about what such a box should contain. Note that the experimenter had never actually seen a block in the target box; infants needed to infer her belief based on her (and their) experience with other similar boxes. Whereas in change-of-location tasks infants only need to remember the location in which the protagonist had put the object, in unexpected-contents tasks infants' representation of the experimenter's belief has some content about what object the experimenter expects to find in the box based on her general knowledge, not her specific past behavior.

If infants passed the current task based only on a behavioral rule, this would need to be a different rule from the one that could be used to pass change-of-location tests (i.e., that people look for things where they last saw them). Obviously, it is possible to come up with another behavioral rule for this task post hoc, for example, that *people expect to find what is pictured on the outside of a box inside that box*. However, this rule would lead to success only in the false-belief condition. In the true-belief condition, another rule is needed (e.g., that *people expect to find in a box what they have already seen inside that box*). Consequently, two different rules would be needed to pass the current test, and three different rules in total would be needed to succeed in the two different paradigms. In contrast, the attribution of beliefs produces correct answers in both of them. Therefore, we take the current results as converging evidence for infants' ability to attribute (false) beliefs to others (Carruthers, 2013; Leslie, 1994; Leslie & Polizzi, 1998).

What, then, does infants' understanding of others' beliefs entail? One possibility is that it is as sophisticated as that of preschoolers (Carruthers, 2013). Another is that it is more limited but still more sophisticated than a simple rule. Apperly and Butterfill (2009) proposed a two-system account, with different systems being at work in the implicit looking and behavioral tasks compared with the explicit verbal tasks. Whereas participants' inference of others' beliefs in explicit tasks is supported by a flexible but effortful system to track beliefs, infants solve implicit tasks based on a fast but limited and inflexible system to track belief-like states of others. That is, they base their responses on what others register or experience instead of their beliefs (see also Perner and Roessler, 2012). Further research is needed to distinguish between these possibilities.

By providing a nonverbal—but still active behavioral—measure of false-belief understanding that is different in important ways from previous similar tests (e.g., a different paradigm, no sneakiness involved), we have demonstrated the flexibility of infants' false-belief understanding. Again, whether this early understanding is of the same nature as that found in older children, whether children's performance in this test will be related to their later performance in the explicit unexpected-contents test, and whether infants could solve more sophisticated versions of these tasks are still open questions (see Apperly and Butterfill, 2009, and Rakoczy, 2012, for further hurdles to clear). By investigating these complexities, we can start to understand how sophisticated infants' belief understanding is and where the limits to it lie.

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