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Three- and 5-year-old children know their current belief might be wrong

Katharina Helming [a,1], Cathal O'Madagain [b,*,1], Michael Tomasello [c]

[a] Department of Psychology, University of Warwick, Coventry CV4 7EQ, UK
[b] School of Collective Intelligence, Université Mohammed VI Polytechnique, Ben Guerir 43150, Morocco
[c] Department of Psychology, Duke University, Durham, NC 27708, USA

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ABSTRACT

By 4 or 5 years of age, children understand when their own past beliefs were incorrect, or when others' current beliefs are incorrect. In the current study, we asked whether young children understand when their *own current* belief might be incorrect. 3- and 5-year old children (N = 77) made a judgment and then experienced a puppet making a judgment about the same situation. Children of both ages rechecked their evidence more often when the puppet disagreed with them than when it agreed with them (and the nature of their rechecking was different in the two conditions as well). These results suggest that already by 3 years of age children understand that they might currently be wrong, and they know that rechecking the evidence can resolve their uncertainty.

Introduction

Adult humans distinguish between their own subjective beliefs and the objective situation and decide what to believe by evaluating the evidence, often in discussion with their peers. The modern scientific method, indeed, is built on this approach (Popper, 1959/2005). Thus, developing children need to learn that individuals' subjective perspectives may conflict and that individuals may sometimes misrepresent the way the world is "objectively." As they come to think scientifically, they must

* Corresponding author.
E-mail address: cathalcom@gmail.com (C. O'Madagain).
[1] Joint first authors.

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constantly be aware that not only others but also they themselves might be wrong. They are confronted with this possibility often in social contexts when peers disagree with their assertions. They may even initially *learn* that they can be wrong in social contexts: by discovering that their peers disagree with them, they may first realize that their own beliefs may be subject to doubt (O'Madagain & Tomasello, 2021; see also Piaget (1923/2005) and Kuhn (2015)).

Classic false belief tasks demonstrate that by 4 or 5 years of age children recognize when others are in fact mistaken (the "Sally Anne" task) or when they were in fact mistaken themselves in the past (the "Smarties" task) (see Wellman et al., 2001, for a review). In other experimental paradigms, even young toddlers show sensitivity to their own potential ignorance—recognizing that they might lack knowledge of an answer. Goupil et al. (2016) gave 20-month-olds a series of memory tasks, and when the task was too difficult the toddlers opted out and asked an adult for help. Similarly, Call and Carpenter (2001) hid objects from 30-month-olds, and when they had no information about the objects' location, the toddlers actively sought more information. In these studies, however, there is no evidence that participants had already formed a belief that they then considered might be wrong. Rather, the studies presented evidence that toddlers can recognize when they lack information or knowledge. Looking-time studies are passed by even younger infants (Southgate et al., 2007), but they are ambiguous between infants recognizing false beliefs in others and expecting others to search for objects where they were last seen; the location the participants glance toward if they "pass" these studies is also the last location in which the mistaken agents saw the objects. Therefore, it is not clear whether these studies reveal false belief understanding or the ability to keep track of where agents last saw objects they are looking for.

Something not directly investigated in any of these studies is children's ability to recognize that what they currently believe might be wrong. This is a strange gap in the literature in many ways. Given that making effective decisions to navigate our environment depends on having accurate current beliefs, there is much more pressure on us as individuals to understand that we might be currently wrong than there is to notice whether someone else has made a mistake or whether we made a mistake in the past—at which point it is already too late to correct the error. Therefore, it is intuitive that such an ability would emerge earlier than the ability to track others' false beliefs or our own past false beliefs. To identify the emergence of false belief understanding, then, we should arguably be looking at children's ability to recognize that they might currently be wrong.

Some recent studies came close to exploring this. In O'Madagain et al. (2022), pairs of 3- and 5-year-old children were presented with two boxes, one of which had a reward deposited in it, as the children watched. Then children were asked to choose which box the reward was in. When a social partner made a choice that conflicted with the child's choice, even at 3 years of age children sought new information (by taking an additional peek inside the box) before making a final decision, suggesting that peer disagreement made them less certain. However, in this study the children had not made an explicit commitment to one box or the other before they observed the partner make the competing choice. This means that they might not have already formed a belief about the situation and instead simply recognized that they did not yet know one way or the other (like the toddlers in Goupil et al., 2016). Similarly, given that participants were seeking additional information rather than rechecking evidence they had already seen, they may have understood that there was more to the situation than they had yet seen rather than calling into question their evaluation of already seen evidence.

In the current study, we approached this question by testing children's tendency to recheck evidence for their current belief in response to peer disagreement. Peer disagreement has been shown to prompt children to change their belief (Young et al., 2012), suspend judgment (Langenhoff et al., 2023; O'Madagain et al., 2022), raise objections (Köymen et al., 2020), and attempt to integrate conflicting claims (Amemiya et al., 2021; Yang et al., 2023). Therefore, it is a promising context to expect to find evidence for false belief understanding. In the experiment, children were told to decide which of a pair of boxes contained a specific item—for example, "a dog," where one box contained a toy dog and the other contained a toy fox. To find the target, children simply looked in the tops of the boxes and expressed to the experimenter their belief about where it was (by pointing). Then a peer puppet looked in the boxes and either agreed or disagreed with the children's choice (by pointing at the box the child had selected and saying "Yes it's definitely this one" or pointing at the opposite box and saying "No, it's definitely this one"). Children then had the opportunity to recheck the evidence on which

their original decision was based by peeking again into the top of one or both boxes before making a final decision. We interpreted children rechecking the evidence as indicating that they recognized their belief could be wrong. If the children did not understand that they could be wrong themselves in this scenario (perhaps thinking the puppet was wrong or lying), they would have no reason to recheck the boxes; rather, they should simply ignore the puppet and repeat their answer. The fact that the children recheck evidence they have already seen, as opposed to looking for new information, reinforces this interpretation: they recognize that their evaluation of the evidence may have been mistaken. Of course, one cannot suppose that one might be mistaken without understanding that beliefs can be false—and therefore we regard this as an effective way to get at children's false belief understanding. To see how children's performance on the task related to their explicit judgments about beliefs as measured in the classic false belief tasks, we also gave children an explicit false belief task with both a first-person question and a third-person question. We focused on 3- and 5-year-olds because it is between these ages that children's ability to pass the explicit tasks first emerges.

Method

Participants

The sample comprised 36 3-year-olds (mean age = 3;7 [years;months], range = 3;5–3;11; 19 girls) and 41 5-year-olds (mean age = 5;8, range = 5;5–5;11; 17 girls). Children were recruited from kindergartens in a medium-sized German city attended by families of diverse socioeconomic backgrounds. The sample size was determined by the following stopping rule: We wanted to have at least 24 children in each condition that were neither at ceiling or at floor (i.e., peeking all the time or none of the time); therefore, we collected data until this point, yielding slightly different numbers of participants in each age group.

Design and procedure

Children were invited to play a game with an experimenter and a puppet in which they needed to collect six items from a list that the experimenter carried and read to the children and puppet (see Fig. 1). For each item, a pair of boxes was first presented to the children, and the children needed to decide which box contained the named item (each box contained a similar item, only one of which was correct). After the children had made their choice, the puppet looked inside the boxes and either agreed or disagreed with the children about which box contained the target object. The children were now asked again which box they thought contained the target item and could recheck the boxes before making a final decision or not. The design was within-participants. Each participant received six trials, three in each condition, counterbalanced for order. The dependent variable was peeking—whether the children peeked into one box, both boxes, or neither box after the puppet had expressed its belief. After the information-seeking game was over, the experimenter gave the children an explicit false belief task, with both first-person and third-person questions (for full details, see online supplementary material). At the end, the children and puppet got a small reward for playing the game.

Coding and reliability

Whether children rechecked the evidence after the disagreement or agreement of the puppet was coded from video by the experimenter. Rechecking was coded as the children leaning forward to recheck inside one or both boxes (1) before or while making their choice; not rechecking was coded as the children making a choice without rechecking inside either box (0). The boxes were positioned at a height so that the children needed to make a little effort to check, often standing on their toes. A research assistant blind to the study design and hypotheses independently coded a randomly selected 25% of the trials given the same rules. Coders were in excellent agreement (Cohen's kappa; κ = .94). The few disagreements between the coders were resolved by discussion.

Fig. 1. Setup of the information seeking game. The child is positioned between the experimenter and the puppet. The table is adjusted to the individual height of each child participant so that the child needs to get on his or her toes in order to peek into the boxes.

Results

Main test

To test the effect of agreement versus disagreement on children's likelihood to recheck the evidence at different ages, we used a generalized linear mixed model. The full model included a main predictor of condition along with its interaction with age; it also included a random intercept of ID and random effects of sex, item type, and trial number. The null model included all elements apart from condition, age, and their interaction. All data and R-scripts can be found on the Open Science Framework.

The full–null model comparison was significant, allowing us to reject the null hypothesis. We then tested for an interaction with age but found none, and so the interaction term was removed from the model. We then tested for and found a main effect of condition (χ^2 = 10.9, p < .01) (Fig. 2); disagreement was more likely than agreement to elicit rechecking of evidence at both ages.

These results indicate that children at both ages understood that they might be wrong, and when faced with peer disagreement they rechecked their evidence. We note that children peeked quite a lot in both conditions (very often in the agreement condition also); this was not surprising to us given that in a warm-up session we encouraged children explicitly to take an extra look whenever they liked—because without this the children seemed to think it was "forbidden" to do so.

Comparison with explicit false belief tasks

Having administered two explicit false belief tasks, in the classic format (direct questions about a mistaken agent's belief and their own mistaken past belief), we found results consistent with previous studies: children were at or below chance in these tasks at 3 years of age and were above chance at 5 years (see Fig. S1 in supplementary material). We now wanted to understand whether children's

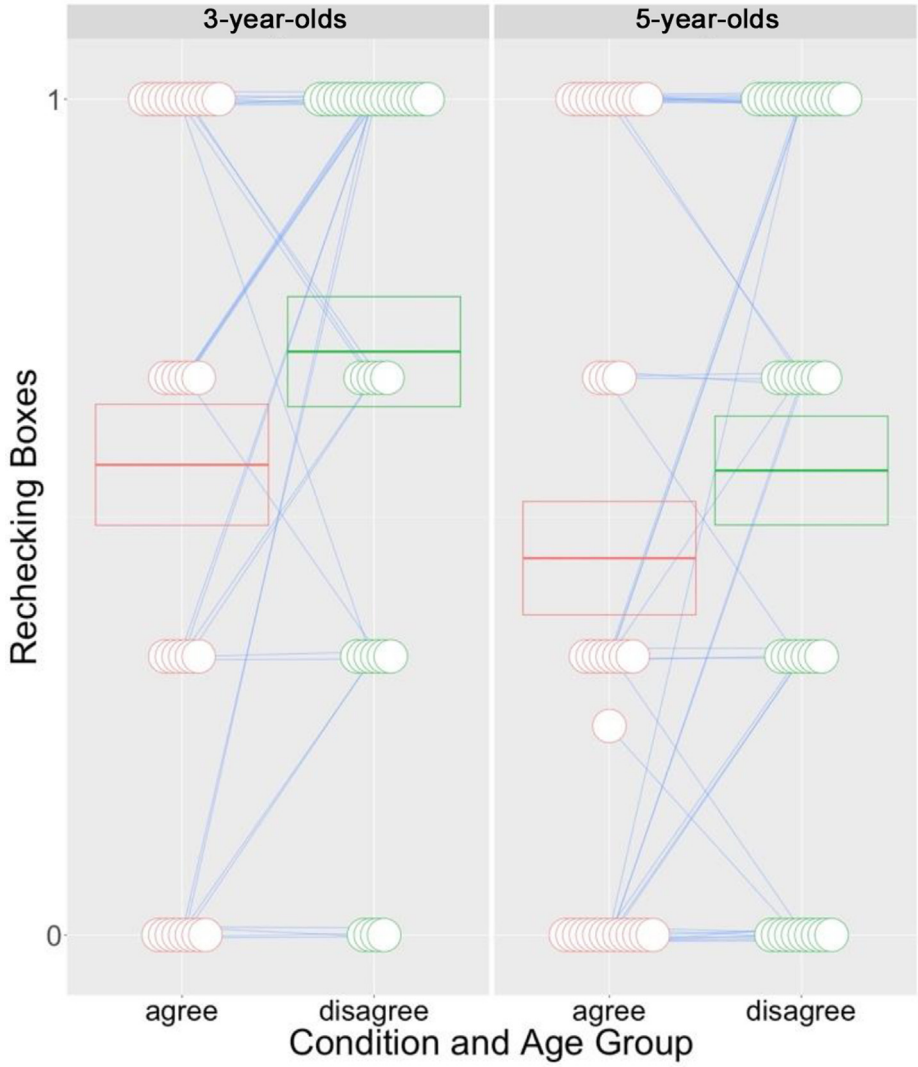

Fig. 2. Rechecking in agree versus disagree condition. Children at both 3 and 5 years of age rechecked more in the disagree condition than in the agree condition. The y-axis represents the frequency of rechecking over (mostly) three trials in each condition. Dots represent individual participants. Boxes represent means and standard errors, dots represent individual averages across trials, and lines connect individuals across conditions. Among 3-year olds, 13 peeked more in the disagree condition than in the agree condition, 5 peeked more in the agree condition, and there were 14 ties. Among 5-year olds, 10 peeked more in the disagree condition than in the agree condition, 5 peeked more in the agree condition, and there were 24 ties.

performance in the current task differed from performance on those explicit tasks. For this, we created a single "performance" score to allow us to evaluate overall performance by task type. First, we created a combined "false belief score," a measure of performance across both false belief tasks, allowing that children might fail both tasks (0) or pass one task (0.5) or both tasks (1). Next, we created a "rechecking difference" score—subtracting the mean amount of rechecking by participants in the disagree condition from that in the agree condition; if this value was positive, children rechecked more when disagreed with than when agreed with, and if it was negative, the reverse was true. Rescaling both variables to a scale from −1 to +1, this gave us a single "performance" metric that we could

use across tasks. We tested for an interaction between age and task type on this measure of performance, where task was a factor with two levels (explicit false belief task or current rechecking task). We found a significant interaction between age and task type ($t = -5.183$, $p < .0001$) (see Fig. S2): children at both ages passed the current task, but children at 3 years performed significantly worse than children at 5 years on the classic tasks. This is not surprising given the initial results: we found no effect of age on the ability of children to differentiate the conditions in the current task, but we should expect a significant effect of age on children's performance in the explicit tasks. An additional test to check whether performance on false belief tasks predicted performance on the current task showed no effect, as should be expected given these results.

Testing for differences in where children checked first

Finally, we tested which box the children rechecked first—the box the children had already chosen or the one the puppet chose. If children were rechecking the boxes because they knew the evidence was relevant to the decision they were making, we might expect that the evidence they checked first would vary from a scenario where their peer agreed on what the right answer was versus where their peer disagreed. Sure enough, testing for an effect of condition with the location of first recheck (the box chosen already vs. the alternative) as the dependent variable was significant (likelihood ratio test: $\chi^2 = 28$, $p < .001$). In the disagree condition, children were more likely to first recheck the opposite box to the one they had chosen than they were in the agree condition (see Fig. S3). In the disagree condition, this is the box the puppet claimed was the correct box. This further supports that participants were rechecking the boxes in order to reevaluate the evidence for their decision; in the Disagree condition, the participants knew that the evidence for the competing choice was more important to recheck than in the agree condition.

Discussion

Both the 3- and 5-year-olds in the current study recognized that their current belief might be wrong. When they observed a social partner making a contradictory choice to their own, they questioned their own original decision. They rechecked the evidence that led to that decision in the first place and affirmed or revised their decision on that basis.

To what extent does this behavior require children to have an understanding of beliefs? In the first step of the study, children looked into the two boxes and formed a belief about which one contained the target item. They asserted this belief by making a choice. This much does not require an understanding of beliefs; in general, merely forming a belief, which infants and many animals can do by simply deciding where to look for food, does not require us to understand that we have beliefs. Opt-out "uncertainty monitoring" tasks do not require understanding of belief either; when participants in these tasks lack or have forgotten information, they can simply avoid making a decision or ask for help to pass the task (Balcomb & Gerken, 2008; Coughlin et al., 2014; Foote & Crystal, 2007; Goupil et al., 2016). But simply recognizing that one does not know how to proceed does not imply one is thinking about one's beliefs. In studies of information-seeking in response to uncertainty, children do a bit more. Engaging in "targeted information-seeking" (Call & Carpenter, 2001; Kloo et al., 2017), they identify just the information needed to resolve their uncertainty (such as peeking in the exact location needed to answer the question they are unsure about), indicating that they know what they do not know and they know what information they need to resolve their uncertainty. The O'Madagain et al. (2022) study required even more. Here, participants formed a belief about the location of a reward and then were faced with discrepant information contradicting that belief. They could have ignored that information, or they could have accepted it and followed its implications, but they did neither of these. Instead, they gathered more information before making their decision. On a rich interpretation, they did this because they recognized that either their belief (or the new evidence) might be unreliable. A shortcoming of the O'Madagain et al. (2022) study, however, is that in the social version of the task the children had not already made an explicit decision before they looked for more information. Therefore, it is unclear whether they were calling into question an already-formed belief

as opposed to not yet having formed a belief at all (like the toddlers in Goupil et al., 2016). In addition, rather than rechecking what they had already seen, they sought new information—again suggesting they might have suspected they did not yet have all the information needed to make a decision. In the current study, children were faced with disagreement regarding a decision they had already made and were given the option to recheck what they had already seen. Their performance in rechecking more when faced with disagreement than with agreement indicates that they were aware the belief they had already formed might be wrong and that they knew how to address this concern by rechecking the evidence relevant to that belief.

The current study makes two contributions to our understanding of children's cognitive development—regarding the development of false belief understanding and regarding the role of peer disagreement in cognitive development.

On the point of false belief understanding, the study indicates that children understand that they might currently be wrong by as young as 3 years of age—significantly earlier than they pass standard false belief tasks, which the 3-year-olds in our study failed. The significant difference between performance on the current tasks and classic false belief tasks needs explaining. We think there are several contributing factors.

First, classic false belief focus either on others' beliefs (e.g., the Sally Anne task (Wimmer & Perner, 1983)) or on the participants past beliefs that they no longer hold (e.g., the Smarties task (Gopnik and Astington, 1988)). The current study, in contrast, focuses on the child's current belief: tasking them with recognizing that what they currently believe might be wrong. Our current beliefs (and potential mistakes) are obviously more relevant to action and decision-making than other people's beliefs or past beliefs that we no longer hold. Therefore, it is natural to expect that young children's understanding that their beliefs can be false will be revealed more readily in a task that confronts them with the possibility that they are currently making a mistake, than in tasks that focus on others' beliefs or on their past beliefs.

Second, in the classic false belief tasks, the participants need to recognize when someone has a false belief while simultaneously knowing what is really the case. In the Sally-Anne task the children know where the marble really is, and in the Smarties task the children have already discovered what is really in the box (pencils) before being asked to recall their past false belief. We believe this over-complicates the situation and departs from a more typical scenario in which we recruit our understanding that beliefs can be false—namely where we wonder whether we are making a mistake without yet knowing what is truly the case. As a result, the current study has, we suspect, greater "ecological validity" as a false belief task, and this is partly why children pass it at a younger age. This is a point that has been made before—that in classic false belief tasks, where the participants already know the right answer, the "pull" of the real answer makes it more difficult to articulate the content of a false belief that contrasts with this (Rubio-Fernández & Geurts, 2013). Some argue that a mature understanding of belief requires the ability to compare a false belief with what is really the case (Bloom & German, 2000). Perhaps what we have evidence for here is not, therefore, a fully mature understanding of belief, but nonetheless it reveals at least an implicit grasp that such mistakes are possible.

Finally, the measurement we employed is an "implicit" measurement; the children's recognition that they may be making a mistake was measured by spontaneous rechecking rather than by their responses to direct linguistic questions. This avoids directly questioning children about their beliefs or uncertainty, which can introduce pragmatic complications that may mask children's ability (Lipowski et al., 2013; Helming et al., 2016) and may also contribute to explaining why children passed our current task at a younger age. Implicit tasks used before to demonstrate false belief understanding are passed by even younger infants (Southgate et al., 2007) but may show only that infants expect others to look for objects where they last saw them. The implict measure in this study demonstrates understanding that a currently held and asserted belief may be false, thereby more clearly demonstrating an understanding in the child that her belief could be wrong.

Another important element of this study is the role of disagreement. Disagreement has been considered to play a specific role in cognitive development in the frameworks of Piaget (1923/2005) and Kuhn (2015), whereas some collaborative learning methods introduce disagreement deliberately as a pedagogical strategy (cf. Driver et al., 2000). It has been argued that human reasoning, in the

metacognitive sense of reflecting on our reasons (Mercier & Sperber, 2011), may first emerge in the context of disagreement—as we discover that our peers have opposing attitudes to the very claims that we think are true (O'Madagain & Tomasello, 2021). This "social first" approach to reasoning and metacognition is supported by the current finding. In a context of peer disagreement, children's ability to evaluate their own beliefs becomes evident at an earlier age than classic false belief tasks would suggest.

Disagreement has been shown to elicit metacognitive awareness (such as false belief understanding) in previous studies. When children's attention is drawn to the contrast between their own true belief and a mistaken agent's false belief in classic false belief tasks, indeed (e.g., "You and I know where the toy is, but where will Sally think it is?") 3-year-olds are more likely to answer the test question correctly (Hansen, 2010; Lewis et al., 2012). Köymen et al (2020) used peer disagreement to elicit metacognitive evaluation of others' arguments, and Young et al. (2012) and Langenhoff et al. (2023) used peer disagreement to elicit belief revision and suspension of judgment. In the latter, children verbally asked for more information when confronted with disagreement from peers who had equal access to testimonial evidence as they did themselves. By 6 years of age, children were more likely to ask for more information when confronted with such disagreement—but not at 4 years. This indicates a trajectory in verbally requesting more information that follows the development of explicit false belief understanding. Our study builds on these findings to elicit spontaneous rechecking of perceptual evidence, revealing an implicit understanding that their current belief might be wrong as young as 3 years of age—well before they pass the explicit false belief tasks.

Overall, our study indicates that children at 3 years of age already understand that their subjective perspective and the objective facts can come apart. This is consistent with evidence that at the same age children become members of the objective world more generally; for example, it is only after 3 years that children understand that individuals can fail to grasp the "objective" norms and conventions that govern social behavior (Tomasello, 2018) and that what is "common knowledge" depends on past interactions, so that some individuals can fail to know what others know (Schmidt & Tomasello, 2012). We add to this picture that already by 3 years of age children implicitly understand that their beliefs might be wrong and that the evidence on which their beliefs are based may need to be revisited, a key step in their emerging "scientific" understanding of the world they are exploring.

Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.jecp.2024.106001.

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