Review

From infants' to children's appreciation of belief

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Evidence is accumulating that infants are sensitive to people's false beliefs, whereas children pass the standard false belief test at around 4 years of age. Debate currently centres on the nature of early and late understanding. We defend the view that early sensitivity to false beliefs shown in 'online tasks' (where engagement with ongoing events reflects an expectation of what will happen without a judgement that it will happen) reflects implicit/unconscious social knowledge of lawful regularities. The traditional false belief task requires explicit consideration of the agent's subjective perspective on his reasons for action. This requires an intentional switch of perspectives not possible before 4 years of age as evidenced by correlations between the false belief task and many different perspective-taking tasks.

A puzzle about belief

Young children's understanding of the role of belief in intentional action has been investigated intensely over the past few decades. This research has uncovered dissociation between different measures of understanding. In the classical false belief tasks, children are asked to predict where the protagonist, Mistaken Max, will look for an object. Max puts his chocolate in the blue cupboard. In his absence it is transferred to the green cupboard. When Max returns, children are asked where he will look for his chocolate [1]. Most 2- and 3-year-olds reliably and resolutely claim that Max will look in the green cupboard, yet young children do show sensitivity to false beliefs in a range of what might be called 'online tasks' (Box 1). For example, in the Anticipatory Looking task children observe the agent watching an object being moved from one cover to another and have learned that the agent's hand will appear through whichever window is located behind the object's actual location. In the false belief condition, the agent is distracted by a phone call and fails to see how it is removed from that second cover, believing it is still in there. The windows start blinking to indicate that the agent is about to search for the object. The child's eye gaze to the left or right window is recorded as indicator of where the child expects the agent's hand to appear [2].

One possible explanation for the dissociation holds that the standard test masks existing knowledge at the earlier age due to performance limitations (competence masking) [3]. An alternative view posits that success in the two types of tasks depends on different cognitive bases, often characterised as implicit and explicit [4–6]. We begin by reviewing the general case for an implicit–explicit distinction and then present an explanation of why the implicit knowledge base is insufficient for success on 'direct' tasks. We go on to compare this account with the competence masking

Glossary

Alternative naming: children familiar with both names of an object (e.g., rabbit and bunny, rabbit and animal) have to say which one of the two names a puppet has not used (e.g. 'What is it?' – puppet: 'Animal', child: 'Rabbit'). Young children tend to repeat what the puppet says.
Ambiguous figures test: children are shown how the same ambiguous drawing (duck/rabbit) joined to the body of a rabbit and of a duck can be a rabbit's as well as a duck's head. Children are then shown the head without body and asked what it is and are probed for whether they can acknowledge both kinds.
Appearance reality distinction: ability to distinguish appearance (looks like a rock) from reality (is a sponge).
Experiential record: children keep track of which events an agent experienced (e.g., was present or looked at) and which the agent did not. The representation of the events the agent experienced is activated whenever attention shifts to the agent.
Explicit knowledge: a regularity (if *x* then *y*) is explicitly (declaratively) known if the inference from *x* to *y* is informed by a representation of the conditional that licenses it (in contrast to implicit knowledge).
False sign task: a direction sign points in the wrong direction and children, knowing where the indicated place really is, are asked where the sign shows that it is.
Identity statements task: children are told about two seemingly different people (e.g., the teacher and Susi's mum). They know where the teacher is, but not where Susi's mum is. Then they are told that Susi's mum is the teacher. Can they infer where Susi's mum is?
Implicit knowledge: a regularity (if *x* then *y*) can be implicitly (procedurally) known by inferring *y* whenever *x* is known without representing the conditional that licenses this inference.
Level 1 perspective taking: refers to the ability to distinguish what another person can see from what that person cannot see.
Level 2 perspective taking: requires understanding that two people may see or interpret something, which both can see, differently depending on their vantage point (e.g., a drawing of a turtle on a table showing the turtle on its feet or lying on its back).
Objective reasons for action: facts that count in favour of acting in a certain way (e.g., there is an objective reason for Max to go to the green cupboard).
Online tasks: false belief tasks in which the observed events generate online ideas about what will happen next or what an agent is doing without requiring a judgment about what will happen next or about justifying reasons for the action.
Simulation theory: a family of views affirming that our conception of others' mental states and processes essentially involves the ability mentally to simulate them.
Standard (classical) false belief test: story character Mistaken Max fails to witness how his chocolate is unexpectedly transferred, therefore believing that it is still in its original location. Children have to predict where he will look for it: in its original or in its new location.
Subjective reasons for action: propositional attitudes that make it rational to act in a certain way (e.g., Max has a subjective reason to go to the blue cupboard).
Theory of mind: a cover term for the ability to attribute mental states to other people and to oneself.
Theory theory: a family of views on which our conception of others' mental states and processes is in salient respects comparable with a scientific theory.

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Box 1. Tasks showing infants' sensitivity to belief

Anticipatory looking [2]
The set-up for this task was later used by Low and Watts [18] and is shown in Figure 1. Children learn first that, when a target object is put under one of two covers, the agent will always reach through the window behind that cover. Children's anticipatory looking to this window is triggered by both windows starting to blink. In Southgate *et al.*'s version [2], children observe the agent watching the object being moved from one cover to the other. The agent is then distracted by a phone call and fails to see how the object is removed from under the second cover. The windows start blinking to indicate that the agent is about to search for the object. The child's eye gaze to the left or right window is recorded as an indicator of where the child expects the agent's hand to appear.

Violation of expectation [5]
Infants are shown either the objectively expected (when the agent goes to or reaches to the believed location) or the unexpected action (when the agent goes to the object's actual location). Looking for longer at the unexpected than at the expected action is interpreted as infants sharing these objective expectations.

Helping [37]
In the helping task of Buttelmann *et al.* [37], an experimenter showed 18- month-olds how to lock and unlock two boxes. With the boxes left unlocked, a male agent entered the room, hid a toy in one of them, and left again. In the agent's absence, the experimenter transferred the toy to the other box and locked both boxes. On his return, the agent tried to open the box where he had hidden the toy, without success. When prompted to help the agent, most infants approached the other box (i.e., the one the agent had not tried to open), suggesting that they had realized that the agent falsely believed the toy was still in its original location and wanted to retrieve it.

Referential communication [38–40]
In the referential communication task of Southgate *et al.* [40], 17-month-olds watched an agent hide two different toys in two boxes with lids. After the agent's departure, the experimenter switched the toys. On her return, the agent pointed to one of the boxes and announced that the toy inside it was a 'sefo'. When asked to hand her the sefo, most infants gave her the object from the other box, evidently realizing that the agent falsely meant to refer to the toy in the other box, because she erroneously believed it to be in the pointed-at box.

account. In brief, we argue that online tasks reflect an implicit theory of behaviour, whereas direct tests require children to offer reason-giving explanations of intentional actions.

Implicit versus explicit knowledge

Early sensitivity to belief responds to task manipulations in much the same way that implicit knowledge does in near-threshold perception and in blind-sight patients [7] (Box 2). This fact speaks in favour of implicit knowledge as the underlying basis on which performance in online tasks rests. An important question here is why blind-seers are unable to exploit implicit visual information in making (unprompted) judgements about the stimulus. The natural answer is that, because they lack any conscious visual experience of the object, they do not consider themselves to be in a position to tell what the object is like. (They know that there is an object there only because the examiner told them.) Judgements normally aim to express knowledge and blind-seers do not think that they have any knowledge of the object's features. The corresponding developmental question is: why is young children's implicit knowledge not sufficient to enable them to pass direct tests? Our answer to this question has three elements. (1) Direct tests induce one to think of the to-be-predicted behaviour as an intentional action – an action performed for a reason. (2) To succeed on a direct test, one needs to understand the difference between objective and subjective reasons, which requires awareness of different perspectives. (3) Children master this ability only at around 4 years of age (Table 1).

Box 2. The case for implicitness of early competence

There are three points of analogy between early sensitivity to belief and implicit knowledge in blind-sight and near-threshold perception.

- Early sensitivity is observed in indirect (anticipatory looking) but not in direct tests (question about future action), an important indicator of implicit knowledge [41]. Clements and Perner [4,22,42,43] had Mistaken Max reappear from different exits depending on where he is looking for his object. At 3 years of age, most children looked to the exit where Max thought the object was, at the same time claiming in their explicit answers that he will come out of the other exit, where the object actually was.
- Early sensitivity is observed in spontaneous responses without delay more often than when children hesitate [42]. This corresponds to two characteristics of implicit knowledge: it is available for only a few seconds after stimulus presentation [44] and is better available if the response does not require a commitment (i.e., the person is asked to guess and not asked to judge) [45].
- Implicit knowledge is observed in the absence of any measurable signs of uncertainty [46]. In fact, children disallow even the possibility that the agent might appear where he thinks the object is, despite their look expecting him there [22].

Intentional action and justifying reasons

Predicting human behaviour is fraught with uncertainty (as financial markets illustrate every day). How do we ever manage to know what someone will be doing next? If you know that I am suffering from hay fever, you may be able to predict my sneezing on entering the haystack. However, an interest in someone's future actions is usually an interest in their intentional actions. The intentional character of the to-be-predicted action is often written into the question: for example, where will Max look for the chocolate? Unlike sneezing, looking for something is inherently goal directed. There is a close – some would say conceptual – connection between intentional action and a certain kind of explanation; at first pass, to act intentionally is to act in a way that is intelligible in terms of one's justifying (or 'normative') reasons. [8,9]. Accordingly, normally the best way to predict what someone will intentionally do is by ascertaining what it makes sense for her to do; that is, what she has reason to do.

In summary, the question 'where will Max look?' involves a view of Max as an intentional agent, with the implication that (usually) the best way to answer it is by determining where it would make rational sense for Max to look.

Objective and subjective reasons

One might wonder whether younger children really understand these finer points of the test question. Perhaps they

Table 1. Developmental pervasiveness of perspective around 4 years of age – relationship between standard false belief task and other perspective-taking tasks

Task	Refs	Participant number and age	Correlation with false belief		
			Raw	Partial	Controlling for
Visual perspective taking Level 2 [23]	[24]	n = 38; 4;2 – 8;5 n = 22; 4;5 – 12;9 (autism)	0.87	0.34	vMA[a], mental rotation
	[25]	Training transfer from false belief task to visual perspective tasks: not successful			
Appearance reality distinction [26]	[27]	Two studies: *N* = 101; 2;10 – 6;3	0.49 – 0.44		
	[28]	*N* = 153; 3;4 – 4;8	Not reported	0.30	Age + vMA
	[29]	Early exposure of deaf children to language, signed or oral, facilitates performance on both tasks			
False signs	[30]	Review of seven studies	0.50 – 0.88	All significant	Age or vMA
Ambiguous figures	[31]	Two studies: *N* = 138; 2;10 – 5;9	0.43 – 0.47	0.24	Age
	[32]	Seven studies: *N* = 326; 2;3 – 6;0	0.42	0.20	Age + vMA
Multiple labels for an object					
Alternative naming	[33]	Four studies: *N* = 133, 2;5 – 4;7	0.65 – 0.83	0.60 – 0.85	vMA or control task
	[34]	One study: *n* = 48, 2;11 – 4;7	0.71	0.54	Age + vMA
	[35]	Three studies, seven data sets: *N* = 100; 2;8 – 6;1	0.53 – 0.77	0.25 – 0.62	Age + vMA
Identity statements	[36]	Study 1: *n* = 41; 3 – 5	0.57	0.39	Age
		Study 2: *n* = 78; 2;11 – 5;11	0.68	.50	Age + vMA
Understanding competition					
Bead game[b]	Priewasser *et al.* (unpublished)	*n* = 86; 2;10 – 5;10	0.43	0.26	Age + vMA + inhibition + working memory

[a]vMA, verbal mental age.

[b]Bead game. Groups of three children take turns casting a die and collecting the corresponding number of beads to stack on a pole. Whoever reaches the top first wins. Instructions make explicit that beads can be taken from either a common source or an opponent's stack. The tendency to poach from an opponent was recorded because it marks an understanding that players take different perspectives on what the goal is (Box 4).

simply guess what Max will do. However, the fact that younger children reliably give the wrong answer suggests that there is some method to their poor performance. We propose the following explanation. Young children do predict where Max will look by determining where he has reason to look. It is just that – not unnaturally – they take the fact that the chocolate is in the green cupboard to mean that this is where Max has reason to go, and they are oblivious to the fact that there is another sense in which Max has reason to go to the blue cupboard. We will express this by saying that young children base their prediction on Max's objective reason (provided by the actual location of the chocolate) rather than on his subjective reason (provided by his belief about the location of the chocolate).

In the philosophy of mind and cognitive science, reasons for action are often simply equated with suitable pairs of beliefs and desires; that is, with attitudes that provide subjective reasons in our sense. Why do we need the notion of an objective reason? Here are some 'intuition pumps' illustrating the central role that objective reasons arguably play in adult commonsense psychology.

(i) The primary context in which we think about practical reasons is a situation in which we deliberate about what to do. Suppose you suddenly remember that there is a staff meeting at 2 p.m. Should you leave your office now to go to the meeting? It would not be sensible for you to try to settle this question by looking for evidence as to whether you believe it to be 2pm. Whether you have a good reason to set off now depends on what the actual time is.

(ii) We make mistakes about practical reasons more often and more easily than about what we believe and desire. Suppose you falsely believe it is only 1.30 p.m. When you discover your mistake, you learn that you should have gone to the meeting (you had a reason to go) some time ago.

(iii) When you are asked to offer practical advice to someone, the natural way to proceed is to reflect on the facts of the advisee's situation. If Max asked you where he should go to look for his chocolate, it would not be particularly helpful to say 'you should go to the blue cupboard – after all, you believe that is where the chocolate is.' The natural advice is 'you should go to the green cupboard – you have reason to (that is where the chocolate is)' [10].

In brief, objective reasons are facts or 'considerations' (usually non-psychological considerations) that justify, or 'count in favour of', doing something [11]. Why, then, in addition, do we need the notion of a subjective reason? We need some such notion (no matter how we label it) to acknowledge the sense in which even an ill-informed action such as Max's can be justified. After all, it is perfectly rational for Max to go to the blue cupboard, despite the fact that there is no objective reason for him to go there. What makes his action rational is that he (rationally) believes the chocolate to be in the blue cupboard. Correlatively, from Max's perspective, it looks as if he has an objective reason to go to the blue cupboard. Thus, discussion about someone's subjective reasons might be understood as a way to talk about their perspectives on their objective reasons. In any case, the two notions are mutually irreducible and neither is dispensable (Box 3).

Our suggestion, in summary, is that young children's answer to the test question reflects their attempt to make sense of Max's action in terms of his objective reasons

Box 3. Reasons in the human 'theory of mind': three issues

The contrast we draw between an implicit theory of behaviour and explicit explanations of intentional actions in terms of justifying reasons recalls the debate between 'theory theorists' and 'simulation theorists' over the nature of folk psychology. We clarify the relationship by distinguishing three issues.

Reasons and action explanation

Theory theorists hold that a 'theory of mind' is a theory in much the same sense as geology or chemistry: we explain the occurrence of an event, whether an intentional action or the eruption of a volcano, by subsuming it under some lawful regularity. (Compare Gopnik and Meltzoff's [47] basic explanatory schema of folk psychology: 'If a psychological agent wants event y and believes that action x will cause event y, he will do x.') Some simulation theorists, rightly in our view, have objected that to think of an action as intentional one needs to be able to explain it in terms of the agent's reason for acting, and they have argued that doing so requires mental simulation, in the sense of recreating in imagination the agent's reason-giving mental states [48,49].

Reasons and rationality

Following Davidson [9], it is commonly assumed in the philosophy of mind and cognitive science that practical reasons are suitable pairs of beliefs and desires. As Hornsby [50] observed, this contrasts with standard practice in ethics, in which practical reasons are conceived not as mental states but as facts (or 'considerations'). The ethicists' notion is arguably indispensable and in a way primary: to understand that Max has a belief–desire reason to go to the blue cupboard, one needs to appreciate that, from his perspective, there appears to be a consideration that counts in favor of going there. The distinction between the two kinds of reasons (or between what we have reason to do and what it is rational for us to do, given our beliefs and desires) opens up the possibility that young children might explain actions 'teleologically', in terms of reason-giving facts rather than beliefs and desires [12,13]. Note that even adults frequently assign an explanatory role to reason-giving facts; we often explain intentional actions in terms of the agent's factive mental states (e.g., she was looking in the blue cupboard because she knew the chocolate was there). In such explanations, the explanans is a mental state that encompasses a reason-giving fact [50].

Perspective taking

What is involved in understanding that, from Max's perspective, there appears to be reason to go to the green cupboard? The basic insight behind 'simulation theory' is that such perspective taking involves using one's own practical reasoning abilities. However, simulation theorists typically make the more contentious claim that the interpreter needs to put these abilities to work by simulating, imagining, or recreating in 'pretend mode' the agent's first-personal practical reasoning. An alternative view is that what is essential is merely hypothetical teleological reasoning: to find out what Max has a subjective reason to do given his belief, one merely needs to determine what he would have objective reason to do, were his belief true. [13] Reason-giving explanation, according to this view, is a more basic skill than standard versions of the simulation theory would lead one to believe.

[12,13]. In an obvious sense, Max should (has reason to) go to the green cupboard; this is what a well-meaning spectator would advise him to do. Thus, children's poor performance on direct tests simultaneously manifests a crucial accomplishment (they are able to think of people as agents of intentional actions) and an important limitation (they equate people's reasons for actions with objective reasons).

Box 4. Outstanding questions

- **Flexibility of early sensitivity:** is early sensitivity based on 'behaviour rules', drawing a direct inference from observed behaviour to predicted behaviour, or on inferring from what is being observed a belief and from that the likely behaviour? A potential test would be to teach children new knowledge in the presence of another person and see whether they apply it spontaneously in their inferences about that person.
- **Competitive goals and sabotage:** children's difficulty to switch intentionally to a different perspective before 4 years of age should not only affect their understanding of beliefs but also of the fact that agents can pursue competing goals and sabotage each other. The only test of this comprises pilot work (see Priewasser *et al.*, unpublished, in Table 1) showing a relationship between false belief understanding and appreciation of competitive games. Investigation of a broader spectrum is needed.
- **The role of language:** late language acquisition tends to have a strong effect on passing classic false belief tests [51] (though not online measures [43]). DeVilliers [52] argued that the effect is due to the grammatical form of that-complements being required for thinking about belief (she thinks that. . .). An alternative reason for the delay could be that language is a prime medium for building awareness of perspectives (e.g., differences in visual perspective become salient when confronted by a seemingly contradictory description given by someone from a different vantage point). One way to adjudicate this would be to investigate whether delayed language equally delays all kinds of perspective tasks or only those that involve that-complements.

Note that there is independent evidence that by 3 years of age children have some understanding of justifying reasons, as shown in their interactions with mother and siblings [14,15].

The role of perspective

To give the right answer to the test question, children need to be aware of Max having a different perspective on his reasons from their own, to switch intentionally to that perspective. Without such awareness, they will predict that Max will go to where he should go, namely where the chocolate is. Children become able to intentionally adopt other perspectives around 4 years of age, as evidenced by the fact that many perspective-taking tasks correlate with correct responding in the false belief task (Table 1).

By contrast, a voluntary shift to an agent's perspective may not be required for children's behaviour, indicating early sensitivity. Eye-tracking [2] and other studies [16] document that infants are keen to register and record what others did and did not perceptually track; that is, they keep an experiential record. The announcement of the agent's reappearance is likely to evoke these records and make the infants think of what the agent had experienced. What the agent had experienced (the object in its original location) corresponds to the content of the agent's false belief. Thinking of this content allows children to anticipate a possible action based on this content and influences their looking behaviour. They can do this unencumbered by any pressure to make sense of the action in terms of practical reasons or having to justify their looking. Because the experiential record perspective corresponds to the agent's belief about the object's current location, this anticipation can be seen as an implicit representation of the agent's

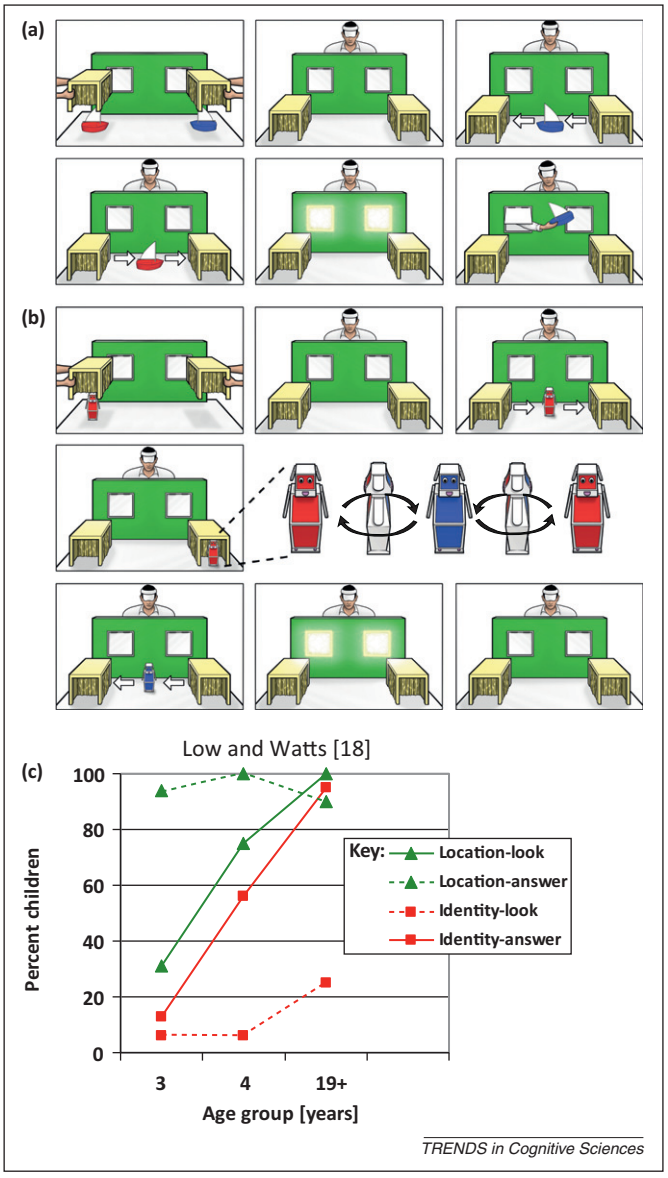

Figure 1. **Identity task by Low and Watts** [18]. Location false belief task (not shown, general set-up similar to figure). Children watch (i) the agent looking how the object is put under the left cover and (ii) that the agent is distracted by a phone call and looks away while the object is moved to under the other cover. (iii) The agent attends to the scene again and the windows start blinking. (iv) The child's eye gaze to left or right window is recorded as an indicator of where the child expects the agent's hand to appear. (v) The child is asked where the hand will appear. Identity task. (**a**) Establishing preference. Children learn that the agent, who watches a red object disappear under one cover and a blue object under the other cover, always prefers to retrieve the blue object through the window that is closest to that object. Before the agent reaches through one of the windows, the windows blink, which makes children look in anticipation to the window they expect the hand to appear. After training, children looked to the window behind the cover with the blue object 94% of times at 3 years and 100% at 4 years. (**b**) False belief test. (i) Children are shown that a red robot is under the left cover. (ii) The agent appears. (iii) The child sees how the agent observes the robot (now with its blue side facing the child) move from under the left to the right cover. (iv) The child but not the agent observes that the red robot is blue on its other side. (v) The child sees how the agent observes the robot move from under the right to the left cover. (vi) The windows blink indicating that the agent is about to search for a blue object. (vii) The child's eye gaze to the left or right window is recorded as an indicator of where the child expects the agent's hand to appear. (viii) The child is asked where the hand will appear. (**c**) Results. In the false belief location version (green triangles in panel c) [2], almost all 3-year-olds look in anticipation to the window in front of the cover where the agent thinks the object is (broken green line), whereas only about 30% make the corresponding prediction in answer to a question (full green line). This percentage increases by 4 years and reaches a ceiling in college students. According to the new false belief identity version red squares in panel c, children's predictions (full red line) lag slightly behind the location version. In stark contrast, there is almost no anticipatory looking (broken red line) by children and even college students (≥19 years). This shows that anticipatory looking occurs only when an experiential record based on Level 1 perspective taking is available (location version) but not otherwise as in Low and Watt's 'identity' problem.

belief. Note that we are not suggesting that children think of an experiential record as evidence that the agent has a certain belief. An implicit representation is not a reasoned judgement. It may not involve the concept of belief at all (though it may play an important role in facilitating the acquisition of the concept) [13] (Box 4).

In summary, the final element in our explanation of false belief understanding in the classical test is the need to intentionally switch to a different perspective to answer a direct test question correctly (to identify the agent's subjective reason for his action). This need is bypassed in the non-committal expectation expressed in the anticipatory looking paradigm.

The competing account: competence masking theory

This approach posits an early – typically assumed to be innately – available essential understanding of belief in infancy [17]. This early competence is masked in the standard false belief task, which exceeds children's performance limitations such as lack of inhibitory control, working memory restrictions, or insufficient language proficiency. Baillargeon *et al.*'s [3] response account is the most detailed version of this approach. Infants are successful on indirect measures because they only need to represent the agent's false belief. They fail in the standard test because '...when asked the test question, children must access their representation of the agent's false belief to select a response,... when selecting a response, children must inhibit any prepotent tendency to answer the test question based on their own knowledge.'

A comparison of the two accounts

A common problem for both accounts arises from the fact that in the helping and the referential communication task (Box 1), a verbal request is made. In Baillargeon *et al.*'s [3] response account, one would assume that this verbal request should lead to the same overload as the question in the standard test. The authors provide the following explanation of why this is not the case: '...the infants in these indirect-elicited-response tasks represented the agent's false belief and used this representation to infer what goal the agent was trying to achieve...or which object was the *sefo*...'. This means that the brittle belief representation does its work before the request is made (e.g. the intended object is identified as 'sefo' before the request is made) and any subsequent overload due to the request does not change this. This explanation also solves the same problem for our account.

The accounts differ in two respects, though they agree that the online tasks make it possible, in a sense, for infants to 'take' the agent's perspective. One difference concerns how children come to adopt the agent's perspective. The other focuses on why children cannot maintain this perspective when a question is asked in the traditional false belief test.

The agent's perspective, in Baillargeon's response account [3], is captured by infants inferring the agent's belief.

In contrast, our account appeals to the experiential record for the agent's actions. For instance, in Southgate's anticipatory looking task (Box 1), the child observes the agent perceptually tracking the object's movement into one location and failing to track the location change when being distracted (Level 1 perspective taking). The study of Low and Watts [18] (Figure 1) makes clear how important it is for young children's success in this task to build such a record. The child sees only the agent track the robot moving from box 1 to box 2 and back. The child cannot see that the object appears to the agent to be a blue robot moving from 1 to 2 and a red robot moving from 2 to 1 (a Level 2 or higher perspective problem). Thus, the experiential record does not correspond to the content of the agent's belief and the looking data show no anticipation of the agent's expected action.

By contrast, all online tasks used hitherto (Box 1) provide a relevant experiential record on the basis of Level 1 perspective taking. For instance, in the helping as well as the referential communication task, the experimenter's reappearance makes the infants think of where the experimenter last witnessed the object. This corresponds to the content of the agent's false belief: the object is still in its original place. This representation prompts children to think of the agent opening the box as an attempt to find the object inside, or to think of the agent pointing to that box and talking about the sefo inside as an attempt to refer to the original content of this box.

Interestingly, Level 1 perspectives [19], but not Level 2 information [20], are registered automatically by adults. This suggests that only automatically processed information is available for performance on indirect measures such as looking in expectation.

The effect of the test question also plays different roles in the two accounts. According to the response account, the question overloads children's processing capacity, the belief representation, being the 'weakest link', is deleted, and the children rely on the basic expectation that people look for objects where they are actually located. In contrast, our account assumes that the question triggers a 'justification mode'. Children look for justifying reasons for what Max should do: he should go to where his chocolate actually is – the typical, wrong answer. To get it right, children need intentionally to switch to Max's perspective to ascertain his subjective reasons. This they cannot do until about 4 years of age (Box 1).

Answer latencies collected by Atance *et al.* [21] support this view. Three-year-old children's wrong answers (actual location) were faster than their correct answers (believed location), whereas 4- and 5-year-olds were faster on correct than on wrong answers. The answer latencies of the younger children pose a problem for the competence masking explanation: if – as assumed – the children represent the agent's belief, are ready to predict his action accordingly, and can also process the experimenter's question, correct responses should be fast. However, when the question overloads their system, they have to fall back on a different assumption leading to wrong answers, which should therefore take longer. This is the opposite of what the data show.

By contrast, the latencies fit with children's certainties [22]. Younger false belief test failers tended to be very certain of their wrong answers and the older failers much less so; however, younger passers were less certain of their correct answers than were older passers. In other words, most younger children go straight for objective reasons and, consequently, give the wrong answer with conviction and quickly. The minority that give the correct answer tend to be fledgling understanders of perspective differences looking for subjective reasons. They are uncertain of their correct answers and slow. By contrast, the older children are either fledgling perspective understanders who still use objective facts but have developed doubts about their universal use and therefore give their wrong answers slowly, or they are solid understanders of perspective differences who are convinced of their correct answer and respond fast.

Concluding remarks

We have made a case for early understanding of belief being implicit. Infants keep track of what agents perceive (experiential record); in particular, the state of the world last seen by the agent. Focus on the agent activates this record and induces them to construe the agent's actions or to anticipate future actions on the basis of this record. Because the record reflects the agent's belief about the state of the world, this interpretation tendency amounts to an implicit understanding of the agent's belief. This online tendency is broken when a question is asked about the agent's likely action (or without question when children of their own accord become concerned about correctness); then, children think explicitly of the agent's reasons for how to act. In the false belief task, this requires an understanding of the agent's divergent perspective on objective reasons. The required switch in perspective is beyond children below about 4 years of age, as evidenced by solid correlations between the false belief task and a large variety of other perspective tasks.

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References

1 Perner, J. and Lang, B. (1999) Development of theory of mind and executive control. *Trends Cogn. Sci.* 3, 337–344
2 Southgate, V. *et al.* (2007) Action anticipation through attribution of false belief by 2-year-olds. *Psychol. Sci.* 18, 586–592
3 Baillargeon, R. *et al.* (2010) False-belief understanding in infants. *Trends Cogn. Sci.* 14, 110–118
4 Clements, W.A. and Perner, J. (1994) Implicit understanding of belief. *Cogn. Dev.* 9, 377–397
5 Onishi, K.H. and Baillargeon, R. (2005) Do 15-month-old infants understand false beliefs? *Science* 308, 255–258
6 Sodian, B. *et al*. Metacognition in infants and young children. In *Foundations of Metacognition* (Beran, M. *et al.*, eds), pp. 119–133, Oxford University Press (in press)
7 Perner, J. and Clements, W.A. (2000) From an implicit to an explicit theory of mind. In *Beyond dissociations: Interaction Between Dissociated Implicit and Explicit Processing* (Rossetti, Y. and Revonsuo, A., eds), pp. 273–293, John Benjamins
8 Anscombe, G.E. (1957) *Intention*, Cambridge University Press
9 Davidson, D. (1963) Actions, reasons, and causes. *J. Philos.* 60, 685–700
10 Kolodny, N. (2005) Why be rational? *Mind* 114, 509–563
11 Scanlon, T. (1998) *What We Owe to Each Other*, Harvard University Press

12 Perner, J. and Roessler, J. (2010) Teleology and causal reasoning in children's theory of mind. In *Causing Human Action: New Perspectives on the Causal Theory of Action* (Aguilar, J. and Buckareff, A., eds), pp. 199–228, MIT Press
13 Roessler, J. and Perner, J. Teleology: belief as perspective. In *UOM-3: Understanding Other Minds* (3rd edn) (Baron-Cohen, S. *et al.*, eds), Oxford University Press (in press)
14 Dunn, J. and Munn, P. (1987) Development of justification in disputes with mother and sibling. *Dev. Psychol.* 23, 791–798
15 Hood, L. *et al.* (1979) What, when and how about why: a longitudinal study of early expressions of causality. *Monogr. Soc. Res. Child Dev.* 44, 1–47
16 Moll, H. and Tomasello, M. (2007) How 14- and 18-month-olds know what others have experienced. *Dev. Psychol.* 43, 309–317
17 Surian, L. and Geraci, A. (2012) Where will the triangle look for it? Attributing false beliefs to a geometric shape at 17 months. *Br. J. Dev. Psychol.* 30, 30–44
18 Low, J. and Watts, J. Attributing false-belief about object identity is a signature blindspot in humans' efficient mindreading system. *Psychol. Sci.* (in press)
19 Samson, D. *et al.* (2010) Seeing it their way: evidence for rapid and involuntary computation of what other people see. *J. Exp. Psychol. Hum. Percept. Perform.* 36, 1255–1266
20 Surtees, A.D. *et al.* (2012) Direct and indirect measures of Level-2 perspective-taking in children and adults. *Br. J. Dev. Psychol.* 30, 75–86
21 Atance, C.M. *et al.* (2010) Thinking about false belief: it's not just what children say, but how long it takes them to say it. *Cognition* 116, 297–301
22 Ruffman, T. *et al.* (2001) Does eye gaze indicate implicit knowledge of false belief? Charting transitions in knowledge. *J. Exp. Child Psychol.* 80, 201–224
23 Masangkay, Z.S. *et al.* (1974) The early development of inferences about the visual percepts of others. *Child Dev.* 45, 357–366
24 Hamilton, A.F. *et al.* (2009) Visual perspective taking impairment in children with autistic spectrum disorder. *Cognition* 113, 37–44
25 Knoll, M. and Charman, T. (2000) Teaching false belief and visual perspective taking skills in young children: can a theory of mind be trained? *Child Study J.* 30, 273–304
26 Flavell, J.H. *et al.* (1983) Development of the appearance-reality distinction. *Cogn. Psychol.* 15, 95–120
27 Gopnik, A. and Astington, J.W. (1988) Children's understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction. *Child Dev.* 59, 26–37
28 Taylor, M. and Carlson, S.M. (1997) The relation between individual differences in fantasy and theory of mind. *Child Dev.* 68, 436–455
29 Courtin, C. and Melot, A. (2005) Metacognitive development of deaf children: lessons from the appearance–reality and false belief tasks. *Dev. Sci.* 8, 16–25
30 Perner, J. and Leekam, S. (2008) The curious incident of the photo that was accused of being false: issues of domain specificity in development, autism, and brain imaging. *Q. J. Exp. Psychol.* 61, 76–89
31 Doherty, M.J. and Wimmer, M. (2005) Children's understanding of ambiguous figures: which cognitive developments are necessary to experience reversal? *Cogn. Dev.* 20, 407–421
32 Wimmer, M.C. and Doherty, M.J. (2011) The development of ambiguous figure perception. *Monogr. Soc. Res. Child Dev.* 76, 1–130
33 Doherty, M.J. and Perner, J. (1998) Metalinguistic awareness and theory of mind: just two words for the same thing? *Cogn. Dev.* 13, 279–305
34 Doherty, M.J. (2000) Children's understanding of homonymy: metalinguistic awareness and false belief. *J. Child Lang.* 27, 367–392
35 Perner, J. *et al.* (2002) Theory of mind finds its Piagetian perspective: why alternative naming comes with understanding belief. *Cogn. Dev.* 17, 1451–1472
36 Perner, J. *et al.* (2011) Identity: key to children's understanding of belief. *Science* 333, 474–477
37 Buttelmann, D. *et al.* (2009) Eighteen-month-old infants show false belief understanding in an active helping paradigm. *Cognition* 112, 337–342
38 Carpenter, M. *et al.* (2002) A new false belief test for 36-month-olds. *Br. J. Dev. Psychol.* 20, 393–420
39 Happé, F. and Loth, E. (2002) "Theory of mind" and tracking speakers' intentions. *Mind Lang.* 17, 24–36
40 Southgate, V. *et al.* (2010) Seventeen-month-olds appeal to false beliefs to interpret others' referential communication. *Dev. Sci.* 13, 907–912
41 Reingold, E.M. and Merikle, P.M. (1993) Theory and measurement in the study of unconscious processes. In *Consciousness* (Davies, M. and Humphreys, G.W., eds), pp. 40–57, Blackwell
42 Garnham, W.A. and Perner, J. (2001) Actions really do speak louder than words - but only implicitly: Young children's understanding of false belief in action. *Br. J. Dev. Psychol.* 19, 413–432
43 Low, J. (2010) Preschoolers' implicit and explicit false-belief understanding: relations with complex syntactical mastery. *Child Dev.* 81, 597–615
44 Bridgeman, B. *et al.* (1997) Interaction of cognitive and sensorimotor maps of visual space. *Percept. Psychophys.* 59, 456–469
45 Scott, R.B. and Dienes, Z. (2010) Knowledge applied to new domains: the unconscious succeeds where the conscious fails. *Conscious. Cogn.* 19, 391–398
46 Dienes, Z. (2012) Conscious versus unconscious learning structure. In *Statistical Learning and Language Acquisition* (Rebuschat, P. and Williams, J., eds), pp. 337–364, Mouton de Gruyter
47 Gopnik, A. and Meltzoff, A.N. (1997) *Word, Thoughts, and Theories*, MIT Press
48 Gordon, R.M. (1986) Folk psychology as simulation. *Mind Lang.* 1, 158–171
49 Heal, J. (1986) Replication and functionalism. In *Language, Mind, and Logic* (Butterfield, J., ed.), pp. 135–150, Cambridge University Press
50 Hornsby, J. (2008) A disjunctive conception of acting for reasons. In *Disjunctivism* (Haddock, A. and Macpherson, F., eds), pp. 244–261, Oxford University Press
51 Milligan, K. *et al.* (2007) Language and theory of mind meta-analysis of the relation between language ability and false-belief understanding. *Child Dev.* 78, 622–646
52 de Villiers, P.A. (2003) The role of language in theory of mind development: what deaf children tell us. In *Why Language Matters for Theory of Mind* (Astington, J.W. and Baird, J., eds), pp. 266–297, Oxford University Press