How children come to understand false beliefs: A shared intentionality account

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This contribution is part of the special series of Inaugural Articles by members of the National Academy of Sciences elected in 2017.

Contributed by Michael Tomasello, July 11, 2018 (sent for review March 20, 2018; reviewed by Ian A. Apperly and Victoria Southgate)

To predict and explain the behavior of others, one must understand that their actions are determined not by reality but by their beliefs about reality. Classically, children come to understand beliefs, including false beliefs, at about 4–5 y of age, but recent studies using different response measures suggest that even infants (and apes!) have some skills as well. Resolving this discrepancy is not possible with current theories based on individual cognition. Instead, what is needed is an account recognizing that the key processes in constructing an understanding of belief are social and mental coordination with other persons and their (sometimes conflicting) perspectives. Engaging in such social and mental coordination involves species-unique skills and motivations of shared intentionality, especially as they are manifest in joint attention and linguistic communication, as well as sophisticated skills of executive function to coordinate the different perspectives involved. This shared intentionality account accords well with documented differences in the cognitive capacities of great apes and human children, and it explains why infants and apes pass some versions of false-belief tasks whereas only older children pass others.

theory of mind | false belief | shared intentionality | social cognition | development

Premack and Woodruff (1) coined the now widespread term "theory of mind." They attributed a theory of mind to a chimpanzee who could discern the intentions of an agent as distinct from its overt behavior. In the ensuing discussion in the field, a consensus emerged that the essence of a theory of mind was not intentions but rather was beliefs. That is, to predict and explain an agent's behavior in novel circumstances, one must understand that agents behave not with respect to reality but with respect to their beliefs about reality: He is searching for his toy over there (even though it is actually here) because he believes it is over there. Understanding how beliefs work thus implies an understanding of the fundamental distinction (traceable back to the ancient Greeks) between a subjective perspective (appearance, opinion, belief) and an objective perspective (reality, fact, truth).

Accordingly, we may say that beliefs are mental representations that their possessor takes to correspond to an objective reality but which everyone who understands such things knows may not. The acid test of whether someone understands beliefs is thus whether she can predict (and possibly explain) an agent's behavior when the agent has a false belief, that is, when the agent is acting rationally from his subjective perspective but irrationally from an objective perspective. Classically, children begin to understand false beliefs at around 4–5 y of age (see ref. 2 for a review and meta-analysis). This is based on tasks in which children must predict what an agent having a false belief will do, either verbally or by pointing to where the agent will go. However, in the last decade or so researchers have reported surprisingly competent behavior from 1- to 2-y-old infants in a variety of so-called "implicit" or "indirect" false-belief tasks. Some theorists believe that these new infant tasks are measuring an understanding of false belief, and the classic tasks are solved only at 4–5 y of age because they involve other, extraneous, task demands (3). Other theorists, in contrast, believe that the infant tasks tap into an interesting competence but not into an understanding of false beliefs (4–6).

Recently, the stakes in this debate have been raised. Two different studies have found that great apes behave as competently as human infants in two of the main infant false-belief tasks (7, 8). This is in contrast to five previous studies in great apes that found negative results in tasks constructed to resemble the classic false-belief tasks (9–13 and see ref. 14 for a review). This dissociation of apes' performance in the infant and classic tasks without any differences in skills for coping with extraneous task demands supports the proposal that the two types of task evoke different cognitive processes and thus that something important happens in children's social cognition in the several years separating their success in the two types of task. It also raises the possibility that the explanation for this developmental progress is somehow bound up with the cognitive and social processes that most clearly differentiate the psychology of humans from that of other great apes.

Our attempt here is to explain what infants are doing in the infant false-belief tasks, what older children are doing in the classic false-belief tasks, and how children get from one to the other. Our general proposal is that infants solve the infant tasks using general great ape social-cognitive abilities evolved for competing with others, whereas older children solve the classic tasks using uniquely human social-cognitive abilities evolved for coordinating mental states with cooperative partners, abilities also known as "skills and motivations of shared intentionality" (15, 16). In this view, children come to an understanding of false beliefs through their continuing experiences in coordinating mental states with others, especially in the context of their species-unique forms of cooperative social interaction and communication. Our theory differs from existing

Significance

In coming to understand minds, the greatest challenge for young children is understanding when others have a false belief. Why is that person searching for the toy over there when it is really over here? There is currently much controversy about when children come to this understanding because experiments of different types yield different results. This paper attempts to resolve the controversy by integrating theory and data in a different way. Specifically, the paper argues that young children do not just come to imagine what is in other minds on their own; rather, they come to this understanding through certain types of social and communicative interactions with others that require them to compare their respective perspectives.

Author contributions: M.T. wrote the paper.

Reviewers: I.A.A., University of Birmingham; and V.S., University of Copenhagen.

The author declares no conflict of interest.

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theories, e.g., theory theories and simulation theories, in that the process is not just one of children imagining what is going on in other people's minds but rather is one of children attempting to coordinate their own and their social partner's differing, sometimes conflicting, perspectives, often with an objective perspective also lurking in the background.

What Are Infants (and Apes) Doing?

Onishi and Baillargeon (17) reported that 15-mo-old infants are surprised (look longer) when an agent who has false information about the location of an object still searches for it in the correct location. Southgate et al. (18) found that 25-mo-old infants looked in anticipation at the location where an agent (gearing up for a search) believed an object to be, not where it really was. Beyond these looking measures, Buttelmann et al. (19) found that 18-mo-old infants inferred that an agent trying to open an empty bucket must be trying to retrieve his favorite toy because he believed it was in there (so instead of helping the agent open the bucket, they fetched the displaced toy from another location). In the new studies with great apes, Krupenye et al. (7) found positive results using the Southgate et al. (18) paradigm, and Buttelmann et al. (8) found positive results using the Buttelmann et al. (19) paradigm. Again, these new studies are in contrast to five other studies that found negative results with great apes in tasks resembling the classic tasks (see ref. 14 for a review).

How do we explain the fact that both infants and apes are successful in the infant false-belief tasks but not in the classic false-belief tasks? Our hypothesis is that in solving the infant (implicit) tasks they use the same social-cognitive skills that they use in a number of other tasks that are not thought of as measuring an understanding of false belief. Many studies show that infants and apes can predict the behavior of an agent based either on what the agent sees now or on what the agent has seen in the recent past (and so "knows," in the sense of knowledge by acquaintance). For example, subordinate great apes will avoid a piece of food when a nearby dominant can see it. They will even avoid it when the dominant (who cannot see it now) saw it moments ago hidden in its current location: They know not only what the dominant ape sees but also what he knows (10, 20). Human infants, in a number of different experimental paradigms, also predict what an agent will do based on what the agent sees and knows (e.g., refs. 21–23). These experiments and many others like them are normally interpreted as showing that infants and great apes can imagine and track the epistemic states of agents and predict their behavior accordingly.

Our contention is that in the infant false-belief tasks infants and apes are doing basically the same thing as in these other studies: They are imagining and tracking the epistemic states of others. Theorists who claim that they are doing more than that focus on the fact that the infants and apes in the false-belief tasks have different information from the agent about where the sought-for object really is. Supposedly, in this view, they use their own knowledge of where the object really is to determine that the agent's belief about the object's current whereabouts is false. However, what if the infants and apes are not making such a determination but only are attempting to discern what the agent sees and knows, without attending at all to their own (discrepant) knowledge of the situation or to the objective situation? In this case, as in many other experiments, they would simply be imagining and tracking the epistemic states of an agent full stop (see also refs. 18 and 24).

To perform well in the infant false-belief tasks, the infants and apes do not need to understand that the agent's belief is incorrect. All they need to do is to track what the agent sees or has seen in the situation and how this information will affect the agent's behavior, with no reference at all to their own view of the situation or to the objective situation. To be clear, we do not agree with those who think that the infants and apes are only submentalizing, that is, predicting behavior without reference to any mental states (e.g., ref. 25; see ref. 26 for a refutation). To predict what the agent will do, they must understand mental states such as seeing, intending, and knowing, perhaps in analogy with their own mental states (27, 28), and how these mental states affect the agent's behavioral decision-making. However, they have no need to compare these mental states with the objective situation as they know it.

What Do Older Children Do That Is Different?

With current data we cannot be sure of this interpretation, but for the moment let us assume that it is correct. The problem is that, in principle, this same interpretation could apply to the classic false-belief tasks that only 4- to 5-y-old children succeed in passing. When an agent sees an object go into the box, and then after the agent leaves the object is moved to the cabinet, to predict where the agent will look when he returns the child needs only to have formed the generalization from past experience that people usually look for things where they last saw them. (This also works in true-belief control conditions as well as in the main alternative false-belief task, *mutatis mutandis*, the change-identity task: In this case the child needs to have made the generalization that people imagine that the picture on the outside of the box reflects what is inside.) Thus, in the classic false-belief tasks, as well as in the infant versions, it would seem that simply imagining or tracking the epistemic states of the agent is sufficient for success, with no need to compare those states with one's own epistemic states or with the objective situation.

However, there is an important additional fact: If children were simply imagining or tracking the epistemic states of agents, they should be continuously successful from 1–5 y of age in one or the other of the infant and classic tasks, with a lack of understanding leading to random guessing. As is well known, however, 3-y-old children do not just guess randomly where the agent will look; instead, they systematically predict that the agent will look in the location where they (but not the agent) know the object to be (reflecting the so-called "pull of the real"). Why do 3-y-olds make this mistake when even infants do not? One possibility is that this mistake actually represents conceptual progress in that it emanates from an emerging conceptualization of an objective perspective on the situation, i.e., what "really is" independent of any individual's subjective perspective. As this understanding is just emerging, 3-y-olds apply it too widely, assuming that people guide their search for things by an objective perspective (5). This assumption makes sense because children are frequently exposed to situations in which an adult knows something that they have not seen the adult learn; for example, their mother often knows what happened at a friend's house even though she was not there. Three-year-olds' confusion is only exacerbated by the fact that they have a cooperative bias that may lead them to interpret the experimenter's question about where the agent will look as a question about where the agent should look (29).

Thus 3-y-olds may understand something about an objective perspective on the situation, but they coordinate that objective perspective poorly with the subjective perspectives involved (see ref. 30, for an experiment that makes this coordination easier and finds successful performance in 3-y-olds). Indeed, an adult-like understanding would actually involve three coordinated perspectives: the agent's perspective, the child's own perspective, and the objective perspective on how things really are. In the classic task, the child's own perspective and the objective perspective are, in a sense, confounded (the child saw the toy being moved to a new location, where she now assumes it really is). However, a fully adult-like understanding would include the proviso that the child herself might potentially be wrong; perhaps the cabinet has a false bottom or someone has tricked her. The objective situation is independent not only of what the agent believes but also of what the child as observer believes. A fully adult-like understanding would thus be that the agent believes that the object is in the box; the child observer believes that it is in the cabinet because she saw

it moved there; thus the child's best guess is that the objective situation matches her own belief (because she has good evidence, and the agent has misleading evidence). To fully understand the notion of belief, one must understand that whether the evidence is weak or strong, the believer—the agent, the person observing, or both—can always be wrong from an objective perspective. That is what defines the notion of belief.

In addition to this interesting U-shaped pattern of development—infants are mostly correct in the infant tasks, 3-y-olds are systematically pulled to the real in the classic tasks, and older children coordinate the different perspectives involved in adult-like ways—a second important fact suggests that only the older children have a full understanding of the notion of belief. In older children, performance in the false-belief task is correlated with their performance in several other tasks that cannot be solved by simply imagining or tracking epistemic states (see ref. 6 for a selective review). Moreover, and importantly, experiments investigating these tasks have helped identify the nature of children's thinking about them (and, by implication, the false-belief task). These studies are all informed by Perner et al.'s (31) conceptualization of false-belief and related tasks as presenting children with "perspective problems," that is, problems created by the fact that different individuals have seemingly incompatible perspectives on the same objective situation (as the child imagines it).

One such task is visual perspective-taking. Moll and Meltzoff (32) gave 3-y-olds experience with a color filter which, when one looked through it, changed the apparent color of the things behind it. Children were then presented with two identical blue objects. The trick was that an adult on the other side of a table saw one of the objects through a yellow filter, so that the object appeared green. The adult, looking straight ahead, then requested either "the blue one" or "the green one." Even though the objects appeared identical to the children, they chose the correct one for the adult in both cases. However, in this study children could simply look at the two objects and determine which one of them appeared green to the adult without contrasting the adult's perspectives with their own. Moll et al. (33) therefore modified the task so that children had to identify (either verbally or by pointing to a color sample) the color of the object both from their own perspective and from the perspective of an adult on the other side of a color filter: They were asked, "How does it appear to you? And to me?" Now the 3-y-olds were pulled to the real, saying that the object appeared blue both to the adult and to them; it was only 4.5-y-olds who understood that the object that appeared blue to them appeared green to the adult across the table. Although there is nothing inconsistent about something appearing blue to me and green to you, if color filters are involved, it is likely that 3-y-olds' think of the color of an object as an objective attribute: Something cannot be simultaneously completely green and also completely blue. Thus, given that 3-y-olds are good at imagining what others see in straightforward situations, it is likely that their emerging sense of an objective perspective—the color the thing really is—and/or their inability to coordinate two perspectives simultaneously interfere with their ability to take the visual perspective of the other when they must explicitly compare it with their own.

A second task of this type is the appearance–reality task. The classic appearance–reality task involves children understanding that an object that appears to be one thing is really another, e.g., that an object that looks like a rock is really a sponge (21). Children also struggle with this task until they are 4–5 y of age. Again, Moll and Tomasello (34) modified the classic task to distinguish cases with and without conflicting perspectives. In a first study they presented 3-y-olds with a nondeceptive object and a deceptive object: e.g., a bar of chocolate along with an eraser that looked like a bar of chocolate. They then asked children to point to the "real bar of chocolate" or, alternatively, to "the one that only looks like a bar of chocolate." Three-year-olds were mostly successful in identifying each object correctly. However, in a second study children of this same age were presented with a single ambiguous object and asked to point to one of two exemplars—an eraser or a bar of chocolate—when asked what this single object "only looks like" and what it "really is." The same children who were previously successful with two different objects were not able to answer this pair of questions about a single object correctly. Moll and Tomasello interpreted this finding in the same way as their finding about visual perspective-taking: In the first task children only needed to conceptualize an object in one way at a time (i.e., as either chocolate or eraser), whereas in the second task they needed to conceptualize it in two different ways simultaneously, and these were ways that seemed to conflict. As in the visual perspective-taking task, it is likely that the 3-y-olds had trouble because they were invoking an objective perspective such that the object cannot be two things at the same time. Four-year-olds resolve the apparent conflict, or else do not even see a conflict, through a new understanding of the situation that accommodates the different perspectives involved: Objects can appear as one thing but function as another.

A final task of the same general type is the so-called "dual-naming task" (35). Children before age 4 or 5 y have trouble reconciling the fact that the same object may be called "a horse" or "a pony" or, in another case, "a horse" or "an animal" (the classic class-inclusion task). Again, there is in fact no conflict here once one learns how linguistic labels work; one may call something "an animal," or "a horse," or "a pony," or "a filly," or "a nag," or "a nuisance," all depending on how one wants to perspectivize the entity or situation for one's communicative partner. In linguistic philosophy, it is said that the same object is being seen or construed under different descriptions or different aspects. Young children may not initially understand the situation in this way and may assume that an object's label is an inherent property so that there is only a single objectively correct label at one time; this assumption creates the conflict (36). Recently, Rakoczy et al. (37; see also, refs. 38 and 39) tested young children for an understanding of aspectuality. They first saw a trick object in one state and assumed it was a toy carrot; later they saw it in another state and assumed it was a toy rabbit. It was only at 4–5 y of age that children understood that an object they knew under two different descriptions—carrot and rabbit—could really be the same object. Again, we may posit that the younger children somehow thought that once something had one description, that description defined what it was objectively, and it could not simultaneously be something else. Importantly, Rakoczy et al. (37) also found that children's ability to perform well in this dual-identity task correlated quite highly with their performance on a false-belief task designed to be very similar in its task structure and demands. This finding provides further support for the proposal that in trying to solve perspective problems, including the classic false-belief task, preschoolers rely on similar cognitive processes.

Perspective problems thus present children with conflicting perspectives about an objective situation that must be somehow resolved or coordinated, sometimes by constructing new concepts. Thus, children see an object that appears from different directions to be either green or blue, and this seems, on the surface, to not be possible. The solution is to recognize that the objective situation may simultaneously appear in different ways from different viewing angles (especially through a color filter). Similarly, an object may appear to be of one type but from a different perspective (with different perceptual information) may turn out to be something else in terms of what it actually does or is designed to do (e.g., a rock or a sponge). The solution again is to recognize that there are two possible perspectives on the same objective thing, in this case one that accords with its appearance and one that accords with its function. Finally, young preschoolers find it natural to think of an object's label as an objective property of that object, which leads them to a nonadult-like reluctance to label the same object with different words simultaneously. An understanding of the

perspectival/aspectual nature of linguistic conventions resolves the problem. In all these cases resolution requires a flexible coordination of the differing perspectives involved, including an objective perspective with which all others must somehow be compatible. Applied to the false-belief task, the toy clearly cannot be in two locations at once because an objective perspective specifies only one place, and the solution is that either the agent or the child (or both) has a false perspective on (belief about) the situation.

Although, again, we cannot be certain of this interpretation, it brings coherence to children's behavior in a number of different tasks in the 4- to 5-y-old age period. In all these tasks 4- to 5-y-olds begin to show an understanding that individual perspectives may or may not mirror the objective situation. They are beginning to distinguish subjective versus objective perspectives, and this insight helps them resolve various particular conflicts of perspective.

A Shared Intentionality Account

Theories about how children come to understand false beliefs span the gamut from proposals for an innate theory-of-mind module (40) to proposals that children must be explicitly taught by adults to read other minds much as they are taught to read books (41). Between these extremes are proposals that young children, like scientists, acquire new knowledge through processes of hypothesis testing and learning, with hypothetical constructs such as "belief" constructed to explain behavior [e.g., when someone acts as though oblivious to reality (42)]. There are also proposals that human adults operate both with an evolutionarily ancient system of mindreading that emerges in infancy and is minimal in that it does not focus on mental states per se and also with a more sophisticated system of mindreading that emerges in older children, is focused on various sophisticated kinds of mental states, and presumably is learned through individual experience (4, 43).

In contrast to these accounts focusing on the individual child, our account focuses on children's attempts at social and mental coordination with others. The point is that for me to understand that you have a false belief, I must judge that your representation of the objective situation does not match my representation of the objective situation; I take my representation as matching the objective situation (while understanding that it might not). This requires exactly the kinds of coordination of perspectives, including an objective perspective, that we saw above in 4-y-old children solving tasks such as visual perspective-taking, appearance–reality, and linguistic aspectuality. Our central contention, which differentiates our account from others in the field, is that this coordinating of mental perspectives is not something that an individual comes to do, or even could come to do, on her own. An individual cannot come to this new way of understanding things either by inventing a clever theory or by simulating another's experience. Rather, to coordinate perspectives and so to understand the distinction between subjective and objective, an individual must triangulate [to use Davidson's term (44)] on a shared situation simultaneously with another individual: We both are attending to X, but you see it this way, and I see it that way. We understand that the two of us are sharing attention to the same entity (under the same description), but at the same time we each have our own perspective on it.

The starting point ontogenetically is the emergence of infants' species-unique skills and motivations of joint attention at around 9 mo of age. Thus, at around the same age that infants are imagining and tracking the epistemic states of others in infant false-belief tasks, they are also acting together with others to attend to things jointly. With joint attention we may say that the infant and partner understand themselves to be attending to the same thing together, but at the same time they understand that they are doing so from different perspectives; they are triangulating on it. Joint attention and perspectives thus come as a psychological package, since without joint attention, there is no common object on which the two of us may have different perspectives; we just see different things (45). This manner of social engagement has been called the "dual-level structure" of shared intentionality because it simultaneously encompasses a shared focus on something and individual perspectives on it (15).

In joint attentional interactions, partners are constantly attempting to align their goals and attention. The aligning of attention may happen as one individual simply follows the attention of the other and they then somehow acknowledge (e.g., by a mutual look) that they are now engaged in joint attention. Often, however, one individual actively attempts to align another's attention with his own via referential communication. In the prototypical situation with infant and adult, one of the partners initiates things by offering the other an object, showing the other an object, pointing to some interesting event, or even using a simple piece of language. The communicator has the goal of having the recipient attend to what the communicator is already attending to; the communicator's (referential) goal is the aligning of their attention in joint attention (46, 47). If the recipient accedes, she moves her own individual attention from something else to jointly attending with her partner. The interpersonal negotiation thus involves each partner's sequential shifting from individual to joint attention as either communicator or recipient. Unlike simply imagining what another person is seeing or attending to, with no attention to one's own seeing or attending, negotiating joint attention brings into focus the relation between the two perspectives. They are not now aligned, and to know that they are now aligned—after communication—there must be at least some imagining of the content of both perspectives and their relationship. This requires an executive level of cognitive functioning (a bird's-eye view) in which the two perspectives may be compared in the same representational format to see if there is alignment (see below for a further discussion of the role of executive function).

Then, during the 1- to 3-y-old age period, children begin to learn to communicate via a conventional language. Their earliest language is organized mainly at the level of the individual utterance, but by around 2.5 y of age they start to participate in relatively extended conversations in which partners take turns making comments about a mutually understood topic. Conversations in which the topic has been linguistically expressed thus involve joint attention on a new level: joint attention to mental content, defined as a shared focus on a mental construal of something about which we express different perspectives or attitudes (48; see ref. 49 for a related view). The topic–comment structure of discourse may thus be seen as another instantiation of the dual-level structure of simultaneous sharedness and individuality: You make an utterance expressing some kind of mental content, e.g., "Look at that cat," and I respond with a comment on the same mutually understood topic, e.g., "It's an Abyssinian." You may then respond with "It's my sister's cat." We are jointly attending to a topic, the cat, and we are expressing different attitudes and/or perspectives on it. This kind of triangulation in discourse is the raw material from which young children discover that mental perspectives themselves, the mental content of conventional linguistic expressions, may be looked at from different perspectives.

Of special importance for current purposes are children's conversations in which the topic is a proposition, that is, some kind of truth-bearing assertion such as "That cat is sick," to which the reply may be "No, its not," or "You're wrong." In such exchanges there is a linguistically expressed statement of fact followed by the expression of some kind of conflicting attitude (or perspective) regarding the mental content of that statement of fact; both cannot both be right. Conversations of this type become adult-like only when the child can take an objective perspective and assess the assertion with respect to the objective situation. A wealth of data suggests that in many activities this occurs at around 3 y of age; that is, at this age children begin to understand things objectively, from the perspective of "anyone." For example, they understand that

some pieces of knowledge are possessed by everyone in the culture, even strangers (50); they understand that everyone in the culture knows the same linguistic conventions (51); they understand pedagogy to be conveying culturally general knowledge (52); they normatively correct people who make false statements (53); and they enforce social norms and show other signs of understanding normativity, which applies to everyone in the culture alike (54; see ref. 55 for a review). Importantly, in most of these activities there is also good evidence that 2-y-olds do not have this universalizing perspective (see ref. 56 for a review). The key conclusion for current purposes is that the objective perspective, which enables discourse about the truth of propositions, emerges at around 3 y of age. [Tomasello (15) argues that the ability and tendency to conceptualize things objectively emerged in human evolution as part of the human adaptation for culture. As cultural groups were emerging, such things as conventions, social norms, and institutions began to structure social interactions. Beyond taking the perspective of individuals, these supraindividual social structures required individuals to take a kind of generalized cultural perspective on things. The claim here is that, in ontogeny, 3 y is the age at which young children start to become group-minded and cultural and so to take an objective perspective on things. Presumably, a maturational capacity emerges at this age, but it actualizes only through social interaction with others (56).]

Coordination to a satisfactory conclusion in such discourse thus involves the coordination of three perspectives—yours, mine, and the objective perspective—and often relies on the recognition that some perspectives are inaccurate or that the different perspectives may not be incompatible after all, e.g., because we are talking about different cats or different criteria for sickness. This manner of functioning is also crucial to children's mastery of what are called "propositional attitude constructions" or "sentential complement constructions" such as "He believes the cat is sick" or "I hope the cat is not sick." In these constructions, the speaker formulates a proposition but embeds it within a propositional attitude such as "I think that . . . ." Diessel and Tomasello (57) found that although 3-y-olds use such constructions, they mostly do so in very formulaic ways that do not require a conceptualization of mental states or perspectives (e.g., "I think it's raining" just means, for them, "Maybe it's raining"). It is not until they are 4 or 5 y of age that children understand the coordination of perspectives involved (i.e., the cat is or is not objectively sick, and this is independent of the attitude about this fact that the speaker expresses in the main clause). With fully understood propositional attitude constructions, young children have a single representational format for expressing both the objective perspective and some subjective attitude about it (58). The theoretical claim is thus that exchanges of perspective in linguistic discourse about truth-bearing propositions made possible by the emergence of an objective perspective begin at about 3 y of age and are crucial in children's coming to distinguish between the situation as it objectively is and the situation as different individuals subjectively believe it to be (59).

To summarize, apes only imagine or track epistemic states; they do not understand different perspectives on a common situation. This means that there is no possibility of perspective problems, no possibility for a mismatch between a subjective perspective and the objective situation, and no coordinating of different perspectives into new understandings. These limitations are because apes do not triangulate on situations by engaging with others in joint attention with the dual-level structure of sharedness (joint focus) and individuality (individual perspectives). Human infants are initially the same. Then they begin to engage in joint attention with others at around their first birthdays, relating the two perspectives involved. However, much social and communicative interaction with others is required before they can construct an objective perspective and then appropriately coordinate their own perspective both with the other person's perspective and with that objective perspective. These constructive processes are mainly realized in linguistic discourse characterized by communicative exchanges involving joint attention to mental content.

Evidence for the Theory

Evidence for this proposal about how young children come to coordinate perspectives and so to understand false beliefs comes from the many studies well known to everyone in the field documenting that children's understanding of false belief is reliably associated with two other psychological processes: linguistic communication and executive function. However, the key is to identify which aspects of these complex processes are critical.

First, a number of studies have found correlations in children's various skills with language and their false-belief understanding (see ref. 60 for a review). Beyond such general correlations, Peterson and Siegal (61; see also ref. 62) report that children growing up deaf and with less than optimal experience with a conventional sign language are significantly delayed in their understanding of false beliefs. Moreover, there is a correlation so that the more linguistic experience these children have, the better are their skills with false beliefs. Even more striking, Pyers and Senghas (63) report the extreme case of deaf children who grow up with little or no experience with a conventional sign language; these persons fail nonlinguistically administered false-belief tasks even as adults! Experience with a language is necessary for coming to understand false beliefs.

However, there is no consensus in the literature as to which aspects of linguistic communication are critical. In the current account we have stressed the exchange of (sometimes conflicting) perspectives that occurs in everyday discourse as it is structured by joint attention to mental content. This view is supported by the training study of Lohmann and Tomasello (64; see also, ref. 65). They gave 3-y-old children who had failed a false-belief task three sessions of training and then readministered a similar but different false-belief task. There were four training conditions. In a control condition, children were given experience with deceptive objects that led them to have a false belief about the identity of the objects initially (e.g., an apparent chocolate bar that turned out later to be an eraser). In this condition there was no relevant language (just things like "Oh, look!"), and the children did not progress in their false-belief understanding. Children in the three other conditions did progress, however. One condition involved the same experience with deceptive objects, but the experimenter and the child engaged in discourse about the experience as it unfolded (notably, without the use of any mental-state language or propositional attitude constructions); for example, the experimenter asked the child to say what the object was initially and then what it was after receiving new information. This was called "perspective-shifting discourse," and it was designed to highlight for the child linguistically different perspectives on or beliefs about the same object. In another successful condition children were not given a deceptive experience but only were given extra training in propositional attitude constructions of the type "He knows that it's an eraser" or "He believes that it's a cat." Building on the theoretical and empirical work of De Villiers (58), Tomasello and Rakoczy (66) argue that such sentences encode a kind of potential perspective-shifting within a single sentence, in that the clause "he knows" signals different possible perspectives or beliefs about the fact that the object is an eraser or cat. Importantly, the third successful condition produced even greater progress than these two successful conditions because it was a combination of both: Children were given experience with deceptive objects while engaging in perspective-shifting discourse containing propositional attitude constructions about this experience.

This study demonstrates that perspective-shifting discourse, especially when it contains propositional attitude constructions coordinating a subjective attitude with a potentially objective fact, is sufficient to produce, in a relatively short period of time, false-belief understanding in children who otherwise would not attain it

(as in the control condition). Why does discourse of precisely this type lead 3-y-olds to an understanding of false beliefs? Children have nonlinguistic experience all day every day in which they believe something to be the case and then it turns out not to be or in which they see a person making a mistake that she would never make if she understood the true situation. Why are such experiences not enough, as they were not in the control condition of the Lohmann and Tomasello (64) study? As adumbrated above, our view is that a conventional language makes possible the public expression of mental content, and this public expression makes the mental content available as a focus of joint attention. With joint attention to mental content comes the possibility of different perspectives toward it. When the topic is a truth-bearing proposition, different discourse perspectives on its mental (propositional) content can actually conflict in that both cannot correspond in a straightforward way to the objective situation. Given the emergence of an ability to conceptualize an objective perspective, we contend that experience with this kind of discourse leads children to construct a distinction between subjective perspectives (appearance, opinion, belief) and the objective situation (reality, fact, truth). It may be that such discourse is especially effective when it occurs between peers; that children with siblings pass false-belief tasks earlier than do children without siblings provides suggestive evidence (e.g., ref. 67).

The other variable consistently found to correlate with false-belief understanding is executive function. Executive function refers to a cluster of skills in which the individual employs an executive/oversight level to control or coordinate behavioral or cognitive processes on a basic level. Thus, one example is inhibitory control, for example, "delay of gratification" when the individual passes up a reward she desires now (inhibits the desire) for a greater reward later. Another example that is particularly relevant in the current context is the ability to hold multiple items in attention or working memory at the same time and possibly to coordinate them in some way, e.g., sorting one set of objects in multiple ways based on multiple physical dimensions such as color and/or shape. Many studies have found relatively strong correlations of false-belief understanding with one or the other of these dimensions of executive function; furthermore, longitudinal studies suggest executive function facilitates false-belief understanding, not the other way around (see ref. 68 for a review and meta-analysis). Recently, experimental methods (depleting executive-function skills by having the individual work concurrently on a demanding executive task) provide further evidence of a causal link going from executive function to false-belief understanding, and not the other way around (69).

As in the case of language, there is no consensus about precisely which skills of executive function are involved in the development of false-belief understanding. However, three different studies suggest that it is not just skills of inhibitory control at work (e.g., the child coming to inhibit the pull of the real), but rather skills for coordinating perspectives or mental states. First, in the meta-analysis of Devine and Hughes (68), the strongest correlation with false-belief understanding across many studies was not any measure of delay of gratification (inhibition only) but rather the Dimension Change Card Sort (DCCS) task, which measures something more like the coordination of perspectives (often characterized as "cognitive flexibility"). Second, Diaz and Farrar (70) found basically the same thing, with the DCCS task in their longitudinal study showing a stronger correlation with later false-belief understanding than other (inhibitory control) measures of executive function. Finally, even more specifically, Fizke et al. administered several measures of executive function and several measures of mental state understanding to 4-y-olds and found that "relations [between executive function and false-belief understanding] are strongest in such tasks where the ascriber herself is one of the two agents, i.e. has a belief or desire herself that stands in contrast to that to be ascribed to someone else. … [T]hese findings suggest that executive function figures in coordinating perspectives more generally, not only epistemic ones, and in particular in coordinating others' and one's own conflicting perspectives" (71, abstract). It is perhaps relevant that one recent study found that executive function does not correlate with performance in infant false-belief tasks (perhaps because they do not involve any coordinations), but it does correlate with classic false-belief tasks (72).

Overall, then, we may characterize the contribution of children's developing skills of executive function to false-belief understanding as follows. Infants, like great apes, have some skills of executive function involving delay of gratification and other forms of inhibiting prepotent responses. At 9 mo of age infants also begin to coordinate attention with a partner in acts of joint attention and referential communication. At 3 y of age, children begin to develop species-unique skills for coordinating multiple mental states in a single task. This fact is evidenced by studies finding that human children's skills of executive function, including coordinating perspectives, only go beyond those of apes beginning at about 3 or 4 y of age (73, 74). These skills, which are at least to some degree domain general (the degree of this generality is open for debate), seem to be responsible for young children's ability to compare and coordinate their own and others' perspectives as different attitudes to mental representations, including propositions. In the case of false-belief understanding in particular, coordinating one's own and a partner's perspectives on the same situation requires that the two perspectives, and an objective perspective as well, must be compared and the apparent conflict resolved, presumably in the common representational format provided by the executive level of functioning.

Finally, one more set of correlational findings is relevant to our social-interactive theory. Several studies have followed young children longitudinally from infancy to early childhood and correlated various measures of their early social cognition and interaction with their later false-belief understanding. Given that understanding false beliefs requires as a prerequisite the imagining and tracking of basic mental states, it is not surprising that some studies have found correlations between infants' ability to track the perceptions and intentions of others, including in infant false-belief tasks, and their ability later, as young children, to understand false beliefs (75), although, as noted above, others have found no such correlation (72). However, most important to the current hypothesis, several longitudinal studies have found strong correlations between infants' skills in joint attention and their later skills in classic false-belief tasks (e.g., 75–77). In addition, the joint-attention skills of infants with autism correlate quite robustly with their later skills in false-belief understanding (78). It would thus seem that infant joint attention is at least as good, if not better, a predictor of children's false-belief understanding as infant performance on implicit false-belief tasks.

An Evolutionary Speculation

This social-interactive view is further supported indirectly by evolutionary considerations. Great apes imagine and track the (nonperspectival) mental states of others. This means that they encounter with regularity the kinds of evidence that the theory, and other accounts based on individual learning, believe are critical: They see others searching for food where it is not, they themselves are surprised when the situation turns out to be other than expected, and so forth. So why do not great apes, like humans, construct a theory of psychological functioning that includes beliefs and false beliefs and thus enables them to pass classic tasks?

Our evolutionary speculation is that evolutionarily ancient skills for imagining and tracking the mental states of others evolved in the context of social competition. Because great apes and most other mammals engage with their groupmates mostly competitively, they have evolved basic skills for predicting what a competitor will do in various situations based on an ability to imagine what that competitor wants (its goals) and what it perceives (or

knows). Making such predictions does not in any way require deciding whether the competitor's mental states do or do not match reality; the only thing that matters is what the competitor perceives or knows. Skills of this same general kind have been observed not only in great apes but also in other nonhuman primates (e.g., refs. 79 and 80), other mammals such as domestic dogs (81) and goats (82), and various species of bird (83). The ancient system comprises the basic skills of social cognition necessary for social animals to compete successfully with others in their group for food, mates, and other resources. In human ontogeny, such skills emerge in infancy, including in infant false-belief tasks, and there are no known experiential correlates.

The uniquely human ability to understand others in terms of beliefs which may contrast with objective reality has no direct evolutionary bases, only indirect ones. The key is the evolution of humans' remarkable cooperativeness. In the context of selective pressures for greater cooperation, humans evolved special skills of social coordination and communication; these are humans' species-unique skills and motivations of shared intentionality (15, 16). Whereas during competition individuals read the minds of their competitors against the competitor's will (when we are competing, I want to conceal my mental states from you), in cooperation and coordination individuals want their partner to read their minds (when we are cooperating and coordinating, I do everything I can to display or advertise my mental states to you to facilitate the process). Thus, in joint attention, I do what I can to help you attend to what I am attending to, and you work toward this same goal as well. In conversation, I do what I can to help you understand me, and you work toward this same goal as well. However, as emphasized by Sperber et al. (84), in the context of such strong assumptions of cooperation I must also develop "epistemic vigilance" to protect against individuals who might exploit my cooperativeness by lying or deceiving, and this brings to the fore the question of whether my partner's communicative attempts reflect the objective situation accurately. Perhaps paradoxically, it is only in highly cooperative social contexts, where altruism and truthfulness and therefore gullibility are the norm, that the need arises to monitor one's social partners for attempts to bend the truth. Young children learn to do this as they begin to engage more widely and more independently with different communicative partners during early childhood and beyond.

In this scenario, the understanding of false beliefs is an emergent ontogenetic outcome for individuals who engage with others cooperatively in joint attention and linguistic discourse, which includes basically all normal humans developing in normal social circumstances. When individuals are not able to engage in these processes (e.g., children with autism who have deficits in joint attention and language or deaf children developing in impoverished linguistic environments), they are not exposed to the experiential raw materials necessary for constructing the concept of belief. Interestingly, when 6-y-old children are coordinating with others cooperatively, e.g., in a coordination game in which they must read one another's minds to be mutually successful, they find it natural not only to understand one another's false beliefs but also to understand one another's second-order false beliefs [i.e., beliefs about beliefs (85)]. Whether special skills of executive function evolved along with shared intentionality, to support it, or have other evolutionary sources, is at this point an open question.

Conclusion

It is worth reiterating that many animal species imagine and track the mental states of others, and they have potentially available to them all the information necessary to understand that others have false beliefs. To explain why only humans operate with the concept of false belief, we must find something that distinguishes the nature of humans' social experiences from those of other species. The most plausible candidate, in our view, is cooperative mental coordination with others as structured by skills and motivations of shared intentionality (86). Humans are ultra-cooperative, both cognitively and motivationally, in ways that clearly distinguish them from even their nearest primate relatives. This creates the possibility of taking and coordinating different perspectives (including an objective perspective) on the same situation and at the same time raises a concern for the truthfulness, or lack thereof, of social partners.

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