Understanding children’s and adults’ limitations in mental state reasoning

Susan A.J. Birch and Paul Bloom

Department of Psychology, Yale University, PO Box 208205, New Haven, CT, 06520-8205, USA

Young children exhibit several deficits in reasoning about their own and other people’s mental states. We propose that these deficits, along with more subtle limitations in adults’ social-cognitive reasoning, are all manifestations of the same cognitive bias. This is the ‘curse of knowledge’ – a tendency to be biased by one’s own knowledge when attempting to appreciate a more naive or uninformed perspective. We suggest the developmental differences in mental state reasoning exist because the strength of this bias diminishes with age, not because of a conceptual change in how young children understand mental states. By pointing out the common denominator in children’s and adults’ limitations in mental state reasoning we hope to provide a unified framework for understanding the nature and development of social cognition.

Preschool children can be remarkably bad at reasoning about mental states. They are often poor judges of what information other people are likely to know, and are notoriously bad at recalling when they themselves acquired new information. For example, once four- and five-year-olds are taught a new fact (e.g. that tigers’ stripes go up and down) they assume that other children know this fact, and insist that they themselves had always known this fact [1]. Young children also have problems with perspective-taking, doing poorly, for instance, at tasks requiring them to figure out how a particular scene will look from another person’s viewpoint [2]. Piaget described this perspective-taking problem as ‘egocentrism’, suggesting that young children are unable to appreciate that other people’s perspectives can differ from their own [3].

Finally, young children have serious difficulties in reasoning about false beliefs. In the standard demonstration of this, children are presented with a story (see Figure 1a) in which one character, Sally, puts an object (e.g. a ball) in one location (Location A) and then goes outside. While Sally is away, Ann moves the ball to a different location (B). The question posed to children is: When Sally returns and wants her ball, where will she look for it? Children younger than four tend to say she will look in location B, failing to attribute a false belief to Sally [4,5].

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Figure 1. (a) A representation of the ‘Sally-Ann’ false-belief task used to assess children’s understanding that other people can hold false beliefs – beliefs that contradict reality. In these tasks, children are told that Sally places an object (e.g. her ball) in one location (A) and then goes outside. While Sally is away, Ann moves her ball to a different location (B). The question posed to children is: When Sally returns and wants to find her ball, where will she look for it? Children younger than age four typically say she will look in location B, failing to attribute a false belief to Sally. (b) A representation of a false-belief task that would remove or diminish the curse of knowledge. We propose this is a better test of children’s abilities to reason about false beliefs because it diminishes the specificity of their outcome knowledge [23]. This task is the same as the standard task outlined in (a), except that an additional location would be added, meaning that the child participant remained ignorant of the exact outcome of the false-belief event. Here, while Sally is away, Ann moves her ball to a different location, either B or C, and the child does not know which one. As in the standard task, to succeed, the child must attribute a false belief to Sally (that she will believe it is in location A) and know this to be false.
A different paradigm shows that this confusion also applies when assessing one’s own beliefs. In the classic ‘unexpected contents’ task [6], children are shown a candy box and asked what is inside. When they answer ‘candy’, the box is opened to reveal pencils. The box is then closed and the children are asked what they originally thought was in the box and what someone else, who was absent when the real contents were revealed, will think is in the box. Children younger than four answer both questions incorrectly, stating that they themselves initially thought there were pencils inside and that someone else would think there were pencils inside. They fail to recall their own earlier false belief and they fail to appreciate that someone else, who was absent when the real contents were revealed, will hold a false belief.

Why do children experience these problems with reasoning about mental states? Children’s difficulties are often taken as reflecting a qualitative and conceptual difference in the way that they understand the mind. For instance, young children are sometimes said to lack a concept of belief or a concept of mental representation more generally [3,7–11]. We offer a different theory (see [12,13] for related accounts). We propose that these difficulties stem from a more exaggerated version of the same cognitive bias that has been found in adults. This is the ‘curse of knowledge’ [14] – a tendency to be biased by one’s own knowledge when attempting to appreciate a more naïve or uninformed perspective. For example, adults who know the solution to a problem tend to overestimate how easy it is for someone else to solve [15]. Similarly, people who know a company’s earnings [14], the outcome of an event [16], or whether or not a statement is sarcastic [17], tend to overestimate the knowledge of others (see also [18,19]). These and similar findings have been given a wealth of other names including ‘creeping determinism’ or ‘hindsight’ bias [16], the ‘knew-it-all-along’ effect [20], ‘the curse of expertise’ [21], ‘adult egocentrism’ [15,22], ‘reality bias’ [12] and ‘epistemic egocentrism’ [13]. We believe they are all manifestations of, and can most accurately be described by, the curse of knowledge (see also Box 1).

Over-estimating what others know and what we ourselves once knew
Do children suffer from the curse of knowledge? In one study to explore this, three-, four-, and five-year-olds were presented with two sets of toys: one described as being familiar to the experimenter’s puppet friend, Percy, and one described as being unfamiliar to Percy. The children were told that each toy had an object inside and were asked to judge whether Percy would know what was inside. The key manipulation was that sometimes the children were shown the toys’ contents, and sometimes they were not. When the children themselves knew the toys’ contents, they tended to overestimate what Percy knew – they were ‘cursed’ by this knowledge. Importantly, this tendency significantly declined from age three to age five [23] (see also [1,24]).

We suggest that the curse of knowledge is an important factor in explaining children’s difficulties in false-belief reasoning, perspective-taking, and knowledge assessment more generally. Indeed, there are some interesting parallels between ‘curse of knowledge’ studies with adults and the knowledge-assessment and false-belief tasks given to children. For instance, Fischhoff provided adults with descriptions of events and told them that these descriptions were also presented to other students [16]. Some participants were told the outcome of the event, others were not. Participants in both conditions were asked to estimate what ‘outcome-naïve’ students would predict as the likelihood of the different outcomes. The participants who had been told the outcome overestimated naïve students’ predictions of that particular outcome. In other words, they responded as if ignorant others shared their knowledge of the right answer – much like children in the ‘Sally–Ann’ false-belief task.

Consider also a task in which adults were asked on the eve of former President Nixon’s trips to China and the USSR to estimate the probability of various possible
outcomes of the visit [25]. Two weeks to six months later, the same participants were asked to remember their original predictions. Participants remembered giving higher probabilities than they originally had to the events that they now knew had actually transpired. These biased recollections resemble young children’s claims that they had known newly acquired facts all along [1] as well as their failures to recall their own earlier false belief about the candy box’s contents [6]. Thus, our knowledge not only interferes with the ability to appreciate what a naïve other will know, it also interferes with our recollections of what we ourselves knew or thought in a previously more naïve state.

**Difficulties in false-belief reasoning**

Standard false-belief tasks are cursed. In these tasks, the children always know the outcome – either that Sally’s ball has been moved to the box or that the candy has been replaced with pencils. Even adults, who undoubtedly have the ability to reason about false beliefs, still experience difficulty on such tasks when they know the outcome of the event. In a four-box version of the ‘Sally–Ann’ task, participants reported the probability that the protagonist would look in each of four possible locations after her violin was moved in her absence. When adults knew the exact outcome of the displacement event (i.e. the violin was moved to the ‘red container’), they were biased by this knowledge, in comparison with adults who heard the same story but did not know which of the boxes held her object (i.e. the violin was moved to ‘another container’). The ‘cursed’ participants were more likely than ‘uncursed’ participants to predict that the protagonist would look to the location where the object actually was, and consequently were less likely to attribute a false belief to the protagonist (S. Birch and P. Bloom, unpublished). Because adults have difficulty reasoning about false beliefs under conditions in which they have outcome knowledge, this suggests that children’s more extreme limitations do not necessarily reflect a conceptual deficit.

It is of course possible that the curse of knowledge is not the only factor contributing to children’s difficulties with false-belief tasks. There are other reasons why children might fail at such tasks, including, among other things, problems they have coping with multiple conflicting representations and with overriding an assumption that agents will act in a rational manner ([26,27], and O. Koos, G. Gergely, G. Csibra and S. Biro, unpublished). And it is possible that, in addition to the curse of knowledge, children also suffer from a conceptual deficit [7–11]. But at the very least, the curse of knowledge makes these tasks unnecessarily difficult, particularly for younger children who are more likely to fall prey to it. Thus, we suggest that these tasks are unfair assessments of young children’s true competencies in false-belief reasoning.

**Difficulties in perspective-taking**

Preschool children are often said to be ‘egocentric’ – they view the world entirely from their own point of view. One prominent area of research on egocentrism has focused on children’s communication. For example, in the classic experiment demonstrating egocentric speech [28], two children are seated across from each other with a screen placed so they cannot see one another. One child is designated the speaker, the other the listener. The speaker’s job is to communicate to the listener what objects he or she is selecting so the listener can choose the same objects. Most four-and-five-year-old children in the role of speaker provide too little information for the listener to be able to choose the correct object. They fail to appreciate that the other person cannot know which object they are referring to. These egocentric tendencies decrease with age [28].

We propose that this limitation is also a manifestation of the curse of knowledge. Children have difficulty appreciating the listener’s more naïve perspective not because they are unable to appreciate that others can have different perspectives, but because they have a hard time putting aside their own knowledge. Indeed, adults, who are undoubtedly able to appreciate that others can have different perspectives, demonstrate similar tendencies. In a study by Keysar and his colleagues [22], a person playing the role of ‘director’ in a communication game instructed a participant to move certain objects around in a grid. Before receiving instructions from the director, participants hid an object in a bag, such as a roll of tape. The participant knew what was in the bag, but the director did not (and the participant was aware that the director did not.) When the director said something such as ‘Move the tape’, there were two candidate ‘tapes’ among the array of objects: a videotape that was visible to both the participant and director, and the secret roll of tape in the bag. The correct response here would be to move the videotape – the director could not be talking about the object hidden in the bag because he did not know about it. Nonetheless, the adults often moved the bag containing the tape. They behaved ‘egocentrically’, interpreting what was said in terms of their own knowledge, not the knowledge of the speaker.

Much of what has been previously labeled egocentrism in both adults and in children could perhaps be defined more accurately as the curse of knowledge. The primary distinction between egocentrism and the curse of knowledge is one of scope. Unlike egocentrism – which is typically defined as an inability to appreciate any perspective other than one’s own – the curse of knowledge is asymmetric. It is a difficulty appreciating a perspective that is more ignorant than one’s own, but not a difficulty appreciating a perspective that is more knowledgeable. That is, when people are knowledgeable they over estimate what someone else knows, but when they are ignorant they do not under estimate what someone else knows [1,23] (see Figure 2). (See also Box 2 for a discussion of how a curse of knowledge account might explain why children exhibit competencies in mental-state reasoning in some circumstances and limitations in others.)

**What is the nature and origin of the curse of knowledge?**

When assessing the knowledge of another person, an adaptive and useful heuristic is to default to one’s own knowledge [29,30], whether it is through a ‘simulation’ process involving imagining oneself as the other person (e.g. [31]) or through a more direct projection of one’s own knowledge [30]. If you are asked to predict whether someone will know the capital of France, for instance, the
best, and often only, way to do so is to appeal to one’s own knowledge state. But when another person’s capacities or experiences are relevantly different from our own, we need to alter this default — this is essential to appreciate that someone knows more than oneself and to attribute ignorance and false belief. Nickerson [29,30] proposes this alternation is a case of anchoring and adjustment [32]: people anchor to their own knowledge, and then, realizing its inaccuracy, they adjust. And, as is typical in other instances of anchoring and adjustment [32,33], the adjustment tends to be insufficient. This is a promising model, but there remains the puzzle of the asymmetry in knowledge assessment: that people tend to overestimate what others know when they are more knowledgeable, but do not underestimate what others know when they are more ignorant. Why would adjusting up from one’s anchor to a more knowledgeable state lead to more accurate assessments than adjusting down?

One possible mechanism that might explain this asymmetry, and result in the curse of knowledge, is cognitive inhibition. When attributing mental states to others, it might be harder to inhibit one’s knowledge than to inhibit one’s ignorance. Differences in the nature of knowledgeable versus ignorant states might explain the asymmetry. Knowledge invariably involves a more substantive mental representation than ignorance. If a person knows the capital of France, then judging that someone else is ignorant requires inhibiting the answer and associated thoughts and mental representations that come to mind (e.g. the name ‘Paris’ and perhaps even a mental image such as the Eiffel Tower). But if the person making the judgment is ignorant, there is not a specific answer and associated mental representations to inhibit. Similarly, a subject in a false-belief task, who knows precisely where the object is, faces a different (and more difficult) inhibitory task than someone who does not or whose knowledge is less specific.

Importantly, age-related changes in inhibitory mechanisms (e.g. [34]) have been found across the preschool years and might explain why younger children are more likely to be vulnerable to the curse of knowledge than older children and adults. Indeed, inhibition has been found to play an important role in false-belief reasoning [35–37]. Increased inhibitory control would allow children to recast their own knowledge more successfully when trying to appreciate a more naive perspective.

Conclusions

We propose that the curse of knowledge account provides a unified framework for conceptualizing mental state
Box 3. Questions for future research

- What is the complete developmental trajectory of the 'curse of knowledge' bias? Are elderly individuals, who experience diminished inhibitory control, particularly prone to suffer from the curse of knowledge?
- Do other related biases in social cognition follow a similar developmental trajectory?
- What is the relationship between the curse of knowledge and children's difficulties with source monitoring and counterfactual reasoning?
- How do our assumptions of how similar someone else is to us, for example in age, gender or ethnicity, affect our assessments of whether that person will share our knowledge?
- What are the specific implications of the curse of knowledge account for theories of moral development?
- How can we best explain individual differences in the extent to which people suffer from the curse of knowledge? Will these simply follow from differences in memory and processing abilities, or will there be more subtle relationships with temperament, personality and empathy?

reasoning throughout development. We suggest that younger children's heightened susceptibility to the curse of knowledge explains their tendencies to overestimate what others know, their proclivity to claim they 'knew it all along', their perspective-taking limitations, and their difficulties in reasoning about false beliefs. Similarly, we propose that several adult biases in social cognition (see, for example, (15–22,24,25)) also stem from this single underlying source.

Research from adult social cognition has demonstrated how the curse of knowledge can manifest itself in several different domains. This is a particularly rich area for study across development (see also Box 3) because the implications of the curse of knowledge are exceedingly pervasive. Biased assumptions about what others know lead in turn to erroneous expectations about how someone will behave or feel, and can thereby permeate our moral judgments, our assessments of others' behavior, our feelings and attitudes towards others, and virtually all social interaction.

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