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Metacognition and the Social Animal

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INTRODUCTION

Metacognition, at its most basic level, is cognition about cognition. For instance, *metamemory* involves judgments and beliefs about memory. In an ideal world, metacognitive processes would provide a perfect reflection of the mind's contents, the way a mirror does. But research has shown repeatedly that metacognition is, at best, a distorted mirror: Predictions of future knowledge and judgments of current knowledge are subject to bias and are frequently inaccurate. The current chapter seeks to answer why, with all of its inaccuracies, metamemory survives as one of the most critical mental processes for any individual in a social world.

Here we consider the link between self-knowledge and knowledge of others and distinguish between three types of metacognition: metamemory, self-awareness, and other-awareness. Using data from a range of populations, including nonhuman animals, adult humans, children, and individuals with autism, we present evidence for a distinction between fast, heuristic-based metacognition and slower, more deliberate metacognition. We claim that without fast, heuristic metamemory processes, which do not necessarily depend on language or self-awareness, our memory systems would be of little value. Moreover, we postulate that metamemory is a key step in allowing individuals to develop into social beings. Taken together, the findings suggest that metacognition is crucial for an understanding of our own uncertainties, as well as the knowledge and intentions of others.

THE ROLE OF METAMEMORY

Over the past century, memory science has focused on how experiences are inscribed in memory, how these traces of the memories are stored in the mind, and how knowledge that has been committed to memory can be recalled at a later time. Over the past few decades, metamemory research has emerged as a new psychological subfield. And while the features of metamemory are linked to those of memory, the two faculties have been thought to be distinct. Consider the following illustration of the difference. Imagine that you learn that Emily Brontë wrote *Jane Eyre* and judge that you are confident that you will always remember this. Your metamemory may be absolutely accurate; that is, you thought you would remember the author and, when asked later, you do. Unfortunately (for you), Charlotte Brontë, not Emily, wrote *Jane Eyre.* Thus, your metamemory can be accurate when your memory is inaccurate. The reverse can also be true: You might know that Charlotte was the author of *Jane Eyre,* but be mistaken, at the metamemory level, in thinking that you will be able to remember that information later.

The use of metamemory is ubiquitous in everyday communication. For example, in response to a question about how well one did on a test, the answer, "I got a perfect score," is very different from "I'm not certain, but I may have gotten a perfect score" because "I'm not certain" and "may" signal uncertainty. They are, in other words, indicators of one's confidence, or lack thereof, in one's knowledge. We constantly produce such signals without much thought, and we understand them just as automatically. The simple act of saying, "I don't know," which many preschool children can do fluently and accurately, signals that people can report a lack of memory confidence from an early age. (Note, however, that the ability to say "I don't know" accurately depends on the child's age and the question the child is asked; for example, children sometimes say they can name an object, or know what it is, even when they do not; see Marazita & Merriman, 2006.)

In line with the preceding examples, empirical research on metamemory has relied on introspection and verbal self-reports. In a typical metamemory experiment, participants study information and give numerical ratings of how sure they are to remember that information later. It is well known, of course, that self-report data can be inaccurate, unreliable, and difficult to interpret (e.g., Nisbett & Wilson, 1977). However, this inaccuracy may be the essence of metamemory. That is, metamemory *is* what people believe about their own memories, whether it is accurate or not.

What is the role of metamemory? A memory is essentially a belief. Metamemory is one's strength or conviction in that belief. Retrieving a memory that is divorced from a feeling of confidence is like receiving a message from an unreliable source. A memory system that endorsed everything with equal confidence would be of little value unless it was free of gaps and errors. Metamemory allows us to recognize—and express—the gaps and errors in our memories. As a result, metamemory can be a check, or restraint, on memory. We learn not to trust our memories when we are not sure that they are accurate (for example, if someone looks only sort of familiar, we restrain ourselves from running toward them and giving them a big hug). In addition, we do not communicate false information to others (or, at least, we qualify the information by saying "I think" or "maybe"). And while metamemory is not perfect either, it serves the vital function of monitoring situations in which memory is not perfect so that the contents of the memory may be interpreted and conveyed to others appropriately.

Metamemory requires knowledge about our own knowledge. The ability to understand our own internal states may serve as a stepping stone to a variety of other higher level cognitive functions. Consider *theory of mind,* which refers to an awareness of our own mental states as well as an understanding that others have similar mental states. It is thought that theory of mind allows us to make inferences about the minds and behaviors of others. The major difference between metamemory and theory of mind is that the former refers to knowledge about the self, while the latter refers to knowledge about another. The two types of metacognition seem to be intimately related. For example, feelings of uncertainty may allow us to recognize that others can have similar feelings of doubt. Perhaps the universal ability to assess one's own uncertainty is a precursor for the complexities of human society, where individuals make room for debate, persuasion, sarcasm, humor, and even deception.

In the remainder of the chapter, we review some of the research on knowledge about the self, knowledge about others, and the link between the two. We begin with a discussion of the basic metamemory abilities that humans share with nonhuman animals.

METAMEMORY WITHOUT LANGUAGE

Within the science of metamemory, participants have typically reported their metamemory judgments verbally. But is language necessary for metamemory? And how did metamemory evolve? Did it coevolve with language, or is the ability linked to other prelinguistic cognitive abilities? These questions have led some to explore metamemory abilities in nonhuman animals. For the remainder of this chapter, we shall use the term "animals" to refer to nonhuman animals.

Understanding metacognition in the animal mind is of theoretical interest for a number of reasons. First, if an animal can make metamemory judgments, we can conclude that metamemory does not require language. Second, examining a nonverbal species allows for a relatively pure assay of metamemory mechanisms, without concurrent contamination by an interior monologue (at least the type of monologue that can exist in humans). Finally, discovering the mental capacities in animals can help unravel the development of human behaviors and abilities.

The most fundamental method of exerting control over one's internal representations is to decide which representations to acknowledge and which to ignore. One example of this kind of cognitive control is *directed forgetting,* in which an individual selectively chooses *not* to remember something. There is good evidence that animals engage in directed forgetting in order to reallocate memory to more important information. Roper, Kaiser, and Zentall (1995) presented pigeons with a delayed match-to-sample task in which a sample stimulus was presented, followed by a cue that indicated whether or not they would be tested on the sample color. If a "remember" cue was presented, after a delay the animal was shown the sample stimulus and a distractor stimulus. Correct responses produced a reward. If a "forget" cue was presented, the animal was not tested on the sample; instead, there was an unrelated discrimination task after the delay.

Occasionally, however, there was a "pop quiz," which tested the pigeons' memories for the "to-have-been-forgotten" sample. On these pop quiz trials, the pigeons' memories for the sample were much worse than on the standard "remember" trials, indicating that they had abandoned the memory when they were presented with the "forget" cue but not after the "remember" cue. Similar evidence of directed forgetting in animals has been reported in studies that used a variety of other task manipulations (e.g., Roper, Chaponis, & Blaisdell, 2005; Zentall, Roper, & Sherburne, 1995). These data illustrate that even animals can actively control their memory processes. More generally, these animals appear to possess an ability to manipulate their own mental states. The question then becomes: Do the animals know it?

How might one test metamemory in a nonverbal species? One approach has been to ask animals to perform a task in which they choose between two stimuli (such as a square densely populated with dots compared to a sparsely populated square) and are given a third option: to skip or "escape" the trial and move on to another trial. These tasks have shown that Rhesus macaque monkeys and other animals tend to escape on particularly difficult trials (see Smith & Washburn, 2005), such as when the target stimuli are not easily distinguishable due to having similar dot densities. This suggests that animals might know that they "do not know."

A task that involves making judgments about stimuli that are currently being presented may qualify as metacognition, but it does not involve making a judgment about one's internal memory state. Hampton's (2001) prospective task directly investigated metamemory. Monkeys were shown sample pictures; after a delay, they saw the sample picture again, along with distractor pictures. The subjects' task was to select the sample. However, after seeing the sample and prior to receiving the test, the monkeys could sometimes opt out of taking the test. On mandatory trials, they had to take the test. The monkeys were more accurate on self-selected test trials than on mandatory trials, suggesting that the monkeys opted out when they knew they did not know the answer. Crucially, they did so when no external stimuli were available as cues at the time of their decision (see also Smith & Washburn, 2005, for metamemory performance using the escape procedure).

Another approach has been to ask animals to make retrospective judgments after they take a memory test. In one such task, monkeys performed a memory task and were then asked to "bet" on the accuracy of their memories (Kornell, Son, & Terrace, 2007). They first studied six images that were presented sequentially on a touch-sensitive computer screen. After viewing these images, one of the six images was presented along with eight distractors and the task was to touch the picture that had already been seen in the initial exposure sequence. Once a monkey had touched his choice, he placed a bet. Betting high risk meant that he would earn three tokens if his recognition response had been right, but lose three tokens if it had been wrong. Betting low risk meant that he would earn one token, regardless of accuracy. Tokens were accumulated at the bottom of the screen and could be exchanged for food pellets when a criterion was reached.

The monkeys in this task acted metacognitively; that is, they tended to choose high risk after correct responses and low risk after incorrect responses. Moreover, they did so within the first few trials of transferring to this task. (The monkeys had previously been trained to respond metacognitively in other, perceptual, tasks; see Son & Kornell, 2005.) It seems, then, that they had learned a broad metacognitive skill that could generalize to new circumstances. They appear to have represented two internal responses: a recognition response and a confidence judgment. These data do not necessarily imply that the monkeys had conscious awareness of their confidence in their memories. But they do imply that the animals could monitor their confidence in their own memories (for recent reviews of animal metacognition research, see Kornell, 2009; Smith, 2009; Terrace & Son, 2009).

CONSCIOUSNESS AND METACOGNITION

Does metacognition—and metamemory in particular—require consciousness and/or self-awareness? Historically, metacognition has often been interpreted as a conscious introspection into the mind linked to language and to self-reflection. As Aristotle said, “Remembering, as we have conceived it, essentially implies consciousness of itself” (350 BC). Clearly, some metamemory judgments are conscious—for example, one can be irritatingly aware of feeling that a lost answer is “on the tip of my tongue”—but do all metamemory states require consciousness? If so, the fact that nonverbal animals exhibit accurate metamemory has important implications.

The simple answer appears to be no. Even humans are not always conscious of their metacognitive judgments. In one study, participants were presented with questions and were asked to judge as quickly as possible whether they knew the answer. In another condition, participants had to retrieve the answer. The data demonstrated that people were able to make the judgments—which were accurate—*prior to* having retrieved the answer and thus too quickly to have made a conscious assessment of its accuracy (Reder & Schunn, 1996). We have argued that these findings, in addition to the monkey data, suggest that some metacognitive processes do not require consciousness (e.g., Son & Kornell, 2005).

Remember however, that Kornell and colleagues’ (2007) metamemory task required monkeys to bet on their responses. Recently, Persaud, McLeod, and Cowey (2007) have argued that the ability to make appropriate wagers after completing a task is an objective measure of conscious awareness. They used three tasks that generally do not involve conscious awareness: blindsight, artificial grammar learning, and the Iowa gambling task. Their participants performed the tasks well, but they could not make appropriate post-task wagers; that is, they rarely bet more after correct responses than they did after errors. Once the conditions were changed to elicit conscious decision making, participants made appropriate wagers. The authors conclude: “This double dissociation suggests that placing a wager is a special sort of decision, one that is closely related to being aware” (p. 260).

As described previously, Kornell et al. (2007) found evidence that monkeys could make accurate wagers about their memories. Does that mean that monkeys have conscious awareness? A monkey’s experience is clearly very different from a human’s, in part because it is not linguistic. Consciousness is a kind of continuum: Humans have extremely flexible, creative conscious experiences, including the ability to reexperience past events and imagine future events. However, monkeys, though they may be aware of their surroundings and the recent past, seem to be stuck in the moment.

Proving anything about another being's experience—even another human—is not possible. In the absence of proof, what is needed is converging evidence of awareness in animals. For example, a hemianopic monkey (i.e., a monkey with blindsight) that can discriminate between stimuli presented in an area of its visual field will, nonetheless, fail to report seeing a stimulus presented in that area in a signal detection task, as though it lacks awareness of what it sees in that area (Cowey & Stoerig, 1995). At this stage, it seems clear that moneys have metacognitive abilities. Evidence is accumulating that monkeys have their own sort of awareness; it is not a sure thing, but it may be worth a wager.

HEURISTICS VERSUS ANALYTICAL PROCESSES

All metamemory is not created equal (Kornell, 2009). For instance, a "tip of the tongue" experience is clearly conscious. The ability to decline to answer a question because of a lack of confidence, though, does not appear to require self-awareness. Moreover, the mechanisms underlying various metamemory processes may differ. Some judgments may be based on a very fast assessment of how familiar one is with the cue or question (Metcalfe & Schwartz, 1993). Other judgments may be based on a slower, but more direct, retrieval of the target from memory (Koriat & Levy-Sadot, 2001). Imagine, for instance, that you had practiced the problem 27 + 41 repeatedly. If you are then presented with the problem 27 × 41, you may judge (too quickly) that you know the answer and, as a result, choose not to calculate but rather to retrieve the answer from memory. Unfortunately, having based your judgment on only the rapid familiarity of the numbers and not the operation and having limited your time, the likelihood of solving the problem accurately is close to nil (Reder & Ritter, 1992).

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It appears that some metacognitive processes require effort. Others are based on heuristic processes (e.g., based on familiarity), and these processes allow humans and other animals to make metacognitive judgments (such as "I know" or "I don't know") quickly and automatically. One negative result of this could be that experts, in situations within their own area of expertise, display a larger degree of overconfidence (or the belief that they know more than they actually do) than do novices. After all, experts are bound to be more familiar with the context (e.g. Oskamp, 1965; Son & Kornell, 2010).

In humans, at least, there are effortful metacognitive processes that are slower, perhaps more likely to involve language, and more likely to become conscious. That is, humans have the luxury of mulling over thoughts and judgments, even after having made numerous quick (and maybe less than accurate) judgments. Furthermore, how much humans mull over their own thoughts can vary from very little interpretation to extensive interpretation (see Petty & Brinol, 2009). And it is this deeper type of metacognition that may give rise to an understanding of the self and of others.

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SELF-AWARENESS AND OTHER-AWARENESS

Like many other primates, humans are an intensely social species. We spend much of our time, effort, and resources on fostering and manipulating social relationships with kin and others. Successfully creating alliances is crucial for our well-being and survival. Theory of mind, or an awareness of another's mind, is a key ability because it allows us to predict what others will do, how they will react to what we do, and how we can manipulate them.

Psychologists have long debated whether self-awareness or other-awareness comes first. In his comprehensive review, Carruthers (2008) summarizes four different possibilities for the emergence of self- and other-awareness. As a first possibility, he proposes that the two skills—dubbed *metacognition* and *mind reading*—are independent. In the second, he proposes that they come from the same fundamental faculty. In the third, he provides evidence for self-awareness being a necessity for other-awareness, and in the fourth model, vice versa. While there are mixed conclusions, we examine a fundamental question raised by Carruthers's review: Could metacognition have evolved to allow for an awareness of others?

One way to approach this question is to examine the relationship between self-awareness and other-awareness in animals. In 1970, Gallup challenged the notion that animals lacked self-awareness by publishing his classic studies on mirror self-recognition. In the study, when preadolescent chimpanzees encountered a mirror for the first time, they made social gestures to the image they saw. After a few days of experience with the mirror, however, such other-directed responses began to wane. At the same time, self-directed responses began to increase. After being marked with a red, odorless dye while unconscious, the chimpanzees touched the marked area on their own bodies (rather than on the mirror) a significant number of times, suggesting that they understood the reflection to be themselves. Remarkably, when Gallup followed up on his original study using chimpanzees raised in isolation, none showed signs of mirror self-recognition (Gallup, McClure, Hill, & Bundy, 1971). One interpretation is that because chimpanzees have had experience with others, they were able to view themselves as another might view them.

The view that other-awareness comes before self-awareness is not a recent one. In 1912, Cooley wrote that the concept of the self was dependent on social interaction. Mead (1934) also proposed that a self-concept is formed as one experiences how others view oneself.

Not all social animals have been able to pass the mirror self-recognition test. While great apes (Gallup, 1970), elephants (Plotnik, de Waal, & Reiss, 2006), dolphins (Reiss & Marino, 2001), and pigs (Broom, Sena, & Moynihan, 2009) have passed, monkeys (who were able to express metamemory) have failed (see Roma et al., 2007). This supports the theory that metamemory—at least the kind that monkeys possess—does not depend on being self-aware. Rather, the ability to express certainty and uncertainty allows monkeys to be cautious and perceptive in an uncertain world. In other words, monkeys may not be self-aware, but they may still have metamemory abilities.

ULTIMATE METACOGNITION: KNOWLEDGE OF OTHERS

Even animals that are not considered to be self-aware can be spectacularly good at responding to the behaviors of others. The ability to know the contents of another's mind may be *the* most sophisticated level of metacognitive skill—and also among the most useful for a social animal. Take, for instance, the complex acts of deception, cheating, and stealing. Researchers have suggested that these malicious behaviors were the evolutionary catalyst for metacognitive processes, especially within the social domain (Cosmides & Tooby, 1994). The data from social reasoning studies of nonhuman primates seem to support this view.

A study by Hare, Call, Agnetta, and Tomasello (2000) showed that subordinate chimpanzees follow the gaze of dominant chimpanzees in order to decide whether or not to raid a food cache that is equidistant between them. In the study, animals were held in enclosures on opposite sides of a large room. Caches of fruit were placed in the middle of the room either in plain view of both animals or in view of only one of the animals (due to the clever placement of a visual barrier). The important finding was that subordinate chimpanzees would not approach the food cache when the dominant chimp had seen it. But, when the dominant chimpanzee had not seen the food cache, subordinate animals readily approached the cache.

A related study by Flombaum and Santos (2005) further supported these findings by showing that rhesus monkeys selectively steal food from humans who cannot see them stealing. Thus, although monkeys and apes are notoriously bad at inferring mental states from eye gaze during traditional theory-of-mind tasks (cf. Povinelli & Eddy, 1996), they succeed at using eye gaze to predict another animal's behavior in a competitive task. In short, deception, cheating, and stealing are three competitive behaviors that seem to play a privileged role in metacognitive reasoning within the social domain.

Though less frequently observed than competitive behaviors in animals, the three altruistic behaviors of helping, informing, and sharing have recently been studied in chimpanzees and in human children (Warneken & Tomasello, 2009). These studies have revealed important similarities in the cooperative acts of these groups. For example, when children and chimpanzees observe a human companion drop a pen or a sponge, they will rush to retrieve it for the companion, even in the absence of any reinforcement or feedback (Warneken & Tomasello, 2006). Thus, both children and chimpanzees understand the immediate intention of their human companion to maintain possession of an object, and both groups are motivated to participate in that goal.

But there are important differences in the altruistic behaviors of children and chimpanzees. Sharing and informing are two behaviors in which human children engage much more frequently than other primates. From 12 months of age, when they know the location of an object lost by an adult, children will actively lead the adult to that object (Liszkowski, Carpenter, & Tomasello, 2006). Brownell, Svetlova, and Nichols (2009) showed that 25-month-olds who are given a choice between delivering food only to themselves or to themselves and a companion will choose to share. In contrast, chimpanzees tested in a comparable paradigm do not exhibit the same sharing instinct and instead choose randomly between the selfish and sharing options (which give them the same payoff). These findings indicate that chimpanzees have a deep lack of familiarity with or faith in a system of cooperation. In fact, some have argued that even the cooperative and altruistic behaviors in which chimpanzees do engage, such as proximal helping, have selfish origins (see Warnecken & Tomasello, 2009).

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Studies that permit chimpanzees to behave cooperatively or altruistically toward kin or other conspecifics have yielded slightly more evidence for altruism in chimpanzees (see de Waal, 2008, for a review). These studies suggest that the natural behaviors of chimpanzees might include more unselfish acts and emotions, such as empathy, than can be observed in artificial experiments with human agents. However, regardless of the testing modality, the extent to which apes engage in spontaneous altruistic and cooperative acts differs from that observed in human behavior. And, importantly, nonhuman primates interact competitively more than they interact cooperatively (Muller & Mitani, 2005). However, some of the differences between humans and nonhuman primates might be linked to the uniquely human ability to communicate large amounts of information efficiently (Warnecken & Tomasello, 2009).

The explanation of why nonhuman primates do not engage in a level of cooperative and altruistic behavior that is comparable to their competitive abilities is an open pursuit. Different social interactions could rely on qualitatively different metacognitive mechanisms (Warnecken & Tomasello, 2009). Alternatively, quantitative differences in the amount or kind of information that serves as the input to metacognitive reasoning could be a crucial factor. Informing, for example, requires the representation of the goal states of others, whereas stealing only requires that another's gaze be tracked. Thus, there may be broad differences in "difficulty" between the metacognitive inferences required by competitive and cooperative acts. Such differences could contribute to asymmetries in the forms of nonhuman primate metacognition.

One possibility is that metacognition emerged earliest within the competitive social domain because the information within that domain had more "meaningful" content and better organization (and was more easily afforded metacognitive assessments). Social relations, kin relations, mating, and dominance are considered the central focus of a primate's existence. Overall, many more competitive exchanges have been reported in observations of ape and monkey social interactions than cooperative exchanges. Thus, based on sheer frequency, nonhuman primates would be expected to have more detailed (and therefore more "meaningful") representations of competition than of altruism or cooperation.

Whether competitive social behaviors were *the* catalyst for the evolution of metacognition is a matter of speculation because it is impossible to reconstruct our evolutionary history. Social information may have played a role in the emergence of metacognition because it emerged earliest as a sufficiently rich knowledge system, or metacognitive processes might have emerged independently within social and nonsocial domains (rather than emerging from a single core process). In that regard, evidence from studies of the development of social and nonsocial forms of metacognition in human children might better reveal the relations among varieties of metacognitive reasoning.

SELF-AWARENESS AND OTHER-AWARENESS IN CHILDREN

What can we learn from the development of a self-awareness and theory of mind in young children? An early and ongoing line of inquiry has been directed toward the development of children's metamemory abilities, or the understanding of one's own memory processes and its contents (e.g., Brown, 1987; Finn & Metcalfe, 2010; Metcalfe & Kornell, 2003). Data have shown that, compared to adults, children make relatively poor use of their judgments (e.g., Bisanz, Vesonder, & Voss, 1978), particularly because young children often have an unrealistic self-concept about the capacity of their memories. For example, a study by Kreutzer, Leonard, and Flavell (1975) found that kindergarteners were convinced that they always remembered well, with 30% of the children convinced that they never forgot anything. (In normal conversation, however, many children in kindergarten or younger can accurately report that they forgot something.) Much research has shown that children are overconfident in their memories (e.g., Flavell, Friedrichs, & Hoyt, 1970) and remain overly optimistic even after experience and feedback on a similar task (Finn & Metcalfe, 2010).

In parallel, research on metacognition has focused on how and when children begin to understand the mental world. This area of research dates back to the work of Piaget and Vygotsky and targets the development of theory of mind. Children's understanding of mental concepts, like thinking, understanding, and belief, has been a focus of theory-of-mind research (Wellman & Estes, 1986). By around 2.5–3 years of age, children begin to use the words "think" and "remember" (Limber, 1973; Shatz, Wellman, & Silber, 1983), suggesting a nascent awareness of their mental world. However, theory of mind continues to coalesce throughout childhood. For example, Wellman and Johnson (1979) showed that 3-year-olds were not able to distinguish between remembering and forgetting, but that children were usually able to make this distinction by the age of 4.

Beyond age 4, children do seem to have a better grasp of the distinction between mental verbs (e.g., remembering versus forgetting; Johnson & Wellman, 1980; Kreutzer et al., 1975; Wellman, 1985), but research suggests that they are still developing a clear understanding of their mental worlds. For example, Flavell, Green, and Flavell (2000) tested 5-year-olds, 8-year-olds, and adults on tasks designed to investigate their ability to introspect. The 5-year-old children showed some ability to report their introspections, but in comparison to the older children and the adults, their reports reflected that they were less aware of their thoughts. Indeed, the 5-year-olds often denied having had thoughts at all.

It would be hard to overstate the importance of understanding one's own mental states. But the ability to understand and respond to the mental states of others is equally important (Jost, Kruglanski, & Nelson, 1998). It is crucial in allowing people to create the rich social and interpersonal relationships that help to define the *Homo sapiens*, or *Homo psychologicus* as characterized by Humphrey (1984). Some have postulated that how we think about thinking itself should also be considered within the context of our assessments about the mental states of others (Nelson, Kruglanski, & Jost, 1998; Perner, 1991). Thus, as noted in the context of animal research, self-awareness and other-awareness seem to be strongly connected.

The relationship between self-awareness and other-awareness is complicated by a rapid development in language and complex behaviors in children between the ages of 3 and 5. Some behaviors, while seemingly correlated with theory of mind, may simply be conditioned responses. Thus, it is important to distinguish between theory of mind and "theory of behavior." If I am able to predict that you will give me a candy bar if I give you a dollar, does that imply theory of mind? Or does it just mean that I've learned from experience that my behavior leads to yours? Clearly, if you are a vending machine, I do not need (nor should I use) theory of mind to predict your behavior. Yet it can be difficult to distinguish between theory of mind and theory of behavior in another actor. This difficulty has led many researchers to employ false-belief tasks in which a theory of behavior would lead to one prediction, but a theory of mind would lead to the opposite.

False-belief tasks assess a person's understanding that others can have beliefs that are different from one's own or distinct from reality. In one of the classic tasks testing false belief—often called the *Sally–Anne task* (Wimmer & Perner, 1983)—a child is shown a doll named Sally and a doll named Anne. Sally puts her marble in a basket and then leaves the room. After Sally leaves, Anne moves the marble from Sally's basket into her own box. Then Sally returns to the room. The children are asked where they think Sally will look for her marble. The question can only be answered correctly if the children understand that Sally believes something different from what the child knows to be true. The literature on false-belief tasks suggests that children younger than 3.5 years are not able to represent others' beliefs appropriately (Wellman, Cross, & Watson, 2001). The ability to make the correct assessment about what the other person will believe is thought to be in place around 4 years of age (Wellman, 1993). In a sense, such tasks put self-awareness and other-awareness in conflict with each other.

By adulthood, most people interpret others' behavior in mentalistic terms effortlessly (Baron-Cohen, 1995). Indeed, our inclination to think in terms of others' minds is so strong that we attribute beliefs and intentions to inanimate objects (Adolphs, 1999; Heider & Simmel, 1944). Our ability to "read minds" helps us make predictions about others' behaviors and helps us to understand why they do what they do. It also helps us to avoid being deceived and to deceive others (Byrne & Whiten, 1988). In essence, theory of mind allows us to be more certain about our unfolding social world.

What if an adult did not have the ability to read other mental states? This is the case for the subset of individuals with autism, who are not able to ascribe minds to others in a usual manner. Researchers like Gopnik (1993) discussed how frightening they imagine such "mindblindness" to be. Gopnik writes:

> This is what it's like to sit round the dinner table.…Around me bags of skin are draped over chairs, and stuffed into pieces of cloth, they shift and protrude in unexpected ways…Imagine that the noisy skin bags suddenly moved toward you and their noises grew loud and you had no idea why, no way of explaining them or predicting what they would do next. (quoted in Baron-Cohen, 1995, p. 5)

Children with autism are much less likely to pass false-belief tasks than typically developing children or even children with Down syndrome (e.g., Baron-Cohen, Leslie, & Frith, 1985; Leslie & Frith, 1988). They are also less likely to engage in spontaneous pretend play (Lewis & Boucher, 1988) and to predict what kinds of emotions someone might have given their beliefs (Baron-Cohen, 1995). Thus, lacking an awareness of others can often reduce an individual's ability to participate in society.

There are two main competing theories regarding the development of theory of mind. The modular class of theories proposes that there is a special, innate structure implicated in theory of mind (see, for example, Baron-Cohen, 1995; Leslie, 1991, 1994). Developmental differences in theory-of-mind tasks arise because the brain structures involved in theory-of-mind judgments are still maturing. The second class of theory proposes a general mechanism that supports, but is not specifically designed for, theory of mind. Perner and colleagues (e.g., Perner & Lang, 1999) have argued that theory-of-mind abilities are tied to the development of executive control, including the inhibition of irrelevant thoughts. Research in support of this theory has shown that there is a positive correlation between executive control—which is implicated in much metacognitive function—and performance on a theory-of-mind task (for a review, see Moses, Carlson, & Sabbagh, 2005). Underlying both theories is a deep connection between self-awareness and other-awareness.

THE ROLE OF LANGUAGE AND SOCIETY

Metamemory is often inaccurate (Dunlosky & Bjork, 2008). Overconfidence, or not knowing that you do not know, is among the most common human biases (Son & Kornell, 2010). We began the chapter by likening metacognition to a distorted mirror that provides a somewhat distorted picture of one's mind. One way to support metacognition is to improve how accurately it reflects actual memory. Do language abilities support metacognition? Studies have shown that when people are trained to use verbalization strategies (e.g., Beurhing & Kee, 1987) or to be more aware of their own thinking (Moreno & Saldana, 2005), overall metamemory accuracy and performance improve. Thus, perhaps human metamemory is more sophisticated when it is entwined with language and self-awareness.

We have suggested that no single mechanism underlies all types of metamemory. For humans, the metamemory process is often entwined with language. Animal metamemory clearly develops independently of language. It is important to keep in mind that, at the end of the day, decision making is the reason metacognition is important. Animals, as well as humans, make decisions all the time, and most decisions are made without language. While humans can take advantage of the benefits that language offers, we should not diminish the need for a fundamental metamemory ability to assess what we do and do not know. Indeed, data have shown that monkeys, like humans, are more likely to seek information particularly when they lack information (Kornell et al., 2007). Thus, even the most primitive type of metamemory plays a role in affecting subsequent decisions.

CONCLUSION

Human metacognition develops gradually. The data, ranging from nonhuman animals to children to individuals with autism, have shown that an awareness of our own thoughts can stem from the awareness of others in the world and their actions.

Similarly, by knowing what we know and what we do not know, we can learn to understand the uncertainties of others.

Animals appear to make decisions based on a rudimentary type of metamemory. Humans seem to share this level of metamemory, but human metacognition has evolved beyond the simple metamemory abilities of animals. On the whole, humans seem to possess at least three levels of metacognition: automatic metamemory, self-awareness, and other-awareness. Each of these levels may have different, if overlapping, underlying mechanisms. And perhaps timing could be used as a proxy for various levels: A fast/familiar response could indicate an automatic metacognition that does not require conscious thought; a slower and deliberate response would indicate that consciousness—either of oneself or another—was present. While the levels may differ mechanistically, they are equal in importance for the individual.

To thrive in an intensely social world requires humans (and perhaps other animals) to know themselves and to find ways to know the secret thoughts of others. Metamemory, in the form of certainty monitoring, helps us to distinguish accurate memories from false ones, which allows us to be truthful. Theory of mind helps us to deceive, cheat, and manipulate, as well as to communicate, cooperate, share, and empathize.

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