The Self and Other: A Missing Link in Comparative Social Cognition

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Abstract and Keywords

The chapter is an extension of Hampton's approach of asking a monkey to respond metacognitively. It focuses on confidence judgments, which in humans are typically made verbally. It describes an experiment on rhesus macaque monkeys. These monkeys were given the opportunity to express their confidence by placing bets on the accuracy of their tasks in a cognitive task. The subjects were required to respond on all trials, easy and hard. After each trial, subjects were required to select a high- or a low-confidence icon. Having shown that the subjects chose the high- and low-confidence icons appropriately, this chapter argues that the metacognitive ability of monkeys is similar to that observed in human subjects in experiments that use the confidence judgment paradigm. Judgment of learning asks how certain they are that they will be able to remember a recently learned item in the future.
The research area of mental state attribution has experienced great change in recent years. Topics such as the understanding of intention, knowledge, and belief are receiving increasing research attention (see Heyes, 1998; see also Call & Tomasello, 2003, for a recent review). However, the area that has developed most in the last few years is the study of the understanding of visual perception in others, particularly in chimpanzees. Studies show that chimpanzees follow the gaze of conspecifics and humans, follow it past distractors and behind barriers, “check back” with humans when gaze following does not yield interesting sights, use gestures appropriately depending on the visual access of their recipient, and select different pieces of food depending on whether their competitor has visual access to them (see Call & Tomasello, in press, for a review). These results, which cannot be explained by invoking a conspecific’s line of sight or orientation as a discriminative stimulus, show that, at a minimum, chimpanzees know what others can and cannot see.

Interest in mental state attribution in others contrasts with the meager research devoted to the study of mental attribution in the self. Since chimpanzees appear to know about what others can and cannot see, one can also ask whether they also know about what they themselves have seen. Partly, an explanation for the little development of this research area can be found in the methods that have been used to answer questions about the self in comparative social cognition. Two approaches have traditionally dominated the study of the self in nonhuman animals: imitation and mirror self-recognition. Although these two paradigms have offered some valuable information about the self, I argue that these two paradigms have exhausted their explanatory power regarding the self. This is particularly true of the conceptual self as opposed to the ecological self. Neisser (1988) defines the ecological self as that who interacts with the environment and receives information about it via the senses, whereas the conceptual self consists of the mental representation of the individual's personal features including his or her knowledge.
Recently, however, new paradigms to investigate metacognition in nonhuman animals have contributed significantly to the renewed interest in this area (as this volume testifies). These paradigms are broadly based on presenting animals with uncertain situations and measuring their responses in an attempt to gauge how much an animal knows about what it knows and whether it can apply that knowledge to exercise control over the information it seeks to obtain (Call & Carpenter, 2001; Hampton, 2001; Smith et al., 1995; Smith, Shields, Schull, & Washburn, 1997). The goal of this chapter is to depict these methods as valid alternatives to more traditional methods and to indicate the significance of studying the self and others for understanding comparative social cognition.

This chapter is organized as follows. First, I present the main findings produced by the imitation and the mirror self-recognition paradigms in relation to the question of the self in social cognition, and I highlight their limitations. Second, I describe some new methods that use uncertainty as alternatives and extensions of the imitation and self-recognition paradigms. I concentrate on the findings of a paradigm based on presenting incomplete information to see if subjects seek additional information before making a choice. Third, I discuss the possibility that the seeking-information paradigm can be used to gauge metacognitive functioning across various species. I then return to the questions I raised at the beginning of the chapter about mental state attribution in others and propose a closer connection, both empirically and theoretically, between the study of mental attribution in the self and in others.

Two Traditions in the Study of the Self in Nonhuman Animals

The comparative study of the self has been based on two paradigms: imitation and mirror self-recognition. Each of these paradigms comes from two different traditions, developmental and comparative psychology, respectively. Due to their different origins, each tradition has imprinted its particular features on the comparative study of the self. Consequently, the questions that each tradition seeks to
answer are not the same, even though they bear some resemblance. Here I review the main findings of each field in relation to the self and note some of their limitations.

**Imitation**

Copying someone else's actions involves making a correspondence between the observed actions and producing actions on the self (Mitchell, 1993). In other words, imitation involves a translation of the visual information (observed actions of others) into kinesthetic information (produced actions by the self). For that reason, imitation is commonly used as evidence of self-recognition (Lewis, 1994) or self-concept (Hart & Fegley, 1994). Moreover, many developmental psychologists see in the imitation of others one of the most fundamental processes by which individuals construct their self-concept (Baldwin, 1902; Lewis & Brooks-Gunn, 1979). This process may be initiated at a very early age when very young infants imitate the facial expressions of others. Gopnik and Meltzoff (1994) have argued that by imitating the facial expressions of others, very young infants get to experience what emotions are associated with certain facial expressions, thus giving them a glimpse of what others feel when they display those facial expressions. Later, the reproduction of others' behavior through imitation will give children additional information about other aspects of others' minds that children will eventually assimilate into their concept of self, and by extension to others will form their mental state attribution abilities (theory of mind).

Some authors have extended the connection between imitation and self-concept to the great apes (Parker & Milbrath, 1994). However, the evidence that apes copy actions is fragile (see Tomasello, 1996, for a review). Currently, there is no consensus regarding whether chimpanzees or other apes spontaneously imitate the actions of others. Some studies suggest that the most likely learning mechanism is for one observer to attempt to reproduce an outcome similar to that produced by a demonstrator rather than copying the demonstrator's actions (Call, Carpenter, & Tomasello, 2002; Call & Tomasello, 1995; Myowa-Yamakoshi & Matsuzawa, 1999; Nagell, Olguin, & Tomasello, 1993; Tomasello, Davis-
Others claim that chimpanzees and other apes are capable of spontaneously copying actions of others to solve problems, although these studies do not effectively distinguish actions from results (Stoinski, Wrate, Ure, & Whiten, 2001; Whiten, 1998; Whiten, Custance, Gómez, Teixidor, & Bard, 1996). It is true that apes raised by humans are more skilled at copying the actions of others (Bering, Bjorklund, & Ragan, 2000; Bjorklund, Yunger, Bering, & Ragan, 2002; Tomasello, Savage-Rumbaugh, & Kruger, 1993). However, these actions usually involve some sort of result such as a noise or a change of state in an object, so that it is hard to know precisely what is the contribution of actions or results to the reproduction of the target behaviors. Some studies have eliminated the objects altogether and focused on the reproduction of gestures (Call, 2001; Custance, Whiten, & Bard, 1995; Miles, 1990). After extensive training, apes can reproduce novel body movements on command, but their accuracy is far from perfect, and there is some indication that apes reproduce those actions with some tangible result more readily than those without results (Call, 2001).

Mirror Self-Recognition

From its inception, the mirror self-recognition paradigm has been closely linked to self-awareness and a concept of self (Gallup, 1970, 1982). According to Gallup, self-directed mirror inspection is evidence for self-awareness (Gallup, 1982), or a representational self (Anderson & Gallup, 1999). The empirical evidence that has been used to support this claim is as follows (see Anderson, 1999; Anderson & Gallup, 1999, for reviews). When confronted with a mirror, chimpanzees and orangutans show social responses first, followed by contingent behavior in front of the mirror, and finally mirror-guided self-directed inspection of body parts not visible otherwise (Lethmate & Ducker, 1973; Suarez & Gallup, 1981). When administered the mark test, in which subjects are anesthetized and an odorless dye is applied to some body part that is not directly visible, these species touch the mark more often in the presence of a mirror than in its absence. Developmentally, the ability to show self-directed behavior appears between 3 and 5 years of age.
age, with adolescents and young adults showing the highest levels of self-directed behavior in front of the mirror. In contrast to orangutans and chimpanzees (and bonobos, for whom there is also some positive evidence; see Hyatt & Hopkins, 1994), most gorillas tested have produced no clear evidence of mirror self-directed inspection. Two possible exceptions to these negative results are two human-reared gorillas that also seem to have passed some version of this test (Patterson & Cohn, 1994; Swartz & Evans, 1994).

Similar tests done with monkeys have produced negative results (see Anderson & Gallup, 1999, for a review). Monkeys also produce social responses to the mirror image, but they do not show clear evidence of self-directed mirror-guided behavior despite the numerous studies that have attempted to find self-recognition in monkeys. Nevertheless, monkeys, like apes, can use mirrors to find hidden food that cannot be observed directly (Anderson, 1986).

Although there has been continued controversy regarding the procedural details of the mirror self-recognition paradigm across the years (e.g., Epstein, Lanza, & Skinner, 1981; Heyes, 1994), the basic findings are generally accepted. Nevertheless, the question of what the mirror self-recognition experiments show regarding self-awareness is still a matter of intense debate. While some authors maintain that mirror self-recognition experiments cannot answer questions about self-awareness (Heyes, 1994), others see mirror self-recognition as evidence of self-awareness (Gallup, 1982), a representational self (Anderson & Gallup, 1999), or a concept of me (Lewis, 1994). I argue that no major advances in answering this question have been made in the last 20 years, even though there is more information about more species. Particularly lacking are answers for the question of the more psychological self rather than the perceptual self. Mirror self-recognition (and imitation) experiments are eerily silent regarding what the self knows, remembers, or sees. But this is not surprising, because these paradigms were not designed to answer such questions in the first place. In my view, these traditional paradigms have offered as much as they can regarding the question of the psychological self, and I agree
with other authors (Anderson, 1999; Gallup, 1994; Itakura, 2001) that novel approaches should complement these more traditional approaches. These novel approaches, however, should not merely be covert mirror self-recognition tests. The study of shadow reflections (e.g., Cameron & Gallup, 1988), video representations of the self (Anderson, 1999), or the use of computer joysticks (Jorgensen, Suomi, & Hopkins, 1995), though interesting in themselves, are not enough. A truly novel approach to the question of the psychological self is needed. Only recently have new studies attempted to get some answers on the more psychological level of the self. Next, I review these studies.

Recent Approaches to the Study of the Understanding of the Self

Research on human metacognition is burgeoning. In general, researchers have used two methods to explore this area in nonhuman animals. One is to create uncertainty and measure escape responses. The other is to provide incomplete information and measure whether subjects seek additional information. Unfortunately, most studies with humans are not applicable to nonhuman animals because they rely heavily on language. Recently, however, two lines of research have used nonverbal measures to assess escape responses in cetaceans and primates, including humans.

Smith et al. (1995) presented an auditory discrimination task to dolphins and humans. They presented subjects with auditory stimuli that varied between 1200 Hz and 2100 Hz. For a given stimulus, subjects had to decide whether the stimulus was low or high pitch. If the stimulus was between 1200 and 2099 Hz, they had to press the low key, whereas if the stimulus was 2100 Hz (the highest pitch) they had to press the high key. For stimuli at the low end of the distribution this discrimination was easy, but as stimuli drew closer to the 2100 Hz mark, the discrimination became increasingly difficult. Subjects were only rewarded for correct responses. Incorrect responses produced a time-out period of 9 to 12 seconds. In addition to the low or high key choice, subjects had a third option: the escape key. Subjects could press this key to skip the current trial and go to the next one, which was always
reinforced. However, to avoid excessive use of this key, the computer gradually delayed the presentation of trials on which reinforcement was guaranteed if the escape key was used too frequently. Results showed that dolphins and humans increased the use of the escape key when the discrimination became increasingly difficult. They rarely used the escape key for low-pitch stimuli, and the percentage of escape responses also decreased for the highest pitch stimulus. Thus, the distribution of escape responses was an inverted U-shaped curve that peaked slightly before the 2100-Hz mark.

In another study, Smith et al. (1997) tested rhesus monkeys and humans with a visual discrimination task and found results similar to those of the previous study. The stimuli varied in the density of pixels presented, and subjects had to discriminate low-density boxes (450–2,949 pixels) from high-density boxes (2,950 pixels). Subjects also had the option of the escape key available. The contingencies for correct and incorrect responses and for the use of the escape key were analogous to those of the previous study. The pattern of results was nearly identical to that found in the previous study. Rhesus macaques and humans increased the use of the escape key when the discrimination became increasingly difficult. They rarely used the escape key for low-density stimuli, and the percentage of escape responses also decreased for the highest pitch/density stimuli. The distribution of escape responses was an inverted U-shaped curve that peaked before the 2,950-pixel mark. Smith and colleagues argued that these studies show that dolphins, rhesus monkeys, and humans behave in similar ways in uncertain situations. All species showed some control over their decision to avoid a given trial under perceptual uncertainty.

Hampton (2001; see chapter 11, this volume) used a different approach to study metacognition in a nonverbal animal. Two rhesus monkeys were trained on a delayed matching-to-sample task that was presented on a touch-sensitive computer screen. Following the presentation of a sample stimulus and a delay of 30 seconds, the subject was presented with the sample and three distractors. On one third of the trials, a desirable reward
(a peanut) was contingent on selecting the sample. Incorrect choices resulted in no reward and a time-out period. On the remaining two thirds of the trials, subjects were offered the option of declining the test. Choosing that option resulted in the delivery of monkey chow, a less desirable reward. Whereas declining a test always produced a reward, opting to take the test produced a peanut only if the subject was correct. Hampton observed that monkeys performed better on those trials in which they were free to decline a test compared with the forced test. This suggested that monkeys may have known when they had forgotten the correct answer.

Two additional tests reinforced this conclusion. In a second experiment, Hampton increased the delay interval between the presentation of the sample and the alternatives. This was done to foster forgetting \(^\text{(p.327)}\) in the monkeys. Results showed that monkeys' performance declined proportionally to the amount of delay between the sample and the alternative stimuli. This was expected. More important, the proportion of trials on which the monkeys chose to decline the trial increased as the delay between the sample and the alternatives increased. In a third experiment, Hampton presented some trials without a sample (a blank picture, to be exact). As expected, the monkeys declined a high proportion of tests when no sample had been offered. Hampton concluded that rhesus monkeys know when they have forgotten and that they can remedy this lack of information by escaping the situation.

An Initial Study on Seeking Information

The two previous studies showed that cetaceans and primates can escape situations of uncertainty. They knew when stimuli were too hard to discriminate or when they did not have information about the sample stimuli. Another avenue to explore metacognition in nonhuman animals consists of presenting incomplete information and seeing whether individuals seek additional information. Call and Carpenter (2001) presented chimpanzees, orangutans, and 2.5-year-old children with a situation in which they had to choose one of two containers to obtain a reward. Previous to this study, subjects had been presented with two opaque containers, and they had to displace one of them to indicate their choice. In
this study, however, we replaced the opaque containers with hollow 30-cm tubes that were placed perpendicular to the subject. We hid food in the side of the tube closest to the experimenter so that the subjects were not able to see the food from their location. However, subjects could see the food inside the tube if they bent down and looked through the tube (see figure 13.1). Using this setup, we presented two conditions. In the visible condition, subjects had visual access to the baiting procedure so that they could see in which tube the experimenter had placed the reward. In the hidden condition, the baiting process was conducted behind a screen so that subjects were prevented from seeing in which tube the experimenter had placed the reward. We recorded which tube they selected, but more important, we recorded whether they looked inside the tube before choosing.

Results indicated that subjects looked significantly more often inside the tubes when they had been prevented from witnessing the baiting process. Typically, in hidden trials, subjects looked inside the tube, and if they saw the reward they stopped their search and selected that tube. If they did not see the reward inside the tube, they checked the second tube and then made their choice (figure 13.2). Although in most trials apes chose after seeing the food, in approximately 20% of the trials in which their first inspection revealed an empty tube, they selected the other tube without inspecting it. This means that subjects' choices (and their looking behavior) were not rigidly and solely controlled by the sight of food. Instead, they could make some inferences regarding the

Figure 13.1 Experimental setup to investigate whether subjects will look inside the tubes before selecting one of them when subjects are prevented visual access to the baiting procedure. E, experimenter; S, subject. From Call and Carpenter (2001). Copyright © Springer-Verlag.
location of food without having seen it. Interestingly, children rarely used this inferential strategy but preferred to inspect all tubes until they found the reward. We also observed that if subjects were not allowed to choose one of the tubes right away, that is, when a 5-second delay was inserted between the end of the baiting and the opportunity to choose, subjects looked significantly more often inside the tube.

**Extending the Initial Findings to Other Species**

The previous study showed that chimpanzees, orangutans, and children looked more often inside the tubes on trials in which they had not seen the location of the reward than on trials in which they saw where the experimenter placed the reward. Thus, they had access to information regarding the location of the reward, and when they did not have such information, they sought it before they selected a container. This initial finding prompted us to probe this skill further. We saw two ways of broadening the scope of these initial findings. One way consisted of probing further the mechanism responsible for this performance. A second way was to study other species, both closely and distantly related to orangutans, chimpanzees, and children. We chose to start broadening the scope by comparing species.

From a comparative point of view, it was not surprising that chimpanzees and orangutans solved this problem, because they also pass the mirror self-recognition test. A more interesting comparison is gorillas because, unlike chimpanzees and orangutans, they do not readily pass mirror tests and do not show mirror-guided self-directed
behavior. Povinelli (1993) has argued that gorillas may have lost the capacity for self-recognition (but see Patterson & Cohn, 1994; Swartz & Evans, 1994), whereas Gallup (1994) has claimed that gorillas may differ in cognition from the other great apes. In addition to studying gorillas, we completed the investigation of the great ape clade by studying bonobos. In particular, we studied 5 orangutans, 12 chimpanzees, 6 gorillas, and 4 bonobos housed at the Wolfgang Köhler Primate Research Center in Leipzig. There were 18 females and 9 males ranging from 4 to 30 years of age. All the bonobos except the female and all the adult chimpanzees were nursery reared, whereas all other subjects were mother reared. All subjects lived in social groups of various sizes, with access to indoor and outdoor areas. Subjects were individually tested in their indoor cages and were not food or water deprived.

Figure 13.2 Typical sequence of events in the hidden and the visible conditions. In the hidden condition, the reward is hidden inside one of the tubes behind a screen (A), the orangutan looks inside the empty tube (B), then the baited tube (C), and makes a choice (D). In the visible condition, the reward is placed inside one of the tubes in full view of the subject (E), and the subject chooses (F). Note the absence of looking behavior in the visible condition compared to the hidden condition. See color insert.
We followed the delayed procedure used in the initial experiment (Call & Carpenter, 2001) with both visible and hidden trials. Thus, the experimenter placed two tubes on the platform and either baited them while the subject watched (visible trials) or conducted the baiting behind a screen (hidden trials). After the baiting was completed, the experimenter held the tubes in view but outside the reach of the subject for 5 seconds. The experimenter then pushed the platform toward the subject so that it could select one of the tubes. All subjects had learned prior to this experiment to touch one of the two objects available to request that container. Subjects received a total of 24 visible and 24 hidden trials presented in four 12-trial sessions. Each session consisted of 6 visible and 6 hidden trials. All trials were videotaped and later coded by the experimenter. We measured two variables across trials: (1) looking inside the tube, and (2) tube selection. A second coder who was unaware of the experimental conditions blindly coded 20% of the trials for reliability purposes on each of the two measures used in this study. Reliability for both measures was excellent (looking inside the tube: Cohen’s kappa = 0.87; choosing the tube: Cohen’s kappa = 1.0).

Figure 13.3 presents the percentage of trials in which subjects looked inside the tubes for each of the two conditions. The four great apes looked significantly more in the hidden than in the visible condition, $F(1,23) = 38.7, p < .001$. There were no differences across species and no interaction effects. Thus, gorillas were indistinguishable from the rest of the apes.

Table 13.1 presents the individual performances of each of the apes in the hidden trials, with particular attention devoted to the pattern of responses across trials. We distinguished three types of acquisition of looking inside the tubes: no acquisition, gradual acquisition, and sudden acquisition. No acquisition consisted of failing to look consistently during testing. Gradual acquisition consisted of progressively...
increasing the looks inside the tube across trials. This type of acquisition included a period of alternation between trials, with and without looks, until the looking response appeared in every trial. Sudden acquisition consisted of looking inside the tube from the first trial (i), or, if subjects did not look in the first trial, once they started to look they looked consistently for the remaining trials (ii). Eighteen of the 27 subjects (67%) showed sudden acquisition of the looking behavior. Of those 18 subjects, 13 (48%) looked from the first trial, whereas 5 others (19%) first did not look, but once they started they did not stop looking. Five subjects acquired the looking response gradually (19%), whereas four other subjects showed no acquisition.

The search pattern was analogous to that found in our initial study (see figure 13.4). Upon finding a baited tube after their first look, subjects stopped their search and selected that tube in the great majority of trials. In contrast, if they found no food after their first look, they continued looking. Nevertheless, in a sizeable number of trials (16–38%, depending on the species) subjects selected the other tube upon finding an empty one, without looking into it. These “blind” choices resulted in a performance that was above chance, \( t(15) = 2.80, p = .014 \).

In sum, we found the same search pattern as before, and gorillas were undistinguishable from the other apes. Thus, the ape clade presents a homogenous performance when seeking information in uncertain situations. One question is how much this skill extends across other taxa. To answer this question, we contrasted the ape results with those of another species distantly related to the apes but which shows some ability to
solve problems that require the use of gaze following, visual communication, or sensitivity to the state of the human's eyes (p.332)

Table 13.1 Subject Information and Percentage of Trials in Which Subjects Look Inside the Tube in Hidden Trials.

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<thead>
<tr>
<th>Species/Name</th>
<th>Sex</th>
<th>Age (yrs)</th>
<th>% Trials w/ Looks</th>
<th>Acquisition Pattern</th>
<th>Looks Across Trials</th>
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<td>6</td>
<td>100</td>
<td>Sudden(i)</td>
<td>YYYYYYYYYYYYYYYYYYYYY</td>
</tr>
<tr>
<td>Kuno</td>
<td>M</td>
<td>5</td>
<td>100</td>
<td>Sudden(i)</td>
<td>YYYYYYYYYYYYYYYYYYYYY</td>
</tr>
</tbody>
</table>

**Notes.** Includes the acquisition pattern and whether the subject looked on each of the 24 trials. Y, Yes; N, No. Sudden(i) indicates that subjects looked inside the tube in the first trial; Sudden(ii) indicates that looks began after the first trial.

(p.333) (see Call, 2004, for a review). This species is the domestic dog. Bräuer, Call, and Tomasello (in press) presented dogs with the same problem that we used with apes but with a modified apparatus. Food was hidden inside a box that subjects could designate by pressing a lever with their

![Figure 13.4](image-url)  
**Figure 13.4** Mean percentage of trials in which apes made a choice after their first look as a function of what they saw inside the tube and the species.
paw. Opposite the lever was a window with holes through which dogs could look and smell the contents of the box before selecting it. As with the apes, there were visible and hidden trials. Figure 13.5 presents the percentage of trials in which dogs inspected the contents of the box (either by looking into it or sniffing it) and the percentage of correct trials. Unlike the apes, dogs did not look (or sniff) before choosing significantly more often when they had not witnessed the baiting. The percentage of correct choices in each condition reflects this fact because they were above chance when they saw the food location but not when they did not see it. So, unlike apes, dogs did not seek information before making a choice.

Seeking Information as a Metacognitive Index

Recent studies have shown that our initial finding that chimpanzees, orangutans, and children seek information when they have not seen the baiting of the reward are replicable with another group of subjects of the same species and can also be extended to bonobos and gorillas. Thus, apes and children (unlike dogs) preferentially seek information when this information is missing. It is important to emphasize that the behavior they use to seek information is not the same that they use to select one of the alternatives present on the platform. They choose by touching the container, not by bending down to look through it. In fact, bending down to look is not a behavior that they usually display in our testing situation. When they are presented with opaque containers on a platform, they do not bend down or engage in other behaviors that may produce information that they do not currently have. Yet one can ask whether this seeking behavior
is evidence of metacognition or can be explained by means of other mechanisms.

Two mechanisms that do not require a metacognitive explanation could explain the apes' performance. One mechanism is that subjects simply use an automatic hard-wired search routine based on executing search responses when information about the food location is missing. Thus subjects would search for food until they found it, then stop their search and select the appropriate container. There are some problems with this explanation, however. First, sometimes subjects stopped searching and made appropriate choices even without seeing the food. Gorillas and orangutans selected the container they had not inspected in 38% of the trials in which they did not see the food after their first look. In addition, recent experiments have shown that when subjects are forced to choose between two stimuli and only partial visual or auditory information is offered, they can still infer the location of food (Call, in press). This argues against a rigid algorithm for food finding. Moreover, not all subjects executed this routine, since some of them never sought information, and some of them that had seen where the food was located still looked inside the tube, albeit less often than on trials in which they had not seen the location of the food.

Another alternative that may explain our results is that subjects may have learned (rather than having a hard-wired response) some fixed rule that has produced positive consequences in the past. Namely, in the absence of food subjects may have produced a variety of search responses indiscriminately and once some of those responses were rewarded, they became established. For instance, during the test subjects may have learned to bend down when a barrier was present during the baiting because that increased the chances of selecting the correct tube. Unlike the previous explanation, this could account for the individual differences observed. However, this explanation cannot account for the successful performance of those subjects who showed no evidence of learning during the test.

Of course, one can argue that learning took place before the experiment began. Note that we have no way to verify this
possibility, but invoking the learning of some fixed rule is often postulated but rarely demonstrated. Although it is true that chimpanzees can associatively learn conditional discriminations based on the presence of a certain cue, it is not a foregone conclusion that they always do so. In fact, apes may not be as skillful as commonly thought about learning such discriminations in social and nonsocial problems (e.g., Call, Hare, & Tomasello, 1998; Tomasello, Call, & Gluckman, 1997). Moreover, note that subjects had never before experienced the tubes and barrier combination as it was presented in the current test. Although one could argue that subjects may have experienced similar situations in the past and they transferred those experiences to adapt to the new situation, this explanation opens the possibility that subjects' choices are guided by the properties of the stimuli rather than the particular stimuli themselves. In other words, subjects may encode information as “when my visual access is blocked, then do something appropriate to gain visual access to it” rather than “when a cardboard screen (or a log, wall, or rock) is present, then do X.”

This more interpretive and flexible rule is a far cry from the initial fixed rule of “when the cardboard barrier is present during baiting, then bend down.” Unlike a fixed rule, it is based on knowledge that was created by experiencing a variety of situations, none of which matched exactly the one that we presented in our test. Additional experiments will be needed to specify more precisely the kind of knowledge that underlies these rules. For instance, what would happen if subjects witnessed the baiting and, once it was completed, a barrier was interposed between the subject and the tubes? Or what would happen if the baiting occurred behind a barrier, but instead of hollow tubes the experimenter used opaque cups? If subjects were using this more interpretive strategy, we would not expect subjects to bend down and look for the food.

A final argument against merely learning fixed rules: Dogs are skillful in other domains of visual perception in social situations, even more than chimpanzees (Call, 2004; Hare, Brown, Williamson, & Tomasello, 2002), but they do not pass
this test. Clearly, dogs’ failures do not convert apes’ successes into metacognition, but it shows that an animal who can learn cues to find food does not seek information when it is ignorant regarding the exact location of food. In any case, the dog-ape comparison highlights the contrast between these species and perhaps indicates a difference between the cognitive mechanisms that govern these two different animal clades.

Thus, I argue that the recourse to fixed rules such as “bend down in the presence of a barrier” is not likely to explain some of the evidence presented here. This does not mean that past experience and learning are unimportant in developing novel solutions to novel problems. On the contrary, past experience is probably crucial to develop appropriate solutions to novel problems. What is disputed here is the validity of using fixed rules to explain phenomena to the detriment of flexible rules based on knowledge accumulation created through multiple experiences, none of which exactly matches our test situation.

In sum, neither of the previous two explanations seems fully satisfactory. One key feature in which both explanations falter is that subjects show flexibility of action in their seeking behavior. This means that subjects have some access to what they have and have not seen, and this access is not likely to be controlled by a rigid program or learned after trial and error. The nature of this access is still unclear, and additional research is needed to pinpoint the exact mechanism responsible for the behavior here described and its scope.

Some additional experiments could probe the effect of increasing delays between witnessing a baiting and choosing (like Hampton, 2001), increasing the quality of the reward, the cost of choosing wrong, or the need to take intermediate steps to find out the location of the reward. For instance, subjects could lift lids to peek inside tubes and once the food has been found, they would have to use tools. One of the advantages of this method is its simplicity. It does not require any training (besides training to touch an object to select) because it capitalizes on spontaneous behavior.
The Self and Other in Social Cognition

Positive evidence is accumulating regarding what chimpanzees know about what others can and cannot see. They follow gaze, look around barriers, use visual gestures mostly when others are looking, are sensitive to the body orientation and the faces of others when using visual signals, and know what others have and have not seen in competitive situations. The findings described in this chapter add another piece to the social cognition puzzle. Chimpanzees and the other great apes also know what they themselves have and have not seen. It is therefore possible to begin to establish a link between mental attribution in others and the self. For instance, the cognitive mechanism that gives rise to following the gaze of another individual behind a barrier to see what the other individual is looking at may be the same as the cognitive mechanism that gives rise to looking through the tubes when one has not seen where the experimenter has deposited the food. Future research will bring about a closer connection between these two complementary aspects of research on mental state attribution.

When discussing the attribution of psychological states to others (and to the self), it is important to be precise about what has been shown. I argue that these studies have shown that at least chimpanzees (and presumably other apes) know what they have seen, and they know what others can or cannot see. Some may be tempted to translate this into meaning that they know what they know and what others know or do not know. Currently, however, there is no study that can tease apart seeing from knowing. In any case, both seeing and knowing are psychological states (see Call & Tomasello, in press, for a more detailed discussion). Yet they differ in the degree of abstraction that they entail. Whereas perceptual information is a key component of seeing, such perceptual support is less relevant in the case of knowing. Individuals may represent the idea of seeing by visualizing someone facing in a certain direction and observing a given event. Knowing is harder to represent at such a perceptual level. This is why knowing is often described as a more opaque mental state than seeing. An analogy with the area of categorization may help to clarify the distinction between seeing and...
knowing and the different levels of abstraction that they represent. Perceptual categories would be analogous to seeing, whereas conceptual (or functional) categories would be analogous to knowing.

Despite its lower abstract load, it is important to emphasize that seeing should not be equated to purely observable behavior. Seeing, like knowledge, is a psychological state, not just observable behavior. Again, using the analogy with categories can help illustrate the difference between seeing and observable behavior. Seeing, like perceptual categories, allows individuals to solve problems with new exemplars of a given category, whereas purely observable behavior, like rote memory, only allows individuals to remember previously seen exemplars. Although seeing falls within the realm of psychological states, it is also important to recognize that it is not equivalent to other psychological states such as knowledge or belief. It is also important to recognize that various psychological states follow different developmental trajectories. For instance, some theorists argue that beliefs owe their special status to the property that the individual can entertain the possibility that a given fact may be false, and that individuals may be induced to hold false beliefs by supplying them with inaccurate information (Perner, 1991). Note that seeing does not afford this “duplicity” property. Individuals either see or do not see a particular event, but they do not necessarily entertain the possibility that what they saw may be false. One of the most critical advances in the study of the attribution of psychological states has been the realization that different species or members of a same species at different ages vary in their ability to attribute the various psychological states to themselves and others. From a comparative perspective, we still do not know whether nonhuman animals attribute knowledge to themselves or others (let alone beliefs) or just visual perception. Moreover, even within the area of visual perception, many questions remain unresolved. As mentioned before, previous studies have shown that chimpanzees know what others can and cannot see. Yet other aspects such as perspective taking (how an individual would see an object from a given perspective) or whether individuals recognize that others can be attending to
two different aspects of an object (e.g., color vs. shape) remain totally unexplored. Future studies should be devoted to develop this field and strengthen the link between the self and the other in comparative social cognition.

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