Meaning and Mind in Monkeys

Nonhuman primates, such as vervet monkeys, seem to communicate in ways that resemble aspects of human speech. But they do not seem to recognize mental states in others

by Robert M. Seyfarth and Dorothy L. Cheney

During the Wimbledon tennis championships in 1981, officials were confronted with an unusual problem. Some male players, notably Jimmy Connors, were regularly grunting loudly as they hit the ball. Their opponents protested, demanding that this practice be stopped. These quieter players claimed the noises were distracting and were emitted deliberately to throw off their timing.

When officials confronted Connors and the other "vocal" players, they received a slightly different explanation. Connors said that some players do grunt on purpose—but not him. He explained that he had no control over his grunting; it just happened when he hit the ball hard. Most of the other grunters were also willing to admit that some players did emit the sounds intentionally, but each denied that he himself had any conscious control over these particular vocalizations.

The Wimbledon officials then observed the different players, trying to discern which grunts were intentional and which were not. They found the distinction virtually impossible to make. The only conclusion they could agree on was that the sounds were indeed distracting, regardless of whether they were made on purpose or just happened as part of the exertion of hitting a ball hard.

The referees' quandary embodies many of the problems confronted by anyone studying the vocalizations of monkeys and apes. East African vervet monkeys, for example, call to one another in a variety of different circumstances. They give loud alarm cries when they see a predator, *wrrs* and *chutters* when they encounter other groups, threat grunts and a different kind of *chutter* when they engage in fights with members of their own group, and quiet grunts during relaxed social interactions. In each case, it is, quite simply, impossible to tell if one monkey deliberately intends to communicate to another or the monkey has no control over its vocalizing and calls out simply as part of ongoing behavior.

In our studies, we have tried to determine whether monkeys have words for things, such as predators, or understand, as we do, that particular sounds represent features of their environment: in other words, do monkeys think? We have also sought to examine whether monkeys have mental states such as knowledge, belief or desire and, perhaps most important, if monkeys do have mental states, whether they recognize that others do as well.

Scientists who carried out the first field studies of monkeys and apes assumed there were few, if any, similarities between animals' calls and human language. Observers took it for granted that human speech was under voluntary control, that it could be detached from emotion (we can talk about fear without being afraid) and that it involved activity in higher cortical areas of the brain. In contrast, the vocalizations of monkeys and apes were thought to be relatively involuntary, to occur only in highly emotional circumstances and to be under limited higher cortical control. Human words represented objects and events in the external world; the calls of monkeys and apes represented only an individual's emotional state or imminent behavior.

The first hint that these assumptions might be wrong came in the late 1960s from two rather different sources. In 1969 Allen and Beatrix Gardner of the University of Nevada at Reno announced that a chimpanzee named Washoe (pronounced "Wash-show") had learned more than 30 hand signs. Washoe used these signs to communicate about objects, make requests and "just talk." (Researchers later showed that the number of signs an ape can learn is much greater.) To many observers, Washoe was like a circus bear riding a bicycle: training had allowed her to acquire a skill that fell outside the range of a chimpanzee's normal behavior. Others were struck by the large number of signs in Washoe's repertoire and wondered if such communication was completely foreign to chimpanzees or other nonhuman primates.

At roughly the same time, in 1967, Thomas Struhsaker, then at the University of California at Berkeley, reported that East African vervet monkeys gave different-sounding calls in response to three predators: leopards, eagles and snakes. Each call elicited a distinct, apparently adaptive, escape response from nearby vervets. Alarm calls given about leopards caused vervets to run into trees, where monkeys seemed safe from feline attack. Eagle alarms caused them to look up in the air or run into the bushes. Snake alarms caused the animals to stand on their hind legs and look into the grass. Like Washoe, vervet monkeys certainly seemed to be using

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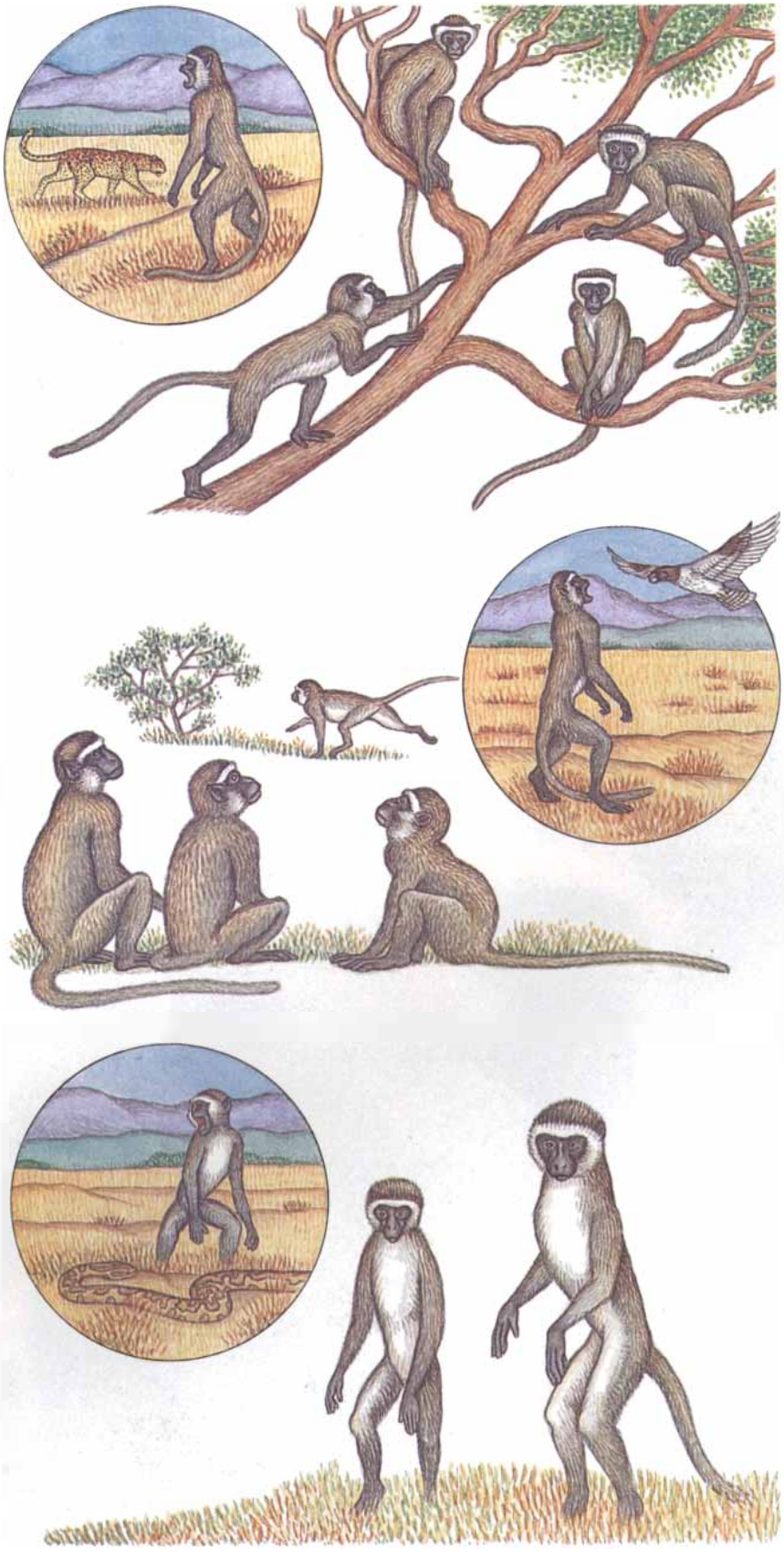
different signs to denote distinct objects or varied forms of danger.

There were, however, more skeptical interpretations. Instead of indicating different predators, the vervets' alarms might simply be general alerting signals that caused the animals to look all around them. Once monkeys spotted the predator, their responses occurred as a result of what they had seen, not what they had heard. Alternatively, the monkeys' calls might not denote different predators but might instead reflect the relative intensity of fear aroused by leopards, eagles and snakes. If this were true, the analogy between vervet alarm calls and human words would be considerably weakened.

In 1977, as postdoctoral fellows in Peter Marler's laboratory at the Rockefeller University, we designed experiments to test these hypotheses. We conducted our work in the same area where Struhsaker had carried out his

EAST AFRICAN VERVET MONKEYS listen to vocalizations of other members of their troop. The sounds can indicate encounters with another group of vervet monkeys, interactions with members of their own troop or the sighting of a predator.



DIFFERENT ALARM CALLS are given by vervet monkeys in response to the sighting of at least three major predators: leopards (*top*), martial eagles (*middle*) and snakes, such as the African rock python (*bottom*). The monkeys vary their escape route in accordance with the specific call. Experiments conducted with recorded alarm calls show that the cries serve as representational, or semantic, signals for the monkeys.

original study: Amboseli National Park in southern Kenya, at the foot of Mount Kilimanjaro. Here vervets live in groups of 10 to 30 individuals—often including one to eight adult males, two to eight adult females and their offspring. Each group occupies an area of roughly 10 acres that it aggressively defends against incursion by other groups.

As in many other Old World monkey species, such as baboons, rhesus macaques or Japanese macaques, vervet females spend their entire lives in the group where they were born, maintaining close social bonds with their matrilineal kin. The members of each matriline often groom and sleep together as well as support one another in aggressive alliances. Males, in contrast, transfer to neighboring groups when they become sexually mature at about four years of age.

Adult females are ranked in order of dominance, and the offspring acquire a position immediately below that of their mother. As a result, vervet monkey groups consist of a hierarchy of families, with all the members of family A outranking all the members of family B, and so on down the line. Even a male assumes his mother's rank until he transfers to another group. After that move, a male's status depends on more diverse factors, including fighting ability, age and his acceptance by the adult females in his adopted group.

In the early months of our fieldwork we began to accumulate recordings of calls. These vocalizations were given by known individual vervets in encounters with leopards, martial eagles (the monkeys' main avian predator) and pythons. We then played calls to monkeys through a concealed loudspeaker and filmed the animals' responses.

When we examined our results, we found that playback experiments closely duplicated the responses to alarm calls that Struhsaker and we had already observed under natural conditions. Playback of leopard alarms caused animals to run into the trees, recorded eagle alarms caused them to look up into the air or run into bushes and snake alarms caused them to stand on their hind legs and peer into the adjacent grass.

The responses elicited by the recordings of various alarm types argued against the idea that calls were general alerting signals. The sounds seemed to convey information about the presence of specific kinds of danger. Moreover, there was evidence that alarm calls did not simply reflect the caller's degree of fear or excitement. When we altered our tapes to vary the caller's level of excitement by making the calls longer or

shorter and louder or softer, the change had no effect on the qualitatively different responses to each alarm call.

Because we presented alarms when no real predators were around, we could rule out the hypothesis that the monkeys' responses depended on what they had seen rather than on what they had heard. In sum, each type of alarm call, presented on its own, elicited the same response as would a particular predator. We concluded that alarm calls functioned as representational, or semantic, signals.

There are, however, good reasons for caution in drawing parallels between monkey vocalizations and human words. We described the alarms of vervet monkeys as semantic signals because of the way these calls function in the monkeys' daily lives. When one vervet hears another give an eagle alarm call, the listener responds as if it has seen the eagle itself. This behavior suggests that in the monkey's mind the call "stands for" or "conjures up images of" an avian predator even when the monkey has not yet seen the eagle.

But this conclusion could easily be incorrect. For Pavlov's dogs, the sound of a bell may have conjured up images of meat. This fact, however, does not prove that the dogs understood the referential relation between bells and meat in the same way that we understand the relation between, say, the word "chair" and a piece of furniture.

A monkey's call would cease to be a sound and would become a word only if a certain transformation took place. As psychologist David Premack, formerly at the University of Pennsylvania, suggests, this change would occur if the properties ascribed to the call are not those of a sound but those of the object it denotes. Human language offers some excellent examples. If we compare the words "treachery" and "deceit," we typically ignore the fact that the sounds have different acoustic properties. We describe the words as similar because they have similar meanings.

In contrast, the words "treachery" and "lechery," despite their shared sound, are found to be different because they have different meanings. In making these judgments, we recognize the referential relation between words and the objects for which they stand. When comparing words, we judge them to be similar or different on the basis of their meaning, not their acoustic properties. We needed, therefore, to determine if the calls of vervet monkeys qualify as words in this stronger sense in order to claim that monkeys understand the meaning of their vocalizations.

To investigate how vervets compare vocalizations, we borrowed a method from research on speech perception in human infants called the habituation-dishabituation technique. This approach is based on the observation that subjects perceiving the same stimulus over and over again gradually cease responding to it: they habituate. If subjects who have habituated to one stimulus perceive another that they judge to be different, however, the strength of their response increases sharply. The habituation-dishabituation technique thus reveals whether an individual finds two stimuli similar or dissimilar.

To test whether vervet monkeys compare vocalizations on the basis of their acoustic properties or their apparent meaning, we chose as stimuli two calls the monkeys give during territorial encounters with neighboring groups. Monkeys make the first—a long, loud trill called a *wrr*—when they initially spot another group. It seems to alert members of both groups that a neighboring group has been seen. The second vocalization, a harsh, raspy sound called a *chutter,* is emitted when an encounter between groups has escalated into aggressive threats, chases or fighting. *Wrrs* and *chutters* have broadly matching referents—both provide information about another group—but are very different acoustically. Vervets asked to compare *wrrs* and *chutters* in a habituation-dishabituation experiment would therefore judge them to be different if they based their comparison on acoustic properties but similar if they based their comparison on meaning.

To begin our experiments, we selected a subject. On the first day we played a particular adult female's *chutter* to this subject in order to establish the baseline strength of the subject's response. This result was the control condition. On the second day the subject heard the same adult female's *wrr* repeated eight times at roughly 20-minute intervals. Because no other group was present, we predicted the subject would rapidly habituate to the call. Finally, roughly 20 minutes after the last *wrr,* the subject heard the female's *chutter* again.

The logic of our experiment involved playing to our subject the same call, a *chutter,* under two conditions: once in the absence of any prior vocalization (the control) and once after the subject had habituated to the same caller's *wrr* (the test). If our subject judged the *wrrs* and *chutters* to be alike—that is, if monkeys compared calls on the basis of their meaning—then habituation to an individual's *wrr* would also produce habituation to the same individual's *chutter.* In addition, the strength of the response would decrease greatly between the control and test conditions.

But if subjects judged *wrrs* and *chutters* to be different—that is, if monkeys compared calls on the basis of their acoustic properties and not their meaning—then habituation to an individual's *wrr* would not produce habituation to the same individual's *chutter.* In this instance, there would be little difference in the strength of the response between the control and the test conditions.

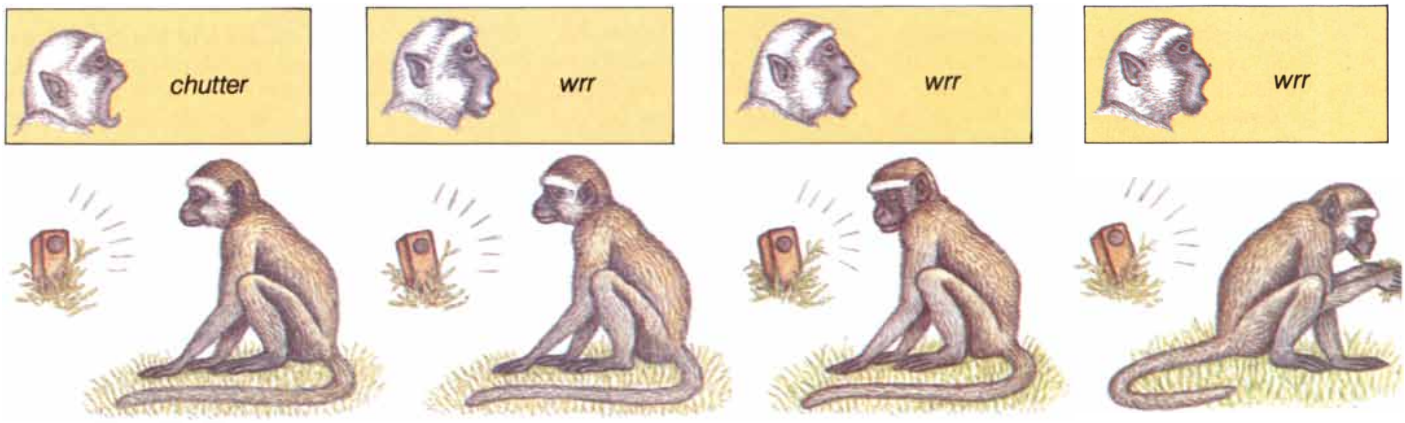
We also decided to evaluate another factor in a monkey's response. From earlier work, we knew that vervet monkeys, like many other birds and mammals, take note of a signaler's identity when responding to calls. Would subjects transfer habituation from one individual to another as well?

In a second series of trials, we varied the test by playing the calls of two group members. On the first day we established baseline data on the strength of a subject's response to individual A's *chutter.* On the second day we played individual B's *wrr* to the subject eight times. After the subject had habituated to B's *wrr,* we tested her to see if she had also habituated to A's *chutter.*

In a third test we examined the effect of changing the call's apparent referent but maintaining the identity of the caller. To do this, we repeated the procedure described for our earlier experiments but instead used as stimuli leopard and eagle alarm calls instead of *wrrs* and *chutters.* Finally, to determine whether subjects would habituate to both individuals and call types, we tested to see if habituation to individual A's eagle alarm would cause subjects to habituate to B's leopard alarm.

Results provide clear evidence that vervet monkeys compare different calls on the basis of their meaning and not just their acoustic properties. When subjects were presented with the same individual's *wrrs* and *chutters,* they transferred habituation to the two types of calls. So if a subject had habituated to individual A's *wrr,* she ceased responding to A's *chutter.* But when subjects heard two calls whose referents were different, they did not transfer habituation to both types of calls: if a subject ceased responding to individual X's leopard alarm call, she responded at normal strength to individual X's eagle alarms.

The identity of the caller also seemed important when vervet monkeys compared vocalizations. Although *wrrs* and *chutters* had similar referents, habituation to individual A's *wrr* did not cause habituation to individual B's *chutter.* Finally, when the calls both had different referents and came from different



HABITUATION STUDIES show that vervets distinguish cries on the basis of their meaning rather than simply on their acoustic properties. *Chutters* and *wrrs* are acoustically different and have slightly different meanings, but both describe encountering another group. When a subject first hears a recorded *chutter* (*far left*), it looks fixedly at the source of the sound. If it later hears the same individual (*yellow*) make a series of *wrrs*, a few of which are shown above (*middle three panels*),

callers, habituation was not transferred.

This series of experiments addressed the question of meaning and reference more directly than did our earlier studies on vervets' alarm calls. The test asked animals to compare two vocalizations, to judge them to be either similar or different and to reveal the criteria the animals used in making their comparison. Our findings suggest that when one vervet monkey hears another vocalize, the listener forms a representation of what that call means. If the listener hears a second vocalization shortly afterward, he or she compares the two calls not just according to their acoustic properties but also according to their meanings.

If we accept the notion that a monkey's call becomes a word when the properties ascribed to the call are not those of a sound but those of what the object denotes, *wrrs* and *chutters* seem to have become words. Thus, vervets seem to have a rudimentary semantic system in which some calls, such as leopard and snake alarms, are quite different in meaning; other calls, such as *wrrs* and *chutters,* are linked to a common referent and can represent shades of meaning within a general class.

Drawing on our knowledge of the vervet's ecology and social behavior, we can suggest why monkeys need such communication and why the cognitive abilities that underlie it may have evolved. If different predators require different escape strategies, then the adaptive value of acoustically different alarm calls is obvious. In addition, monkeys often vocalize when out of sight from one another. This practice favors the evolution of calls whose meanings can be derived from acoustic features alone and that do not depend crucially on contextual cues, such as what the listener sees.

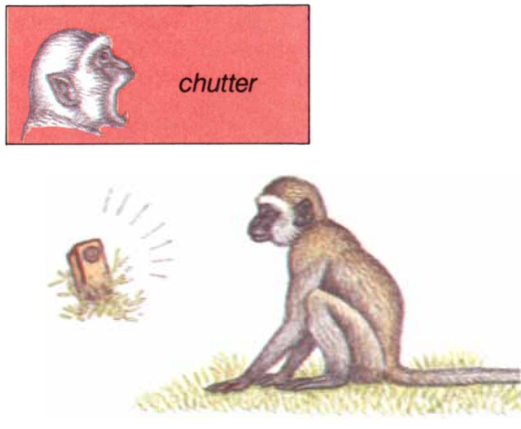
Further, the appropriate response to a vocalization may differ markedly from one individual to the next. A monkey on the ground who gives an eagle alarm may be looking up into the sky, but other monkeys nearby should run into bushes, and those in trees should climb down. These circumstances favor callers who can communicate about events in ways that are relatively independent of their own behavior as well as listeners who can interpret a call's meaning in a manner relatively independent of what the caller is likely to do next. They favor semantic, representational communication.

Our findings, however, did not indicate whether monkey calls could be elevated to the status of human words. Human language involves more than just a referential relation between words and the objects or events they denote. When communicating, we also attribute mental states such as knowledge, beliefs and desires to others. We recognize that mental states have causal power. For instance, we warn young children not to step into the street while waiting for a light to turn green. Our warning is not prompted by their behavior—which may be perfectly safe—but by the lack of knowledge that we attribute to them. As children get older, the same warning provokes outrage and indignation. Older children have learned to attribute mental states to their parents. They know that what parents say reflects what they think, and children do not like being thought of in a condescending way.

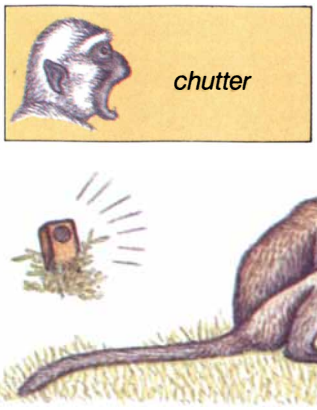
To attribute beliefs, knowledge and emotions to others is to have what psychologists call a theory of mind. We wanted to know whether monkeys could distinguish between their own beliefs and the knowledge and beliefs of others and whether they take special steps to inform an individual who is ignorant or to correct another's false belief.

Hints that animals might be sensitive to the mental states of others came from recent work on what is called the audience effect in various birds and mammals. Marler, now at the University of California at Davis, and his colleagues repeated one of Nikolaas Tinbergen's classic experiments in which a model of a hawk's silhouette was suspended on a wire and "flown" over a group of jungle fowl. Marler found that roosters gave alarm calls in the presence of a hen but remained silent when they were alone with a female of another species. In the wild, Paul Sherman of Cornell University found that adult female ground squirrels were more likely to give alarm calls if they had close kin present than if they did not. In experiments with captive female vervet monkeys, we found that adult females gave more alarm calls when they were with their own offspring than when they were paired with unrelated vervet monkeys of the same age and sex.

Although animals are clearly sensitive



CALLER'S IDENTITY is important to the listener. When one individual (*red*) makes



it habituates and ceases to respond. When the subject finally hears a *chutter* again, it does not respond—the habituation is transferred.

to the presence or lack of an audience, this fact does not prove that they are also sensitive to their audience's state of mind. Moreover, considerable evidence suggests that animals cannot recognize the distinction between an ignorant audience and a knowledgeable one. Roosters and vervet monkeys, for instance, continue to give alarm calls long after their companions have seen a predator and made their escape.

To test for a theory of mind in monkeys, we carried out experiments on two groups of rhesus macaques and two groups of Japanese macaques at the California Primate Research Center in Davis. In their natural habitats, rhesus and Japanese macaques live in groups that are larger but similar in composition to groups of vervet monkeys. By studying monkeys in large outdoor enclosures, we were able to maintain natural social groups while providing some individuals with information that others did not possess.

The subjects for our experiments were adult females and their two- to three-year-old offspring. In the knowledgeable condition, mother and offspring were seated next to each other in a chute that led into a large circular arena. Both watched two scenarios: a researcher placed apple slices in a food bin in the empty arena, or a predator—in this case, a technician who carried a net used to capture monkeys—made threatening gestures and then hid behind one wall of the arena.

In the ignorant condition, mother and offspring were again seated near each other, but a steel partition separated them. Only the mother could see the food bin being filled or the predator hiding. In both knowledgeable and ignorant conditions, after the food had been placed in the bin or the predator had concealed himself, the offspring was released into the arena.

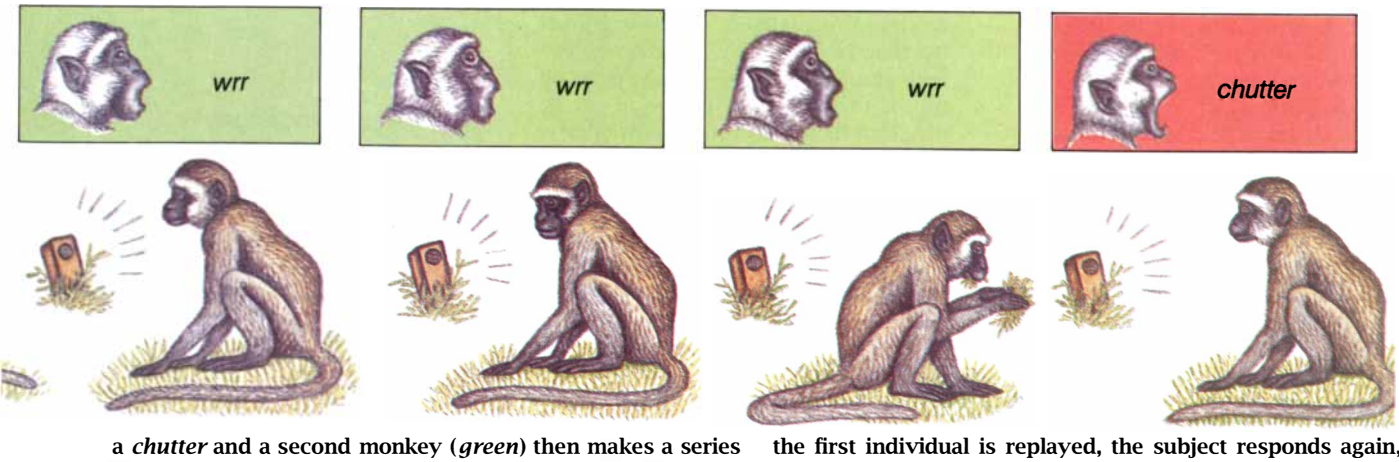
In the ignorant condition the mother had observed her offspring being isolated nearby—and presumably could determine that her offspring was unable to see into the arena. Our goal was to see if the mother, like humans under comparable conditions, would conclude that as a result of its isolation her offspring would not know about the food or the predator. If monkeys are sensitive to others' mental states, mothers should have uttered more calls, or in some other way altered their behavior, when their offspring were ignorant than when they were informed. On the other hand, if animals are unaffected by their audience's mental states, the mother's behavior should have been the same regardless of whether or not their offspring had seen the food or the danger.

As it turned out, mothers had ample opportunity to assess their offspring's knowledge. Ignorant offspring not only were isolated behind a partition, they also behaved differently after being released. In food trials, knowledgeable offspring quickly found the apple slices, whereas ignorant offspring almost never did. In predator trials, knowledgeable offspring stayed close to their mothers after being released, whereas ignorant offspring wandered around the cage, seemingly unaware of the predator's proximity. Despite all these cues, however, we found no difference in the mother's behavior under the two conditions: in neither case did the mother make calls to her young.

Clearly, such negative results do not allow us to distinguish between an inability to attribute a state of mind to others and a failure to make use of such an ability. It is certainly possible that monkeys do recognize the difference between their own knowledge and that of others, but this awareness has no behavioral effect. If rhesus and Japanese macaques can distinguish ignorance and false beliefs in others, however, their apparent failure to act on this information is striking.

Research on chimpanzees suggests that these apes, unlike monkeys, may possess a rudimentary theory of mind. In 1978 Premack and Guy C. Woodruff, then at University of Pennsylvania, conducted experiments in which they showed a chimpanzee named Sarah videotapes of trainers trying to solve a variety of problems. In one case, the trainer could be seen trying to operate a record player whose cord was not plugged into a socket. After each videotape the researchers gave Sarah several photographs, one of which depicted the solution to the problem. She consistently chose the correct photograph.

Premack and Woodruff interpreted Sarah's behavior as evidence that she recognized the videotapes as representing a problem and inferred purpose to the human trainers. Interestingly, when tested with videotapes of a favorite and a less favored trainer, Sarah chose correct solutions for the favorite trainer but incorrect ones for the other trainer. More recently, Daniel J. Povinelli, now at



a *chutter* and a second monkey (*green*) then makes a series of *wrrs,* the subject ceases responding. When the *chutter* of the first individual is replayed, the subject responds again, showing that habituation does not extend to different callers.

YOUNG VERVET MONKEY will learn by observation alone, without tutelage from his mother. In the field and in experiments, mothers have shown an inability to recognize or address ignorance in their offspring. These observations suggest that vervets lack a theory of mind; that is, they do not attribute emotions, beliefs or knowledge to others.

the University of Southwestern Louisiana, and his colleagues obtained comparable results in experiments that required chimpanzees to distinguish between a knowledgeable and an ignorant human condition.

At Gombe Stream Reserve in Tanzania, Jane Goodall once watched an adolescent male chimpanzee, Figan, deceive others in order to obtain a hidden cache of food. As a group of chimpanzees assembled in the provisioning area, Figan suddenly stood up and strode into the woods in a manner that caused all others nearby to follow him. Shortly thereafter, Figan abandoned his companions and circled back to eat the bananas. Of course, anecdotes like this can easily be overinterpreted—one can readily imagine an explanation of Figan's behavior that does not require a theory of mind.

But at the same time, the scientific literature contains an impressive number of cases in which chimpanzees have been observed to deceive others in several different contexts and by an extraordinary variety of gestures, postures and facial expressions. By their number and variety such anecdotes gain in persuasive power and suggest at least the possibility of a theory of mind in apes.

Clearly, the inability to attribute knowledge to others limits a species' actions. Consider some of the initiatives animals cannot undertake if they lack a theory of mind. For example, when infant vervet monkeys begin giving alarm calls or responding to the alarms of others, they make many mistakes. Some, like an infant's eagle alarm given in response to a pigeon flying overhead, are relatively harmless. Other errors, such as that made by an infant who looks up in the air when he or she hears a snake alarm, are more serious, and they actually increase the infant's risk of being taken.

Under these conditions, one might expect adults to intervene and help their infants learn about predators. Somewhat surprisingly, they do not. Despite extensive observations and experiments, we have found no evidence that adults selectively encourage infants who have given alarm calls appropriate to the predators, nor do adults correct infants who have responded to an alarm call inappropriately. Infant vervets learn by observation alone, without explicit tutelage. Such reliance on observational learning is widespread among animals and can, in our view, ultimately be traced to the adults' failure to recognize that their offspring's knowledge is different from their own.

Research on animal communication is inextricably linked to research on how animals think. Our studies of vervet monkeys allow us to conclude that primate vocalizations are not just involuntary shrieks but calls used selectively by individuals who take account of their audience and who use different vocalizations to signal about different features of their environment. Like words, the calls of monkeys function to denote different objects or events, and the monkeys themselves may even recognize the referential relation between a call and the object or concept for which it stands.

At the same time, we are beginning to understand more precisely how the communication and cognition in monkeys differ from that in humans. Although much of human communication is designed to influence the knowledge, beliefs and motives that underlie behavior, there is no evidence at present that monkeys ever communicate with the intent of influencing another animal's mental state. Monkeys and perhaps even apes cannot communicate with the intent to modify the mental states of others because, apparently, they do not recognize that such mental states exist.

FURTHER READING

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