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How Baboons Think (Yes, Think)
By NICHOLAS WADE

Royal is a cantankerous old male baboon whose troop of some 80 members lives in the Moremi Game Reserve in Botswana. A perplexing event is about to disturb his day.

From the bushes to his right, he hears a staccato whoop, the distinctive call that female baboons always make after mating. He recognizes the voice as that of Jackalberry, the current consort of Cassius, a male who outranks Royal in the strict hierarchy of male baboons. No hope of sex today.

But then, surprisingly, he hears Cassius's signature greeting grunt to his left. His puzzlement is plain on the video made of his reaction. You can almost see the wheels turn slowly in his head:

"Jackalberry here, but Cassius over there. Hmm, Jackalberry must be hooking up with some one else. But that means Cassius has left her unguarded. Say what — this is my big chance!"

The video shows him loping off in the direction of Jackalberry's whoop. But all that he will find is the loudspeaker from which researchers have played Jackalberry's recorded call.

The purpose of the experiment is not to ruin Royal's day but to understand what goes on in a baboon's mind, in this case how carefully the animals keep track of transient relationships.

Dorothy Cheney and Robert Seyfarth, a husband-and-wife team of biologists at the University of Pennsylvania, have spent 14 years observing the Moremi baboons. Through ingenious playback experiments performed by themselves and colleagues, the researchers say they have worked out many aspects of what baboons use their minds for, along with their limitations.

Reading a baboon's mind affords an excellent grasp of the dynamics of baboon society. But more than that, it bears on the evolution of the human mind and the nature of human existence. As Darwin jotted down in a notebook of 1838, "He who understands baboon would do more towards metaphysics than Locke."

Dr. Cheney and Dr. Seyfarth are well known for a 1990 book on vervet monkeys, "How Monkeys See the World," in which they showed how much about the animals' mental processes could be deduced from careful experiments.

When a baby vervet's call is played to three females, for instance, the mother looks to the source of the sound. The two others look to the mother, evidence that vervets know whose baby is whose.

An experiment like this — recording the sounds, waiting until the animals are in the right place and performing numerous controls — can take months to complete, but the results are widely admired by other biologists. "Any work of Dorothy and Robert's is going to be as good as you get in the field," said Robert M. Sapolsky, a Stanford biologist and an author who has studied baboons in the wild for many years.

"There is no one else in the area of animal behavior who does such incredibly interesting experiments in the field," said Marc Hauser, a biologist at Harvard who was their first

student.

Dr. Cheney and Dr. Seyfarth have summed up their new cycle of research in a book titled, after Darwin's comment, "Baboon Metaphysics." Their conclusion, based on many painstaking experiments, is that baboons' minds are specialized for social interaction, for understanding the structure of their complex society and for navigating their way within it.

The shaper of a baboon's mind is natural selection. Those with the best social skills leave the most offspring.

"Monkey society is governed by the same two general rules that governed the behavior of women in so many 19th-century novels," Dr. Cheney and Dr. Seyfarth write. "Stay loyal to your relatives (though perhaps at a distance, if they are an impediment), but also try to ingratiate yourself with the members of high-ranking families."

Baboon society revolves around mother-daughter lines of descent. Eight or nine matriline are in a troop, each with a rank order. This hierarchy can remain stable for generations.

By contrast, the male hierarchy, which consists mostly of baboons born in other troops, is always changing as males fight among themselves and with new arrivals.

Rank among female baboons is hereditary, with a daughter assuming her mother's rank.

News of that fact gave great satisfaction to a member of the British royal family, Princess Michael of Kent. She visited Dr. Cheney and Dr. Seyfarth in Botswana, remarking to them, they report: "I always knew that when people who aren't like us claim that hereditary rank is not part of human nature, they must be wrong. Now you've given me evolutionary proof!"

Baboons live with danger on every side. Many fall prey to lions, leopards, pythons and the crocodiles that in the wet season stalk the fords where baboons cross from one island to another. Baboon watchers are subject to the same hazards. Dr. Cheney and Dr. Seyfarth say their rules are not to work alone or to wade into water deeper than knee high. They often find themselves sitting in a tree with baboons waiting out a lion below. But going into New York is more petrifying, they contend, than dodging Botswana's predators.

The baboons will bark to warn of lions and leopards, but pay no attention to some other species dangerous to humans like buffalo and elephant. On two occasions, baboons have attacked animals, a leopard and a honey badger, that threatened their human companions. "We haven't lost any post-docs," Dr. Seyfarth said.

For female baboons, another constant worry besides predation is infanticide. Their babies are put in peril at each of the frequent upheavals in the male hierarchy. The reason is that new alpha males enjoy brief reigns, seven to eight months on average, and find at first that the *droits de seigneur* they had anticipated are distinctly unpromising. Most of the females are not sexually receptive because they are pregnant or nurturing unweaned children.

An unpleasant fact of baboon life is that the alpha male can make mothers re-enter their reproductive cycles, and boost his prospects of fatherhood, by killing their infants. The mothers can secure some protection for their babies by forming close bonds with other females and with male friends, particularly those who were alpha when their children were conceived and who may be the father. Still, more than half of all deaths among baby baboons are from infanticide.

So important are these social skills that it is females with the best social networks, not those most senior in the hierarchy, who leave the most offspring.

Although the baboon and human lines of descent split apart some 30 million years ago, the species have much in common. Both are primates whose ancestors came down from the trees and learned to survive on the ground in large social groups. The baboon mind may therefore shed considerable light on the early stages of the evolution of the human mind.

In some of their playback experiments, Dr. Cheney and Dr. Seyfarth have tested baboons' knowledge of where everyone stands in the hierarchy. In a typical interaction, a dominant baboon gives a threat grunt, and its inferior screams. From their library of recorded baboon sounds, the researchers can fabricate a sequence in which an inferior baboon's threat grunt is followed by a superior's scream.

Baboons pay little attention when a normal interaction is played to them but show surprise when they hear the fabricated sequence implying their social world has been turned upside down.

This simple reaction says a lot about what is going in the baboon's mind. That the animal can construe "A dominates B," and distinguish it from "B dominates A," means it must be able to break a stream of sounds down into separate elements, recognize the meaning of each, and combine the meanings into a sentence-like thought.

"That's what we do when we parse a sentence," Dr. Seyfarth said. Human language seems unique because no other species is capable of anything like speech. But when it comes to perceiving and deconstructing sounds, as opposed to making them, baboons' ability seems much more language-like.

Assuming that early humans inherited the same ability from their joint ancestor with baboons, then when humans first started to combine sounds in the beginning of spoken language, "their listeners were all ready to perceive them," Dr. Seyfarth said.

Baboons may be good at perceiving and thinking in a combinative way, but their vocal output consists of single sounds that are never combined, like greeting grunts, the females' sexual whoop and the males' competitive "wahoo!" cry. Why did language, expressed in combinations of sounds, evolve in humans but not in baboons?

A possible key to the puzzle lies in what animal psychologists call theory of mind, the ability to infer what another animal does or does not know. Baboons seem to have a very feeble theory of mind. When they cross from one island to another, ever fearful of crocodiles, the adults will often go first, leaving the juveniles fretting at the water's edge. However much the young baboons call, their mothers never come back to help, as if unable to divine their children's predicament.

But people have a very strong ability to recognize the mental states of others, and this could have prompted a desire to communicate that drove the evolution of language. "If I know you don't know something, I am highly motivated to communicate it," Dr. Seyfarth said.

It is far from clear why humans acquired a strong theory of mind faculty and baboons did not. Another difference between the two species is brain size. Some biologists have suggested that the demands of social living were the evolutionary pressure that enhanced the size of the brain. But the largest brains occur in chimpanzees and humans, who live in smaller groups than baboons.

But both chimps and humans use tools. Possibly social life drove the evolution of the primate brain to a certain point, and the stimulus of tool use then took over. Use of tools

would have spurred communication, as the owner of a tool explained to others how to use it. But that requires a theory of mind, and Dr. Cheney and Dr. Seyfarth are skeptical of claims that chimpanzees have a theory of mind, in part because the experiments supporting that position have been conducted on captive chimps. "It's bewildering to us that none of the people who study ape cognition have been motivated to study wild chimpanzees," Dr. Cheney said.

"Baboons provide you with an example of what sort of social and cognitive complexity is possible in the absence of language and a theory of mind," she said. "The selective forces that gave rise to our large brains and our full-blown theory of mind remain mysterious, at least to us."