Dorothy Leavitt Cheney*

Life and Work

Robert Seyfarth

Dorothy L. Cheney studied the social behaviour, communication, and cognition of monkeys. Her goal was to uncover the selective forces that have shaped the evolution of the human mind.

Dorothy Leavitt Cheney was a leading figure in the study of behavior, communication, and cognition in animals, particularly nonhuman primates (monkeys and apes). Her greatest contribution was to ground the study of primate vocal communication and cognition in the natural lives of the animals themselves. In two long-term studies of wild primates—vervet monkeys in Kenya and baboons in Botswana—Dorothy and I considered the problems that animals might need to solve in order to survive and reproduce. Our particular focus was on problems of communication and cognition: how has natural selection shaped the minds and communicative skills of our closest animal relatives, the nonhuman primates? What do they know—what do they need to know—about their environment and their social companions to survive and reproduce successfully? In posing these questions, we hoped to bring together two scientific fields that had largely been separate. On the one hand, psychologists were interested in comparing cognition across different species—and thereby gain an understanding of how human intelligence differed from that of other animals—but they worked almost entirely in laboratories, studying rats and pigeons using arbitrary stimuli like circles and squares, and without any reference to social behavior. Questions about the evolution of cognition seemed of little interest to them. On the other hand, ethologists and evolutionary biologists studied a variety of species in their natural habitat and described social

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Figure 1. Dorothy Cheney with baboons in the Okavango Delta, Botswana.

behavior in detail, but while evolution was a central interest, they had little interest in cognition. Our goal was to combine these two fields, asking questions about the evolution of cognition in the wild.

Keywords
Evolution, vocal communication, cognition, primates, vervet monkeys, baboons.

To do this, we conducted systematic field observations of behavior, made tape-recordings of the vocalizations of known individuals, and used these vocalizations in 'playback' experiments. We reasoned that just as we can gain insights into human knowledge and cognition by studying language and its use in social interaction, so we can gain insights into the minds of our closest animal relatives by studying the meaning and function of their communication with each other. Here are some examples of Dorothy's and my research.

In 1967, Tom Struhsaker, a graduate student at the University of California, Berkeley, returned from 18 months' fieldwork on vervet monkeys in Kenya's Amboseli National Park. Struhsaker was mainly interested in the vervets' social organization and ecology, but he also described an interesting feature of their vocal communication. The vervets, he reported, gave acoustically different alarm calls to different predators, and each call elicited a different, adaptive response. For example, when the monkeys were foraging on the ground and heard one member of their group give a 'leopard alarm', they ran into the trees; when they heard an

The vervets, Tom Struhsaker reported, gave acoustically different alarm calls to different predators, and each call elicited a different, adaptive response.

Figure 2. During parts of the year, the Okavango Delta is partially flooded. Baboons walk or swim from one elevated 'island' to another, and observers must follow then through the water.

'eagle alarm' they looked up into the air or ran into bushes where they were safe from an eagle's attack (eagles can take monkeys if they are on the trees); and when they heard a 'snake alarm' they stood on their hind legs and peered into the grass around them.

From Struhsaker's description, it seemed as if the vervets' different alarms were like words, but scientists were skeptical. Perhaps the calls just reflected different levels of 'fear' and, therefore, elicited different sorts of response, or perhaps, they were just general 'alert' calls—like shouting "Hey!"—with no specific meaning and only elicited different responses because nearby animals heard the call, looked all around them, saw the predator, and responded not to the alarm itself but because of what they had seen. If these views were correct, there would be little similarity between the vervet monkeys' alarm calls and human words.

To test these hypotheses, Dorothy and I conducted 'playback' experiments on wild vervet monkeys. We first waited until no predator was in the area, then began filming the monkeys. Then, from a concealed loudspeaker, we played one of the monkeys' different alarm calls. These experiments required a great deal of care and were often very frustrating. For example, if we were going to play an alarm call we had originally recorded from Porcellian—a male

Figure 3. Dorothy Cheney in 2010.

member of one of our study groups—he had to be completely out of sight, and the speaker had to be hidden in an area where he might reasonably be expected to be. And often, just as we had the camera and speaker set up, Porcellian would appear, and the trial would have to be aborted. Completing a full set of trials took 18 months!

Playback experiments elicited the same responses that had been observed in natural encounters with leopards, eagles, and snakes. This allowed us to reject the idea that different responses depended upon what the animals had seen because there was no predator present in our tests.

When they were finished, results showed that our playbacks elicited the same responses that had been observed in natural encounters with leopards, eagles, and snakes. This allowed us to reject the idea that different responses depended upon what the animals had seen because there was no predator present in our tests. Instead, we concluded that in the mind of a vervet monkey, each of the different alarm calls 'represented' or 'stood for' a particular predator, much as the words in our language represent or stand for different objects. Subsequent experiments on many other animal vocalizations have supported this interpretation: for further discussion, see the chapters in [1].

Here is the second example of Dorothy's and my research. Vervet

monkeys and baboons have similar social organizations. Females become adults at roughly 5–6 years of age and remain throughout their lives in the group where they are born, maintaining close ties with their mothers and matrilineal sisters. In each group, the females can be arranged in a linear dominance hierarchy. Daughters acquire ranks immediately below those of their mothers, so the permanent core of each group consists of several matrilineal 'families'. Long-term studies have shown that family ranks remain stable for 35 years or more. Males, in contrast, leave the group where they were born, moving from one group to another throughout their lives. In India, rhesus macaques have a similar social organization.

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This description is typical of what one might read in a popular article or on a television show by the BBC or National Geographic. It describes a richly complex social organization in monkeys, but it begs an important question. Humans may describe monkey society in terms of rank and matrilineal kinship, but we already know that humans can organize data in terms of such concepts—what about monkeys? Do the monkeys themselves understand such relations? Do they recognize the rank and kinship ties among their companions? These are the questions we sought to answer.

To test the hypothesis that monkeys recognize each other's dominance ranks, Dorothy and I took advantage of the fact that when vervet monkeys or baboons compete, the dominant individual utters characteristic aggressive vocalizations, whereas, the subordinate individual utters characteristic submissive vocalizations. Drawing on our library of calls from known individuals, we created call sequences that were either consistent with the existing hierarchy (higher-ranking animal threatens lower-ranking animal) or violated the existing hierarchy (lower-ranking animal threatens higher-ranking animal). When the sequences were played to nearby listeners, the listeners showed no strong response to the consistent sequence but responded with curiosity and surprise if the sequence of calls violated the existing dominance hierarchy. This result showed that they recognized the rank relations of

Figure 4. Dorothy Cheney observes baboons grooming and collects data on a small hand-held computer.

other individuals—information they could only have obtained by observing others and making the appropriate conclusions.

In a similar experiment that tested animals' recognition of matrilineal kin relations, Dorothy and I showed that when females hear the distress call of an immature, they look at the immature's mother.

Finally, in an experiment that tested whether animals arranged other individuals into a nested hierarchy based simultaneously on kinship and rank, we showed that listeners responded more strongly to evidence of a rank reversal between members of two different families than to a rank reversal between members of the same family. We concluded that the linear rank relations and matrilineal kinship we observe in vervet monkeys and baboons are not mere anthropomorphisms—products of the human mind—they also exist in the minds of the animals themselves. Full details of these and other experiments can be found in [2].

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From these and other experiments, Dorothy and I concluded that like the finches' beaks famously studied by Darwin, the minds of monkeys have been shaped by natural selection—in particular, by natural selection acting in a social environment.

Baboons and vervet monkeys live in societies where reproduc-

tive success depends on social skills. To survive and reproduce, a male must live a long life, maintain high dominance rank, establish close (albeit temporary) bonds with females, and protect the infants he has fathered. Among males, longevity and lifetime rank appear to be the best predictors of reproductive success, and fundamental to a male's lifetime rank is his ability to deal with other males. During their lives, males experience the greatest stress from predation and challenges to their status.

To achieve the same goals, a female must live a long life, raise healthy infants, protect them from infanticide, and maintain an extensive network of related and unrelated companions. Among females, longevity and infant survival are the best predictors of reproductive success, and the best predictor of infant survival is the extent of a female's social integration. During their lives, females experience the greatest stress from predation, especially when it involves the loss of a close companion, challenges to their infants from infanticidal males, and challenges to their family's status. When faced with the loss of a close companion, a female can alleviate stress by broadening and extending her social network; when her infant is threatened with infanticide she can alleviate stress through friendship with an adult male; and when confronted with a challenge to her family's dominance rank, she can maintain her status through close bonds with kin.

Natural selection has favored in these monkeys a mind that is specialized for observing social life, computing social relations, and predicting other animals' behavior. When a female hears another female's vocalization, she does not just hear a sound. She perceives a signal that evokes a representation of the caller, what she is doing, her rank, and family membership. Baboons and vervets seem compelled to respond this way. Just as we cannot hear a word without thinking about its meaning, so baboons cannot hear a vocalization without thinking about the animal who is calling and the events the call describes. And they cannot hear an exchange of vocalizations between, say, Sylvia and Hannah (the names of two of our baboon subjects) without thinking about these animals' identities, ranks, and family membership, about

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their relationship, and about its place in the social order. When baboons hear Sylvia, Hannah, or any other animals interacting, they respond instantly, and as far as we can tell, unconsciously. They have a social mind that is innately computational and judgmental.

Suggested Reading

[1] ***How Monkeys See the World*, Dorothy L. Cheney and Robert M. Seyfarth, University of Chicago Press, 1990.**

[2] ***Baboon Metaphysics*, Dorothy L. Cheney and Robert M. Seyfarth, University of Chicago Press, 2007.**

[3] ***The Social Origins of Language*, Robert M. Seyfarth and Dorothy L. Cheney, Princeton University Press, 2018.**

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