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EUGENE GARFIELD

INSTITUTE FOR SCIENTIFIC INFORMATION®
3501 MARKET ST., PHILADELPHIA, PA 19104

When the Apes Speak, Linguists Listen. Part 1. The Ape Language Studies

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"Come open," "Hurry drink milk," "You chase me," and "Please machine give milk" are all parts of conversations between humans and apes. Since the late 1960s psychologists and anthropologists have launched intensive projects to teach great apes—such as the chimpanzee, gorilla, and orangutan—a form of communication that is comparable to human language. The apes are large tailless primates that are classified just below humans in the evolutionary tree. Research on "animal linguistics" and the different approaches to it have resulted in debate among the ape language researchers and among linguists as to the definition and uniqueness of human language. This first part of a two-part essay focuses on the ape language projects. Part 2 will discuss the controversies surrounding them.

The earliest language experiments were attempts to teach spoken language to young home-raised apes. These attempts failed for many reasons. According to Winthrop N. Kellogg, professor emeritus of experimental psychology, Florida State University, Tallahassee, when the home-raised chimpanzee is exposed to the same linguistic and social environment as a human child, the ape displays little evidence of the vocal imitation common in children.¹ The long period of babbling and prattling that human babies undergo seems to be a prerequisite for subsequent articulation of words.

Fred C.C. Peng, professor of linguistics, International Christian University,

Tokyo, noted that apes do not lack the intelligence needed for language. Rather, the most significant difference is between the human and chimpanzee vocal tracts.² Philip Lieberman, Department of Linguistics, Brown University, Providence, Rhode Island, reported differences in the structure of the oral cavity and less tongue mobility in chimpanzees compared to humans.³ In the chimpanzee, the tongue is longer and narrower than the human tongue. The placement of the chimpanzee's tongue and its maneuverability within the oral cavity prevent the chimpanzee from producing the full range of vowel sounds necessary for human speech.

Of the early efforts to teach spoken language to a chimpanzee, the project carried out in the 1950s by Keith J. Hayes and Catherine Hayes, then of the Yerkes Laboratory of Primate Biology, Orange Park, Florida, was the only one to achieve even an approximation of oral language. The Hayeses raised their chimpanzee, Vicki, in a home environment similar to the setting in which human parents raise their children. However, Vicki never articulated more than three or four words—"Mama," "Papa," "Cup," and something that sounded like "Up." And these were learned with great difficulty, over a six-year period, with the Hayeses shaping Vicki's mouth in some instances so she could articulate the sounds.⁴

The ape language studies and the ensuing controversies really began in 1969 when R. Allen Gardner and Beatrix T.

Gardner, Department of Psychology, University of Nevada, Reno, introduced Washoe—the first language-trained chimpanzee—to the world.⁵ In 1966 the Gardners acquired Washoe, a 10 month-old female chimpanzee born in the wild. Based on their observations of spontaneous gestures used by chimpanzees and of the proclivity chimpanzees show for imitation, the Gardners decided to teach Washoe a gestural form of language, American Sign Language (ASL), rather than spoken language. ASL is a sign language that is used by deaf people in North America. It consists of a set of manual configurations and gestures that correspond to particular words or concepts and has its own grammatical structure.⁶

Although Washoe lived in a trailer in the Gardners' backyard, she was raised in a social environment "similar" to that of a human child except that ASL was the only means of communication. No spoken language was allowed in Washoe's presence. ASL training took place in the context of Washoe's daily activities. Assisted by Roger S. Fouts, then a graduate student in their laboratory, and other assistants, the Gardners taught Washoe sign language by molding her hands into the proper ASL shape, a method they found more practical than waiting for Washoe to spontaneously produce the sign made by the trainer.⁷ At the same time, Washoe was shown the actual item represented by the ASL word. They repeated this procedure until Washoe made the sign spontaneously. Later, she learned signs by observing and imitating. As a criterion for determining that a sign was indeed a part of Washoe's vocabulary, the Gardners required that she use it appropriately and spontaneously each day for 15 consecutive days. After 14 months of training, Washoe knew and used 13 signs. By the end of the third year, Washoe's vocabulary had increased to 85 signs.⁸

To test Washoe's vocabulary, the Gardners devised a double-blind experiment in which Washoe was seated be-

fore a box that the trainer opened to reveal the picture of an object projected on a screen. The trainer asked Washoe the name of the object, and two observers who did not know which object was shown on the screen recorded her response. The Gardners reported about 90 percent agreement between the observers,⁹ and that Washoe identified 70 to 80 percent of the items correctly.¹⁰ However, even when Washoe made an error, she generally identified the item as something in the same category as the pictorial representation. For example, an animal picture was often identified as another animal.

These vocabulary tests served several purposes. One was to show that the chimpanzee can use sign language to communicate information. Another objective was to show that the chimpanzee could use signs to refer to natural-language categories. For example, they wanted to show that the chimpanzee could use the ASL sign for "dog" to identify pictures of dogs. According to the Gardners both objectives were accomplished with Washoe and with other chimpanzees in their later studies.¹⁰

Ten months after the project began, when Washoe knew approximately eight signs, she began to combine two or more signs. Washoe was then between 18 and 24 months old, which is close to the age when children begin to use two-word combinations. These combinations allowed her to amplify the meaning of the single-sign utterances. As an example, the Gardners noted that Washoe signed "Listen dog" when she heard an unseen dog barking.⁵

The Gardners maintained diaries of Washoe's use of language to establish a record of the signs, the context of their use, and interchanges between the trainers and the chimpanzee. These recordings, made by a skilled observer transcribing Washoe's signs into English words, also provided a diary of her use of signs in combinations so they could be compared with records of human children.

The Gardners reported that the phrases Washoe used were appropriate to her referent. For example, Washoe referred to soft drink as "Sweet drink." The Gardners noted that she used sign language for requests, and she answered questions about objects and events. And Washoe initiated many of these conversations with questions and statements of her own. At the end of the 51-month period during which the Gardners worked with Washoe, the chimpanzee correctly used a total of 132 signs.¹¹

The Gardners' work with Washoe ended in 1970. However, this was not the end of Washoe's language training or of the Gardners' involvement with signing apes. Washoe was moved to the primate center at the University of Oklahoma in Norman, where Fouts continued her language training. The Gardners' work with Washoe demonstrated that ASL can be a suitable means of communication for the great apes and that chimpanzees are capable of performing and comprehending certain language operations.

In the next several years, the Gardners extended their work to include four other chimpanzees—Moja, Pili, Tatu, and Dar. To make a more valid comparison between language acquisition in children and chimpanzees, language training for these animals began in early infancy. One significant difference between this second project and Project Washoe is that the ASL teachers for this group were all fluent ASL signers. Both Moja and Pili began to make recognizable ASL signs when they were about three months old.¹² Although this may seem early for language development, parental reports indicate that it is not dramatically different from the age at which deaf children produce their first signs. Hilde S. Schlesinger, Center on Deafness, University of California, San Francisco, and Kathryn P. Meadow, Gallaudet Research Institute, Gallaudet College, Washington, DC, cited a parental report of a deaf infant signing for milk at around five months of age.¹³ In fact,

the Gardners reported that at this young age, the chimpanzees used signs with variation in form and in appropriate variations in a basic context.^{10,14} An example is Pili's use of the sign "More" when his water bottle was taken away or after the trainer stopped playing with him.

These chimpanzees, like Washoe, were able to extend the use of signs they learned for a few items, such as flower or cat, to include all flowers and cats. The chimpanzees seemed to divide the world into conceptual categories just as humans do. For example, the Gardners reported that Moja, on seeing a large cut of fresh beef on the kitchen table, signed "Meat." Moja had not been taught to include both fresh and cooked meat in the meat category. The transfer from cooked to raw was spontaneous.¹⁰

The Gardners were interested in the ability of the chimpanzee to respond to questions, because there is extensive data on this developmental aspect of child language. Children generally are able to respond to "What," "Where," and "Who" questions by the age of 21 months. With the new group of young chimpanzees, this aspect of language development could be studied. The Gardners found that Pili and Tatu responded with the appropriate sign to questions containing "What" and "Where" at 18 months of age. Between ages two and three years, Moja and Tatu responded with proper names and pronouns to "Who" questions.¹²

Ape language researchers wondered whether a young chimpanzee could learn ASL from its mother, as human children learn language from their mothers. At Central Washington University, Ellensburg, Fouts and colleagues studied the transfer of ASL skills between the Gardners' chimpanzee Washoe and Washoe's adopted child, Loulis. When this project began, Washoe was 15 years old and her vocabulary consisted of 180 signs. After eight days with Washoe, Loulis was observed to produce his first ASL sign. The sign was the name for one

of his human caretakers. Fouts and colleagues expected Loulis to acquire ASL from Washoe by imitation. However, they report evidence that she actively taught Loulis the sign for "Eat/food." "Washoe stopped signing and took Loulis's hand in hers and molded it into the *food sign* configuration and touched it to his mouth several times." The fact that none of the humans had used ASL in Loulis's presence supports the argument that Washoe was his only teacher. At a little over two years of age, Loulis had a vocabulary of 17 signs.¹⁵

Around the same time the Gardners began working with Washoe, another ape language project was under way at the Psychology Department, University of California, Santa Barbara. David Premack, now at the University of Pennsylvania, Philadelphia, taught his chimpanzee, Sarah, a language based on plastic shapes symbolic of words.¹⁶ Each "word" had a unique color and shape. For example, an apple was represented by a small blue triangle. These plastic shapes were backed with metal and used on a magnetic slate. Premack equated the act of placing the plastic word on the board with writing.

Premack began working with Sarah when she was over 5 years old. Her training required that she learn to associate the plastic symbol with the object it represented. Although Premack reports that Sarah was able to do this with an accuracy of over 80 percent, he does not indicate the length of training required to achieve this goal. The initial vocabulary of object names was extended to include words for action. Sarah ultimately learned to arrange the shapes on the board to create sentences. She also learned to follow rules of word order in her sentence construction that suggested a mastery of elementary syntax.¹⁶

Today, Premack's work with chimpanzees no longer focuses on language, but rather on general cognition. Since language is not only a tool for communication, but also a tool for thinking, Premack believes his language-trained

chimpanzees are better able to solve certain types of problems than his chimpanzees who have not received language training. In a 1983 article in *Behavioral and Brain Sciences*, a journal that also publishes peer review commentary, Premack noted that language training enhances the chimpanzee's ability to solve problems involving abstract judgment, such as analogical reasoning. Spatial abilities, such as the location of items in space, are not improved by language training.¹⁷

In 1972, a chimpanzee named Lana, at the Yerkes Regional Primate Research Center, Atlanta, Georgia, learned to communicate by using a computer and a "language" her trainers called "Yerkish." The original Yerkes Primate Center, located in Orange Park, Florida, was founded by comparative psychologist Robert Yerkes in 1929; in 1961, it became part of the National Institutes of Health Primate Research Centers Program and moved to Emory University in Atlanta. At Yerkes, Lana's specially designed computer keyboard, mounted on the wall of her enclosure, initially contained 25 word keys. Each key was marked with a unique symbol to distinguish it from the others and when Lana pressed the key it lit up to indicate that it had been pressed. All of Lana's language interactions were recorded by the computer. The trainers' responses to Lana appeared on a separate "receive" display situated above her keyboard.

Psychologists Duane M. Rumbaugh and Timothy V. Gill, Georgia State University, Atlanta, along with my dear friend Ernst C. von Glasersfeld, Department of Psychology, University of Georgia, Athens, found that after six months of training, Lana was able to read the beginnings of familiar sentences and appropriately complete them.¹⁸ Like Sarah, Lana was also required to follow basic rules of Yerkish grammar.¹⁹ She communicated by selecting the appropriate words and pressing the keys serially as in a sentence, in appropriate word order. Lana used her computer to

request food and answer simple questions.¹⁸ A little over two and one-half years after the computer language project began, Lana had a vocabulary of 80 words.²⁰

Rumbaugh and his graduate student, Gill, observed that, once Lana understood the basic concept of naming, she began to spontaneously request the names of objects for which she had no name. Or, like Washoe with ASL, she invented her own names by combining the symbols on her keyboard.²¹

The LANA Project was extended to study language-like communication between two young chimpanzees using Yerkish. E. Sue Savage-Rumbaugh and colleagues, also of the Yerkes Center in Atlanta, taught two young chimpanzees, Sherman and Austin, the meaning of computer-key symbols for individual food items and to request the food by pressing the appropriate keys.²² The two chimpanzees spontaneously requested and received specific food items from one another, indicating that they were able to exchange information by using the computer symbols.

An important question in ape language studies is whether the animals understand the meaning of their symbolic communication or whether they learn contextually appropriate usage. Savage-Rumbaugh tested this by putting food in containers that required tools to be opened. One animal had the tool kit and the other the food container.^{23,24} In order to gain access to the food, the chimpanzee had to correctly identify the necessary tool and request it from the other animal. Sherman and Austin were able to do this with an accuracy of about 90 percent.²⁴ According to Savage-Rumbaugh and colleagues, these experiments demonstrate that the apes are learning the basics of language and not just responding to stimuli; that is, the chimpanzees have a mental image of the object represented by the symbol.²³

Savage-Rumbaugh and colleagues found large differences in the communicative abilities of two species of chim-

panzee. Unlike common chimpanzees that require extensive training to acquire language skills, their pygmy chimpanzee, Kanzi, learned to use Yerkish with no direct instruction.²⁵ As an infant, Kanzi played in the laboratory while the researchers taught his mother the Yerkish system of symbolic communication. At two and one-half years of age Kanzi spontaneously began using several symbols correctly. Six months later he was using nearly 30 symbols appropriately and demonstrated an ability to understand their symbolic meaning. However, the most profound difference the researchers found between the two chimpanzee species was Kanzi's ability to understand spoken English, a skill that seems to elude Sherman and Austin.²⁵

Another study, using a computerized method similar to that used in the Yerkes projects, examined mathematical abilities in the chimpanzee. Tetsuro Matsuzawa, Department of Psychology, Primate Research Institute, Kyoto University, Inuyama, Japan, found that the chimpanzee was able to identify arabic numbers by selecting the numeral on the keyboard corresponding to the number of objects displayed. The chimpanzee Ai was also able to correctly identify the object's color and category label, such as "Dog" for all dogs.²⁶

The Gardners' ASL studies with Washoe have been extended to include other great apes. For her doctoral dissertation, developmental psychologist Francine G. Patterson, then of Stanford University, began working with the young female gorilla Koko. Patterson showed that chimpanzees are not unique in their ability to use a human form of communication. Koko was one year old when Patterson began ASL training, using techniques similar to those described by the Gardners.^{27,28} Patterson established two criteria for a sign to be considered part of Koko's vocabulary: a) it must be recorded by two independent observers, and b) it must be used spontaneously and appropriately on at least half the days of a given month.²⁷ After three

years of training, Koko's vocabulary consisted of 127 signs.²⁸ (p. 87) When she was between five and six, Koko's vocabulary consisted of 246 words.²⁹

Like the ASL-trained chimpanzees, Koko also used signs in combinations. For example, Patterson reported that at about 14 months of age, the gorilla signed "Gimme food" in response to a drink held out of her reach.²⁷ In a *National Geographic* article, Patterson noted that, compared to the ASL-trained chimpanzees, the gorilla is calmer and more deliberate. "Koko seems to resort to the sign language more often to express herself, and she discusses a wider range of activities."³⁰

One of the hallmarks of human language is displacement, or the ability to refer to past emotional states or events.³⁰ Patterson claimed that Koko is able to refer to past experiences without actually experiencing them at the moment. As an example, Patterson queried the gorilla about a biting incident that had occurred the day before. When asked, "What did you do to Penny?" Koko responded, "Bite."³⁰ This ability has also been found in the chimpanzee.¹⁶

Patterson also has trained a male gorilla named Michael in ASL. Koko and Michael are able to communicate with each other in sign language. However, Patterson noted that Koko signs to Michael more frequently than Michael signs to her. In fact, there is evidence that Michael learned some of his sign language from Koko.²⁸ (p. 175) Researchers at the Gorilla Foundation, Woodside, California, founded by Patterson in 1977 to support her work, hope that eventually Koko and Michael will produce a young gorilla and teach it ASL as Washoe did with Loulis.

Another ape language project is being carried out by anthropologist H. Lyn Miles, University of Tennessee, Chattanooga, with a seven and one-half year-old orangutan named Chantek.^{31,32} The

orangutan is an interesting subject for language training since anatomic evidence indicates that the orangutan brain is more asymmetric, and therefore more like the human brain, than the brains of the other great apes. Marjorie LeMay, Department of Radiology, Massachusetts General Hospital, Boston, and the late Norman Geschwind, Harvard Neurological Unit, Boston City Hospital, studied this problem. They found that indirect measures of the planum temporale, a left-hemisphere language area in the human brain, indicate that the left side is significantly larger than the corresponding right-hemisphere area in the orangutan. Although there is a degree of asymmetry in the chimpanzee and gorilla, it is most pronounced in the orangutan.³³ A larger left hemisphere in the human brain is associated with left-hemisphere specialization for language.

Miles reported that Chantek first signed after one month of training, and that his sign-language acquisition was comparable with that of Koko and Washoe. Chantek's first sign was followed by a new, additional sign about every 25 days. He spontaneously produced two-sign combinations in the second month of training, and three-sign combinations in the tenth month. Miles suggested that Chantek initiates communication with his trainers at a higher rate than that reported for chimpanzees.³¹ In 1983 after three and one-half years of training with criteria for sign acquisition similar to those of Patterson, Miles reported that Chantek acquired a vocabulary of 56 signs. Today Chantek has a vocabulary of 125 signs.³² Miles noted that production of ASL signs by the orangutan is slower and more deliberate than that of the chimpanzee.³¹ Another interesting aspect of this research is the observed propensity of the orangutan to produce ASL signs with his feet. In his book on orangutan behavior, Terry L. Maple, School of Psychology, Georgia Institute of Technology, Atlanta, sug-

gested that this may be a reflection of the arboreal, or tree-dwelling, adaptations of the orangutan.³⁴

These ape language studies provide information on linguistic behavior as a measure of intelligence and provide a greater understanding of the continuity between human and nonhuman intelligence. However, ape language research raises more questions than it answers. The primary question concerning language-trained apes is whether they use language in the human sense. Another question focuses on the ape's awareness of the meanings of the words it uses. In 1976 Donald R. Griffin, Rockefeller University, New York, addressed the issue of animal awareness in his book *The Question of Animal Awareness*.³⁵ In addition, ape language studies have stimulated linguistic research into the essence of human language and the differences between it and the natural communication system of the great apes.

Original research on ape language studies is limited by the availability of research subjects and the special facilities required to house them. Consequently, the number of original research papers published on this subject is limited. Twenty-one articles, published between 1976 and 1984, were retrieved from the *Arts & Humanities Citation Index™* (A&HCI™). *SciSearch®* identified 43 articles published on ape or primate language studies from 1974 to 1984. *Social SciSearch®* identified another 122 articles on ape language studies published from 1972 to 1984. While these two databases reflect the somewhat arbitrary separation of the *Science Citation Index®* (SCI®) and the *Social Sciences Citation Index®* (SSCI®), this is not the case in our research fronts. They are derived from a combined SCI/SSCI file.

Based on citation analysis, only one distinct research front (#83-6410) dealing with ape language experiments was found—"Animal awareness, cognition and language in chimpanzees and other

species." It did not carry through to any 1984 research fronts. The four core papers that identified this research front were not heavily co-cited in 1984. These include the original ape language paper by the Gardners,⁵ Rumbaugh's book²¹ on the LANA Project, the book by Griffin,³⁵ and a paper by psychologists Herb S. Terrace, Columbia University, New York, L.A. Petitto, Harvard University, Cambridge, and R.J. Saunders and T.G. Bever, also at Columbia.

The paper by Terrace and colleagues describes Project Nim, an ape language study. From this study, the authors concluded that, while apes learn words, they do not produce new and original sentences.³⁶ This research convinced the Columbia group that the great apes do not use language in the human sense. Others also question the claims made by ape language researchers regarding the linguistic abilities of their research subjects. These criticisms, which raise questions about the methodology and interpretation of the ape language studies, will be discussed in the next part of this essay.

I would like to make a special point in thanking the numerous scientists who took the time to referee this essay. The nature of their criticisms, however, is perhaps the best indicator that animal linguistics is as yet a soft science. Norman W. Storer, then of the Social Science Research Council, New York, used the terms soft and hard science to differentiate the "social" from the natural sciences.³⁷ Perhaps the level of controversy in a field is one of the best indicators of softness.

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