Talking to Dogs
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Can dogs really understand words? Many dog owners believe that they can. In fact, you probably know someone who has resorted to spelling words (as in, should we take doggy for a W-A-L-K?) in order to deceive a four-legged friend.

Now, German scientists have conducted a novel study that seems to prove dog enthusiasts right. Julia Fischer and her colleagues Juliane Kaminski and Josep Call of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany tested the word comprehension skills of a border collie named Rico. They found that the savvy pooch was able to accurately fetch dozens of objects by name, and could even learn new words on the first try and remember them a month later (an ability called "fast mapping"). The research, reported in the June 11, 2004 issue of *Science*, adds another piece to a perplexing puzzle: how did the ability to communicate with language evolve in the human species?

Another Clever Hans?

Rico, a family-owned pet border collie born in 1994, was featured on a German variety game show called *Wetten, Dass...?* (which roughly translates as “Want to bet that...?”). On the show, Rico fetched toys and other playthings by name; his owners claimed that Rico had a “vocabulary” of over 200 words. Fischer and her colleagues were intrigued by the television performance, but they were also skeptical: was Rico nothing but another Clever Hans?

Just after the turn of the 20th century, a horse named Hans captured the imagination of the German public with displays of seemingly human-like intelligence. To the delight of Berlin circus audiences, and the bewilderment of scientists, Hans would apparently solve arithmetic problems and answer various questions by stamping his hoof on the ground. Hans was advertised as the "smartest animal in the world" until psychologist Oskar Pfungst, in a groundbreaking series of controlled experiments, showed that Hans's abilities were not miraculous at all. In fact, the horse was responding to subtle, unintentional cues from his trainer that signaled when to stop tapping out the "answer." When his trainer did not know the answer to a question, or was out of the horse's sight, Hans could no longer answer a single question correctly.

Pfungst published his classic work on the matter, *Clever Hans (The Horse of Mr. von Osten)*, in 1907. However, even modern scientists have been fooled by what is now called the "Clever Hans effect." One well-known example concerns a chimpanzee named Nim Chimpsky (a play on the name of prominent linguist Noam Chomsky). Nim and other trained primates aroused great public interest in the 1970s when it was claimed that they had learned American Sign Language, and that their use of signs showed characteristic properties of human language. Some scientists made strong statements

about the implications of their primate pupils' apparent linguistic skills. Francine Patterson, trainer of Koko the gorilla, even pronounced in a 1978 *Brain and Language* article that "language is no longer the exclusive domain of man."

Scientific interest in primate sign language training cooled considerably when Herbert Terrace, lead scientist on the Nim Chimpsky project, repudiated claims that Nim could use language. After an exhaustive review and analysis of videos showing Nim interacting with his human trainers, Terrace and his colleagues concluded that the chimpanzee had not in fact demonstrated any real linguistic abilities. Rather, they wrote in an article published in the November 23, 1979 issue of *Science*, "Most of Nim's utterances were prompted by his teacher's prior utterances." Instead of combining hand signs creatively in order to convey new information, the way humans do, Nim usually (at least 40% of the time) just imitated whatever signs his trainers happened to make in front of him. Like Hans before him, Nim actually was quite clever: he had learned to mimic a human interlocutor "in order to obtain some reward."

Fischer, Kaminski and Call did not want to fall into the Clever Hans trap, so they carefully designed a series of experiments to test Rico. In the first experiment, the researchers placed 10 of Rico's 200 familiar toys in a separate room. For each trial, Rico's owner instructed him to fetch a specific toy by name (for example, the *Weihnachtsmann*, German for a "Santa Claus" doll). Rico would then run into the adjacent room and select a toy without being able to see his owner or the scientists. This experimental design insured that no visual cues (unconscious or otherwise) would be available to influence the collie. Tested in this way, Rico was remarkably accurate: in a set of experimental trials, the dog was able to correctly retrieve 37 out of 40 toys requested by name. That means Rico was right 92.5% of the time, an impressive achievement for a border collie.

"Fast Mapping" and Word Learning

"Fast mapping" is a learning strategy that partially characterizes vocabulary acquisition during early childhood. Starting at around 2 years old, young children begin a process of rapid vocabulary acquisition. They learn most word meanings from passive exposure, without explicit instruction from caregivers or peers. The process peaks between the ages of about 6 to 10 years, when children are learning as many as 10 new words per day. This astonishingly fast learning rate allows normal English-speaking children to end up with a vocabulary of about 60,000 words by the time they graduate from high school (the precise figure depends on how words are defined).

One reason children are able to learn so many words with such great ease is that they do not come up with every possible hypothesis about the meaning of a new word. Rather, there appear to be innate constraints that limit the kinds of guesses a child will make about word meanings. Fast mapping is one of these constraints. Experimental and observational studies have shown that children know innately that "new words tend to refer to objects that do not already have names," explains Yale University psychologist and language acquisition specialist Paul Bloom in a *Science* piece that accompanied the Rico study. This allows children to learn the meanings of new words at an extremely

rapid pace, usually on the first attempt—hence the term fast mapping—and remember them later.

Scientists want to know if fast mapping is unique to human language acquisition, or if it is a general learning mechanism that is available to other animal species. So the next experiment was designed to determine if Rico could learn words by fast mapping—if he was able to "infer the referent of a new word by exclusion learning," as Fischer and colleagues wrote in their *Science* report. To test Rico's fast mapping abilities, the researchers placed 8 toys in the adjacent room; 7 of these were already known to Rico, but one was a toy the dog had never seen before. After one or two attempts at fetching the familiar toys, Rico was told to bring back the novel toy, referred to with a new word. On his first try, Rico correctly retrieved the new toy. In subsequent trials, he was right 7 out of 10 times, a 70% success rate.

"This tells us he can do simple logic," Fischer said to the *Seattle Times*. "It's like he's saying to himself, 'I know the others have names so this new word cannot refer to my familiar toys. It must refer to this new thing.' Or it goes the other way around and he's thinking, 'I've never seen this one before, so this must be it.' He's actually thinking."

The scientists wanted to know if, like human children, Rico would remember the words he had learned by fast mapping. They returned to Rico's house 4 weeks after the original experiments to administer a final test. This time the researchers placed 9 objects in the adjacent room: 4 were Rico's familiar toys, 4 were toys that he had never seen, and one was a toy that Rico had retrieved during the fast mapping test a month earlier. Again, the border collie warmed up with one or two requests to fetch familiar toys. Rico was then instructed to fetch the toy whose name he had apparently learned by fast mapping. Would Rico remember?

"If he hadn't remembered, we wouldn't have been surprised," Fisher told *BBC News Online*. "So when he came out of the room with the correct toy we were all stunned." Rico's performance was stunning indeed: he recalled, and retrieved, the right toy 50% of the time, in 3 out of 6 sessions. (In the other 3 sessions, Rico fetched one of the new toys; he never brought back a familiar toy in this experiment.) Fischer said, "What blew us away was that after a single exposure"—that is, after learning by fast mapping—"he was able to remember four weeks later, in half the cases". Children in fast mapping experiments have demonstrated a level of word retention only slightly better than Rico's. That makes him one smart dog, and it shows "that rapid word learning by toddlers is mediated by simple cognitive building blocks that are present in other species," as Fischer said to *Science News Online*.

What's in a word?

Do these experiments prove that a border collie is learning the same words as humans, in the same way that children do? Not exactly, some scientists say. "I think it's a gorgeous study," Yale's Bloom told the *Seattle Times*. "It's clever and impressive. But I'm skeptical about exactly what [Rico] has learned. I'm not sure I would call it a 'word.'"

In his *Science* commentary, published with the Rico study, Bloom discusses some of the substantial differences between children's acquisition of words and the abilities demonstrated by Rico. For one thing (as Fischer and colleagues also note in their report), Rico doesn't know a fraction of the number of words that a child of the same age does. Rico is 9 years old, with a vocabulary of around 200 words according to his owners. In contrast, a 9-year-old human child knows well over 20,000 words. (And a college-educated English-speaking adult may have a vocabulary of 100,000 words.)

Unlike Rico, children don't just know words for toys (although some might wish that were the case). A child knows words for all kinds of physical objects, not to mention words for actions, states and feelings. Words have a grammatical status: every word falls into one or more grammatical categories, such as nouns, verbs and adjectives. Children understand these categories, experiments and observations have proved. For example, when children are exposed to a nonsense word that is a noun ("the wug") they pluralize the new noun without error when prompted by experimenters ("the wugs"). Children even understand and use purely grammatical words that do not refer to anything in the world, such as articles like "the," conjunctions like "and" and prepositions like "of." Needless to say, Rico demonstrates no knowledge of grammar (and no animal ever has).

But the differences between dogs and children are not just quantitative, or grammatical. From the earliest stages of language acquisition, children know that words can be referential. That is, words can pick out objects, individuals or categories of things in the external world. So the word "sock", for example, "can be used to request a sock, or point out a sock, or comment on the absence of one," as Bloom writes in his commentary. But it is not clear from the experiments that Rico understands the referential nature of words. He demonstrates his comprehension of words only by performing the very specific doggy task of fetching toys for his owner. Moreover, Rico learns new words only in the context of this fetching game, and only when the request is spoken by his owners. Thus for Rico the border collie, "sock" only seems to mean something like "fetch-the-sock-for-master." That is qualitatively different from the way children learn, understand and use words.

Both Bloom and the authors of the Rico study acknowledge that further experiments are needed to determine whether Rico has really learned words in anything like the way humans understand them. "Can [Rico] learn a word for something other than a small fetchable object?" asks Bloom in his commentary. "Can he display knowledge of a word in some other way than fetching [or] can Rico follow an instruction *not* to fetch an item, just as one can tell a small child not to touch something?" Until such experiments provide "answers to these questions," Bloom writes, "it is too early to give up on the view that babies learn words and dogs do not."

Of course, there is also another important question: "Maybe this is the Albert Einstein of dogs. Or maybe this is something that other dogs can do, too," said Fischer to the *Seattle Times*. "We just don't know. We need to find out."

Rico and the evolution of language

Even if Rico hasn't really learned human words, what can scientists learn from this canine Einstein? A crucial question for researchers concerned with the evolutionary origins of human language is which aspects of language are unique to humans, and which are present in other species. Answering this question will help us understand how the ability to communicate using language arose in the human species, and why it did not evolve in other animal species.

Until the Rico experiments, Fischer explained to the *Seattle Times*, "Fast mapping was thought to be something exclusively human. It is how children learn the meanings of new words. Nobody thought this could be done by an animal." Rico's demonstrated ability to learn by fast mapping, she told *New Scientist*, "shows that fast mapping is not specific to humans, that it probably has a more general purpose in figuring things out in your world." Katrina Kelner, *Science*'s deputy editor for life sciences, sums it up: "Such fast, one-trial learning in dogs is remarkable. This ability suggests that the brain structures that support this kind of learning are not unique to humans, and may have formed the evolutionary basis of some of the advanced language abilities of humans."

Fischer and her colleagues believe that the auditory (hearing) and cognitive (thinking) skills necessary to associate sounds with meanings developed before the ability to speak. In their *Science* article, they write that "some of the perceptual and cognitive mechanisms that may mediate the comprehension of speech were already in place before early humans began to talk." This hypothesis fits in with other current research on animal communication and the evolution of language. For example, recent experiments with monkeys suggest that phrase structure grammar—the psychological "rules" that organize words into phrases and sentences—may be absent in primates, and may therefore have evolved later in humans. All such research contributes to a better understanding of the true communication and cognition abilities of animals, and how these may have formed the evolutionary precursors of human language.

If nothing else, the experiments with Rico the border collie "might signal the emergence of a vibrant area of comparative cognition research," writes Bloom in his commentary. "For psychologists, dogs may be the new chimpanzees."

Further Reading:

"Word Learning in a Domestic Dog: Evidence for 'Fast Mapping.'" Juliane Kaminski, Josep Call and Julia Fischer. *Science*, June 11, 2004, page 1682.

"Can a Dog Learn a Word?" Paul Bloom. *Science*, June 11, 2004, page 1605.

"Evidence Against a Dedicated System for Word Learning in Children." Lori Markson and Paul Bloom. *Nature*, February 27, 1997, page 813.

"Can an Ape Create a Sentence?" Herbert S. Terrace et al. *Science*, November 23, 1979, page 891.

Internet Resources:

"Clever Hans – Wikipedia." (en.wikipedia.org/wiki/Clever_Hans) An entry about Clever Hans in the free online encyclopedia, with links and references.

"Biological Psychology Links." (www.biopsychology.com) This companion site to the textbook *Biological Psychology* provides numerous searchable links to the latest science news about the biological basis of psychological processes in animals and humans.

"Linguistic Society of America – LSADC.ORG." (www.lsadc.org) Homepage of the Linguistic Society of America, contains information and other resources about linguistics, the scientific study of language.

KEYWORDS for electronic searches:

evolution of language, evolution of communication, animal communication, language acquisition, vocabulary acquisition, word learning, biology and psychology, cognitive science, syntax, Clever Hans, Nim Chimpsky, Rico the border collie