TIME IN PARTNERSHIP WITH CNN

Monday, Mar. 22, 1993

Can Animals Think?

By EUGENE LINDEN

In a sun-dappled pool not far from the clamor of Waikiki Beach, two female dolphins poke their heads out of the water, waiting for a command. "O.K.," says Louis Herman, founder and director of the Kewalo Basin Marine Mammal Laboratory, "now let's try a tandem creative." Two graduate students, positioned at opposite ends of the 50-ft. tank, throw full body and soul into communicating this message to the animals, Phoenix and Akeakamai. First the humans ask the dolphins to pay attention by holding a finger high in the air. Then they tap the index fingers of each hand together, forming the gesture that has been taught to mean tandem. Next they throw their arms up in an expansive gesture that signifies creative. The dolphins have just been told, "Do something creative together."

The dolphins break away from their trainers and submerge in the 6-ft.-deep water, where they can be seen circling until they begin to swim in tandem. Once they are in synch, the animals leap into the air and simultaneously spit out jets of water before plunging back into the pool. The trainers flash huge smiles at their flippered pupils and applaud wildly. The animals also seem delighted and squeak with pleasure.

What is going on here? Do the dolphins actually understand the command tandem creative as a request to make some joint artistic statement through movement? Did they communicate in some fashion to choose a routine and coordinate their movements? In order to spit, for instance, they both must take water into their mouths before they leap into the air -- a trick that takes some forethought. Other requests for tandem creatives have yielded a variety of results, including a synchronized backward swim culminating in a simultaneous wave of the tails. Or could it be that these routines are nothing more than one dolphin very closely following the lead of another? In the wild, after all, dolphins are extraordinarily skilled at tuning their actions to the movements of others in their group.

In cluttered quarters at the University of Arizona -- half lab, half toy- strewn nursery -- Alex, the voluble African gray parrot, is, as usual, commenting on all he sees. "Hot!" he warns in a sweet, childlike voice, as a visitor picks up a mug of tea. Alex spots a plateful of fruit and announces his choice: "Grape."

Everyone knows parrots can talk, but for the past 15 years, ethologist Irene Pepperberg has been working with Alex, exploring the degree to which the birds understand what they are saying. Pepperberg picks up an object from a crowded tray and inquires, "What toy?" Alex promptly answers, "Block." He then responds to questions about the plaything, describing its color, shape, what it is made of ("wood") and whether it is bigger or smaller than other objects on the tray.

Something less than true creativity may account for the dolphin flights of fancy seen at Kewalo Basin, but something more than simple mimicry seems to be at work in the case of this 1-lb. bird.

Alex also uses English to communicate what appears to be his feelings. After incorrectly answering how many rose-colored pieces of wool are mixed in with other objects on the tray, he says, "I'm sorry." A moment later the obviously frustrated bird says, "I'm gonna go away" and turns his feathered back on the offending tray. Does Alex know what he is saying, or is "I'm gonna go away" merely a collection of sounds he emits when frustrated?

Since antiquity, philosophers have argued that higher mental abilities -- in short, thinking and language -- are the great divide separating humans from other species. The lesser creatures, Rene Descartes contended in 1637, are little more than automatons, sleepwalking through life without a mote of self- awareness. The French thinker found it inconceivable that an animal might have the ability to "use words or signs, putting them together as we do." Charles Darwin delivered an unsettling blow to this doctrine a century ago when he asserted that humans were linked by common ancestry to the rest of the animal kingdom. Darwinism raised a series of tantalizing questions for future generations: If other vertebrates are similar to humans in blood and bone, should they not share other characteristics, including intelligence? More specifically, did the earliest humanlike creatures, who split from the ancestors they shared with apes between 5 million and 7 million years ago, already possess a primitive ability to form plans, manipulate symbols, plot mischief and express sentiments?

Even to raise these questions challenges humanity's belief that it occupies an exalted place in the universe. Moreover, scientists have historic reasons to be skeptical of claims concerning animal intelligence. At the turn of the century, a wonder horse named Clever Hans wowed Europeans with his apparent ability to solve math problems, expressing his answers by tapping a hoof. Dutch psychologist Oskar Pfungst ultimately showed that Hans was merely responding to inadvertent cues from his human handlers, who, for instance, would visibly relax when the horse had tapped the proper number of times. When blindfolded by Pfungst, Hans ceased to be so clever.

Not surprisingly, then, accounts of the first language experiments with apes in the 1970s produced one of the most fractious debates in the history of the behavioral sciences. Washoe the chimp and Koko the gorilla became famous for their linguistic feats using sign language, but scientists argued bitterly over the significance. Did the "speech" of these animals reflect a genuine ability to think symbolically and communicate thought, or was it largely the result of rote conditioning or of cuing -- a la Hans -- by trainers? Skepticism carried the day, and researchers who had dedicated their lives to working with the apes saw their work dismissed as a mere curiosity. So chilly was the climate that many young researchers left the field.

But the skepticism also served as a challenge. A number of scientists launched innovative probes of animal intelligence, while those who remained in language work designed careful experiments to meet the objections of critics. Their aim is to determine, as precisely as possible, what animals know and how well they can communicate it. The result is that animals are once again talking up a storm, as well as demonstrating other intellectual skills. Most scientists now take seriously the flood of new evidence suggesting that other species share with humans some higher mental abilities.

The Lessons of Kanzi

No animal has done more to renew interest in animal intelligence than a beguiling, bilingual bonobo named Kanzi, who has the grammatical abilities of a 2 1/2-year-old child and a taste for movies about cavemen. The 12-year-old pygmy chimpanzee lives with a colony of other apes in a cage complex on the wooded campus of the Georgia State University Language Research Center, near Atlanta. Under the tutelage of psychologist Sue Savage-Rumbaugh, he makes his desires known either by pointing to symbols printed on a laminated board or by punching the symbols on a special keyboard that then generates the words in English. While Kanzi cannot speak (apes lack the vocal control to form words), he understands spoken language.

In the time-honored fashion of ambitious young interns, Kanzi became involved in language experiments by catching the boss's eye. Savage-Rumbaugh noticed that the young ape was learning words she was struggling to teach his mother Matata. The language was a system of abstract visual symbols developed by Savage-Rumbaugh's husband Duane Rumbaugh during his first language experiments with chimpanzees. "If Kanzi could learn without instruction, I wondered, Why teach?" says Savage-Rumbaugh. From then on, Kanzi learned language much the way human children do: by going through the ordinary activities of his day while humans spoke in English and pointed to the appropriate lexigrams on the portable boards.

Kanzi soon began using the lexigrams as a means of communication, requesting games, treats and activities. Eventually he learned to combine two or more symbols to convey his desires. When, for instance, he wanted to watch a favorite movie, Quest for Fire, he would ask for "Fire TV" (Kanzi also adores Greystoke, a Tarzan movie).

Kanzi's most noteworthy achievement has been to demonstrate a grasp of grammatical concepts such as word order. Savage-Rumbaugh and psychologist Rose Sevcik created an extended experiment to compare the ape with a two-year-old girl named Alia in responding to commands expressed in 660 spoken English sentences. The sentences combined objects in ways that Kanzi and Alia were unlikely to have encountered before: "Put the melon in the potty," or "Go get the carrot that's in the microwave."

Through most of the experiment, Kanzi and Alia were neck and neck. At the end, however, Alia's language skills began to outpace the bonobo's, while Kanzi's grammatical comprehension topped out at the level of a 2 1/2-year-old. Though not impressive by human standards, even that toddler level implies vastly more sophisticated abilities than critics have acknowledged.

In truth, Kanzi's achievements are no greater than those claimed for Koko or other subjects in early language studies. His real significance is that scientists are more willing to accept the results as valid because of the tight controls used during the studies. For instance, a one-way mirror prevented Kanzi and Alia from seeing who gave them commands, while those tracking what the ape and toddler did in response wore earphones to prevent them from hearing the requests. Each sentence was also utterly new to both ape and child. The young bonobo has thus helped break a two-decade deadlock during which language experimentation with animals was paralyzed by concerns that the animals were responding to cues from their trainers rather than demonstrating true abstract abilities.

The Knowledge of Dolphins

It is not terribly surprising that apes, humanity's closest relatives, might possess some measure of smarts. But is it possible that more distantly related species might also have some capacity for symbolic communication? Herman offers a partial answer through his work with dolphins, animals whose ancestors diverged from other mammals' more than 45 million years ago.

Communication between humans and dolphins at Kewalo Basin occurs mostly through a gestural language that borrows some words from American Sign Language. The trainers make the gestures with big, enthusiastic arm movements, asking Phoenix or Akeakamai to follow such commands as "person left Frisbee fetch," which means "bring the Frisbee on the left to the person in the pool," or "surfboard person fetch," in which Akeakamai gently pushes a human volunteer over to the surfboard.

Such requests probe the dolphin's understanding of word order in ways somewhat analogous to the work with Kanzi. Herman insists that the dolphin's grammatical competence is at least as sophisticated as Kanzi's. Herman's group has also determined that dolphins can form a generalized concept about an object: they respond correctly to commands involving a hoop, no matter whether the hoop is round, octagonal or square. They also seem to retain a mental image of an object whether or not it is present in their environment. Thus they can accurately report whether a ball or hoop is in the pool (by touching their snouts to YES and NO paddles placed in the water).

The dolphins have a better attitude toward their schooling than many children. When correct, they squeak excitedly as they race back to the trainer. When wrong, they sag noticeably and look about as depressed as it is possible for these benign creatures to look. Herman notes that they are not above resorting to tricks familiar to every student, such as rushing over to another object after choosing the wrong one, or positioning themselves at some ambiguous midpoint between two choices with the apparent hope that the trainer will say "Right!" On occasion, when wrong, they will take their chagrin out on the object and beat a hoop or basket as though it were at fault.

But Do the Animals Really Understand?

Because of their big brains, genial smiles and noble foreheads, dolphins have long attracted human champions quite willing to credit the marine mammals with all sorts of higher mental abilities. To a hard-nosed scientist, however, the noble forehead is a housing for sonar gear, the upturned smile is an adaptation that makes it easier for the animal to scoop up fish, and it is open to question for what purposes the animal uses its large brain. Herman and others working with animals have been criticized for using linguistic terms like word or syntax when some cruder system may describe what is occurring in a dolphin's head.

Unfortunately, it is impossible to know precisely what goes on in another creature's mind and to what degree it understands the languages it uses. Take the case of the gorilla Koko, first taught 20 years ago to use American Sign Language by psychologist Penny Patterson. On one much discussed occasion, the powerful gorilla had inadvertently knocked a sink off its moorings in her living quarters. Koko signed the words "Kate there bad," pointing to the sink. Was the muscular animal trying, rather implausibly, to shift the blame to one of Patterson's slightly built female assistants? Or was she merely making signs vaguely associated with the event? Sixteen years later, there is still no definitive answer.

For his part, Herman admits that his dolphins are a long way from humans in their use of language. But he vehemently insists that they do have a conceptual grasp of the words they learn. "If you accept that semantics and syntax are core attributes of human language," says Herman, "then we have shown that the dolphins also account for these two features within the limits of this language."

Some scientists, particularly those from the behaviorist school of psychology, take a more skeptical view. What looks like language, they say, may be simply mimicry or rote learning. One of Herman's critics, animal behaviorist Ronald Schusterman, insists that before anyone can say an animal is speaking, they had better determine whether the beast is capable of the kind of abstract thinking that forms the basis of speech. "My argument is that the language experiments have moved too fast," says Schusterman. "They have not looked at some fundamental cognitive abilities that give rise to linguistic abilities." At Long Marine Laboratory in Santa Cruz, California, Schusterman has been trying to fill that gap.

Games of Logic with Sea Lions

Unlike the sunny-dispositioned dolphins, sea lions radiate intensity. Schusterman chose them for his research because they are easily trained. He did not attempt to teach seven-year-old Rio a language. Instead, he wanted to determine if the female sea lion could understand logical relationships between symbols presented on poster boards. For instance, by rewarding the sea lion selectively, trainers taught Rio that a symbol looking like a mug was equivalent to one that looked like a watch. Then she was taught that the watch symbol was equivalent to a third symbol that looked like a bomb. The question was whether she could make the jump to understanding that the mug was therefore equivalent to a bomb.

Schusterman devised an elaborate procedure to ensure against cuing: signals to Rio were delivered by a trainer who did not know the correct answer. Rio would start the test by choosing one of two randomly selected symbols on a scoreboard-like apparatus next to her tank. She would then be presented with two new icons and asked to pick which one was logically equivalent to the symbol she had chosen earlier.

Unlike dolphins, sea lions seem to treat training as if it were a life-or- death matter. At the start of each session Rio rivets her stare on her trainers. When wrong, she barks in frustration. But on one particular day she had little to complain about, answering correctly 24 out of 28 times. Schusterman takes this performance as proof that the animal has at least some of the cognitive skills required for language. Thus, he says, it is now much easier for him to accept that bigger-brained dolphins and apes understand and manipulate their vocabularies symbolically as well.

Words of Love from a Parrot

If the animal-language experiments had an awards dinner, the prize for best accent would go to the befeathered Alex. The parrot acquired his Midwestern accent from his mentor, Pepperberg. She became intrigued by the language work with great apes in the 1970s and decided to examine the abilities of an animal with an entirely different brain structure. She chose parrots in part because they can actually talk and because studies had established that the birds could perform as well as chimps on some psychological tests, suggesting that brain size is not the only determinant of mental ability.

Like Kanzi, Alex learned his vocabulary in a social setting, though the approach was more contrived. Pepperberg would, for instance, show a student a cork (one of Alex's favorite objects). If the student said the word cork, Pepperberg would give it to her; but when another word was used, the student would be scolded. Alex quickly got the drift of this game, and over the years has acquired more than 71 labels denoting objects, actions, colors, shapes and materials. Apart from answering several different questions about the same object, Alex also seems to understand quantity. Most impressively, he can look at an assortment of objects on a tray and say how many pieces of green wool or how many blue blocks lie amid the clutter.

At some level, Alex apparently understands language as a social interaction and uses it to maintain contact and get attention. "The way Alex uses English does not necessarily have all the aspects of language," says Pepperberg, "but it provides a two-way communication system that allows me to explore the way he thinks." At times his choice of words is touchingly apt, even if he uses phrases to get results rather than express emotion. When the parrot, who lives with Pepperberg, became sick a few years ago, she had to take him to a vet and leave him overnight in a strange place for the first time in his life. As she headed for the door she heard Alex calling in his plaintive child's voice, "Come here. I love you. I'm sorry. Wanna go back."

Why Did Intelligence Evolve, Anyway?

If animals indeed have the capacity to understand and manipulate symbols, the question then becomes why and when did they develop it. For answers, scientists have turned once again to chimps, who both in the wild and in captivity show the ability to formulate plans and make tools. Kanzi has been most helpful in this regard.

In an experiment supervised by Nicholas Toth of Indiana University, Kanzi watched as a favorite treat was placed inside a box. The box was then locked, and the key was placed inside another box tied up by a cord. It added up to a Houdini-like challenge for the chimp: how to get to the treat.

But inside his cage, Kanzi had the makings of a tool that could solve the riddle: some pieces of flint he had selected during an excursion to the countryside. No sweat! By slamming the flints against the concrete floor, the chimp created knifelike chips, which he used to cut the cord and free the key. He then used the key to open the other box and grab the treat.

Toth notes that in several runs through the experiment, Kanzi always used the chip to cut toward himself, an observation that might help Toth better understand the first tools of Homo habilis some

2 million years ago. "For a Stone Age archaeologist like myself, seeing this is almost like a religious experience," says Toth, whose university awarded Kanzi a prize for providing the most insight into the origins of technology.

Observations of apes in the wild provide further insights. In the Tai forest in the Ivory Coast, Swiss biologist Christophe Boesch points out a flat piece of granite with two small hollows on the top. The rock has marks from heavy use for some purpose. "If an anthropologist came upon this in the forest," says Boesch, "he might think he had found a human artifact." Instead, it is used by chimpanzees for nut cracking. The chimps place a panda nut in one of the depressions and then smash it with a smaller stone. Boesch has watched a mother chimp instruct her young in the art of nut cracking.

Still, toolmaking does not entirely explain why apes, humans and other animals developed big brains. Gorillas, orangutans and bonobos are roughly the intellectual peers of chimps but rarely resort to tool use. Nor does the need to build tools fully account for the enormous expansion of human brainpower during the past million years. As recently as 100,000 B.C., Homo sapiens were using only the crudest tools, even though their brains had already reached the present size -- large enough to put men on the moon, probe the basis of matter and tinker with the genetic code. Because big brains need a lot of high- calorie food and require large craniums, which makes childbirth difficult, scientists have looked for other evolutionary pressures to account for their development.

Machiavellian Chimps

The answer may be politics, which is hardly confined to human society. Scottish psychologists Richard Byrne and Andrew Whiten believe chimps are positively "Machiavellian" in their efforts to acquire power within a group. In the Mahale Mountains in Tanzania, for instance, Japanese primatologist Toshisada Nishida observed one male chimp shift his support between two more dominant males who needed his allegiance to maintain power. The bigger males curried favor with this artful manipulator by allowing him access to fertile females. When a ruler began to take him for granted, the canny old chimp would shift allegiance to the pretender, thus ensuring himself continual access to mates without fear of attack from his superiors.

In the complex game of social chess played by chimps and other primates, having the intellectual skills to anticipate a rival's moves and engage in deceit is a distinct advantage. Consider the double deception observed at a feeding station in Tanzania's Gombe Stream Reserve. A wild chimp had the luck to be alone next to a feeding box when it was opened by remote control. Noticing that another, more dominant chimp was approaching, the first one closed the box and moved nonchalantly away until the second chimp moved on. Once the interloper was gone, the first chimp opened the box to claim the food. The second chimp, however, had cleverly hidden himself just out of sight and triumphantly returned to snatch the bananas. There are enough examples of such ape trickery to suggest that perhaps Koko really was lying when she made the signs "Kate there bad."

Knowing Whom to Trust

A crucial question raised by such devious behavior is, To what degree does an animal actually understand what's in its rival's mind? If an animal knows when another creature is misinformed or has valuable knowledge, it gains an enormous advantage. In the late 1980s, a pioneer of animal-language work came up with an ingenious way of probing this question.

David Premack actually devised his simple test to study children. First, a child is shown a tableau in which a little girl named Sally puts a marble in her bag and then leaves the room. Before Sally returns, another girl, Ann, takes the marble from Sally's bag and puts it in a box. The child is then asked where Sally will look for the marble when she returns. Three-year-olds will point to the box, because that is where the marble is; but four-year-olds understand that Sally has the mistaken belief that the marble is still in her bag and that she will look for it there.

Psychologist Daniel Povinelli at the University of Southwestern Louisiana has conducted a number of experiments that adapt Premack's test for primates. In one version, chimpanzees had to choose which of two humans would be better at helping them find some hidden food. While the animals themselves could not see where the food was being hidden, they could observe that only one of the two humans had a full view of the process. When asked to choose a helper, the chimps overwhelmingly chose the human who knew where the food was hidden.

Just as four-year-olds have an insight that three-year-olds lack, chimps have an advantage over lesser primates. When Povinelli tried his experiment with rhesus macaques, the monkeys proved unable to distinguish between the human who knew where the food was and the one who didn't -- even after 600 attempts.

Psychologists concoct some absurd situations to plumb the depths of chimp insight. For instance, one experiment has the apes observe two handlers deliver cups of juice. One accidentally spills juice on the floor; the other overturns the cup deliberately. When asked to choose a handler to deliver their next cup of juice, chimps prefer the clumsy person, suggesting that they are aware they are better off with a klutz than with a helper with evil intent. Again, in analogous experiments capuchin monkeys appear to be less shrewd. The animals will, pitiably, continue to put their trust in a human helper who eats rather than delivers their food, even after he or she has stuffed himself 150 times with the monkeys' treats.

To Andrew Whiten, the striking difference between monkeys and chimps supports the notion that within primates there is a "mental Rubicon -- not the familiar one with humans on one side and everyone else on the other, but with man and at least the apes on the same side."

Even if some other creatures have crossed this mental Rubicon, human analytical abilities remain vastly superior to anything demonstrated elsewhere in the animal kingdom. In virtually all studies of animal intelligence and language skills, performance plummets as more elements are added to a task and as an animal has to remember these elements for long periods. By contrast, humans can call on vast working memory.

Many evolutionary scholars suspect that as ancient human groups became larger, the need to keep track of ever more complex social interactions was what really pushed the human brain toward superiority. Both dolphins and chimps have very complex interactions, but the intricacy of their social world pales beside the lattice of entanglements that characterized human society as early Homo sapiens banded together to gather food and defend themselves. In Somalia today, warring clans identify friend or foe by demanding that those accosted recite their ancestry going back many generations. It is easy to see how similar challenges in antiquity might have driven the development of brainpower.

It does not lessen the grandeur of the human intellect to argue that it evolved partly in response to social pressures or that these pressures also produced similar abilities in "lesser" creatures. Instead, the fact that nature may have broadly sown the seeds of consciousness suggests a world enlivened by many different minds. There may even be practical applications. Studies of animal cognition and language have yielded new approaches to communicating with handicapped and autistic children. Some scientists are pondering ways to turn intelligent animals like sea lions and dolphins into research assistants in marine studies or into lifeguards who can save the drowning upon command.

If the notion that animals might actually think poses a problem, it is an ethical one. The great philosophers, such as Descartes, used their belief that animals cannot think as a justification for arguing that they do not have moral rights. It is one thing to treat animals as mere resources if they are presumed to be little more than living robots, but it is entirely different if they are recognized as fellow sentient beings. Working out the moral implications makes a perfect puzzle for a large-brained, highly social species like our own.