



HUMAN EVOLUTION

Why We're Different: Probing the Gap Between Apes and Humans

Researchers at a high-level meeting probe the ancient question of what sets the human brain apart from that of other primates

GÖTTINGEN, GERMANY—We sometimes see apes and monkeys in the movies, but we never see them *at* the movies. Although non-human primates can do remarkable things—chimps have rudimentary cultures, and some monkeys have highly complex social systems—none shows the kind of creativity and innovation that are the hallmarks of *Homo sapiens*. Researchers have long puzzled about which human behaviors stem from our primate roots and which are unique to the hominid line.

Beginning in the 1960s, scientists focused on the similarities, as lab and field studies revealed that the cognitive talents of other primates had been underestimated. But during the past decade or so, researchers say, there has been renewed interest in the traits that set us apart. At a recent meeting* here, anthropologist Carel van Schaik of the University of Zurich, Switzerland, emphasized this evolutionary divergence. “Mind the gap!” he said in a keynote talk. “Humans have a huge number of [novel] characteristics.” Indeed, participants at the meeting, which was designed to compare and contrast humans and nonhuman primates, demon-

strated several of these seemingly unique human behaviors: advanced planning (the conference was months in the making), social organization and cooperation (everyone showed up at the same time and place), and culture and teaching through language.

At the conference, researchers heard evidence that many of these behaviors, such as planning, may have deep evolutionary roots. But some talents, such as cultural innovation, seem unique to our species, and others, including altruism, may represent a novel blend of old and new characteristics. The challenge now, says van Schaik, “is to figure out how one ape among many—humans—could become so radically different.”

The waiting game

“Genius,” said the 18th century French naturalist Buffon, “is only a great aptitude for patience.” To many researchers, our ability to trade immediate gratification for long-term rewards sets us apart from other, more impulsive animals. Without patience, activities from planting crops for later harvest to sending space probes to Mars would be impossible. But a talk at the meeting by behavioral ecologist Jeffrey Stevens of the Max Planck Institute for Human Development in Berlin suggests that patience has evolutionary roots

◀ **Watch me!** The ability of chimps to learn from each other may have been underestimated.

that predate the ape-human split—and that in some situations, humans may be even more impulsive than apes.

Most studies suggest that animals have a low tolerance for delayed gratification. When offered a choice between two food pellets immediately or six pellets later, pigeons will wait only about 3.5 seconds for the larger reward. Rats are only slightly less impulsive in similar tests, and even monkeys seem to live largely in the present: In a 2005 study, Stevens found that the patience of marmosets wore thin after 14 seconds. One notable exception is the scrub jay, which stores food for later use and probably represents a case of parallel evolution, says psychologist Nicola Clayton of the University of Cambridge in the U.K., who led the jay research (*Science*, 23 February 2007, p. 1074).

In new studies, Stevens and his co-workers measured how long our closest relatives, chimpanzees and bonobos, would play the waiting game. The apes were placed in an apparatus designed to give them a choice between two grape halves immediately or six grape halves later. (Trial runs taught the apes that the larger food amounts arrived after a delay.) Bonobos accepted a delay of about 74 seconds, whereas chimpanzees sweated out a full 2 minutes to get the larger reward—although they did a lot of fidgeting and head-scratching while they waited.

The experiment shows that a capacity for delayed gratification was already present in the common ancestor of humans and apes, says Stevens. “The ability to restrain impulsiveness would certainly seem to be a prerequisite for the sort of planning we see in many human activities,” agrees primatologist Dorothy Cheney of the University of Pennsylvania.

Stevens also tried to directly compare humans and chimps in a similar experiment. To his surprise, humans (who were eating raisins, M&M candies, or popcorn) caved much more quickly than apes: About 72% of the chimps waited the 2 minutes for a bigger share, whereas only 19% of the humans did so. But given humans’ ability to buy groceries for the week, van Schaik suspects that “people did not really take the experiments as seriously as the chimps.”

This cricket’s on me

Although chimpanzees may be surprisingly patient, they fail miserably at another typically human behavior: lending a spontaneous helping hand to one’s neighbor without

* Primate Behavior and Human Universals, Göttingen, Germany, 11–14 December 2007.

expecting anything in return. Such altruism is very common among humans, some of whom even sacrifice their own lives to help others. Yet recent work by anthropologist Joan Silk of the University of California, Los Angeles (UCLA) and Michael Tomasello of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, has shown that chimps, although remarkably cooperative in many ways, do not spontaneously help fellow apes. Other work has found that most nonhuman primate cooperation involves self-interested reciprocal exchanges. Many scientists have concluded that true altruism requires higher cognition, including an ability to read others' mental states, called theory of mind (*Science*, 23 June 2006, p. 1734).

Yet humans may not be the only altruistic primates. A team led by Judith Burkart of the University of Zurich, which included van Schaik, looked for helping behavior in marmosets, who lack advanced cognition but are highly cooperative. One monkey, the donor, was given a choice of pulling a tray with a bowl that contained a juicy cricket or pulling a tray with an empty bowl into an area where another monkey was sometimes present. Only the recipient could get the food, with no payoff for the donor. Nevertheless, the donor pulled the cricket tray an average of 20% more often when a recipient was present than when it was absent, Burkart said at the meeting. Moreover, the marmosets were about equally generous to genetically unrelated monkeys as they were to their kin.

Why do marmosets and humans engage in spontaneous altruism when other primates do not? The answer, Burkart proposed, is that both species, unique among primates, are cooperative breeders: Offspring are cared for not only by parents but also by other adults. Marmoset groups consist of a breeding pair plus an assortment of other helpers, whereas human parents often get help from grandparents, siblings, and friends. Burkart suggests that primate altruism sprang from cooperative breeding. In humans, these altruistic tendencies, combined with more advanced cognition, then nurtured the evolution of theory of mind.

"This is an excellent piece of work," says Silk, although she cautions against drawing sweeping conclusions about the evolution of human altruism from "just two data points," humans and marmosets. Nevertheless, Tomasello says, if the results are valid, they "demonstrate that generosity with food and complex cognitive skills are independent adaptations, which humans may have combined in unique ways."

Cultural ratchet

Researchers agree that cultural innovation is one arena in which humans stand alone. Chimps and other primates do show signs of rudimentary culture, such as different traditions in the use of tools to crack nuts (*Science*, 25 June 1999, p. 2070). But the highly complex cultures produced by human societies are unique to our species. What accounts for this cultural gap?

Some scientists, including Tomasello and UCLA anthropologist Robert Boyd, who both attended the meeting, have argued that other primates are poor at imitating others and learning from them. Humans, in contrast, are such good imitators that they accumulate culture and knowledge over generations, a "ratcheting" effect that bootstraps the slow pace of biological evolution with a powerful dose of cultural evolution.



Beyond the family. Did cooperative breeding help make both marmosets and humans altruistic?

Yet studies led by psychologist Andrew Whiten of the University of St. Andrews in Fife, U.K., have found that chimps' ability to imitate might be underrated. Some of these experiments have employed a special food dispenser that can be operated both by poking a stick into it and by using the stick to lift a lever. When chimps who had learned one or the other technique from humans were reintroduced to their peers, the other animals quickly learned to follow their example (*Science*, 26 August 2005, p. 1311). But Tomasello suspected that the chimps might be emulating the motion of the dispenser rather than imitating another chimp.

In new work reported at the meeting, Whiten and his co-workers claim to have ruled out that possibility. They tied a length of fishing line to a lever so that they could surreptitiously pull it to deliver a grape. Yet when 12 chimps were exposed to this "ghost"

apparatus, none learned to pull the lever themselves. The team concluded that chimps could only learn to use the machine if taught by another chimp or a human—through social learning or imitation.

"A decade ago, people were doubting" that social learning took place in nonhuman primates, says Joanna Bryson, a cognition researcher at the University of Bath, U.K. "Since then, Whiten has ... prove[d] beyond a doubt that it occurs."

Whiten said at the meeting that these results suggest that imitation was in place long before cultural ratcheting and imply a somewhat different model for cultural evolution from that of Tomasello and Boyd. The element that kept chimps and possibly early hominids from complex culture might have been a poor ability to innovate, he suggested. For example, early humans made Acheulean

hand axes in the same basic form for hundreds of thousands of years.

Van Schaik agrees with this logic: "It might be that apes ... fail to produce anything that goes beyond what they already have." And Tomasello now says his earlier views require modification. "[Whiten's results] demonstrate that chimpanzee social learning is more powerful than I previously thought," he says.

Indeed, for some researchers at the meeting, talks such as Whiten's suggested that the evolutionary gap between humans and other primates might not be insurmountable. "We are just primates with a particular combination of traits," says Bryson. "Seeing how all those traits came together and exploded into our current culture is really interesting. It makes you wonder whether it might happen soon for another species, given a chance."

—MICHAEL BALTER