VANESSA WOODS,

author of It's Every Monkey for Themselves, *is an award-winning journalist. She has a double degree in biology and English from the University of New South Wales and received a master's degree in science communication from the Centre for the Public Awareness of Science at the Australian National University in 2004. She is a researcher with the Hominoid Psychology Research Group and studies the psychology of bonobos and chimpanzees in Africa.*

BRIAN HARE

is an anthropologist and an assistant professor in the Department of Biological Anthropology and Anatomy at Duke University. He studied anthropology, psychology, and human and natural ecology at Emory University and received his Ph.D. from Harvard University in 2004. His research centers on human cognitive evolution, and his experience in the field includes working on a fox farm in Siberia, chasing chimpanzees through the jungle of Uganda, and helping orphaned bonobos in the Democratic Republic of the Congo.

OUT OF OUR MINDS

How Did *Homo sapiens* Come Down from the Trees, and Why Did No One Follow?

VANESSA WOODS AND BRIAN HARE

Mikeno sits with his chin resting on his right hand, in a startling imitation of Rodin's *Thinker.* His left arm is thrown over his knee, and his eyes are slightly out of focus, as though he's deep in thought. With his black hair parted carefully down the middle and his rosy pink lips, Mikeno looks human. But he isn't. Mikeno is a bonobo—an inhabitant of Lola ya Bonobo, one of a number of African sanctuaries for apes orphaned by the bushmeat trade, this one in the Democratic Republic of the Congo.

Bonobos share more DNA (98.7 percent) with us than they do with gorillas—enough so that under his glossy black hair Mikeno has the body of a young athlete, complete with chiseled biceps and a developing six-pack. The question is: where among the three billion nucleotides of his genome is the 1.3 percent that makes Mikeno a bonobo instead of a human?

We have been seeking to define our humanity for thousands of years. Plato described a human being as a featherless creature that walks on two legs; in response, Diogenes turned up at one of Plato's lectures holding a plucked chicken. Other definitions have come and gone: Only humans use tools. Only humans intentionally murder one another. Only humans have souls. Like mirages in the desert, the definitions are always shifting.

In the six million years since hominids split from the evolutionary ancestor we share with chimpanzees and bonobos, something happened to our brains that allowed us to become master cooperators, accumulate knowledge at a rapid rate, and manipulate tools to colonize almost every corner of the planet. In evolutionary time, our progress has been swift and ruthless. What allowed us to come down from the trees, and why?

Are You Thinking What I'm Thinking?

When children turn four, they start to wonder what other people are thinking. For instance, if you show a four-year-old a packet of gum and ask what's inside, she'll say, "Gum." You open the packet and show her that inside there's a pencil instead of gum. If you ask her what her mother, who's waiting outside, will think is in the packet once it's been reclosed, she'll say, "Gum," because she knows her mother hasn't seen the pencil. But children under the age of four will generally say their mother will think there's a pencil inside—because children this young cannot yet escape the pull of the real world. They think everyone knows what they know, because they cannot model someone else's mind and in this case realize that someone must see something in order to know it.

This ability to think about what others are thinking about is called having a theory of mind.

Humans constantly want to know what others are thinking: *Did he see me glance at him? Does that beautiful woman want to approach me? Does my boss know I was not at my desk?* A theory of mind allows for complex social behaviors, such as military strategies, and the formation of institutions, such as governments.

Throughout the 1990s, scientists ran dozens of pioneering experiments in an attempt to determine whether chimpanzees—who, like bonobos, share 98.7 percent of our DNA—possess a theory of mind. An experiment conducted by Daniel Povinelli of the University of Louisiana at Lafayette gave chimpanzees the choice of using a visual gesture to request food from someone who was blindfolded, someone with a bucket over his head, someone whose hands were over his eyes, or someone who could actually see them. The chimps didn't discriminate; they made the begging gesture at people who obviously couldn't see them just as often as they begged from people who were looking straight at them. If chimpanzees have no theory of mind, which this set of findings suggested, then that could be what distinguishes humans from other animals.

That was before Brian and two colleagues, Josep Call and Michael Tomasello, began working with Jahaga, a female chimpanzee at the Wolfgang Köhler Primate Research Center of the Leipzig Zoo. The experiment went like this: In a room at the center, you sit behind a Perspex panel with a tray extending from it that holds a banana. Jahaga sees the banana. She can also see you watching, and knows that if you see her coming, you'll pull in the tray, because you've already kept food from her like that. Instead of simply rushing for the banana, Jahaga casually walks to the back of the room, as though she didn't want your measly banana and was bored by the whole game. She continues along the back wall, slinking around a partition until she's out of sight. Then, when she knows the partition is blocking your view of her, she walks low and fast behind it and swipes the banana off the tray.

This was the first experiment to investigate whether chimpanzees will actively deceive another individual based on what that individual can or cannot see. Deception can be one important test of whether or not you possess a theory of mind, because, in many cases, in order to deceive someone you have to know what they're likely to be thinking and then try to manipulate the situation such that their thinking changes in your favor. Jahaga's behavior in this experiment—and later that of other chimpanzees—seemed deceptive, not just because she slinked to a place where she knew you couldn't see her (that is, she was sensitive to what you were thinking) but also because she seemed to be deceptive about being deceptive: she looked as though she were pretending not to be interested in the banana (that is, she may have been trying to manipulate what you thought about her intent).

After Jahaga, a whole range of experiments have shown that in a number of contexts chimpanzees do think about what others are thinking about. Low-ranking chimpanzees will always go for the food that's hidden from a dominant chimpanzee's view, because they know the dominant has not seen it. If you suddenly look up, a chimpanzee will follow your gaze, wondering what you've seen. If you delay giving chimpanzees food, either by teasing them or accidentally dropping it, they know when you're being intentionally mean, and they act more frustrated than they do when you're just being clumsy. But does this mean that chimpanzees have the same theory of mind that we do?

Point It Out

Even though Jahaga and other chimpanzees exhibit a sophisticated theory of mind on one level, on another level they're hopeless. If you hide a banana under one of two cups in such a way that Jahaga cannot see which cup you've chosen, and then you point to the cup where the banana is; Jahaga can't use your gesture to find it. You can tap on the cup, put a bright-colored block on it, maybe even dance around it, but Jahaga won't pick the correct cup any more often than she picks the wrong one. Dozens of trials later, she might start guessing the pattern, but if you change the cue from pointing to, say, tapping, she doesn't realize that the new cue will help her find the food. She has to learn to make use of your new gesture all over again.

However, human children under the age of two can use your pointing to find food. Even if you just *look* at the correct cup, children will follow your gaze and use it to gain information about what you know. They understand that you're trying to help them by communicating the location of the hidden goodie.

From these types of experiments with chimpanzees, it seems reasonable to conclude that using communicative gestures is something that evolved in our species after our lineage split from the other apes. Perhaps sharing information in this way enabled early humans to develop a much more complex form of culture than that seen in other animals. But if that's so, then how might such an ability have evolved in the first place?

Go Fetch

Oreo was the best dog any kid could wish for. He would take you to your friend's house and sit outside until it was time to ride your bike home again. He would let you give him as many hugs as you wanted when you were at an age when it wasn't cool to hug anyone except your dog. Most important, Oreo loved to play fetch. He would play fetch until your arm fell off, because he could easily carry three tennis balls in his mouth at once. The problem was, he usually couldn't keep up with where all the balls were going; after collecting the first two, he wouldn't have a clue where the third one had landed. After a few moments of frantic searching, he would race back to eye you, panting expectantly, waiting. If you pointed in the right direction, he would be back seconds later, with all three balls covered with slobber and ready for throwing again.

Anyone with a dog knows that when they want something and they know that you know where it is, they will watch your body language like a hawk for the slightest clue. Sure enough, when Brian and colleagues played the cup game with a myriad of dogs, they could point to, gaze at, or tap with a toe on the hiding place and the dogs would immediately find the hidden treat (and not because of their powerful noses—in these experiments, dogs cannot determine which cup hides the food without a visual cue).

Why does an animal like a dog succeed where our closest living relative fails?

One idea is that dogs live with us, so over thousands of hours of interacting with us, they learn to read our body language. Another idea is that the pack lifestyle and cooperative hunting of wolves, the canids from which all dogs evolved, made all canids, dogs included, more in tune with social cues.

To test the first idea, you need to play with puppies. If nine-week-old puppies pass the cup test, then perhaps reading human gestures isn't something dogs learn as they grow older but something they're born with. Brian and colleagues found that such puppies passed the test, but there was still the question of whether their first nine weeks had been enough to pick up human communicative gestures. So puppies reared in a kennel, with very little exposure to humans, were tested, too. The kennel puppies passed.

As for the second idea, you need to spend some time with the big bad wolves. When Brian and colleagues tested wolves at a wolf sanctuary and compared their accomplishments with those of a group of pet dogs, it became obvious that wolves were no better than chimpanzees at acting on human social cues. Thus it seems that dogs must have evolved to act on human social cues within the last forty thousand years—that is, since they split from their wolf ancestor through the process of being domesticated. The implications are exciting: a social skill that is an important developmental basis for human culture, cooperation, and language—a precursor and component of the human theory of mind—may have evolved in the dog as a result of interacting with us over many generations. Could it really be that domestication can lead to such a change in problem-solving abilities? So it would seem, but to test this idea you have to go to the middle of Siberia.

Clever Fox

The train ride from Moscow to Novosibirsk in summer is two days of green meadows filled with bright flowers. Once you get to Novosibirsk, you journey another half hour or so to Akademgorodok, the home of one of the greatest experiments in modern genetics.

Dmitri Belyaev was fired from a research laboratory in Moscow because his Mendelian view of genetics conflicted with that of Trofim Lysenko, the great Soviet scientist. Belyaev was lucky that his punishment ended with losing his Moscow job; under Stalin, dissent from Lysenko's theories of environmentally acquired inheritance was against the law, and many prominent scientists died in the Gulag. In 1958, Belyaev moved to Novosibirsk, where he became director of the Institute of Cytology and Genetics and, in the following year, began breeding 130 silver foxes in a kind of Mendelian experiment. He put one group under severe selection pressure using a simple method: those foxes that approached an experimenter lived to breed for another generation; those that snarled at humans or showed aggression toward them were turned into fur coats. The other group, a control, was bred randomly with regard to how they behaved toward humans.

After only forty generations, the selected foxes began to display changes you (and Darwin, too) might think would take millions of years to evolve. As expected, they became incredibly friendly toward humans. Whenever they saw people, they barked, wagged their tails, sniffed the people, and licked their faces. But even stranger were the physical changes, which occurred at a higher frequency than in the control group. The ears of the selected foxes became floppy. Their tails turned curly. Their coats lost their camouflage and became spotty, with a star pattern appearing on the forehead. Their skulls became smaller. In short, they looked and behaved remarkably like their close relative the domestic dog.

Now came the big test. If dogs had acquired social skills in the process of domestication, then perhaps the selected silver foxes acquired those skills, too.

And they did. Domesticated silver foxes could read human body language as well as any dog. The control lineage could not.

The skill of silver foxes at reading human social cues is a crucial piece of the puzzle. People (including the authors) had supposed that the unusual social skills found in dogs had probably evolved because smarter dogs had been more likely to survive and reproduce during domestication. But Belyaev's foxes weren't bred to be smarter than the average fox, just friendlier. It seems that the selected foxes are more skilled at reading human cues as a by-product of a loss of fear of humans, which was replaced by an intense interest in interacting with us. The social skills of dogs may have evolved through a similar process during their domestication. In order to avail themselves of garbage around human settlements, protodogs had to lose their fear of us. Subsequently, and by accident, while interacting with us they began deploying the social skills they were using to interact with one another—as if we were just part of the pack.

Most important (and controversial), something similar may have happened in human evolution. Instead of getting a jump start with the most intelligent hominids surviving to produce the next generation, as is often suggested, it may have been the more sociable hominids—because they were better at solving problems together—who achieved a higher level of fitness and allowed selection to favor more sophisticated problem-solving over time. Humans got their smarts only because we got friendlier first.

The Chimpanzee Deficit

Cooperation is a cornerstone of human achievement, in part dependent on our sophisticated theory of mind and use of social cues. But humans are not the only species to be skilled cooperators. What is it about humans that makes us such flexible cooperators? Or, put another way: what goes wrong with chimpanzee cooperation? They live in highly social groups, hunt food together, maintain political relationships. What stops them from becoming as flexible as humans (or dogs, for that matter) at solving problems involving cooperation and communication?

Ngamba Island Chimpanzee Sanctuary is a sprawling hundred acres of primary forest in the middle of Lake Victoria, in Uganda. On a clear day, you can hear the pant hoots of chimpanzees across the water. In the chimps' night enclosure, Kidogo and Connie are faced with a dilemma. A wooden plank just out of reach is piled high with food on either end. To bring it within reach, they each have to pull on a rope threaded through metal loops on the plank. If only one of them pulls, the rope comes unthreaded and the plank stays where it is. Kidogo, a dominant female, pushes Connie out of the way and pulls on Connie's end of the rope—which then whizzes out of the loops so that no one gets any food.

This behavior is puzzling, because chimpanzees in the wild are great cooperators, frequently hunting for food in what appears to be a complicated and organized fashion. But perhaps there is not much thinking going on behind this kind of cooperation; it could simply be that because each animal wants the same thing and all are at work at the same time, success happens by accident and just looks like a cooperative endeavor.

But if you watch Kidogo and Connie at feeding time, you will notice that they don't share food. If Connie has a piece of food and Kidogo is around, Kidogo will most likely steal it from her. On the other end of the spectrum, Sally and Becky have grown up together in the sanctuary and are like sisters. They share food peacefully, all the time. When you give them the rope test, they succeed on the first trial.

Clearly, if you allow for tolerance, chimpanzees can cooperate spontaneously. Not only do they know when they need someone, they also remember who's a good partner. Mawa, another dominant chimpanzee, is not a very good cooperator. He doesn't wait for his partner to pick up the other end of the rope and instead pulls it free of the plank. Bwambale, on the other hand, is a great cooperator; he waits for his partner, and they are nearly always successful in getting the food. At first, the other Ngamba chimps chose Mawa and Bwambale equally, but after Mawa botches it, most chimps chose Bwambale on the next trial.

However, such cooperation in chimpanzees is highly constrained. Chimpanzees will cooperate only with familiar group members, with whom they normally share food. If they don't know or like a potential partner, they won't cooperate no matter how much food is at stake. Humans, however, make a living collaborating, even when it's with people they don't know and in many cases don't particularly like. (Do you have a boss?) This high level of social tolerance is likely one of the building blocks of the unique forms of cooperation seen in humans.

So perhaps a lack of tolerance is one of the main constraints on chimpanzees' developing more flexible cooperative skills. But humans have another closest relative, one who is usually forgotten and may be more like us than we know.

Long-Lost Cousins

In contrast to chimpanzees, who live in male-dominated societies with infanticidal tendencies and other forms of lethal aggression, bonobos live in societies that are highly tolerant and peaceful thanks to female dominance, which maintains group cohesion and regulates tensions through sexual behavior.

Since bonobos are more tolerant than chimpanzees, what does this mean for their cooperative abilities?

Further tests were done with the chimpanzees at Ngamba Island. As long as the food was in two separate piles on either end of the plank, most of the chimps could cooperate fine. But as soon as you put the food in one monopolizable pile in the middle, chimpanzee cooperation fell apart. Even though chimpanzees participating in the test were relatively tolerant of each other and had passed the rope/plank test many times before, whenever the food could be monopolized by a dominant chimp, the other chimp generally refused to pull.

When we gave the same test to bonobos, they played and had sex to negotiate with each other—even though this was their first run-through. Bonobos are notorious for their sexuality. Females rub their clitorises together; males have sexual activity with males. Neither age nor gender seems to matter. Sex is a tension-relieving activity in the group, used to soothe ruffled tempers or form alliances. It also appears to be a negotiating activity, engendering a high level of tolerance in bonobos.

So what we have are chimps who cooperate but aren't very tolerant, and bonobos who are very tolerant but don't really cooperate in the wild. What probably happened six million years ago, when hominids split from the ancestor we share with chimpanzees and bonobos, is that we became very tolerant, and this allowed us to cooperate in entirely new ways. Without this heightened tolerance, we would not be the species we are today.

Finding Our Minds in Africa

Spontaneous cooperation is not the only way in which bonobos are more like humans than chimpanzees are. As with humans, gender differences in bonobos are less pronounced. The males are not physically very different from the females. Female bonobos, like human females, develop strong bonds, whereas female chimps generally don't. Humans and bonobos have similar temperaments, in that we are both risk averse and wary of the new.

Understanding bonobos is crucial to understanding what makes us human. Unfortunately, their numbers are dwindling fast. The only country where they're indigenous is the Democratic Republic of the Congo, and the various wars that periodically break out there have made studying them difficult. Africa's ape sanctuaries, including Lola Ya Bonobo, Ngamba Island, and the Tchimpounga Sanctuary for chimpanzees in the Republic of the Congo, offer an exciting opportunity to probe the minds of our closest relatives. Unlike lab animals, who are likely to suffer chronic psychological and physical problems in captivity, sanctuary apes live in large social groups in vast areas of tropical rain forest. The semicaptive apes can be tested in indoor enclosures, similar to conventional laboratories but much less costly. Sanctuary animals show no aberrant behavior (e.g., rocking or feces eating), and preliminary data suggest they may outperform captive apes in a variety of physical tasks, presumably because of the richness of their everyday environment.

Mikeno, the bonobo who sat like a Rodin sculpture, died in September 2006. An autopsy revealed a contusion on his brain, which suggests he died of a concussion after falling from a tree. Mikeno's close friend Isiro sat by him and refused to leave the body. Did she understand death? Did she feel a humanlike grief?

We're still a long way from discovering exactly what makes us human, but even if we do, there will still undoubtedly be a thousand more questions to answer about what makes a chimpanzee a chimpanzee and a bonobo a bonobo.