EVOLUTION

# 2 Mental Abilities Separate Humans from Animals

Two key features created the human mind

By Thomas Suddendorf | Scientific American September 2018 Issue

*Credit: Victo Ngai*

## IN BRIEF

**Humans clearly think differently than animals**, but experiments that show *how* human cognition is unique have been hard to do.

**Yet research has revealed two distinct human features**: complex scenario building and exchanging thoughts with others.

**Together these traits underlie critical human** capacities such as language, culture, morality, foresight and even a kind of "mind reading."

Why are we, and not the gorillas, running the zoos?

Other primates live inconspicuously in dwindling habitats, but humans have expanded and changed our surroundings to an astounding degree. Our dominance is obviously not the result of our physical ability; other animals are stronger and faster and have more acute senses. It is because of our mental abilities. Yet determining the cognitive traits that make us so special has turned out to be a devilishly complicated question to answer—one made more confusing by the frequent arrival of new studies that seem to show that animals from birds to chimpanzees can match many human cognitive skills.

Last year, to name just one example, a study published in *Science* boldly claimed that ravens can plan for the future just like humans do. Five birds learned to pick a stone and drop it into a box to get a reward. Subsequently, these ravens picked the rock from among distracting items minutes or even hours before the box was available to them. The researchers concluded from this achievement, along with a similar task in which the birds could exchange bottle tops for rewards, that the ravens were "thinking ahead" in flexible ways, an ability that is a key to human brainpower.

Yet the achievements of the ravens, as well as cognitive feats of apes in other studies, can be explained in simpler ways. It also turns out that animal and human cognition, though similar in many respects, differ in two profound dimensions. One is the ability to form nested scenarios, an inner theater of the mind that allows us to envision and mentally manipulate many possible situations and anticipate different outcomes. The second is our drive to exchange our thoughts with others. Taken together, the emergence of these two characteristics transformed the human mind and set us on a world-changing path.

## BIRD BRAINS

Let us begin by taking a harder look at that raven experiment. Even before the tests started, the birds had learned, over several trials, to recognize that the target item, the stone, led to rewards and that distractor items did not. So it is not really surprising that when the actual trials began, the ravens selected what had already been reinforced.

This is a good reason why scientists, before they jump to conclusions about "rich" animal capacities, need to carefully rule out more straightforward, or "lean," alternative explanations. They also need to conduct independent replications. In my laboratory, we have tried to do this by conducting studies with children that carefully limit the possibility of mistaking behavior actually driven by lean mechanisms for the products of rich cognition. We used single trials with novel tasks on our subjects to avoid giving them the learning opportunities that occur through repeated exposure. We also changed up the timing and spatial contexts of the tests to avoid cueing the children about the solution, and we concocted problems that involved the use of different skills to mitigate the effects of behavior that may result from a narrow innate predisposition.

For example, we showed the youngsters a puzzle box in one room before taking them to another room in which they were distracted with unrelated tasks. After 15 minutes, they were given the opportunity to pick one of several novel objects to take back to the first room. The three-year-olds picked randomly, but the four-year-olds tended to select the object that could later help solve the puzzle they were initially given. We have used this basic paradigm to assess the capacity for deliberate practice, which is the rehearsal of actions aimed at improving future performance [see "An Evolved Uniqueness"]. For instance, the children had the opportunity to practice catching a ball on a string with a cup in preparation for a return to the first room, where they could get a reward for success in a similar task. We found that the children could intentionally shape their own future abilities—they would practice the relevant skill in room two—after around age four or five but not before.

These tasks are designed to show basic capacities in areas such as foresight, and they do not map the upper limits of those abilities. When my son was four years old, for instance, we gave him a version of this task, and he succeeded. Later that day, when we were sitting on the bed back home, he put his hand on my thigh and said, "Papa, I don't want you to die." When I asked why he thought of that, he said that he would grow up, and I would become a granddad, and then I would die. He had a sophisticated capacity for envisioning the future that produced this unwelcome existential realization. Our study merely demonstrated that he had mental foresight and ruled out the leaner explanations.

The raven research and other animal studies have not met similar stringent criteria for establishing foresight, nor have they demonstrated deliberate practice. Does this mean we should conclude that animals do not have the relevant

capacities at all? That would be premature. Absence of evidence is not evidence of absence, as the saying goes. Establishing competence in animals is difficult; establishing the absence of competence is even harder.

Consider the following study, in which my colleague Jon Redshaw of the University of Queensland in Australia and I tried to assess one of the most fundamental aspects of thinking about the future: the recognition that it is largely uncertain. When one realizes that events may unfold in more than one way, it makes sense to prepare for various possibilities and to make contingency plans. Human hunters demonstrate this when they lay a trap in front of all their prey's potential escape routes rather than just in front of one. Our simple test of this capacity was to show a group of chimpanzees and orangutans a vertical tube and drop a reward at the top so they could catch it at the bottom. We compared the apes' performance with that of a group of human children aged two to four doing the same thing. Both groups readily anticipated that the reward would reappear at the bottom of the tube: they placed their hand under the exit to prepare for the catch.

Next, however, we made events a little harder to predict. The straight tube was replaced by an upside-down Y-shaped tube that had two exits. In preparation for the drop, the apes and the two-year-old children alike tended to cover only one of the potential exits and thus ended up catching the reward in only half of the trials. But four-year-olds immediately and consistently covered both exits with their hands, thus demonstrating the capacity to prepare for at least two mutually exclusive versions of an imminent future event. Between ages two and four, we could see this contingency planning increase in frequency. We saw no such ability among the apes.

This experiment does not prove, however, that apes and two-year-old humans have no understanding that the future can unfold in distinct ways. As I mentioned, there is a fundamental problem when it comes to showing the absence of a capacity. Perhaps the animals were not motivated, did not understand the basic task or could not coordinate two hands. Or maybe we simply tested the wrong individuals, and more competent animals might be able to pass.

To truly prove this ability is absent, a scientist would have to test all animals, at all times, on some fool-proof task. Clearly, that is not practical. All we can do is give individuals the chance to demonstrate competence. If they consistently fail, we can

become more confident that they really do not have the capacity in question, but even then, future work may prove that wrong. The debates between rich and lean interpretations of animal behavior, coupled with this fundamental problem of proving that an ability is always missing, have made it difficult to establish what does and does not set humans apart.

## MIND THE GAP

Difficult but not impossible. In my book *The Gap: The Science of What Separates Us from Other Animals*, I surveyed the evidence for cognitive capacities most frequently assumed to be distinctly human and found that animals are smarter than widely thought. For instance, chimpanzees can solve problems through insight, console others in distress and maintain social traditions. Nevertheless, there is something profoundly distinct about human language, foresight, intelligence, culture and morality, and the ability to imagine the thoughts of another individual (we commonly speak about putting yourself in someone else's shoes). And in each of these domains, two underlying characteristics kept reemerging as making the critical human-animal difference. One is what I call "nested scenario building," which is our ability to imagine alternative situations, reflect on them and embed them into larger narratives of related events. The other is the "urge to connect," which is our deep-seated drive and capacity to exchange our thoughts with others, when we put our minds together to create something greater than what one individual can do alone.

Nested scenario building enables us to imagine other people's situations, moral conundrums or entirely fictional stories. In the context of thinking ahead, it allows us to picture potential future events, reflect on possibilities and embed them into larger stories of unfolding events. This, in turn, enables us to plan and prepare for opportunities and threats before they materialize.

Other animals, even bacteria, are attuned to long-term regularities such as day-night rhythms, and many can adjust to local patterns as well. Through associative learning, animals can predict that a reward or punishment is coming after a specific event. But people can mentally entertain situations, even entirely novel scenarios without external triggers, by combining and recombining in our mind basic elements, such as actors, actions and objects, and we can draw prudent conclusions from these mental exercises. A simple example: you can picture

playing blindman's bluff on a busy street and figure out that it is a dangerous proposition even if you have never been in that situation. Nested scenario building depends on a host of sophisticated abilities working in concert, including imagination, memory, reflection and executive decision making.

Think of creating nested scenarios as an internal theater in which we can bring situations to life. Like a play, scenario building depends on certain components that have to come together. There is a "stage" to imagine events that are not actually occurring at that moment. Those events involve "actors" and their "set": individuals and objects that are linked in a narrative. We also employ capacities akin to a "director" who evaluates and manages the scenes and an "executive producer" who makes the final decisions about what to pursue. These components map onto psychological constructs such as working memory, recursive thought and executive function, features that develop at different rates during human childhood. As a result, competence at foresight emerges slowly as we mature. And as adults, we still frequently fail to anticipate future situations accurately—I most certainly do. We are not clairvoyants.

Thus, because nested scenario building is a risky way to reach decisions, humans need to pair it with that second characteristic: connecting our minds. Psychologist Michael Tomasello has described this ability as shared intentionality [see "The Origins of Morality"]. After all, the best way to find out about the future is to ask someone who has already been there, as it were.
If you really want to know what a holiday in New Zealand is like or what a career in psychology entails, you can envision all the scenarios you want, but your best bet is to ask someone who has been to that country or has pursued such a career. Human language is ideally suited for such exchanges; most of our conversations are about events displaced in time. In this way, we can learn from one another's experiences, reflections and plans. We ask questions and give advice, and we build deep bonds in the process. What is more, we can also shape the future in more deliberate ways by coordinating our actions in the pursuit of shared goals. We often do this by commenting on a companion's strategy, reviewing progress and then guiding the person to the next step.

Most of our extraordinary powers, when you think about it, derive from our collective wit. Consider that we all benefit from the tools and technologies other people invented. Many animals use tools, and some even make them, but to turn them into an innovation, one has to recognize that it will be useful again in the

future. After that realization, one has a reason to retain the tool, to refine it further and to share it with others.

We can see this evolution in our inventions of increasingly effective ways to cause harm at a distance. This was probably a vital capacity for our early ancestors, who shared the land with dangerous saber-toothed cats. At first, our progenitors may have thrown rocks to drive away predators, but eventually they armed themselves with spears, then invented spear throwers, and then bows and arrows. New tools are only an advance, however, if one can use them effectively, which brings us back to deliberate practice. Chimpanzees in Senegal have been reported to make rudimentary spears that they thrust into tree hollows to kill bush babies. But there is as yet no observation that they practice thrusting, let alone throwing. Unlike humans, they could not benefit from the invention of a spear thrower. You can safely give them one of ours; they would not use it as we do.

The earliest evidence of deliberate practice is more than a million years old. The Acheulean stone tools of *Homo erectus* some 1.8 million years ago already suggest considerable foresight, as they appeared to have been carried from one place to another for repeated use. Crafting these tools requires considerable knowledge about rocks and how to work them. At some sites, such as Olorgesailie in Kenya, the ground is still littered with shaped stones, raising the question of why our ancestors kept making more tools when there were plenty lying around. The answer is that they were probably practicing how to manufacture those tools. Once they were proficient, they could wander the plains knowing they could make a new tool if the old one broke. These ancestors were armed and ready to reload.

Most animal species can be categorized as either specialists or generalists, but humans are both: we are capable of quickly adapting to local demands, even to anticipated demands, by acquiring relevant expertise. Moreover, through cooperation and division of labor, we can benefit from complementary skills, thereby enabling us to dominate most diverse habitats. We can keep even the fiercest predators in our zoos because we can foresee what they need and what they can and cannot do. So far there is no obvious evidence of other species engaging in such mental time travel nor in exchanging plots for a coordinated escape from the zoo when the conditions are right next summer.
With nested scenario building and the urge to wire their minds together, our ancestors eventually spawned civilizations and technologies that have changed the face of the earth. Science is the disciplined use of our collective wit, and we can

deploy it to better understand the origin of our place in nature. We can further use it to model the future systematically and ever more clearly. By foreseeing the consequences of our actions, we are also confronted with moral choices between different options. We can predict the consequences of continuing pollution or destruction of animal habitats, inform others about them and, as the Paris climate agreement dramatically demonstrates, negotiate globally coordinated actions aimed at more desirable outcomes.

None of this is an excuse for arrogance. It is, in fact, a call for care. We are the only creatures on this planet with these abilities. As Spider-Man's Uncle Ben declared, communicating complex ideas in an urge to connect with his superhero nephew, "With great power comes great responsibility."

*This article was originally published with the title "Inside Our Heads"*

## MORE TO EXPLORE

**The Gap: The Science of What Separates Us from Other Animals.** Thomas Suddendorf. Basic Books, 2013.

**A Natural History of Human Thinking.** Michael Tomasello. Harvard University Press, 2014.

**Flexible Planning in Ravens?** Jonathan Redshaw, Alex H. Taylor and Thomas Suddendorf in *Trends in Cognitive Sciences*, Vol. 21, No. 11, pages 821–822; November 2017.

**Prospection and Natural Selection.** T. Suddendorf, A. Bulley and B. Miloyan in *Current Opinion in Behavioral Sciences*, Vol. 24, pages 26–31; December 2018.

## FROM OUR ARCHIVES

**If I Had a Hammer.** Ian Tattersall; September 2014.

## ABOUT THE AUTHOR(S)

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*Credit: Nick Higgins*

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