EVOLUTION

The Cultural Origins of Language

What makes language distinctly human

By Christine Kenneally | Scientific American September 2018 Issue

Credit: Victo Ngai

IN BRIEF

Human communication is far more structured and complex than the gestures and sounds of other animals.

Scientists have, however, failed to find distinctive physiological, neurological or genetic traits that could explain the uniqueness of human language.

Language appears instead to arise from a platform of abilities, some of which are shared with other animals.

Intriguingly, the intricacy of human language may arise from culture: the repeated transmission of speech through many generations.

Dolphins name one another, and they click and whistle about their lives or the dangers posed by sharks and humans. They also pass on useful bits of know-how from mother to child, such as how to catch fish or how to flee. If they had language in the same sense that we do, however, they would not only pass down little bits of information but also aggregate them into a broad body of knowledge about the world. Over the span of generations clever practices, complex knowledge and technology based on two, three or several components would develop. Dolphins would have history—and with history, they would learn about the journeys and ideas of other dolphin groups, and any one individual could inherit a fragment of language, say, a story or poem, from another individual who had lived hundreds of years before. That dolphin would be touched, through language, by the wisdom of another dolphin, who was in every other way long gone.

Only humans can perform this spectacular time-traveling feat, just as only humans can penetrate the stratosphere or bake strawberry shortcake. Because we have language, we have modern technology, culture, art and scientific inquiry. We have the ability to ask questions such as, Why is language unique to humans? Despite the accumulated genius we inherit when we learn to speak or sign, we have yet to work out a good answer. But a diverse group of brain scientists, linguists, animal researchers and geneticists are tackling the question—so we are much closer to a real understanding than ever before.

AN UNANSWERABLE QUESTION

That language is uniquely human has been assumed for a long time. But trying to work out exactly how and why that is the case has been weirdly taboo. In the 1860s the Société de Linguistique de Paris banned discussion about the evolution of language, and the Philological Society of London banned it in the 1870s. They may have wanted to clamp down on unscientific speculation, or perhaps it was a political move—either way, more than a century's worth of nervousness about the subject followed. Noam Chomsky, the extraordinarily influential linguist at the Massachusetts Institute of Technology, was, for decades, rather famously disinterested in language evolution, and his attitude had a chilling effect on the

field. Attending an undergraduate linguistics class in Melbourne, Australia, in the early 1990s, I asked my lecturer how language evolved. I was told that linguists did not ask the question, because it was not really possible to answer it.
Luckily, just a few years later, scholars from different disciplines began to grapple with the question in earnest. The early days of serious research in language evolution unearthed a perplexing paradox: Language is plainly, obviously, uniquely human. It consists of wildly complicated interconnecting sets of rules for combining sounds and words and sentences to create meaning. If other animals had a system that was the same, we would likely recognize it. The problem is that after looking for a considerable amount of time and with a wide range of methodological approaches, we cannot seem to find anything unique in ourselves —either in the human genome or in the human brain—that explains language.

To be sure, we have found biological features that are both unique to humans and important for language. For example, humans are the only primates to have voluntary control of their larynx: it puts us at risk of choking, but it allows us to articulate speech. But the equipment that seems to be designed for language never fully explains its enormous complexity and utility.

It seems more and more that the paradox is not inherent in language but in how we look at it. For a long time we have been in love with the idea of a sudden, explosive transformation that changed mere apes into us. The idea of metamorphosis has gone hand in hand with a list of equally dramatic ideas. For example: that language is a wholly discrete trait that has little in common with other kinds of mental activity; that language is the evolutionary adaptation that changed everything; and that language is wired into humanity's DNA. We have looked for a critical biological event that brought complex language into existence around 50,000 years ago.

Findings from genetics, cognitive science and brain sciences are now converging in a different place. It looks like language is not a brilliant adaptation. Nor is it encoded in the human genome or the inevitable output of our superior human brains. Instead language grows out of a platform of abilities, some of which are very ancient and shared with other animals and only some of which are more modern.

TALKING TO THE ANIMALS

Animal researchers were the first to challenge the definition of language as a discretely human attribute. As comparative psychologist Heidi Lyn has pointed out, the only way we can truly determine what is unique to human language is to explore the capacities of other animals. Interestingly, almost every time researchers have proposed that humans can do something that other animals cannot because humans have language, studies have shown that some animals can do some of those things, at least some of the time.
Take gestures, for example. Some are individual, but many are common to our language community and even to all humans. It is clear that language evolved as part of a communication system in which gesture also plays a role. But landmark work has shown that chimpanzees gesture in meaningful ways, too. Michael Tomasello, now emeritus at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and his colleagues have shown that all species of great apes will wait until they have another ape's attention before they signal, and they repeat gestures that do not get the response they want. Chimpanzees slap the ground or clap their hands to get attention—and just as a belligerent human might raise a fist, they roll their arms over their head (normally a prelude to an attack) as a warning to rivals.

Even so, Tomasello's laboratory found that apes were very poor at understanding a human pointing gesture that conveyed information, such as, for example, the location of a hidden object. Does pointing—or rather the ability to fully understand it—represent a critical step in the evolution of language? The claim struck Lyn, who worked with bonobos that are now at the Ape Cognition and Conservation Initiative, as absurd. “My apes understood when I pointed to things all the time,” she says. But when she set up pointing experiments with chimpanzees at the Yerkes National Primate Research Center at Emory University, she was surprised to find that the apes there did not understand her pointing well at all. Then she went back to the bonobos in her lab and tested them. All of them did.

ALEX, a celebrated African grey parrot, could recognize and name some 100 different objects, along with their color, texture and shape, as well as convey his desires and intentions by means of sentences such as “Wanna go back.” Chimpanzees can also be taught to use human language. Credit: *Getty Images*

The difference between the pointing apes and the nonpointing apes had nothing to do with biology, Lyn concluded. The bonobos had been taught to communicate with humans using simple visual symbols; the chimpanzees had not. “It's apes that

haven't been around humans in the same way that can't follow pointing," she explains.

The fact that the bonobos were taught by humans has been used to dismiss their ability, according to Lyn, as if they were somehow tainted. Language research with parrots and dolphins and other animals has been discounted for the same reason. But Lyn argues that animals trained by humans provide valuable insights. If creatures with different brains and different bodies can learn some humanlike communicative skills, it means that language should not be defined as wholly human and disconnected from the rest of the animal world. Moreover, whereas language may be affected by biology, it is not necessarily determined by it. With the bonobos, it was culture, not biology, that made the critical difference.

GENETIC CODE

The list of abilities that were formerly thought to be a unique part of human language is actually quite long. It includes parts of language, such as words. Vervet monkeys use wordlike alarm calls to signal a specific kind of danger. Another crucial aspect is structure. Because we have syntax, we can produce an infinite number of novel sentences and meanings, and we can understand sentences that we have never heard before. Yet zebra finches have complicated structure in their songs, dolphins can understand differences in word order and even some monkeys in the wild seem to use one type of call to modify another. The list extends to types of cognition, such as theory of mind, which is the ability to infer others' mental states. Dolphins and chimpanzees are excellent at guessing what an interlocutor wants. Even the supposedly unique ability to think about numbers falls by the wayside—bees can understand the concept of zero, bees and rhesus monkeys can count to four, and cormorants used for fishing in China reportedly count to seven. The list includes genes. The famous *FOXP2* gene, once called a language gene, is indeed a gene that affects language—when it is mutated, it disrupts articulation—but it performs other roles as well. There is no easy way to tease out the different effects. Genes are critical for understanding how language evolved, says Simon Fisher, a geneticist at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands, but "we have to think about what genes do." To put an incredibly complex process very briefly: genes code for proteins, which then affect cells, which may be brain cells that form neural circuits, and it is those circuits that are then responsible for behavior. "It may be that there is a network of genes that are

important for syntactic processing or speaking proficiently," Fisher explains, "but there won't be a single gene that can magically code for a suite of abilities."

The list of no-longer-completely-unique human traits includes brain mechanisms, too. We are learning that neural circuits can develop multiple uses. One recent study showed that some neural circuits that underlie language learning may also be used for remembering lists or acquiring complicated skills, such as learning how to drive. Sure enough, the animal versions of the same circuits are used to solve similar problems, such as, in rats, navigating a maze.

Michael Arbib, a cognitive neuroscientist at the University of California, San Diego, notes that humans have created "a material and mental world of ever increasing complexity"—and yet whether a child is born into a world with the steam train or one with the iPhone, he or she can master some part of it without alterations in biology. "As far as we know," Arbib says, "the only type of brain on earth that can do that is the human brain." He emphasizes, however, that the brain is just one part of a complex system, which includes the body: "If dolphins had hands, maybe they could have evolved that world."

Indeed, making sense of the human world requires not only the brain in the body but also a group of brains interacting as part of the human social world. Arbib refers to this as an EvoDevoSocio approach. Biological evolution influences the development and learning of individuals, and individual learning shapes the evolution of culture; learning, in turn, can be shaped by culture. To understand language, the human brain has to be considered a part of those systems. The evolution of language was polycausal, Arbib says. No one switch was thrown: there were lots of switches. And it did not happen all at once but took a great deal of time.

CULTURAL REVOLUTION

Culture also plays a critical role for Simon Kirby, a cognitive scientist who runs the Center for Language Evolution at the University of Edinburgh. From the beginning, Kirby was fascinated by the idea that not only is language something that we learn from others, but it is something that is passed down through generations of learners. What impact did the repeated act of learning have on language itself?

Kirby set out to test the question by fashioning a completely new method of exploring language evolution. Instead of looking at animals or humans, he built digital models of speakers, called agents, and fed them messy, random strings of language. His artificially intelligent agents had to learn the language from other agents, but then they had to teach other agents the language as well. Then Kirby rolled over generations of learners and teachers to see how the language might change. He likened the task to the telephone game, where a message is passed on from one person to the next and so on, with the final message often ending up quite different from the original.

Kirby found that his digital agents had a tendency to produce more structure in their output than they had received in their input. Even though the strings of language he initially gave them were random, sometimes by chance a string might appear to be slightly ordered. Critically, the agents picked up on that structure, and they generalized it. “The learners, if you like, hallucinated structure in their input,” Kirby says. Having seen structure where there was none, the agents then reproduced more structure in what they said.

The changes might be very tiny, Kirby notes, but over the generations “the process snowballs.” Excitingly, not only did the agents' language begin to look more and more structured after many generations, the kind of structure that emerged looked like a simple version of that which occurs in natural human language. Subsequently Kirby tried a variety of different models and gave them different kinds of data, but he found that “the cumulative accretion of linguistic structure seemed to always happen no matter how we built the models.” It was the crucible of learning over and over again that created the language itself.

Now Kirby is re-creating his digital experiments in real life with humans and even animals by getting them to repeat things that they learn. He is finding that structure indeed evolves in this way. One of the more thrilling implications of this discovery is how it helps to explain why we can never pin down the right single gene or mutation or brain circuit to explain language: it is just not there. Language seems to emerge out of a combination of biology, individual learning and the transmission of language from one individual to another. The three systems run at entirely different timescales, but when they interlock, something extraordinary happens: language is born.

In the short time since the field of language evolution has been active, researchers may have not reached the holy grail: a definitive event that explains language. But their work makes that quest somewhat beside the point. To be sure, language is probably the most unique biological trait on the planet. But it is much more fragile, fluky and contingent than anyone might have predicted.

This article was originally published with the title "Talking through Time"

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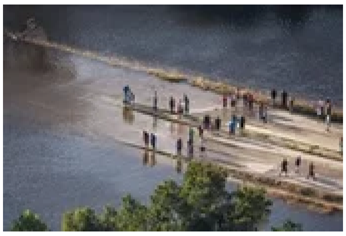

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