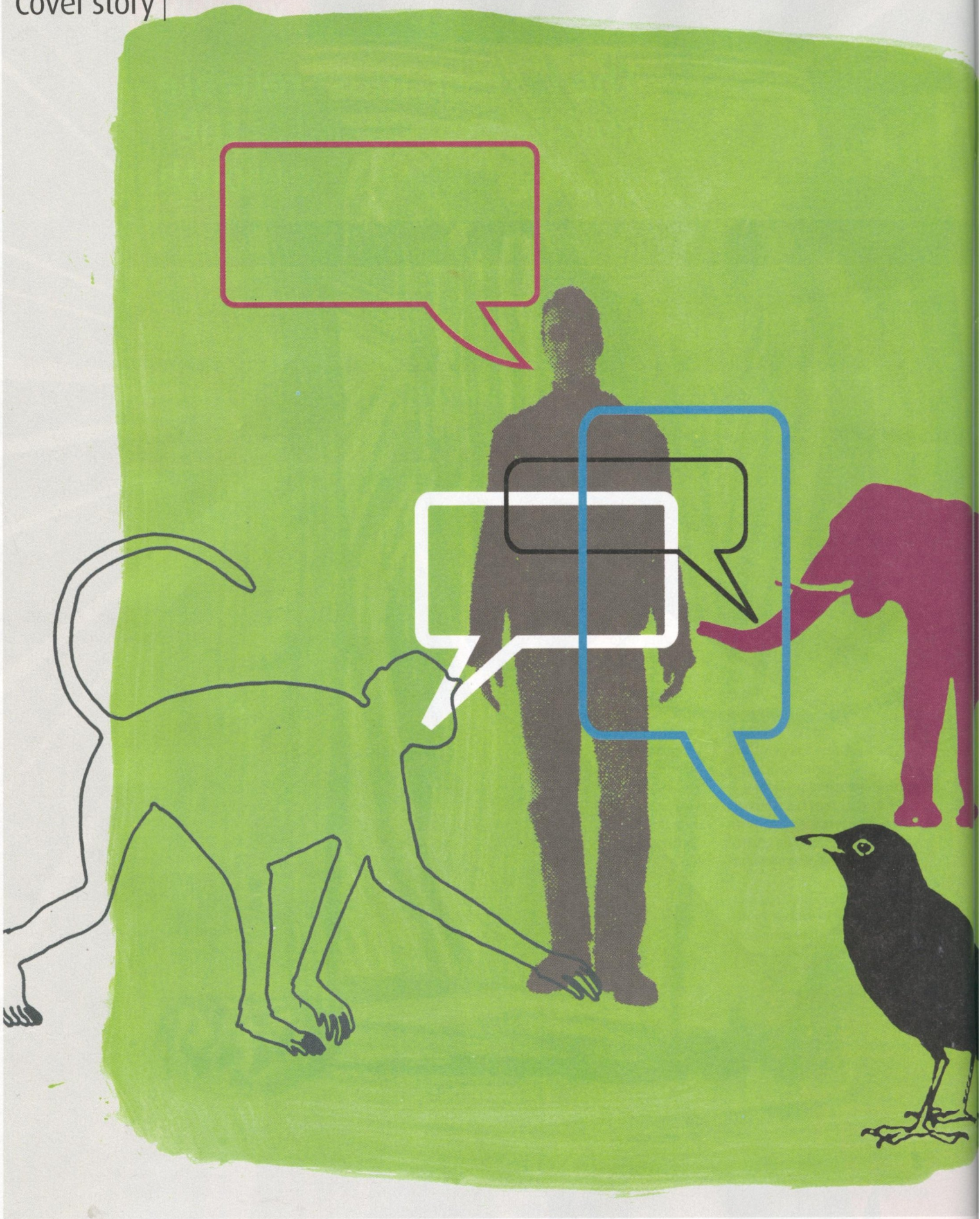


GARY SAWYER

So you think you're unique

We humans are not as special as we might like to think. Over the past decade, hard scientific fact has steadily chipped away at our supposedly unique qualities, revealing many of them to be just more sophisticated versions of traits found elsewhere in the animal world. The line dividing us from the rest of nature has steadily shifted. Now the last stronghold of human uniqueness has fallen. **Christine Kenneally** reports

THERE was a time when we thought humans were special in so many ways. Now we know better. We are not the only species that feels emotions, empathises with others or abides by a moral code. Neither are we the only ones with personalities, cultures and the ability to design and use tools. Yet we have steadfastly clung to the notion that one attribute, at least, makes us unique: we alone have the capacity for language.

Alas, it turns out we are not so special in this respect either. Key to the revolutionary reassessment of our talent for communication is the way we think about language itself. Where once it was seen as a monolith, a discrete and singular entity, today scientists find it is more productive to think of language as a suite of abilities. Viewed this way, it becomes apparent that the component parts of language – everything from gesticulation and babbling to meaning and syntax – are not as unique as the whole. In fact, a boom in research into animal cognition and communication has gradually picked off most items on the list one by one.

Take gesture, arguably the starting point for language. Until recently it was considered uniquely human – but not any more. Mike Tomasello of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and others have compiled a list of gestures observed in monkeys, gibbons, gorillas, chimpanzees, bonobos and orang-utans, which reveals that gesticulation plays a large role in their communication (*Gesture*, vol 5, p 39). Ape gestures can involve touch, vocalising or eye movement, and individuals wait until they have another ape's attention before making visual or auditory gestures. If their gestures go unacknowledged, they will often repeat them or touch the recipient.

An experiment carried out in 2006 by Erica Cartmill and Richard Byrne from the University of St Andrews in the UK underscores the similarity between the way humans and apes use gesture (*Current Biology*, vol 17, p 1345). They got a person to sit on a chair with some highly desirable food, such as banana, to one side of them, and some bland food, such as celery, to the other. The orang-utans, who could see the person and the food from their enclosures, gestured at their human partners to encourage them to push the desirable food their way. If the person feigned incomprehension and offered the bland food, the animals would change their gestures – just as humans would in a similar situation. If the human seemed to understand while being somewhat confused, giving only half the preferred food, the apes would repeat and exaggerate their gestures – again in exactly the same way a human would.

Such findings highlight the fact that the gestures of non-human primates are not ▶

merely innate reflexes but are learned, flexible and under voluntary control – all characteristics that are considered prerequisites for human-like communication. The fact that we can interpret ape gestures also suggests that there is a shared evolutionary basis for gesticulation in humans and other primates. The innate similarities were demonstrated by Joanna Blake from York University in Toronto, Canada, who examined the literature on the gestures of human infants aged between 9 and 15 months and that on gestures by apes of various ages. She found that both human babies and apes use similar gestures to make requests, such as extending a hand to beg for food and raising both arms to be picked up and carried. Both use their whole hand to point. Infants and apes alike make the same gestures of protest, pushing someone away or turning away themselves while shaking their heads. They also emote by stamping their feet, flapping their arms and rocking. When they want someone to do something, both take another individual's hand and place it on the object they want to manipulate.

WENDY SHATTIL/ISTOCK CONNECTION/DBR.NET

As well as gesturing, pre-linguistic infants babble, and it turns out they are not alone in this either – dolphins, and even songbirds, do it too. At about five months babies start to make their first speech sounds, which some researchers believe contain a random selection of all the phonemes humans can produce. But as children learn the language of their parents, they narrow their sound repertoire to fit the model to which they are exposed, producing just the sounds of their native language, as well as its classic intonation patterns. Indeed, they lose their polymath talents so effectively that they are ultimately unable to produce some sounds – think about the difficulty Japanese speakers have pronouncing the English "l" and "r".

Dolphin calves also pass through a babbling phase. Laurance Doyle from the SETI Institute in Mountain View, California, Brenda McCowan from the University of California at Davis and their colleagues analysed the complexity of baby dolphin sounds and found it looked remarkably like that of babbling infants, in that the young dolphins had a much wider repertoire of sound than adults. This suggests that they practise the sounds of their species, much as human babies do, before they begin to put them together in the way characteristic of mature dolphins of their species (*Journal of Comparative Psychology*, vol 116, p 116).

Of course language is more than mere sound – it also has meaning. While the traditional, cartoonish version of animal communication renders it inchoate, unpredictable and involuntary, it has become clear that various species are able to give meaning to particular sounds by connecting them with specific ideas. Dolphins use "signature whistles", so called because it appears that they name themselves. Each develops a unique moniker within the first year of life and uses it whenever it meets another dolphin. Elephants also use sounds in a word-like way according to Katy Payne, who, before she retired, led the Elephant Listening Project at Cornell University's Bioacoustics Research Program. Working with Joyce Poole of the Amboseli Elephant Research Project in Kenya, Payne began to compile a dictionary of sounds produced by individual elephants for various purposes, such as greeting a fellow member of the clan. Whales have a similarly diverse vocal repertoire. This year, Rebecca Dunlop from the University of Queensland in Australia and colleagues announced that they had put together a catalogue of 34 different humpback social sounds that remained stable over several years and were distinct from the whales' song (*The Journal of the Acoustical Society of America*, vol 112, p 2893).

One of the clearest examples of animals making connections between specific sounds and meanings was demonstrated by Klaus Zuberbühler and Katie Slocombe of the University of St Andrews in the UK. They noticed that chimps at Edinburgh Zoo appeared to make rudimentary references to objects by using distinct cries when they came across different kinds of food. Highly valued foods such as bread would elicit high-pitched grunts, less appealing ones, such as an apple, got low-pitched grunts. Zuberbühler and Slocombe showed not only that chimps could make distinctions in the way they vocalised about food, but that other chimps understood

Mobile voice boxes

Some time in the six million years since we last shared a common ancestor with chimps, the position of our larynx dropped, creating two tubes of roughly equal size, one above and one below the larynx. These allow us to make our wide range of different vowel and consonant sounds.

For a long time, the descent of the larynx was the "smoking gun" of speech evolution. However, Tecumseh Fitch at the University of St Andrews in the UK discovered that the larynx is far more mobile than previously thought. He found that some animals without a permanently descended larynx simply pull it into a lower position when they vocalise. Dogs do it, and so do goats, pigs and monkeys. In addition, Fitch found that other animals, including lions and koalas, have a permanently descended larynx. He concludes that we cannot presume the larynx descended in humans to facilitate speech.

Orang-utans' gestural communication is remarkably similar to ours

what they meant. When played recordings of grunts that were produced for a specific food, the chimps looked in the place where that food was usually found. They also searched longer if the cry had signalled a prized type of food (*Animal Behaviour*, vol 72, p 989).

While working in the Budongo Forest in Uganda, Slocombe and Zuberbühler discovered that wild chimpanzees make distinctive noises during fights which other individuals can interpret. Victims produce screams with a very consistent pitch, while the screams of aggressors have a variable pitch that falls at the end. Slocombe's recordings reveal that in high-risk situations victims' screams tend to be long and high-pitched, whereas in low-risk situations they are shorter and lower in pitch. What's more, she found that if a high-ranking individual was nearby the victim's screams were higher-pitched, suggesting that they were exaggerating the severity of the threat to get more help (DOI: 10.1073/pnas.0706741104).

What a hoot

Wild chimps also use loud cries known as pant hoots to communicate at a distance, and careful observation has revealed that these too are neither meaningless nor involuntary. Pant hoots can last between 3 and 23 seconds and have a complex internal structure, including an introduction phase of low-pitched tones, a build-up phase of panting sounds, a climax that might include long wails or roars and a let-down phase where pitch and volume gradually decline. They are uttered in specific situations such as resting, feeding and during travel and display, and are often used to rally support and keep individuals in a group together.

Pant hoots are learned, and differ between individuals and groups (*Animal Behaviour*, vol 58, p 825). While nobody has demonstrated that the sounds refer to specific meanings as human words do, there does seem to be a connection between the kind of call and the situation in which it is made. For example, pant hoots made while travelling or in response to finding a lot of food are more likely to have a let-down phase than other pant hoots (*Animal Behaviour*, vol 70, p 177). Given that chimpanzees are so closely ▶

Not so special either

We like to think we have a truckload of unique traits, but this pick of the *New Scientist* archive suggests otherwise

CULTURE

Art, theatre, literature, music, religion, architecture and cuisine – these are the things we generally associate with culture. Clearly no other animal has anything approaching this level of cultural sophistication. But culture at its core is simply the sum of a particular group's characteristic ways of living, learned from one another and passed down the generations, and other primate species undoubtedly have practices that are unique to groups, such as a certain way of greeting each other or obtaining food.

Even more convincing examples of animal cultures are found in cetaceans. Killer whales, for example, fall into two distinct groups, residents and transients. Although both live in the same waters and interbreed, they have very different social structures and lifestyles, distinct ways of communicating, different tastes in food and characteristic hunting techniques – all of which parents teach to offspring.
(24 March 2001, p 26)

MIND-READING

Perhaps the surest sign that an individual has insight into the mind of another is the ability to deceive. To outwit someone you must understand their desires, intentions and motives – exactly the same ability that underpins the "theory of mind". This ability to attribute mental states to others was once thought unique to humans, emerging suddenly around the fifth year of life. But the discovery that babies are capable of deception led experts to conclude that "mind-reading" skills develop gradually, and fuelled debate about whether they might be present in other primates. Experiments in the 1990s indicated that great apes and some monkeys do understand deception, but that their understanding of the minds of others is probably implicit, rather than explicit as it is in adult humans.
(14 February 1998, p 22)

EMOTIONS

Emotions allow us to bond with others, regulate our social interactions and make it possible to behave flexibly in different situations. We are not the only animals that need to do these things, so why should we be the only ones with emotions? There are many examples of apparent emotional behaviour in other animals. Elephants caring for a crippled herd member seem to show empathy. A funeral ritual performed by magpies suggests grief. Was it spite that led a male baboon called Nick to take revenge on a rival by urinating on her? Divers who freed a humpback whale caught in a crab line describe its reaction as one of gratitude. Then there's the excited dance chimps perform when faced with a waterfall – it looks distinctly awe-inspired. These days, few doubt that animals have emotions, but whether they feel these consciously, as we do, is open to debate.
(26 May 2007, p 42)

TOOL USE

Some chimps use rocks to crack nuts, others fish for termites with blades of grass and a gorilla has been seen gauging the depth of water with the equivalent of a dipstick, but no animal wields tools with quite the skill and alacrity of the New Caledonian crow. To extract tasty insects from crevices, they craft a selection of hooks and long, barbed tapers called stepped-cut tools, made by intricately cutting a pandanus leaf with their beaks. What's more, experiments in the lab suggest that they understand the function of tools and use creativity and planning to construct them.

Nobody is suggesting that toolmaking has common origins in humans and crows, but there is a remarkable similarity in the ways in which our respective brains work. Both are highly lateralised, revealed in the observation that most crows are right-beaked – cutting pandanus leaves using the right side of their beaks. New Caledonian crows may force us to reassess the mental abilities of our first toolmaking ancestors.
(17 August 2002, p 44)

MORALITY

A classic study in 1964 found that hungry rhesus monkeys would not take food they had been offered if doing so meant that another monkey received an electric shock. The same is true of rats. Does this indicate nascent morality? For decades, we've preferred to find alternative explanations, but recently ethologist Marc Bekoff from the University of Colorado at Boulder has championed the view that humans are not the only moral species. He argues that morality is common in social mammals, and that during play they learn the rights and wrongs of social interaction, the "moral norms that can then be extended to other situations such as sharing food, defending resources, grooming and giving care".
(13 July 2002, p 34)

PERSONALITY

It's no surprise that animals that live under constant threat from predators are extra-cautious while those that face fewer risks appear to be more reckless. After all, such successful survival strategies would evolve by natural selection. But the discovery that individuals of the same species, living under the same conditions, vary in their degree of boldness or caution is more remarkable. In humans we would refer to such differences as personality traits. From cowardly spiders and reckless salamanders to aggressive songbirds and fearless fishes, we are finding that many animals are not as characterless as we might expect. What's more, work with animals has led to the idea that personality traits evolve to help individuals survive in a wider variety of ecological niches, and this is influencing the way psychologists think about human personality.
(3 June 2001, p 34)

Kate Douglas

JOSE B RUIZ/NATUREPL.COM

Primal scream

Alarm calls used to be seen as possible "animal words". Vervet monkeys, for example, make three kinds of alarm call depending on whether they have spotted an eagle, a leopard or a snake. Last year, it was revealed that the alarm calls of Siberian jays not only identify hawks, but can distinguish between hawks which are sitting, hunting or attacking (*Current Biology*, DOI: 10.1016/j.cub.2007.11.069). In fact, many species of monkey, bird and even prairie dog make distinct alarm calls. But what rules these out as "words" is that they are genetically pre-programmed – animals produce them even when raised in isolation. The prevailing view is that alarm calls are less like human language and more like laughter or crying, which are instinctive and universal responses triggered by particular events.

Nevertheless, aspects of the use of alarm calls do suggest overlaps with the skills we bring to language. For a start, even though there is a genetic component to alarm calls, animals may still have some control over them. Monkeys have been seen suppressing their calls in situations where making a noise might endanger them, for example. Then there is the fact that the interpretation of alarm calls is learned – animals understand what each cry means only after they have experienced it in a meaningful context.

In fact, the ability to interpret another individual's utterances is so universal that some animals even learn to understand alarm calls made by other species. Prey animals can use such information to avoid predators, for example. Christopher Templeton of the University of Washington in Seattle found that red-breasted nuthatches understand and differentiate between the alarm calls of black-capped chickadees so well that they know whether a call signifies a medium or high-level threat (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0605183104). Likewise, some predators who hear the alarm call of their prey often give up the hunt – presumably because they know they have been spotted.

Finally, the observation that monkeys may combine their calls to create new meanings shows that learning is clearly taking place, but that it is "scaffolded onto a predisposition to use calls in predetermined ways", says Klaus Zuberbühler of the University of St Andrews in the UK.

Alarm calls are not animal "words", but could be their precursor

related to us, some ape experts believe that the connection between context and call-type could be an evolutionary precursor to the human ability to make specific words refer to specific things.

The most hotly contested territory in the language evolution debate is syntax, the grammatical rules we use to combine words in a meaningful way. It has long been believed that only we are capable of understanding and deploying any of the structural devices found in human syntax, but in recent years Zuberbühler has shown that wild monkeys use a rudimentary syntax when they communicate. Campbell's monkeys in the Tai Forest of Ivory Coast have an alarm call that warns other monkeys of crowned hawk eagles and a different call for leopards (see Primal scream). They also use a combination cry, in which either of the alarm calls is preceded by a boom sound. This indicates a lesser threat such as the detection of a far-off predator or breaking branches (*Animal Behaviour*, vol 63, p 293). Zuberbühler likens the boom to qualifiers we use, such as "maybe" or "kind of".

The meaning of pyow

Male putty-nosed monkeys also combine two basic calls to add meaning to a message. Typically, they produce a "pyow" sound in various situations – most often as an alarm in response to the sighting of a leopard – and they make a "hack" sound when they see an eagle. Zuberbühler and colleague Kate Arnold discovered that these monkeys also make a "pyow-hack", a combination call that means something like "let's go" (*Animal Behaviour*, vol 72, p 6430). Recently they have shown that the various hacks and pyows contain at least three types of information: the caller's identity, the threat it has witnessed and whether or not it intends to move to avoid the danger. Other monkeys are able to extract all this meaning from the calls (*Current Biology*, vol 18, p R189). The findings, says Zuberbühler, suggest that primates have some naturally occurring syntactic abilities, challenging the widespread belief that the transition from non-combinatorial to combinatorial communication was an essential step in the evolution of human language.

Other researchers remain sceptical, and recent experiments show how difficult it can be to determine whether or not animals have some grasp of syntax.

A simple grammar may account for some structures found in human language, for example, a so-called finite-state grammar that follows the general rule (AB)n, where one syllable A is always followed by another syllable B, n times: as in AB, ABAB or ABABAB. However, if you want to account for the ▶

VINCENT J MUSI/AURORA PHOTOS

Who's a clever boy?

Some animals go way beyond squawks, woofs and hoots

As well as studying how animals communicate with each other, language researchers want to know the extent to which animals can learn to use human language. They have discovered some impressive animal linguists.

In 2002, a team at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, announced that a Border collie called Rico had learned the meanings of hundreds of words (*Science*, DOI: 10.1126/science.1097859). He could go into another room and retrieve an object he had been asked for, and was even able to do so when asked to retrieve an unfamiliar item from a set of objects for which he had already learned names. This suggests he was associating the unfamiliar word with the novel object, and assuming that that was what he had been asked for. The ability to make inferences is integral to the way we use language, but if Rico is able to do it, evolution of the general skill underpinning it may have preceded language by millions of years.

Another renowned communicator was an African grey parrot called Alex, studied for more than two decades by Irene Pepperberg at Brandeis University in Waltham, Massachusetts. Alex, who died last year, had learned the words for 50 different objects, seven colours and five shapes. He understood numbers under 10 – though could not count in sequence – and grasped the idea of "zero", a concept considered particularly sophisticated because it requires an understanding of nothingness.

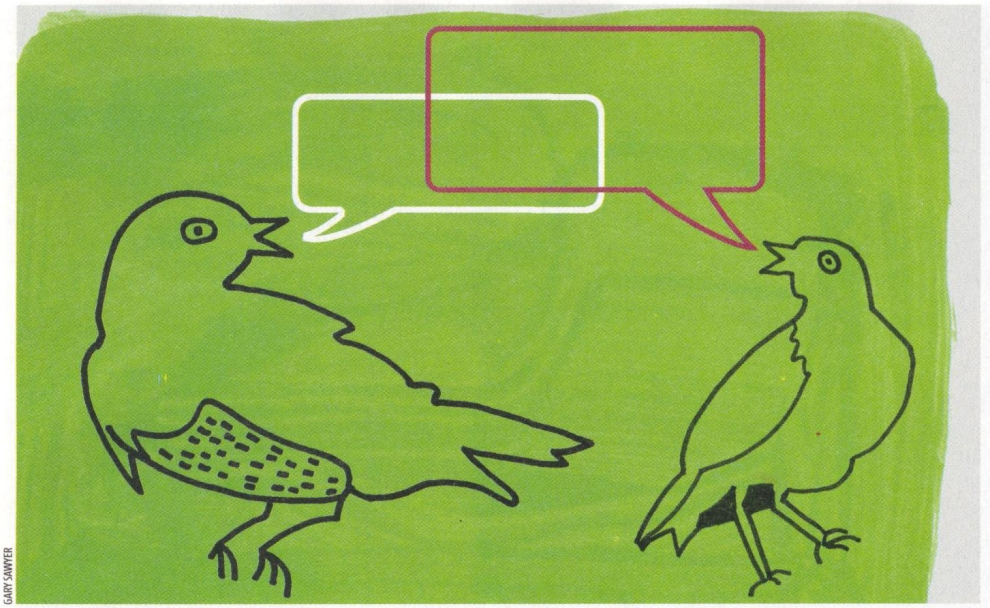
One of the longest-running and most productive investigations into the ability of animals to understand and use components of human language has been with apes. This line of research really took off in the early 1980s, when Sue Savage-Rumbaugh, then at Georgia State University in Atlanta, realised that chimps are best taught indirectly rather than explicitly – just like human toddlers. For years she had been trying to teach words on a picture keyboard to a bonobo called Matata, with limited success. Meanwhile, Matata's son, Kanzi, had observed these lessons. When Savage-Rumbaugh finally focused on Kanzi, he immediately used the picture keyboard, combining symbols to communicate what he wanted her to do and what he wanted to do next. He had been learning language all along.

Over many years, Kanzi and other apes have learned to comprehend spoken English, coming to understand hundreds of single words and longer constructions. Using picture keyboards, they participate in two, three and four-way conversations with humans and one another, about objects, intentions, actions and states of mind.

Bonobos can understand sentences that contain one verb and three noun phrases – "Will you carry the M&Ms to the middle test room?" – but have trouble with conjoined sentences that require two separate actions. They have been known to spontaneously combine single words to create new words, using "water" and "bird" as "waterbird" for a duck, for example. Kanzi in particular is able to comprehend hundreds of sentences that he has never heard before, such as "show me the ball", "get me the snake picture" and "can I tickle your butt?" On one occasion, Savage-Rumbaugh told him to put water on a carrot, and he promptly threw the carrot outdoors. Thinking he had misunderstood, she repeated the request. In response, Kanzi pointed insistently outside. It was raining.

The fact that bonobos can acquire language skills equivalent to those of a 2½-year-old child shows that having a rudimentary language ability is not uniquely human – even if having a superlative capacity for language is.

Alex the African grey parrot had an impressive vocabulary and grasp of concepts



GARY SAWYER

most complicated human syntax, you need a more expressive construction, called phrase-structure grammar. This can be captured by the basic rule An Bn, where a given number of A syllables is followed by the same number of B syllables: as in AB, AABB, AAABBB.

In 2004, Tecumseh Fitch from the University of St Andrew's and Marc Hauser from Harvard University tested the ability of tamarins – monkeys with whom we last shared a common ancestor 45 million years ago – to understand these two different types of grammar, by playing them recordings of sequences of sounds. When the recordings mainly followed the (AB)n rule, monkeys would react with surprise to sequences that violated it, suggesting that they had an expectation about how the sounds would be arranged. However, they showed no sign that they could detect violations of the An Bn structural rule. Adult humans, in contrast, noticed irregularities in sequences of sounds whether they represented a finite-state grammar or a phrase-structure grammar (*Science*, vol 303, p 377).

In 2006, Timothy Gentner from the University of California, San Diego, and colleagues used the same experimental approach with starlings. Using natural starling sounds and exposing their subjects to many more examples than Fitch and Hauser had done, the team found that the birds could detect violations of both types of grammar (*Nature*, vol 440, p 1204). Gentner's paper received a lot of public attention, and many researchers were surprised by the results. Some welcomed the findings as proof that the syntax underlying human language is not a monolithic ability – that the differences in our syntactic capabilities and those of other animals are quantitative rather than qualitative. The experiment was not universally accepted, however. Some scientists questioned whether the birds were really grasping syntax as opposed to just counting the strings of As and Bs. Others pointed out that the humans in the original experiment might also have been counting the experimental stimuli – a possibility that Fitch acknowledges.

One reason why Gentner's results have been so hotly contested is that he claimed they indicate that starlings are capable of understanding recursion – linguistic structures that are embedded inside other structures of the same type, for example, sentences within sentences. That is a bold claim, given that Noam Chomsky, Hauser and Fitch have argued recursion may not only be the central process of syntax, but may also be the only component of language that is unique to humans. Nevertheless, whether or not Gentner's interpretation is correct, other linguists are increasingly questioning that special status for recursion. Daniel Everett from Illinois State University in Normal has claimed that there is no recursion in the language of an Amazonian people called the Piraha. Recently the outspoken linguist Derek Bickerton from the University of Hawaii in Honolulu even suggested that recursion does not exist, it is simply an artefact of analysis.

What nobody disputes, though, is that human language is a spectacular phenomenon. It is hard, for instance, to overestimate the intricacy and power of all the syntactic strategies that human languages deploy, and there remain many complexities of linguistic structure that have no apparent analogue in the animal world. Similarly, animals may well show the ability to understand and even use some words, but no other species can deploy the sheer number of words that humans do.

Speech also remains remarkable. Philip Lieberman from Brown University in Rhode Island argues that the athletic precision with which we manipulate our mouths and tongues in speech is the singularly human part of the language suite.

Nevertheless, other animals clearly do have greater talents for communication than we realised. In particular, the finding that primates in the wild use simple structural rules, not to mention the fact that many different kinds of animals can make use of human words (see Who's a clever boy?, page 33), contradicts the idea that creating meaning with sound and structure is unique to humans. Sure, we are still special, but it is a far more graded, qualified kind of special than it used to be. ●

Christine Kenneally is a writer based in New York. Her book, *The First Word: The search for the origins of language*, is published by Viking

What's left to us?

ART: Although various primates, and even elephants, have charmed the art world with their abstract paintings, humans are the only species capable of representational drawing.

COOKING: Terrestrial animals have an innate fear of fire but it seems our ancestor *Homo erectus* overcame it to pioneer cooking, perhaps as early as 1.9 million years ago.

RELIGION: Belief in a supernatural being is probably not attainable by non-human animals, since they lack sophisticated imagination and the ability to attribute mental states – such as desire, belief and knowledge – to other individuals.

HUMOUR: Chimps, gorillas and even rats laugh but, slapstick aside, humour requires language skills beyond the reach of non-human animals.

SPORT: All social animals play, but sport is a unique kind of play often entailing special equipment, complex rules, referees and dedicated spectators. Far from being trivial, sport is underpinned by many of our most advanced congitive abilities.

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for more about the origins of morality, culture, personality and emotions, plus video clips of animals behaving in ways once thought unique to humans