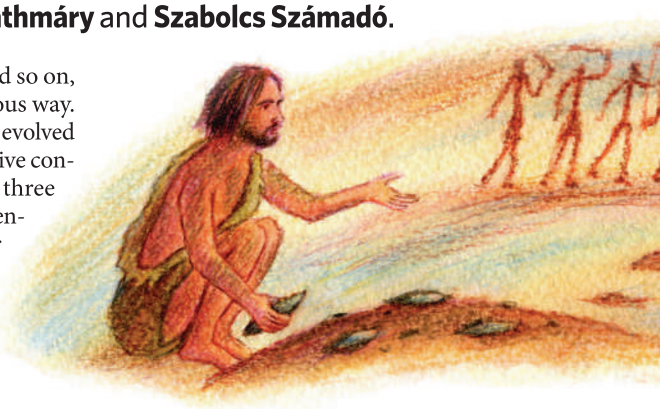
ESSAY

Language: a social history of words

Language evolved as part of a uniquely human group of traits, the interdependence of which calls for an integrated approach to the study of brain function, argue **Eörs Szathmáry** and **Szabolcs Számadó**.



Our ability to communicate using language is often cited as the element that sets us apart from other animals. Although language is not uniquely human in all aspects — dogs and apes, for example, can learn the meaning of many words — it almost certainly merits special status. This is because, more than any other attribute, language was probably key to the development of the set of traits that makes humans unique.

The evolution of language probably occurred in concert with the evolution of many of the other traits we associate with being human, such as the ability to fashion tools or a strong propensity to learn. If this is true, it suggests that we shouldn't be trying to understand one characteristically human trait in isolation from the others. Moreover, instead of the brain being a collection of separate modules, each dedicated to a specific trait or capacity, humans are likely to have a complex cognitive architecture that is highly interconnected on multiple levels.

Enhanced communication would have aided humans at least as far back as the Late Pleistocene, around 120,000 years ago. By this point, humans were proficient at hunting large game. Indeed, the advantages that groups of hunters would have derived from better communication may have helped drive the evolution of language at first. But language was almost certainly later co-opted for a wide array of activities. The diversity of behaviours that appeared during the Late Pleistocene, including fishing, use of pigments, and tool and weapon making, as well as the rate at which they emerged, suggest that by the time humans acquired the full set, they could also communicate using complex language.

Many of these developments had a clear social context: making spear points or using pigments, for example, must have relied on learning from other group members. Studies of chimpanzees show that without language, the spread of knowledge in basic tool-using tasks, such as using a stone hammer and anvil to crack a nut, is highly inefficient.

In fact, the bulk of our grammatical machinery enables us to engage in the kinds of social interaction on which the efficient spread of these tasks would have depended. We can combine sentences about who did what to whom, who is going to do what to whom, and so on, in a fast, fluent and largely unconscious way. This supports the notion that language evolved in a highly social, potentially cooperative context, involving and requiring at least three attributes: shared attention, shared intentionality and theory of mind. In other words, individuals would have been able to pay attention to the same scene or object as others; be aware that they must act as a group in order to achieve a common goal; and attribute mental states to others as well as to themselves.

Uniquely human

The probable emergence of modern language in the context of these other capacities points to the evolution of a uniquely human set of traits. We've barely begun to probe the architecture of this 'suite', but there is little to suggest that each capacity evolved one by one, or that they could be lost independently without harming at least some other traits in the set.

Take cooperation. In humans, practices such as staying faithful to one sexual partner and sharing food suppress competition within groups. These can be upheld more easily with language, because language means details can be agreed on and conflicts cleared up. Hunting in packs is more efficient if hunts can be planned and plans communicated. And both cooperation and communication using language are easier if people can pay attention to the same thing, are aware that others have states of mind that may differ from their own, and realize that they need to act as a group.

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Moreover, some of the traits in the suite require very similar types of operation. Language is not critical for making tools; the steps involved can be spread by non-verbal teaching and imitation, or learnt through individual experience. But, in the same way as syntax, the 'action grammar' of complex manipulations involves hierarchical processing. When we fashion a tool, just as when we form a sentence, we construct it from simpler units.

Joined-up development

Evidence supporting the close-knit evolution of traits comes, for example, from experiments showing that people who struggle with grammar also have difficulties drawing hierarchical structures, such as a layered arrangement of matches.

In addition, recordings of brain activity suggest that the same cognitive structures are involved in linguistic processing and tool making. In a recent study, a group of people was asked to make a specific type of ancient stone axe, which required different types of work to be done in a specific order. Brain images taken during the process revealed activation in a region in the right hemisphere. This is analogous to a region in the left hemisphere called Broca's area that is involved in language. The right-hemisphere area is also known to take on language-processing duties when the left hemisphere is damaged at an early age.

Establishing how the genes underpinning the various traits interact may likewise provide support for the idea that the human traits are closely interrelated. Of course, genes don't code for language or the capacity to fashion tools. They code for proteins and RNA molecules that serve structural, functional and regulatory roles. Take the *FOXP2* gene. When mutated, this disrupts motor control of the mouth and face, and the shaping of words, such as regular verbs in the English past tense. *FOXP2* is expressed in vertebrates other than humans and in human tissues other than the brain. In birds and mammals, it seems to be involved in the general development of neural circuitry that ensures the smooth, fast delivery of sequential movements.

That the genes involved in a cognitive trait affect other traits, and have effects that interact with each other, is business as usual for complex behaviour. But the result is likely to be a network of interacting effects, in which evolution in one trait builds on an attribute already

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modified as a by-product of selection acting on another. The nature of the gene networks underpinning complex behaviour suggests that several genes will have been selected for because they enhanced proficiency in a range of tasks — whether in social, linguistic or tool-use domains.

Analysing whether the genes involved in, say, cooperation, influence other traits in the suite is an exciting avenue for research. As a first step, it would be useful to clarify the functions of the hormones oxytocin and arginine vasopressin. Certain genetic variants of these hormones' receptors have been linked to autism, a brain disorder that impairs social interaction by disrupting language development and the capacity to pay attention to the same thing as other people. Genetic changes in the vasopressin receptor gene also correlate with how people allocate funds to other players in a game of experimental economics investigating altruism.

Cutting out the knife

The functional interdependence of characteristically human cognitive traits, plus the interlinked gene networks likely to underpin them, point to a complex cognitive architecture. The distinct gene networks and brain regions underpinning each trait can be likened to the separate towers of a castle, which are connected by common rooms and corridors. This picture could potentially replace the much-used 'Swiss army knife' view of the brain. Long advocated in evolutionary psychology, this proposes that separate cognitive modules perform specific functions. Several observations that are at odds with the knife model could be explained by the more holistic castle view.

For example, as shown by people with syntax deficiencies being poor at drawing hierarchical structures, capacities can be synergistic, where proficiency in one domain means proficiency in another. In addition, disruption in a specific element of one trait is often accompanied by a problem in another capacity. For instance, people who have trouble formulating grammatical sentences tend to fare worse than average in IQ tests because of poor short-term memory. This is consistent with the view that genes affecting a combination of cognitive capacities are far more common than genes whose disruption would harm a single trait.

The disorder known as specific language impairment also poses problems for the Swiss army knife view. As its name suggests, this condition is generally considered to affect only language. Nonverbal IQ is apparently left largely intact. But, although in the 'normal' range, children with this syndrome tend to show significantly lower IQ scores than their siblings. And even adult sufferers often have problems in capacities aside from language, for example, in auditory processing and motor skills.

Together, these observations suggest that if the modular, Swiss army knife picture of the brain is applicable at all, it may be so only to the final outcome of development. Associations of specific brain regions with certain traits are clearly evident, but these should be assessed at different stages in development and investigated as part of a multilayered network of interactions. A more holistic approach is likely to reveal 'intermediate capacities' that have emerged as a result of evolutionary selection acting on multiple traits. Analogical reasoning — the ability to transfer information from one object to another and deduce something about the second object from the first — may fall into this category, as this is critical in tool use and tool making, but probably also opened up possibilities for complex language.

The evidence strongly suggests that language evolved into its modern form embedded in a group of synergistic traits. However, language almost certainly holds special status over the other traits in the set. More than any other attribute, language is likely to have played a key role in driving genetic and cultural human evolution.

Language enables us to pass on cultural information more efficiently than can any other species. It's taken about 40 million years, for example, for five agricultural systems to appear in fungus-growing ants. Human agriculture diversified on a massive scale in just a few thousand years. Language makes it easier for people to live in large groups and helps drive cumulative cultural evolution — the build-up of complex belief systems, and the establishment of laws and theories over several generations. It has allowed us to construct a highly altered social and physical world, which has in turn shaped our evolution. Cultural evolution has shown us that one word can be worth a thousand genes. Language was the key evolutionary innovation because it built on important cognitive prerequisites and opened the door to so much else. ■

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