

No motor action is more difficult to coordinate than speaking

Linguist and cognitive scientists Philip Lieberman about the evolution of our ability to speak

Philip Lieberman had a long career. He was one of the first linguists to work in the Darwinian framework of natural selection. His new book, *The Unpredictable Species: What Makes Humans Unique*, explains what creativity and language have in common.

Mr. Lieberman, is language a biological or a cultural phenomenon?

It is both. All humans have the same cognitive abilities. The cultural framework determines which language they speak and how complex it is. The structure of our brains makes it possible to acquire language. This happens through learning processes. We need neither a specific language organ nor a universal grammar.

UG is a concept of the American linguist Noam Chomsky. It claims that all human languages follow the same grammatical principles, which are innate. You do not share Chomsky's view?

His concept does not work. For example the passive of Turkish violates a principle that is supposed to be universal. In Brazil exists the Pirahã language. It also lacks an element that Chomsky claims all languages share: complexity¹. Chomsky's theory makes the wrong predictions.

You have been once Noam Chomsky's student.

That is true. I took his courses when I studied engineering sciences. But later I moved slowly away from his views. His explanations made less and less sense to me. At the core, all languages seem to be like English.

How did you come to linguistics from engineering?

In my dissertation I worked on breathing control during speech and investigated the complex regulation of the muscles that are involved. That means I started to deal with biology, and I read the books of evolutionary biologist Ernst Mayr. At that time I was one of the first linguists who worked in the framework of Darwinian natural selection.

Evolution also plays an important role in your newest book [not yet available in German]. Why did you call it 'The unpredictable Species'?

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In my book I deal with the questions why are humans creative and whether the brain bases of creativity and language are connected. The answer is: of course, the cognitive abilities that have evolved in humans underlie both creativity and language. Our behavior is not as determined by our genes as that of other organisms. In novel situations individuals can invent new things and modes of behavior that are copied by almost everyone else. Our culture, our behavior, and our languages are constantly changing. In this sense we are unpredictable.

Chimpanzees also have considerable cognitive abilities. Why are they not able to speak?

Their brain does not allow them to learn and execute the complex motor routines that are needed for speech. No other human motor routine is harder to learn than speech. Only by age of 10 – 12 years do children speak at the same level of proficiency as adults. Speech also involves odd anatomy: humans have the strangest tongues of all animals. The human tongue is sited way down in the throat, which enhances the process by which speech is perceived. But that comes at the cost of increased risk of suffocating while swallowing food. In the USA this is still the 4th common cause of accidental death. Newborns have still the entire tongue in the mouth. Neanderthal skulls look like enlarged infant heads because Neanderthals did not have their tongues and larynx sited as low in the throat as we do.

In 1971 you were one of the first to simulate the speech of Neanderthals with computational models. How did you do that?

Because of the similarities between newborns and Neanderthals we used x-rays from infants who were swallowing and screaming to simulate the speaking abilities of Neanderthals on a computer. We discovered they could make all the sounds except for i, u, and a.

So Neanderthals already spoke to one another?

They certainly had a language. Our scientific paper from 1971 is often misinterpreted. We never denied that Neanderthals spoke. Our conclusion was that they could speak, just not as efficiently as we.

Was this inefficient speech of the Neanderthals still useful?

Even though there was a pretty high error rate they could communicate, certainly an advantage. The fact that humans evolved our strange tongue indicates that the ancestors of modern humans and Neanderthals had speech. Otherwise this adaptation would have brought no advantage. I believe language evolved gradually through a process that began several million years ago. Possibly even *Homo erectus* had already a form of speech. I have changed my view on this. Earlier I thought, the evolution of our ability to speak began a few hundreds of thousands of years ago.

Are there also genetic data that corroborate this?

The FOXP2-gen, which played an important role in the evolution of our ability to speak, is different in modern humans and Neanderthals compared to chimpanzees. This change must have occurred before modern humans and Neanderthals split roughly 500,000 years ago. But there is an additional mutation, which is only found in the modern human version of FOXP2. This was probably essential for the evolution of the human brain.

How did the possibility of genetic research change your field of research?

Now we can trace the changes that affected the human brain on a fundamental level – and in the distant past. Thanks to complete DNA profiles from bones that are thousands of years old speculation about the Neanderthal brain has been replaced by objective research.

How important are image-creating techniques in language and cognitive research?

The problem is that some of these techniques produce nonsensical results. You can, for example, attempt to isolate a part of the brain area that allows us to playing tennis. You can start by imaging the brain of someone who first imagines playing tennis and image the person while they imagine themselves just running back and forth. If you then subtract the running around neuroimaging from that of imaging that you're playing tennis can identify the supposed center or neural module for playing tennis. That is of course, nonsense. But there are researchers who are identifying modules for morality or religion in this manner.

What are, nevertheless, the advantaged of these new [imaging] techniques?

If used properly they allow indeed finding out more about the function of certain brain structures. But it is important to keep in mind that the brain does not consist of modules that each control a particular aspect of behavior. The brain is a complex system, the parts of which are connected by circuits. Some of the circuits share elements. Interestingly our neuronal circuits are very similar to those of rhesus monkeys. But we are neither rhesus monkeys nor chimpanzees. The key difference probably in regulatory genes like FOXP2 which increase the efficiency of the entire circuit

Then there is no module for language in the brain, like say the Broca-area?

A module for language does not exist. A whole series of structures must work together to enable various linguistic processes. For example when one retrieves words from memory, a circuit that links areas of the prefrontal cortex, basal ganglia, and other sub-cortical structures is activated. The circuit is connected to brain structures that store memories.

But the theory that the Broca-area is the language center is still widely accepted.

Probably because it intuitively explains our language ability. But in the 1980s researchers showed that humans do not suffer permanent language loss, except when subcortical regions are damaged. And on the other hand, there are many cases in which patients had a completely destroyed Broca's area after a stroke and ability to use language returned.

Do you think that the basal ganglia (brain-structures with motor- and cognitive functions) play an important role for language [speech]? What supports this view?

Basal ganglia are involved in many functions. They evolved hundreds of millions of years ago in animals that are similar to modern frogs. But the capacity of the human basal ganglia has been massively increased during the last 200,000 years through genes like FOXP2. That's why we have neural circuits that enable human language, creativity, and fine motor control. In Parkinson disease, where basal ganglia activity is compromised, one thus finds a syndrome - symptoms that are seemingly completely unrelated to each other. Besides cognitive deficits there are also language impairments, fine motor impairments and changes in personality. This shows that different parts of the brain communicate via the basal ganglia.

How do speech problems manifest themselves in Parkinson patients?

They have difficulties understanding sentences that 10-year old children easily comprehend. We tested medication that improves basal ganglia function for Parkinson patients. The patients showed much better comprehension with medication than without. Similar deficits occur in high altitude mountain climbers. We tested climbers at Mount Everest and found that at higher altitude they had problems with speech coordination. The basal ganglia need more oxygen than other parts of the brain and are affected first in high altitudes.

What makes you proud when you look back at your scientific career?

I am glad that I can say that some of the theses I introduced in presentations, scientific papers and books have been confirmed or improved by newly available scientific methods. Others have been disproven. But that is equally important.