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> ONE MONTH, ONE PROTEIN <

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Talking heads

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Humans can talk. Other animals cannot. So there must be something inside us that is quite particular to the species. Certainly, the human larynx is placed in such a way that it supports our vocal miracles. But the positioning of the larynx itself is not at the heart of our capacity to form words, nor to learn them, remember them, reproduce them and place them in an order which makes sense to our listeners. All this demands neuronal as well as motor facilities, which are unique to humans. Could the art of speech be genetic? 'Well…kind of', say researchers. There certainly seems to be growing evidence that the human faculty of vocal communication bears a genetic component. And who says gene, says protein… FOXP2, a transcription factor, was discovered a few years ago and, though its exact function remains unknown, it is now quite certain that it participates in human language skills.

Talking and thinking, Atanur Dogan

Courtesy of the artist

In the 19th century, the British Academy and the Société Linguistique de Paris were expressly requested not to discuss the origins of language because the subject – though captivating – was so abstract that no one could come to a consensus. Things have become a little less hypothetical since a family with a speech impediment – the KE family – was discovered in the late 1990s. Speech impediments do seem to run within families but what is peculiar to the KE family is that their impairment is obviously inherited and in a clean Mendelian fashion. That is to say that, over three generations, descendants have inherited the speech defect as an autosomal dominant phenotype. Traces of the first speech problem were diagnosed in the grandmother, so she must have inherited the mutated genotype from her parents.

Theories of the genetic origin of human language have been hovering over the scientific community since the 1950s. And scientists have been searching for what they would like to call 'the speech gene' – or SPCH1 – for years. In the 1990s, they had managed to narrow down their research to a domain on chromosome 7. And when the KE family appeared, they managed to pinpoint the exact spot, which turned out to be a gene coding for a transcription factor belonging to well known family of proteins: the forkhead group of transcription factors. These factors all sport forkhead-box (hence FOX) domains, which are regions made up of stretches of 80 to 100 amino acids that bind to DNA. So following the current gene nomenclature, SPCH1 became FOXP2.

What kind of speech impairment is the KE family inflicted with? In a nutshell, those who have inherited the phenotype cannot form the subtle facial movements necessary to pronounce words properly but they also have problems with the comprehension and production of grammar as well as written language. However they have no muscular facial malformations, which suggests that the deficiency is neurological. FOXP2 appears pretty early in foetal development where it is found in the brain. So it is not implausible to imagine it

playing a role in the formation of parts of the brain connected with spoken language. What is more, neuroimaging studies of affected members of the KE family show structural and functional anomalies in a number of brain regions, amongst which is Broca's area known to be related to language.

It is most likely that FOXP2 alone is not the sole cause of the speech impediment. FOXP2 is a transcription factor, and it is probably at the top of a genetic cascade which ultimately has an effect on brain development, and more specifically on parts of the brain involved in language. So the idea of a 'one speech gene' does not fit. What is more, FOXP2 is also expressed in the heart and the lungs, and there is no evidence of deficiencies in these tissues. In this light, it may well be that FOXP2 acts in a dose-dependent way, i.e. that the affected individuals do not have enough functional FOXP2 for complete brain development, however the level is sufficient for the development of the heart and lung tissue.

Mice also express FOXP2 in their brain. And so do chimpanzees. So why can't they speak? What most probably happened is that a genetic cascade – and hence a protein cascade – favouring the development of speech has been tinkered with and put to human advantage over time. Although it has not undergone all that much tinkering since FOXP2 has been very conserved across species and through time. The human protein sequence has only undergone three amino-acid changes since humans diverged from mice – which was about 100 million years ago – and merely one amino-acid modification since we diverged from chimpanzees, about 5 million years ago. This third mutation probably arose around 200 000 years ago, together with the emergence of modern humans… It all seems to fit in very well, yet some scientists call for caution. There is no fossil evidence of language dating back so far. The first archaeological evidence of the existence of language – though always hypothetical – dates back 50 000 years to the emergence of subtle funeral rites and certain forms of art.

FOXP2 and the KE family have certainly shed a different light on the theory of the origin and development of language in humans, as well as inflictions related to language. How about gene therapy? We are dealing with humans, and though research in this direction would be extremely informative, there are ethical barriers. Scientists can tamper neither with humans nor with non-human primates. And inserting a human version of FOXP2 into a mouse, for example, would be of little value because of the great physiological difference between us. Despite all this, the fact that language does have a genetic component certainly puts things into a different perspective and is a basis from which theories on its origins can be made.

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