Fundamentals of language Acquisition

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Week 01

Lecture 03

Lec 3: Biological markers of evolution

Hello and welcome back. Today we will have our Lecture 3, and we will continue with the biological markers of human evolution and the evolution of language. In the previous segment, we saw that the primary data and primary analysis from the biological markers are heavily dependent on analogous and homologous comparisons and how they have informed us about how humans are different and what kinds of similarities and dissimilarities we can find. So today we will start with the markers themselves. There are a few markers, which are called biological markers, that are considered to be essential for the emergence of language among humans. Okay, so first we will talk about the gene, the genetic marker, and eventually, one after another, we will talk about the brain, the larynx, the vocal tract, and so on.

So, let us start with the gene, the genetic markers. Now, we have already talked about Darwin and his influence on the theory of language evolution. Another important name that has shaped the understanding of genetics among humans is Gregor Johann Mendel. His 1866 work contributes heavily to the understanding of genetics and subsequent research that has looked at mutation as one of the key factors in determining how genetics in humans and other species behave.

As a result of Gregor Johann Mendel's influence, much subsequent research looked at genetic mutations. So, one of them is, for example, Hugo de Vries, who talks about mutation as the main mechanism of evolutionary change, and thus he regarded it as more important than natural selection. However, at the same time, there are a number of other scientists who prefer natural selection because they believe that small mutations and small changes over a period of time do not necessarily lead to the big changes that are typically part of evolution. So, the influence of the accumulation of numerous mutations had a small effect on the phenotype is how they put it. By the 1930s, genetic studies had become quite popular, and many important studies were published during that time, resulting in the emergence of neo-Darwinism; this is called the neo-Darwinian synthesis.

Eventually, of course, with more technological progress, genetic studies delved into the biochemical processes within the genetic structure itself. And so, this is the background in which we examine the genetic underpinnings of language and language evolution. One of the most important genes in this regard is FOXP2. This is the forkhead box, which is shortened to FOXP2. It is from the P family, and it is the second gene that was discovered.

Now, this gene is the hero of our story because it is connected to language capacity in humans. Now, it has a very important function in the genetic system because it plays a regulatory role. What does it mean? The regulatory role means that this gene also regulates the functioning of many other genes. As a result, FOXP2 is not only responsible for itself and its expression, but also for the expression of other genetic structures. For example, the genes related to, I quote, "influence many phenotypic attributes, including the morphology of the lungs, the heart, the bowels, and the brain.

" So, that is how important the FOXP2 gene is. Now, for language development, both copies of the gene must be inherited by children; if there is any problem, such as not inheriting it in its entirety or a genetic change, for example, a mutation, there will be repercussions for language. Now, this was not known overnight. There is a very interesting beginning to this entire story with respect to FOXP2 and language capacity. It all started with a family that was found to have a number of SLI patients within the same family, and it seemed to be hereditary.

The family is called the KE Family. And within a single extended family, there were a number of SLI patients. SLI stands for Specific Language Impairment. Specific Language Impairment, as the name suggests, is not dependent on any other cognitive disorders, delays, or anything else. It specifically affects linguistic capacities.

That is why it is called that. Now this happened in the 1960s; later, when FOXP2 was discovered and its structure was found, it became possible to connect the FOXP2 gene with the language disorder. And eventually, it was understood that there was a mutation in the FOXP2 gene that caused the disorder. Eventually, of course, there were further studies on this topic. So this finding with the family, and subsequently the understanding of the structure of the FOXP2 gene and how the mutation of the gene can affect language disorders, is important.

This was the beginning of connecting language as a faculty to genetic structure itself. So, this was the beginning, and of course, today we in the studies have been more and more fine-tuned, and today scientists warn that even though FOXP2 has a very important role to play, it is not a single gene that decides how language evolution took place. So, it is kind of polygenic in nature; the influence is polygenic, which means that more than one gene is probably related to the development of language. Now, this FOXP2 gene has also figured in a large number of publications in terms of whether it is intricately and inherently a human characteristic or available in other primates, higher primates, as well as our other ancestors like the Neanderthals and Denisovans, and so on and so forth. So, a large number of studies took place in the 2000s.

In fact, there was a project called the Neanderthal Project that looked at these issues at a much more critical level. So, the initial finding, for example, Ennard said that this is a specifically human gene, and as a result, this idea was used by the saltationists to claim that language appeared suddenly. Saltationists claimed that language appeared out of nowhere; there was no evolution, there was nothing; it just appeared suddenly at some time in evolutionary history. So they connected the sudden appearance of language to the mutation of the FOXP2 gene. So this is how it was viewed at that time.

But eventually, many more findings came to light, and it was found that even Neanderthals shared some derivatives of the same FOXP2 gene. So, as a result, the idea that Neanderthals possibly had a language took shape. So, not only the primates, but also at that level, there is homology—specifically, FOXP2 homology—available in terms of the gene level between humans and birds. So, these are some important findings that are quoted here. Not only in humans but also in Neanderthals and birds do we find traces of the same genes.

In fact, the Neanderthal debate also brought to light that a similar kind of mutation was found in the Neanderthals. So, this is quite a groundbreaking finding. So, this was completed in 2010. It brought to light that 99.7 percent of the base pairs exist.

Now, what is this base pair? All of us know that humans are similar to other higher primates at the genetic level by as much as 99 percent. So, the 1 percent difference that exists actually contains millions of pieces of genetic material. So, within that, we share a large number of similarities with Neanderthals and others, for example, the Denisovans. So, if that much similarity exists between modern humans, Homo sapiens, and the Neanderthals and Denisovans, there must be much more than just appearances and other traits. So, Fox P2 plays a very important role.

So, this meant that the genetic blueprint of these species was remarkably similar. So, the specific genes that are responsible for speech, language, and cognition support this assumption because they are also found among our close relatives. So this was found not only in one specimen but also in Neanderthal specimens found in different locations. For example, Neanderthal specimens from Spain, as well as those from the Altai Mountains in the Siberian region, are included. So, there are all these important findings, all these important papers, and there are many more that discuss how FOXP2 is not a uniquely human phenomenon.

It was also shared by Neanderthals, and as a result, they probably had language. So, for anyone who is interested in reading more about this, I have added the references. This is a rather lengthy debate, and there are some very interesting and landmark papers out there that you can read. We will move on to the structure of the brain. Now, at the genetic level, of course, we know that there is at least one gene responsible for the evolution of language.

Whether we share it with Neanderthals or others is not that important. What is important is that there are genetic underpinnings for linguistic capacities. Similarly, the brain is structured. Brain structure, as we all know today, includes certain areas of the human brain that are called "language areas." The most important of them are Broca's area, Wernicke's area, the auditory cortex, and the sensorimotor cortex, which all come together to help us speak and understand.

Monkeys and non-human apes are equipped with homologous subcortical circuits, and songbirds' subcortical circuits are analogous to ours, but they do not represent homologous structures. Recent imaging studies also show that apes and humans share similarities in the brain region known as BA 44, or Brodmann area 44, which largely corresponds to Broca's area. But the finding that we share Broca's area with many other higher primates, as well as with other animals, does not mean that they perform the same function. The most important finding in this regard is that, in spite of the similarities in the region, there are differences in terms of function. So, they differ not only in size and grade of laterality but also in cytoarchitecture and cortical connectivity.

So, even though it might look like the same regions are shared, the function differs because of all these factors. Now, in the case of apes, this particular area, Brodmann area 44, which is Broca's area, corresponds to sophisticated gestures, and for humans, this area is responsible for language, primarily language production, because we all know that in the case of a problem with Broca's area, we will have a problem with articulation, as it is connected to the articulation of speech. So, on the other hand, this is responsible for the sophisticated gestures of the apes. Now, early hominids had a structure that corresponded to Broca's area. However, over time, this area has undergone many changes.

What kind of changes? As we just saw, even though higher primates have the same Broca's area, in their case, it is used for gestures—sophisticated gestures. Now, in the case of the early hominids, this Broca's area existed. However, the functioning was not as fine-tuned as it was today. For example, scientists believe that Neanderthals did not have adequate control of their tongues.

The tongue is a muscle. So, in order for us to use the tongue to produce complex speech sounds and combine them, we need a very sophisticated control mechanism, which Neanderthals probably did not have, according to many researchers. Another problem is that we do not really know when the change happened or at what stage during evolution the change from an archaic system to a finely tuned, sophisticated system occurred, of which we are not very sure. Another thing about the brain that has been found out recently and has been talked about a lot is the capacity known as modern language computational capacity; now, just having the brain—that is, the hardware—is not enough; you have to have the software as well. It is called the MLCC, or Modern Language Computational Capacity. Now, this is based on a neurobiological substrate.

So, you need to have the hardware in place on which you will use the software, much like you need a certain kind of configuration for your PC to load specific software—something of that sort. Now, as humans progressed from early hominids to modern humans to Homo sapiens, this feature also underwent certain changes, and findings today suggest that early hominids did have a primordial aspect of the same capacity, which researchers have called PMLCC, a precursor to the MLCC responsible for basic compositionality for symbolic, vocal, and gestural signals. There was a certain amount of computational ability among the early hominids, which was primordial and later developed into what is called the MLCC: Modern Language Computational Capacity. So, when we talk about the brain as a brain structure and a biological marker, we mean both the size of Broca's area and its connectivity, cytoarchitecture, and computational capacity. Of course, we cannot go into more detail because of the time constraints.

Now, we move on to the third biological underpinning, which is the vocal tract and is more visible and easier to understand. So, the vocal tract, as we all know, is responsible for producing speech sounds. So, even if you have the genetic capacity, the brain structure, and the software in place, you need the instrument to create the speech sounds, which are your vocal cords. Now the vocal cords have a particular mechanism called the source-filter model on which they operate. What is that model? There has to be consistent airflow, there has to be vibration to create the sound waves, and there should be some mechanism to modify the sound structure, as well as a combination of various kinds of sounds so that you have a large inventory of sounds in the language.

So, first and foremost, the airflow, then the vibration, and then the combination of these things creates the language that we speak. Now, humans are not the only species. So, as a result, we are not the only ones endowed with vocal tracts. Many other species also have vocal tracts. So, everybody is aware of the birds' songs, and we also know about the dolphins' cries, which are considered quite sophisticated.

Similarly, whales and many other animals also have some sort of vocalization or another, which is not very simple; some are simple, some are slightly complex, but nothing is as complex as human speech. As a result, there must be something special about the human vocal tract that is capable of doing what no other species can do. So, at an abstract level, human language, as we have already talked about, is characterized by what we call design features, which may or may not have a parallel in other vocalizations. As of today, with the knowledge we have so far, we can say that we have not found similar complexity, but there is no guarantee that we will find it. So, today, we do not see any other species that has a similar level of complexity.

Secondly, at the level of speech sounds, we have a wide range of possibilities, and those sounds can combine, as we just mentioned. So, the main differences are as follows: So, the vocal tract in humans is not a uniformly tubular structure. The position of the larynx within the vocal tract is different from that of other species. Our larynx is much lower than that of other species, and another important aspect is the functional division of the vocal tract into two distinct parts, which includes the right-angle bend specific to humans. So, these are the characteristics of the human vocal cords.

So, the differences can be viewed this way. So, in most mammals, the larynx is located high enough in the throat to engage with the nasal passages, enabling simultaneous breathing and swallowing of fluids. This is one of the most important differences between the human vocal tract and those of other animals. The larynx is much higher in other species, which allows these species to breathe and swallow at the same time. But that is not the case with humans because our larynx is much lower; we run the risk of choking on food if we try to speak at the same time or breathe as well. That is why choking is a common occurrence among humans.

And this is also true for younger children. So, infants also have a larynx that is positioned quite high. It starts to lower around 3 months of age, and after that, it continues to lower until we reach the optimal position. So, the lower adult larynx sits at the bottom of a shared single tube through which both food and air travel. That is why we have the incidence of choking. In fact, this has been utilized as an argument for evolution because a particular biological feature must have evolved to be like this, resulting in some accidents having greater benefits.

What is that benefit? In our case, this is considered to be the use of language. So, we could speak, and choking could be a form of collateral damage; that is the idea here. So, the vocal tract is another important biological and physiological adaptation that is thought to be responsible for humans' ability to speak. Now, the human vocal tract is different from that of our closest cousins among the higher primates. This puts us at risk, but we have already talked about it.

Now, based on these 3 to 4 characteristic biological features among humans that apparently enable us to speak a language, a number of theories have been proposed, and there are arguments as well. So, the different theories and arguments are based on biological endowments. Let us look at some of those arguments. Now, these arguments have come from a large number of disciplines, as we have already seen that there are many domains from which language evolution is studied. So, there are linguistics, anthropology, psychology, evolutionary biology, and so forth.

Now, what is the problem, and where is the split? So, the primary split is whether there was an evolutionary leap that led to a discontinuity between humans and other primates. As we have already seen, FOXP2 was shared, and even the mutation or mutations were shared with Neanderthals. The vocal tract is among others with some differences, and so on. Similarly, brain regions are affected. So, was there continuity between other species and humans, or was there an evolutionary leap? Suddenly, some humans started to speak while others were left behind.

That is one of the debates. Secondly, is language primarily used for communication or for structuring thoughts? These are the two types of debates that we have regarding the concept of biological markers. So, first and foremost, the Saltationist view is. The saltationist view primarily states that language appeared suddenly. Suddenly, there was a particularly favorable genetic situation: the mutation of FOXP2. The names that you can see are some of them; there are many others, but some of the most influential scholars of our time have taken the saltationist view that language appeared suddenly.

Chomsky and many of his collaborators are on this list. So, Berwick and Chomsky take an all-or-nothing stance on this; that is, it appears suddenly. On the other hand, the Miyagawa approach allows for a certain amount of continuity. So, even within the saltationist view, there are two types. Some of them favor a sudden, all-or-nothing approach; on the other hand, Miyagawa allows for a certain amount of evolutionary continuity. So, Chomsky and Berwick maintain that syntax evolved suddenly in its entirety.

Now, this idea is based on Chomsky's theory that syntax is the most important aspect of language. So, if you have language, you have syntax; that is the kind of equivalence that Chomsky and his followers draw. As a result, when you say that humans started speaking, it means they started to have syntax. So, he does not have any proto-language or proto-form of syntax that is allowed in his theory. So, he says that it suddenly appeared, facilitated by a single biological event, such as a mutation.

So, as a result, there could not have been any protoform; there could not have been a simpler syntax. According to them, "the simplest assumption, hence the one we adopt, is that the generative procedure emerged suddenly as the result of a minor mutation." "There is no room in this picture for any precursor to language, such as a language-like system with only short sentences," I said. So, according to them, the mathematical acumen needed to understand evolution was not present in Darwin. In fact, they find fault with many other people, saying that those individuals do not possess the required qualities.

On the other hand, they provide a solution to this issue. For this, they have the idea of a strong minimalist thesis and propose it as the only serious way to understand the evolution of language, in which syntax is reduced to a single operation called Merge. So, they propose the operation of Merge, which takes care of the sudden appearance of syntax that, in turn, arises because of a biological facilitation in the form of the FOXP2 mutation. They have also made many other claims. Most of them boil down to the simple fact that none of the evidence provided by the other group was good enough. Either they are not theoretically strong, or they do not have the acumen to discuss it.

In one of their most important papers, Hauser and Chomsky's group discussed two kinds of the faculty of language: language in the broad sense (FLB) and language in the narrow sense (FLN). While FLB designates processes that are shared with other animals and are thus involved in language, as well as other sensory, motor, and conceptual intentional processes, FLN, in contrast, describes processes that are unique to humans. So, this is the human language that they are talking about. Now, there is a funny argument between Chomsky's group and the other groups. In terms of syntax, according to Chomsky and his group, it must be simple for it to be evolvable.

And since it has to be simple, it must have arisen from a single, minor mutation. This circular, entangled argument has been called "Chomsky's knot" by Progovac. On the other hand, we have Miyagawa, who talks about saltationism with a certain degree of continuity. The primary thesis of Miyagawa is that there is a coming together of the vocal system and the expressive system to create human language. How he goes about it is by saying that language did not suddenly appear in its full glory; it did not simply spring into existence.

He proposes what is called the integration hypothesis as an alternative to strong saltationism. This states that human language evolved from two distinct systems coming together: the lexical system, which is similar to the alarm calls of monkeys, and the expressive system, which is like birdsong. So, in the case of alarm calls in monkeys, he says that these are like lexical items: different calls for different kinds of entities. So, monkey calls do have different kinds of references. So, one kind of animal makes one kind of call like this: So, he calls it a lexical system.

On the other hand, birdsong is not called a lexical system because, according to him, it is just a sort of pattern of melody without any specific lexical meanings. Now, independently, these two systems have evolved for millions of years, and finally, they integrated into human language somewhere around 100,000 years ago; that is the idea. Now, in this way, he takes a middle path in some sense and considers how human language could suddenly emerge. Now, the problem is that there are many issues with his theory. One of them is that it is not clear why the precursor to human language took millions of years to emerge, while human language appeared suddenly.

Because remember, Miyagawa is also part of the saltationist group. So, there is no answer as to why this coming together happened suddenly and why humans started speaking. Secondly, there is an issue of correlation among human language, monkey calls, and bird song. So, if human language is a combination of birdsong and monkey calls, there should be some sort of correlation between them. So that is also not here. For example, one of the questions that has been raised is in what way birdsong truly corresponds to the functional and grammatical components of human language.

And how this monkey call maps onto the vocabulary of human language is that human vocabulary is much larger than monkey calls. So, that is how you account for that; that is another question. And then, what were the evolutionary forces? Why did it happen? That is another question, and it is unclear what kind of modifications were needed in the human brain to enable these questions. And thirdly, the other set of questions that has been asked, according to Miyagawa, is simple. Both birdsongs and monkey calls are simple structures, but human language is a complex structure.

So, how and why would it happen that one or two simple structures come together to create a complex structure? That has also been questioned by many scholars; for example, Talerman and Pragovac have questioned it. So, they find the idea fascinating. This is an interesting idea. However, the mapping is not very satisfactory, so to speak.

So this has not been fully approved by the scholarly community. So this is where we stop with this segment. We will cover the other parts in the next lecture. Thank you.