Cognition and its Computation
Prof. Rajlakshmi Guha
Prof. Sharba Bandyopadhyay
Biotechnology and Bioengineering
Indian Institute of Technology, Kharagpur

Lecture - 46
Introduction to Speech and Language (Development)

Welcome, we will be starting the series of lectures on Speech and Language. So, today in this introductory lecture we will discuss about Speech and Language the ideas behind speech and language and about language acquisition.

Next, we will be discussing the components of speech and how speech is produced and then we will talk about speech perception and finally, we will talk about lessons from animal models for vocalization production and possible learning in the different species and of course, the disorders with speech and language I have to end it.

So, if you think of the human species we are the only ones in the entire planet who actually produce speech using language that uses huge number of symbols or vocabulary that can be used to convey information. So, often we refer to speech and language as probably the most different form of cognition or higher cognition that is present among animals and that is present only with humans. And all of development I mean human development relies on this form of communication and comprehension of speech or language.

So, there are many forms of communication that is possible that is if you think of the ancient times through hieroglyphics or through symbols or through smoke signals or even through different kinds of sounds not exactly speech and also through hand gestures or other gestures that were parts that were a kind of language in the sense that they conveyed a meaning to the party that was receiving it and they would actually react based on the perception of the symbol that has been sent by the transmitting person.

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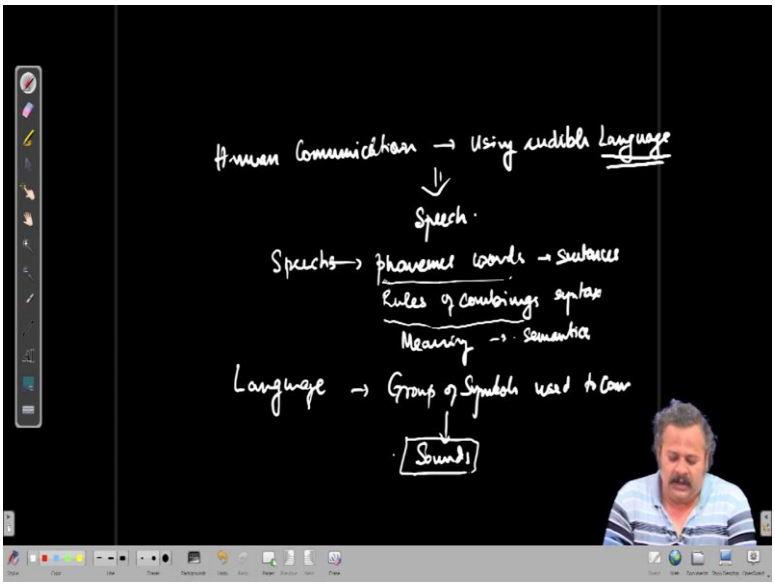

And if we think of speech it is the a specific form of those kind of languages and that is the form of human communication that uses audible language, human communication using audible language. So, the language is implicit here we have not quite said what language exactly is although there are many definitions of language, this is basically what we mean by speech.

So, we will get into this term language more in more detail but from the meaning of the literal meaning of language as you understand that is sufficient to understand what we mean by speech and this sentence that the human form of communication that uses audible language or spoken language and that is what is speech. So, speech is based on sounds or specific types of sounds and a huge variety of them that are created by the flow from the lungs and then shaped by the vocal folds and the pharynx and then articulated in the oral cavity.

And that is then produced to convey a particular kind of sound and so, speech contains many of these what we call phonemes as part of them, these are the utterances that are shaped by particular processes in the vocal tract and those phonemes and are form a sequence to form syllables and then words and then sentences. So, this kind of rules that are followed to finally, form the sentences that is actually part of language and speech is simply a tool of tool used by language in order to communicate.

So, speech has these phonemes as one part of them then there are the rules of combining them rules of combining them and that is basically the syntax and then we use them to we use them in a particular meaningful way and that is each of them has some meaning and that is what we mean by semantics. These three we will see are also part of language, but here it is the; it is the part of the language that is being used as a tool. So, that is the main distinction between speech and language.

So, if we talk of speech in terms of a vocalization without language that speech would have actually no meaning. So, the one inherent component of language is speech. So, and similarly speech requires language to be produced meaningfully. So, language if we say language is simply a set of symbols that can be that are used to communicate between a group of people or group of individuals.

This is probably the loosest definition of language that is possible although it is indeed correct and in we must qualify the group of symbols a little more and that is the it is an arbitrary group of symbols.

So, it does not have to have any particular nature. Although how many people use it and what and that it will be called a language, those are points of debate and all that and how two languages are different up to what extent in differences with what those are debatable points, but in terms of the meaning of language it is use of a group of arbitrary symbols to communicate between a group of people.

And that is indeed if you think of all the languages that you have heard of they are basically so, even if you think of a computer language that is programming language that is also a very similar thing. So, in terms of this group of symbols used to communicate so this, when this group of symbols are sounds when these are sounds that is they are produced by us and they are audible then the tool that we are using is speech and the language in this case would be audible or spoken language.

The other way to look at it other way if we think of more of specific definition of language then it would be the use of then then speech would come into it. So, we will not go into that kind of a definition but we will see as we have seen that speech is part of the language already.

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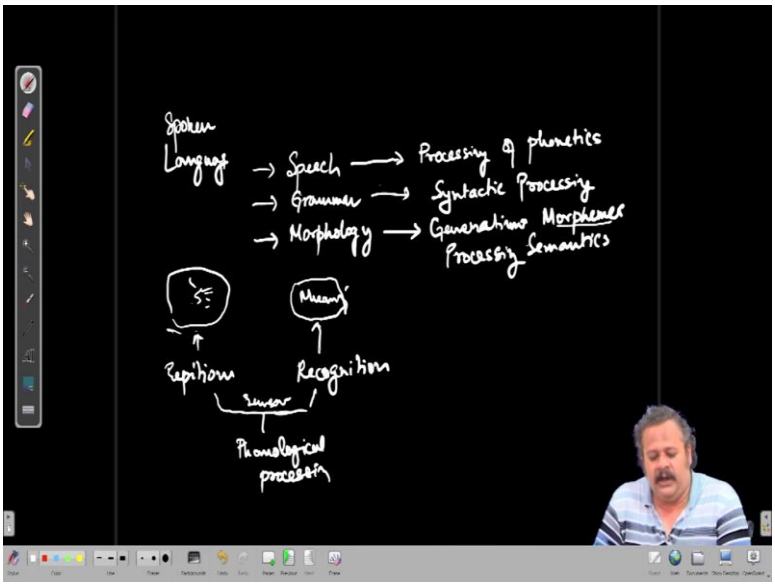

So, the basic components of language are first is the means of communication and so, if we talk of spoken language, then it is speech, then there is grammar and then there is morphology. So, the means of communication or speech this has to do with processing of phonetics, when we mean processing we mean either production or understanding that is the receptive part of language.

When we mean grammar, we actually mean syntactic processing that is the syntax that we were looking at that how different sounds should be combined together and the word should be combined together to produce meaning that is syntactic processing. And produce meaning is what is morphology and that is basically generation of what we call morphemes or that is processing semantics.

So, these three components are the real part of language where we have a new term here morpheme a morpheme is a unit of meaning. So, when we talk of semantics that is basically what we mean that the morphology of the language. So, as we have seen a little bit in the auditory system if we think of processing of phonetics then it is about how the impinging speech sounds the actual sound waveform impinges on the ear drum and is processed through the cochlea up to the auditory cortex and beyond this is part of the processing of phonetics.

So, this part is the receptive side of speech or the recognition side of speech and the other is the repetition side which is the production side of phonetics or phonological

processing. So, it is this this phonological processing is task dependent is task dependent, in recognition we are actually trying to get the meaning of a particular word and in repetition we are actually thinking of our production we are actually thinking of the motor side of it to actually produce that sound through our mouth.

So, there must be two different aspects of the brain systems that are involved in the repetition part and the recognition part because although they are they have to do with processing phonetics one has to do with comprehension or understanding and the other has to do with production or motor movement.

So, there is one both requires sensory inputs one goes into the direction of sensory motor output and the other goes into the sensory and into memory where we have associated words with meanings or concepts that are that we already know about with which we are associating the current word and understanding the meaning.

So, while at the root they are same starting with the auditory system that is the sensory side of it we go into the motor side for repetition or production and we go into the memory side for recognition and understanding and comprehension.

So, indeed you will see that actually the two areas that are involved with language and, but they are not exclusive have to do with these two elements or task dependence of phonological processing and it is the Broca's area and the Wernicke's area, where the Broca's area has to do with the production of speech and the Wernicke's area has to do with comprehension of speech.

We will discuss those a little more in later lectures and then we if we go into syntactic processing then it is not fully understood how the different brain regions are involved in syntactic processing we are only scratching the surface in terms of understanding that and it is believed that a lot of the frontal cortex has to play a role given the nature of the processing. And similarly the meaning part of it also requires higher cognitive processes because it has to do with memory and also recall of the memory and understanding.

So, it is not that there is one localized region in the brain that has to do with these forms of processing the phonological processing syntactic processing or semantics processing, it is not just that the Broca's area and the Wernicke's area are the ones that are respectively involved in speech production and speech comprehension there are other

areas also. Because from lesion studies when people have stroke and based on the deficits they have in terms of speech and language we can identify the involvement of many other regions in the processing of language or understanding of language or using speech to convey meaning.

So, recently of course, that is over the past few decades with advances in technology with getting far higher resolution FMRI faster than earlier higher with larger magnets and with MEG getting up to level where we can actually look at and localize the sources of the magnetic fields from currents in the brain tissue. We are actually now starting to understand much more about the specific regions that are involved and what aspects they are involved in for grammar and morphology.

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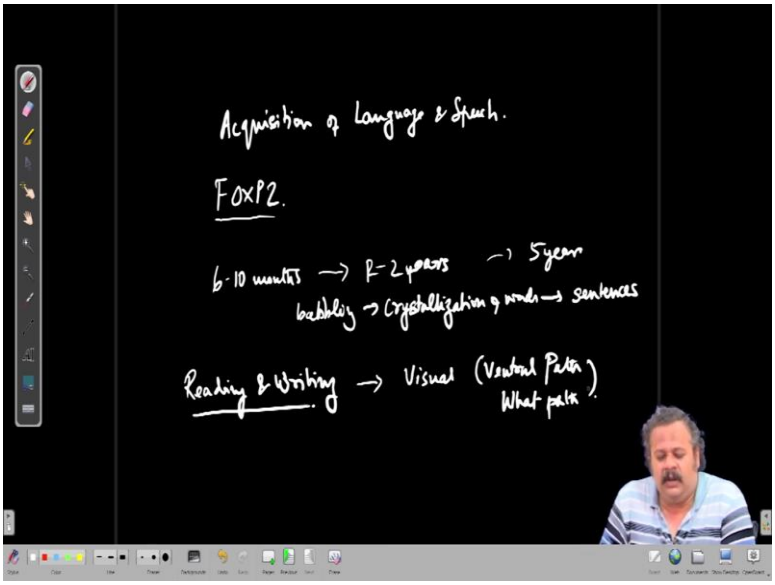

So, these are still open research like questions, one important aspect of this speech and language is the part of acquisition of speech or language acquisition of language and speech. So, this is a very important topic and has been a topic of debate for some time and is still ongoing over the last 50 odd years Noam Chomsky has been the one of the leading linguists and who has done a lot of work in terms of acquisition of language and what language is and so on.

The idea is that the language is specific to humans and that it is an innate ability of humans that other species do not have. So, while some part of it may be true based on evidence especially, given the discovery of the FOX P 2 gene. So, these are things that I

am talking about our over or like research topics in the last few last decade where it is not really into textbook material.

So, this is for your knowledge only that, this particular gene is if this there is a mutation in this gene in humans then they have disabilities in speech and language this one particular gene, but there are other kinds of learning are intact and the only deficit they have in speech learning is in speech learning and speech production and so, they do not understand language.

And so, that has supported the idea that it is genetic somehow the capability of being able to process language and speech is inherent in humans and that is it is genetic in origin which is not present in other species, other animal types.

However, the counter arguments are that there have been multiple experiments with the great apes where people have tried to communicate with the great apes in terms of a language and the most successful case was that when one was able to teach an ape at least more than 100 symbols and the ape could communicate with the human for all of its needs. And so, that is a counter argument that language is a specific to human.

Similarly, there are many other aspects of language and speech that are present in many other species and that is like in the mouse, in the monkeys that is non human primates and specifically the songbirds. The songbirds have been ideal in order to study speech and language at the very basic level, because we are unable to get that kind of information from human brains; obviously, because of experimental limitations and.

So, the birds the songbirds there are thousands of species of birds and at least half of them have are singing birds that is they are they produce songs and these songs are actually learned much like humans learn speech or language during the critical period of development that is early on and there are many other parallels of this form of communication in birds and humans human speech.

So, the speech development as you can the speech or language development in humans starts early on as early as 6 to 10 months, some may argue that it is much earlier. So, why we say 6 to 10 months is that when the baby starts to babble there is actually structure in the babbling that they produce and ultimately from that babbling they

crystallize into a few words and then finally, they know many words and then form sentences by the age of 3 years or 4 years.

So, by 2 1 to 2 years they learn the sounds and after 2 they start speaking. So, from babbling there is a process that makes the crystallization of the sounds and then finally, the sentences and by the age of 5 they are producing good sentences. And then it is beyond that it is beyond say at 6 to 10 years it is increasing the vocabulary there is an immense capacity that grows with age and experience and reading and so on.

So, I just said reading and that is another aspect of language that is reading and writing which show shows that language is not I mean if we talk of language in all forms then reading and writing are also forms of communication through symbols between a group of individuals.

So, however, it is totally visual systems ability and the visual system is intricately involved primarily it is the ventral path of the visual system that is as we have discussed it is the what path of the visual system. That is involved in word recognition, in terms of meaning of words and so on, that are based on our observations by reading the words and recognizing characters and also similarly in this case the expression is through motor side which is through writing which also is controlled by our visual feedback.

So, these are ideas that are all these aspects have a different developmental milestones as we learn these over the different ages and we will talk of just one simple basis by which we actually know that the brain is involved in these kind of processing in terms of infants or babies. So, for 2 year old infant or even one and a half, 2 year old or one and a half year old and so on these range of ages if you produce if you have; if you have the ability to collect EEG responses.

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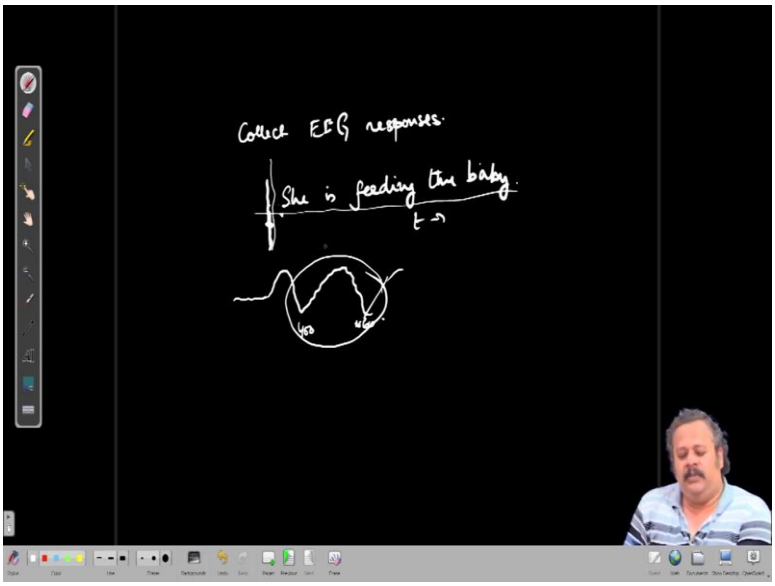

So, this was actually done and these are now possible in the last few 10s of years where we can actually do these experiments in infants very easily without much trouble to the baby or the families and so they are allowed ethically. And so, with the babies we know that if we have a sentence let us say; she is feeding the baby. This sentence is heard by the baby that is let us say 2 years 24 months and we are recording EEGs then the particular locations in the brain region are if we get the event related potentials that is the starting point of the sentence in time.

So, this is the time when the sound of she is made she is feeding the baby is made then with the event related potential we can get some features that are at particularly an n 400 and n 600 kind of region there are these potentials that are formed, but now if we produce the same sentence is done with semantic error then these potential changes these ERPs change.

So, if it is that she is feeding the picture which is a semantic error or if the sentence is she feeding is the baby then we have syntactic error, in both these cases the ERPs change dramatically in babies. So, that is the one thing that we were going to discuss about that indeed. So, syntactic and semantic processing is detectable or the changes or mistakes in those processing are detectable and so that kind of processing is going on in such young babies.

So, while there are many other such examples over development and in adults with FMRI, MEG and EEG; however, we cannot get into the basics of speech processing or speech understanding and also speech production without going into possible animal models because we cannot get to the neural level. And so, that requires us to have animal studies if we can draw parallels with speech and language in animal species. So, that will be a topic of discussion in a later lecture next we will be introducing you to the components of speech and speech production.

Thank you.