The Psychology of Language
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Module No. #01
Lecture No. #07
Speech Production - I

Friends, welcome back to this Lecture number-7, on the course on, the Psychology of Language. This course, as I said, will focused on, the psychological aspects of language. So, before we go into today's lecture, which is a very interesting lecture, we will do a quick recap of, what we have done, in the previous lectures. So, summing it up, we started off, by defining, what is language, and what is the need for language?

So, the main issues that we dealt is, what should we call as, language. And, what is the difference, between communication, and language. And there, what we saw, is the very basic language, which can be analysed, or which can be studied, is the Animal communication system. So, we started off, by looking at the animal communication system, and finding out its basic features. We saw, why animals communicate. And, we also saw, features of the animal communication system.

We use, several models like, the honeybee, or the vervet monkey. And, we saw, how these organisms, or animals, use the most primitive form of language. We moved further, to looking at, what is Human language, and how Human language, is different from, the Animal language system. We looked at, characteristics of the Human language system. We looked at the, structure of the Human language system, which is in terms of, the basic speech sound, which are called the Phones.

And then, moving up, to form the Morphemes, the Word, the Sentence, the structure of the sentence, that is the Syntax, and the rules, of forming a sentence, which is the Grammar, and the Semantics of a sentence, which is the meaning of it, and from thereon, Discourse. We then looked at, how language evolved, the Human language evolved. And. So we looked at, the Continuity and the Discontinuity Theories of Language evolution.

We also, went down the memory lane, and looked at, how the Protolanguage, which was used by our great, great, great grandfather's, how that developed into, first the Pidgin, which is an

evidence of, how language developed, and then the present form of language. So, in the first section itself, we covered a little bit about, what is language, how it is to be defined, what is the nature of it, and what is the structure and meaning of language.

Then, we proceeded on, to studying, the Research Methodology, which is used in studying of language, in specific, and Behavioral Sciences, in general. So, we looked at, how do we do research. We define, something called the Research cycle, for doing research in language. And, what this Research cycle comprises of, is how, a theory, body of knowledge, produces certain hypotheses. And, how these hypotheses, through a method of deduction, is destined through certain observations.

And, how these observations, through the process of induction, leads to certain patterns, or certain results, which either, falsify the theory, or support it in some way. So, we looked at the whole process of how the hypothesis is formed, the problems statement is generated, and how it is tested. We looked at, how modelling is done. How models are used, to create this observation, to get observations from hypothesises. Then, we looked at experimental design, which is, lamely speaking, the plan of doing a particular experiment.

So, we looked at something called, the within group, and between group design, and in more detail, other designs. If you refer to that section, come to know more about, what we did there. Then, we looked at, what are the two measures, which are used in language studies, in the laboratory. And, we focused on latency, which is also called the reaction time, or how quickly a particular response is generated. And, the accuracy, which is, how correct a response, particular response is, to a language related stimuli. So, we focused onto that.

And, then we described several experiments, to show you, how studies in language are done. We, at the end of it, we describe certain brain areas, and neuroimaging techniques, which are used in, studies of language. The last two lectures, which is Lecture number 5 and 6, we actually started venturing into, the language dimension. And so, as it is very natural, while taking a course in language, we started studying, how speech is produced, or how speech is perceived, how do we hear.

And so, there we looked at, the way, speech is transmitted, and it is perceived. So, speech perception. We looked at how, speech sounds, have amplitude and frequency, and the

fundamental frequency, and the overtones, and how these things are measured. We then looked into details, the way in which, the Auditory system is made. And, how the auditory system, has the Basilar membrane in the Cochlea, which is arranged, or the hair cells in the Basilar membrane, which is arranged in a tonotopic manner.

And, how they perceive speech sounds, or these speech waves, as I would say, and then make meaning of it, or transmit these sound waves, into electrical impulses, or convert these sound waves into electrical impulses, and then transport it to, something called the Primary auditory area, from where there, it is sent to the Secondary auditory area, where speech perception, or meaning is extracted from, speech sounds.

We looked at, how the speech stream is made, in terms of the Spectrograph. We looked at, how consonants and vowels are perceived. And, how speech, despite the fact, that it looks non-continuous, is continuous in nature. We looked at, several other properties of speech. For example, how the Formants, the Fricatives, the Plosives, and these kind of Sonorants, these kind of features of the speech sound is expressed, and what do they, mean in detail.

We looked at the idea of, how humans, perceive speech sound, through categorical perception. And, we looked at them phoneme restoration effect, which is a statement, or an evidence, of the categorical perception of the speech sound. Towards the end, we looked at, the development of speech perception in children, how children develop speech perception. And there, the most important point that we looked at, is the way, the mother, or the caregiver, talks the child, that is the most important way, the child perceives the speech stream.

So, we looked at, various details of that. And, we also looked at, how children develop this speech streams, or children develop this idea of the speech stream, how they perceive it, and how they understand, what boundaries of certain clauses, which are there, and how do they actually perceive the speech. Lastly, we looked at, several Theories of Speech Perception.

We started with the Motor Theory, which emphasizes the fact that, the vocal cord movement, is what is responsible for the speech. Then, we looked at, and they also proposed, the speech is special. We looked at the, General Auditory Framework, which says that, speech is not special. And, it is as similar, to Auditory perception. And, they gave several evidences for that. And last, we looked at, the Principle of Direct realism.

And, how this Direct realism, proposes that, speech which comes towards us, the speech sound which comes to us, carries all the necessary information. And, we do not need to use, any special mechanisms, for perceiving speech. And, they provided, or they use the mirror neurons, as the evidence, the biological evidence, for the fact that, speech which the humans hear, it contains all the necessary information, for decoding it.

So, that is where, we ended the last class. What we are going to do today is, we are going to look at, how the speech is produced. Now, in the last class, we looked at, how speech is perceived. In today's class, we look into, how speech is produced. So, we will do an analysis, or we will do a detailed study, of the vocal apparatus, the vocal cord, the glottis, the vocal box, and the mouth itself, and how these speech sounds are produced, in itself.

And, that is the role, or that is the main issue, in this, and the next lecture, which is supposed to follow. So, let us start, by looking at how, humans, produce speech. Now, the humans, they talk to each other. And sometimes, when they are alone, they even talk to themselves. But, then this, how this talking is developed, or how this talking takes place, the sound is produced, that is of interest. So, let us look at, the vocal tract, and the speech perception.

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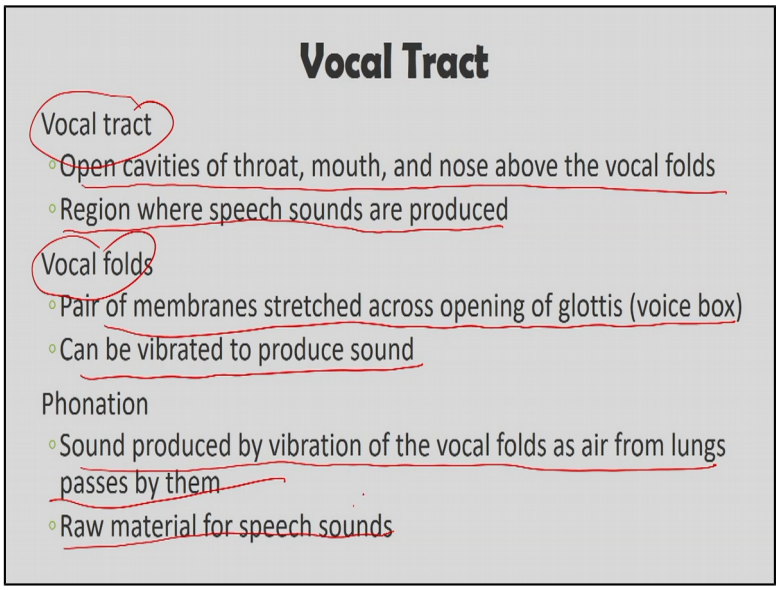

So, humans, they do a very good job, by blowing air out of the mouth, they communicate complex thoughts, to other member of the species. So, by just blowing some air out of their vocal cord, they are able to produce certain sounds. And, these sounds can communicate,

information, between different people. Now, speech production, generally begins, in the lungs, from where the air stream flows up, the trachea through the glottis, or the Voice box.

So, right at the lungs, the air stream starts, and then it moves up, to the trachea, through the trachea, through the glottis, which is called the Voice box. Now, the vocal folds consist of, so the trachea or the vocal the vocal tract, has something called, vocal folds. Now, these vocal folds, they consist of pairs of membranes, which are stretched across the opening of the glottis. So, if this is my glottis, the vocal folds are, stretched across the glottis, that can be vibrated, to produce sounds.

So, these vocal folds, they receive air, through the trachea. And, these air, they make a vibration in this vocal folds. And, this vibration, is what you hear as, sound. Now, when the vocal folds are retracted back, they are not open, the airstream flow is uninterrupted, and it is breathing. So, when it is stretched to the glottis, the voice box, you hear speech. And, when it is retracted back, what you hear is the, speech sound.

So, the same apparatus, which is used for breathing, is also used for producing sound, or producing the speech stream. Now, the vocal tract, generally speaking, it consists of the, oral and the nasal cavity. So, you have the oral cavity, in the vocal tract. And, you also have, the nasal cavity, in the oral tract. And, they serve as resonating chambers, for the Phonation produced, by the vibrations of the vocal cord.

So, the resonation, that happens of the stream of air, which passes through the vocal tract, it happens, either in the vocal cavity, which is here, or in the nasal cavity, and so, that leads to the Phonation. So, Phonation is the sound, which is produced by the vibration of the vocal cord, that is that is, what is called, Phonation. And so, there are two tracks, which I use, or two cavities, which I use, one is the nasal cavity, the other is the vocal cavity.

So, vocal tract, as you can see, open cavities of throat, mouth, and nose, above the vocal folds, and regions where, the speech sounds are produced. So, that is what, the vocal tract is. And, the vocal folds, these are pair of membranes, stretched across opening of the glottis, which is the voice box, and can be vibrated, to produce sound. What is Phonation. These are sound, produced by vibrations of the vocal folds, as air from the lungs are, passed through them. And, that is what, we have discussed. And, this air, is the primary material, for speech sounds.

Now, in the English language, vowels are generally produced, by directing the airflow, through the mouth, producing resonation in the oral cavity. So basically, in English, the vowels are produced by, unimpeded movement of the air, out of the mouth, and by the resonating in the oral cavity. In comparison, the consonants are produced, by restricting the airflow. The vocal tract itself, is shaped as, like an inverted Saxophone. If you have ever seen a Saxophone, if you invert the Saxophone, so the big this is how, my Saxophone actually looks like.

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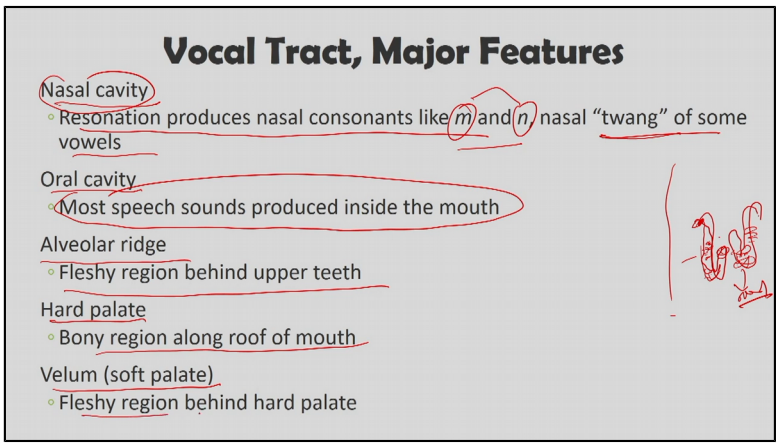

This is my reed. This is my place from where, this is this is my tube. And, by constricting, by making the tube, or changing the structure of the tube, a sound is produced. So, if I invert this, this is, if I invert this figure, and it goes like this, to this. This is how my, vocal tract will, actually look like. So, it looks like an inverted Saxophone, with the vocal folds, acting as the reed, and the oral and nasal cavities, as the resonating tube.

So, this is my, oral and nasal cavities. And, the vocal tract, which is, this is, this part of it, it is called a reed. Beside this, the Tongue, Jaw, and Lips, can be used, to change the shape, and size, of the oral cavity. So, the Tongue, the Jaw, and the Lips, can all work together, and they can change, the size of the oral cavity, and produce different consonants, or in in in the English language. Now, the Tongue, teeth, and Lips.

So, the Tongue, the teeth, and the Lips, can also block or constrict, the airflow. Now, before this, we are talking about vowels, where unimpeded air moves through the vocal tract, and resonate in the oral cavity, and come out of it. So, if you are not restricting the air, it is a vowel. But, if there is a restriction, so restriction in terms of, either the Tongue, or the teeth, or the Lips, they block or constrict the airflow, and influence the quality of the sound.

So, that also, this constriction also, leads to the production of consonant. Now, the fleshy region of the mouth, covering the bone, where the upper teeth is anchored, is called the, Alveolar ridge. So, this is my, Alveolar ridge. It is the, upper teeth. And so, this hard thing here, is called the, Alveolar ridge. And, it is important for, consonant production. So, this is important for the al the Alveolar ridge is important for, consonant production.

Now, behind the Alveolar ridge, the bony region, along the roof of the mouth, so this region, which is right here, along the roof the mouth, is called the, Hard palate, so, this is my Alveolar ridge, and this is my Hard palate. And, both of them are important, for producing the consonant sound. So, vowels are produced by, uninterrupted passage of the air, from the vocal stream, into the oral cavity. And, that is how, the vowel is produced.

Now, how is the consonant produced. The consonants, they are produced, by obstructing the airflow, through the oral cavity. So, this is my vowel. So, I have the nasal cavity, and the oral cavity. These are the two places, where you generally see, the resonation happening, in terms of vocal production, or the air which comes out of the track, the vocal track. It resonates in two process. Either it is a nasal cavity, so resonation produced in the nasal consonants like, m, n, twang, and some vowels, which are there.

So, you have either the, m or n, which is in terms of consonants. So, the twang, of some vowels, are also produced here. In the oral cavity, more speech sounds produced, inside the mouth. What is the Alveolar ridge? It is a fleshy region, behind the upper teeth. So, this region. And, the Hard palate, is a bony region, along the roof of the mouth, so inside. And, Velum is a soft palate, which is a flashy region, behind the hard palate. So, this region is called the, Velum.

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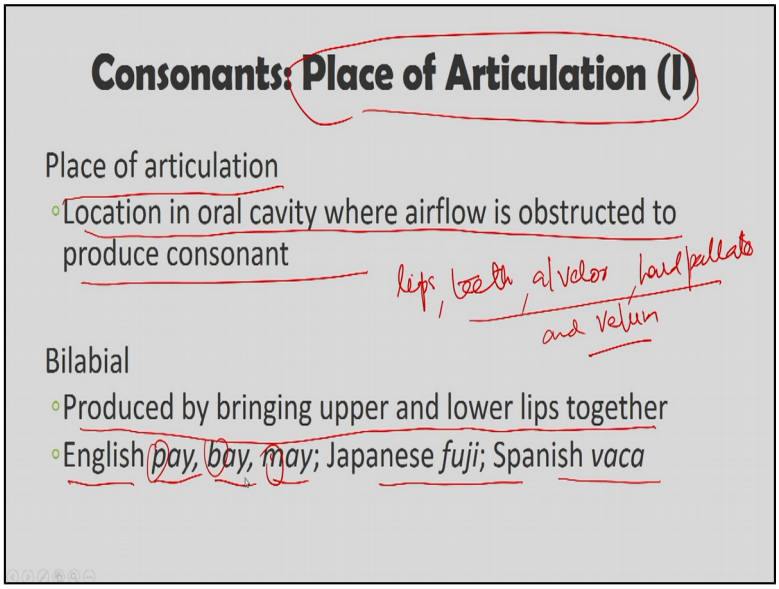

So, this is a quick diagram of the vocal system. And, you can see, these are the vocal folds. This is my Tongue. This is my Jaw. And so, Jaw movement is also important, in producing consonants. The Tongue is also important, in producing consonant. So, these are not important, in producing vowels, but they are important, in producing consonants. You have the Lips. You have the Alveolar ridge. You have the nasal cavity, here. This is the Hard palate, this region. This is the Velum. And, this is the oral cavity. So, this in total, is what is the, vocal tract actually, looks like.

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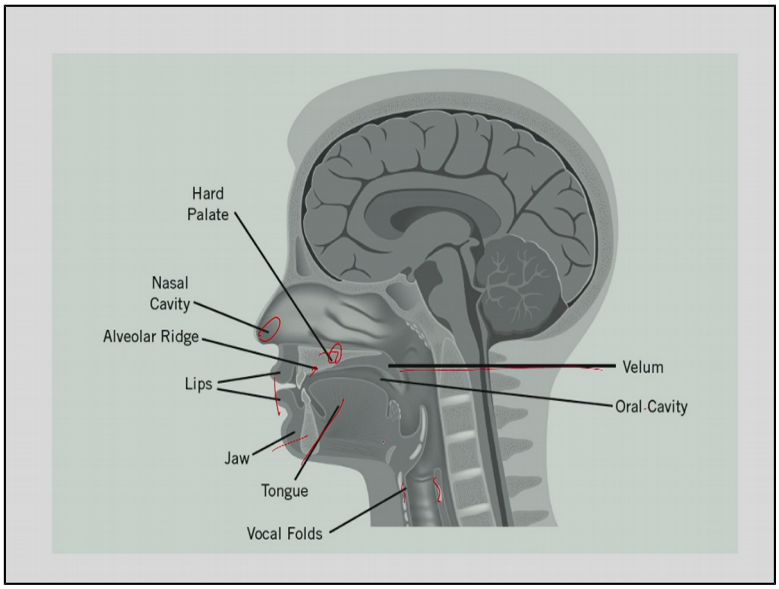

Now, we looked at, how the vowels are produced. Let us look at, consonants. So, as I said, consonants are produced by, obstructing the flow of air, through the oral cavity. So, if I obstruct the air, if the air, which is coming out of the vocal cavity, is not obstructed, it is basically, vowel. But, if it is constricted in some way, it is blocked in some way, you actually produce, or

what is produced out of that, is something called a, consonant. Now, there are three factors, which determine consonant quality.

So, the consonants, they depend on three factors, or there are three different types of mechanisms, for producing the consonant. The first is, of the quality of the consonant, the first is called, the place of articulation. Second is, the manner of articulation. And, third is, the voicing, or the voice onset time. So, place of articulation, what role, does it has. The place of articulation, as you say, as you see here, describes the location, along the vocal tract, where the obstruction occurs, to produce the consonants.

So, where is the obstruction? The place of articulation, defines the obstruction, the place of obstruction, of the air stream, which is coming from the vocal cord. And, that defines, what consonant will, actually be produced. So, locations in oral cavity, where airflow is obstructed, to produce consonants. So, important places of articulation, the most important place of articulation, are the Lips. So, you have Lips, you have the teeth, the Alveolar ridge, the Hard palate, and the.

And so, these are the places, where the obstruction can, actually happen. Now, consonant sound, that is produced by, bringing the upper and the lower Lips together, is called a Bilabial consonant. So, Bilabial, which is produced, by bringing upper and lower Lips, together. In English, you have so example you have pay, bay, may. And, in Japanese, you have fuji. In Spanish, you have the vaca. Now, you have to purse your Lips, before you let go of the air. So, do that. And, that is how, you do.

So, purse your Lips, before you let go of air, and see, what it produces. It produces a P-sound. And, this is called the, Bilabial. So, this is, like this, the sound that you hear, this is the P-sound. So, p as in pay, b as in bay, and m as in may, these are the Bilabial consonant. So, upper Lips, both the Lips together, when it is used for constriction, the Bilabial consonant is produced. Now, consonant, that is produced, by bringing the upper Lip, bringing the lower Lip, against the upper teeth, is the, Labiodental consonant.

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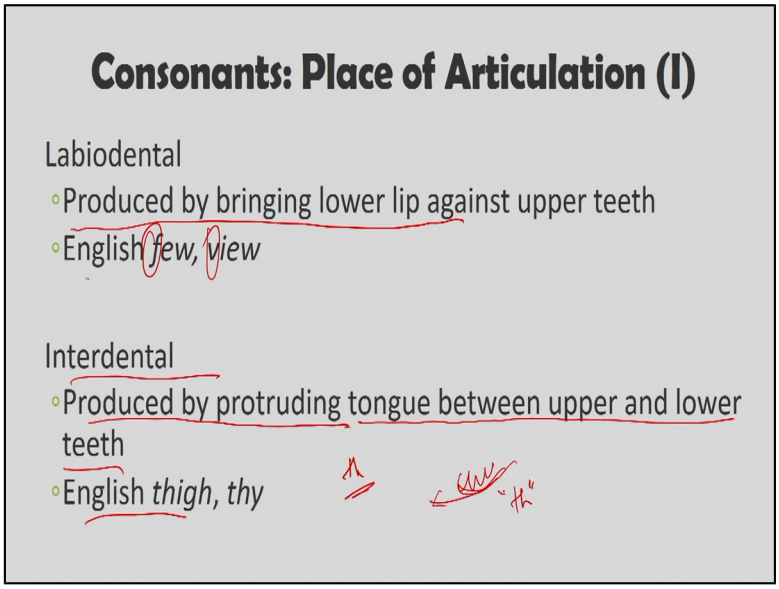

So, it is produced by, bringing the lower Lip, against the upper teeth. Right. For example, few. Try saying, few. So, this this Lip goes, and attaches itself, or constricts to the teeth, and so you produce the, f in few, and v in view, so few. Then, a consonant, which is produced, by protruding the Tongue, between the upper and lower teeth, is called the, Interdental. So, Interdental consonants are those which are produced by, protruding the Tongue between, the upper and the lower teeth. For example, thigh and thy.

Thigh and thy, what you are doing is, you are protruding the Tongue, between the upper and the lower teeth. And, that is how, it is producing. So, thigh, tie, or thy. So, if you can try this, you can place the blade of the Tongue, against the upper teeth, and let some air, come hissing, sssh, sssh, sssssh. So, when I do that, sssssssh, I get the th sound. The so, this is my Tongue, plays it against the upper teeth, and let some air out of it, the sound that you get is the, th, tha sound. Now, a consonant, which is produced, by pressing the Lip of the Tongue, against the fleshy area, behind the upper teeth is the, el Alveolar consonant.

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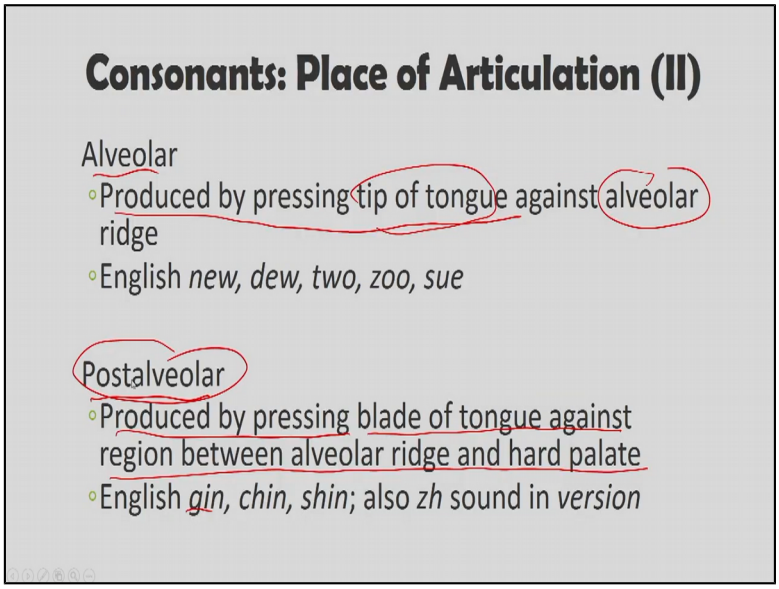

So, what is the Alveolar consonants. These are produced, by pressing the tip of the Tongue, against the Alveolar ridge, like this. So, I get, new, new, dew. Try, saying it. This Tongue, will press against the Alveolar region, and that is how, you produce this sound. So, saying new, dew, two, zoo, sue, all of them require you, to press the tip of the Tongue, against the Alveolar ridge, which is, just behind the upper teeth.

Now, a consonant, which is produced, by press the blade of the Tongue, against the region, between the Alveolar ridge, and the Hard palate, is called the, Postalveolar. So, Postalveolar consonants, what are they? They are produced, by pressing the blade of the Tongue, against regions between, the Alveolar ridge, and the Hard palate. So, this is my Hard palate, and this is my Alveolar ridge, this area, and Hard palate, this area.

And, by placing the blade of the Tongue, against this, between these two, right here, is what you get, for them. For example, try saying, gin. Gin, the moment you say that, the blade of the Tongue, gets in between, the Alveolar ridge, and the Hard palate. Or, chin, shin, shin. Also, zha sound, the zh sound in, version, version. That is how, this particular Postalveolar sound is, a postalveolar consonant is, produced.

Now, the consonants, which are produced, by pressing the root of the Tongue, against the soft palate, this region, against the back of the mouth, are referred to as the, Velar. So, Velar are those consonants, which are produced by, pressing the root of the Tongue. So, this is my root. So, if I press the root of the Tongue, again the soft palate, which is somewhere here inside,

against the back of the mouth, the sound which are produced, or the consonants which are produced, in that way, is what are called the, Velar consonant.

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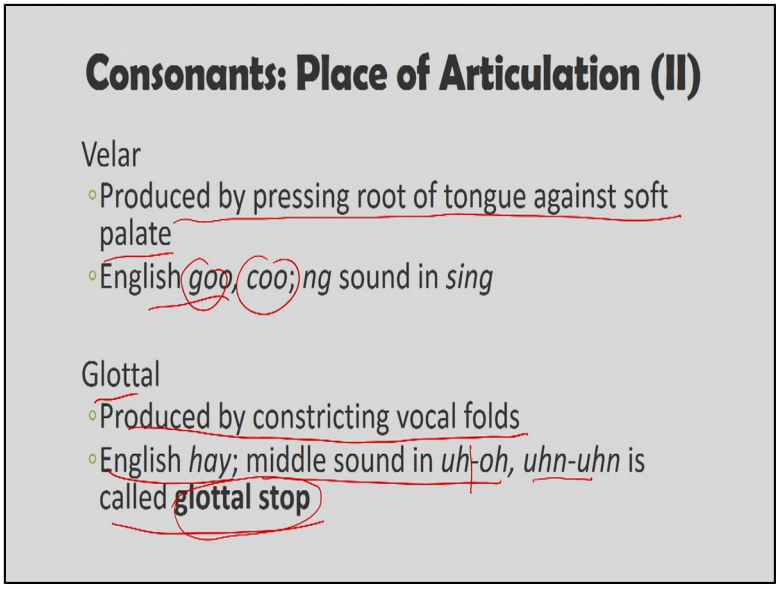

So, produced by, pressing the root of the Tongue, against the soft palate. For example, goo, coo, the ng sound in, sing, wing, that kind of sound, which are produced. And so, that are called the, Velar consonants. Now also, I have the Glottal consonants. So, what are the Glottal consonants, then. These are produced by, the glottis, which is the voice box, which houses the vocal fold, can be used to make consonant sounds.

So, this can also be used, to make the consonant sound. The h sound in English, is essentially a voiceless. Ah, so h, is actually a voiceless sound, that you get. Now, alternating between, and a a a, one finds the vocal folds vibrate for a a a, and not for h. So, if you alternate between h h h h h h and a a a a, you see that, for a a a, there is a vibration of the vocal cord, so when you say, a a a. But, when you say, h h h, there is no vibration of the vocal cord. And so, this is the h sound, is the voiceless, sound. So, Glottal, these are produced by, constricting the vocal fold.

Now, English hay, the middle sound in uh-oh, or uhu-uhn, is the called the, Glottal stop sound. The Glottal stop is a consonant, which is produced by, constricting the vocal fold. Now, if you try constricting the vocal fold, the sounds, which are produced by, constricting the vocal fold, is what is called the, glottal stop Glottal stop consonant. And so, these are produced in examples of, examples of these are, the middle of the sound in the expression uh-oh, or the uhn-uhn, or the middle of that, uhu-uhm, that that you produce, is basically the, Glottal stop sound. And, this is produced by, constricting the vocal folds.

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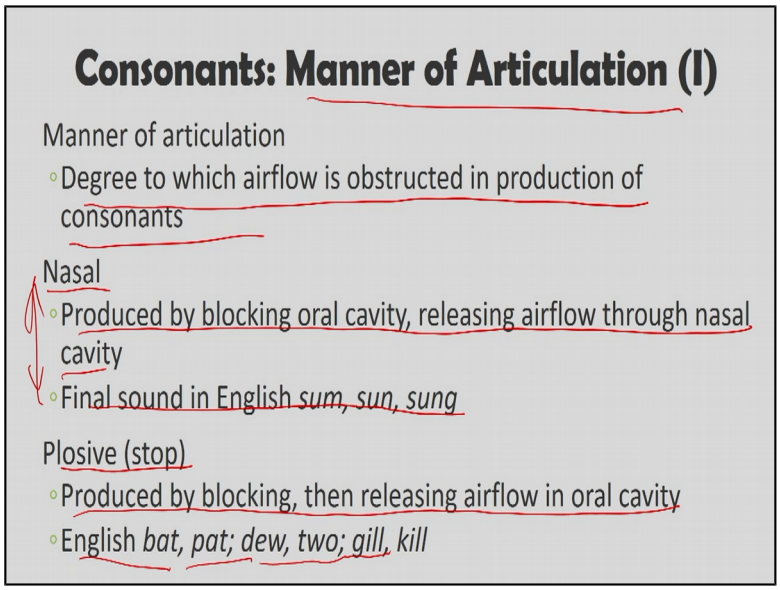

So, this is all about, the place of articulation, and how they produce consonants. Another way, in which consonants can be produced, is by, the manner of articulation, which is, how we restrict the stream of air, which is coming from the vocal tract. So, Manner of articulation, they describe, the degree to which, the airflow is obstructed, in the producing a consonant. So, the degree, to which the airflow is obstructed, is the definition, of the Manner of Articulation, of producing the consonant.

So, Manner of Articulation, degree to which, airflow is obstructed, in production of the consonant. The obstruction can involve, a complete stop. So, the Manner of Articulation could be, a complete stop, a constriction, or a diversion of the airstream. So, it could be a complete stop, it could be a constriction, some kind of constriction, so stopping it in some way, or it could be a total diversion, of the air stream.

Now, Plosive is a consonant. So, you could have nasal, produced by blocking oral cavity, releasing airflow through the nasal cavity. And, final, sound in English, for example. So, you could also have used, the nasal stream, the nasal cavity called also, be produced, it can be a Manner of Articulation. And so, final sounds in English, for example, sum, or sun, or sung, uses the nasal cavity. Now, the Plosives is a consonant, which is produced, by momentarily stopping, and then, releasing the airflow.

So, if we do this, momentary stop, total stop of the airflow, and then release it, the consonant which is produced, are called the, Plosives. For example, the b, d, g, or the p, t, k, are those

kinds of consonance. So, Plosive is, the stop consonant. These are produced, by blocking, and then releasing the airflow, in the oral cavity. English, bat, pat; dew, two; gill, kill, all of these, when you are producing that, what is happening is, I am temporarily blocking, the airflow, and then letting it go. And, because of that, I am able to produce, the b, in bat, bat.

So, somewhere, I am constricting, and letting it go. Now, consonant, which is produced, by passing an airflow, a consonant that is produced, by momentarily blocking the airflow, and then releasing it through a light constriction. So, momentarily blocking it, and then releasing it, through a light constriction. So, small constriction is made. Think of it, as a host pipe with water. So, you block it with your thumb, and then, lightly release the water. That is the same situation, here. And, that constriction is called the, Affricate

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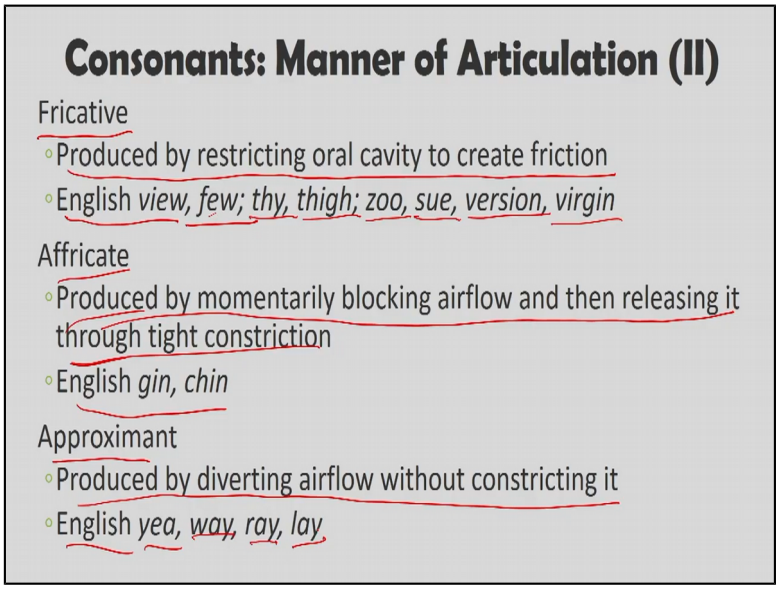

This is what my, Affricate is all about. So, produced by momentary blocking airflow, and then releasing it, through a tight constriction. So, take the thumb, take a hose pipe with water, take the thumb and totally block it. And then, release it partially, through a narrow constriction. This is what, my Affricate is. This is how, the Affricates are produced. And, the English, gin, and chin, are called the, Affricates.

Similarly, you have the Fricative. And so, how are the Fricative produced. A consonant, which is produced, by passing the airflow, through a constriction in the oral cavity, is a Fricative. So, these are produced, by restricting oral cavity, to create friction. So, you restrict the oral cavity, so a friction happens. And, when you do that, the consonants, which are produced out of it, is what is called the, Fricatives.

And, what are they. The English, view. So, when you say, view, what you are doing is, you are restricting the oral cavity, so a friction is produced, to produce v in view, f in few, t in thy, th in thigh, z in zoo, s in sue, v in version, and v in virgin. So, when you say, view, few, thy, thigh, zoo, what you are doing, especially the word zoo, when you do that, you can hear the friction, which is happening.

Or, view, few, these, when you say that, that what is happening is, there is a friction, which is being happening at the vocal cord, because you have restricted the airflow. And, the consonants, which are produced out of it, is what is called, Fricative. There is also something called the, Approximant. What is the Approximant? Now, the Approximants are, is a consonant, which is produced, by diverting the airflow, without constricting it.

So, if you divert the airflow, without constricting it, what you get is the, Approximant. And, what is the Approximant. Approximants are, l, r, y and w sounds. For example, in English, the yea. When you say, yea, way, ray, lay, what you are doing is, you are not constricting the airflow, which is coming from the vocal cord, but you are diverting the airflow, in some way. And, that is how, you say, ray and lay. The l-word, the r-word, the y-word, and the w-word, are these consonants, are what are called the, the Approximants.

Now, approximants are produced, without turbulence to the airstream. So, these approximants ah, they are produced by, turbulence in the airstream. And, since they are not produced by restricting the airflow, so sometimes, they are also called as the, semi vowel. So, semivowels are equivalent to, what the approximants are. And also, consonants are produced by, voicing.

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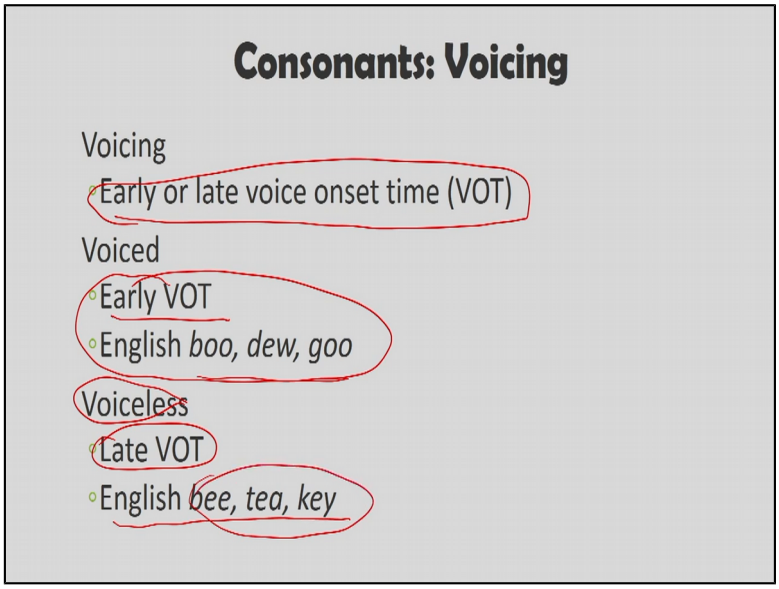

For example, Early or late Voice onset time. So, you can have the voice consonants, with the early voice onset time. So, voice onset time is, the way, the sound is produced, or the time difference between, the vibration of the vocal cord, and the actual production of the sound, from the vocal cavity, that is called, voice. So, in voice, you have the, Early VOT, for example, English, boo, dew, and goo. And, in Voiceless, you have the Late VOT, voice onset time.

So, there is a delay, in the production of the sound, from the oral cavity, and the vocal vibrations. And, if this is less, it is called the, voiceless. And, the bee, tea and key, in English are, voiceless. So, this is how, the consonants are produced. So, you have the Manner of Articulation, the Place of Articulation, and the Voicing, which is the timing difference between, the oral cavity production, and the vibration of the vocal fold. So, this is how, consonants are produced. Now, let us take a look at, how vowels are produced.

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Table 4.1 English Consonant Inventory

Manner	Voicing	Bilabial	Labio-dental	Inter-dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Nasal	Voiced	*m*at			*n*ew			wi*ng*	
Plosive	Voiced	*b*at			*d*ew			*g*ill	
Plosive	Voiceless	*p*at			*t*wo			*k*ill	uh-*o*h
Affricate	Voiced					*g*in (virgin)			
Affricate	Voiceless					*ch*in			
Fricative	Voiced		view	*th*y	*z*oo	(versi*o*n)			
Fricative	Voiceless		few	*th*igh	*s*ue	*sh*in			*h*i
Approximant	Voiced				*r*aw		*y*ell	*w*ell	
Lateral	Voiced				*l*aw				

Now, before that, this is the inventory, that you can see, the Manner, the Nasal, Plosive, Plosive, Affricate, Affricate, Fricative, Fricative, Approximants, and Lateral. And, if you can see, it is voicing, voiced, voiced, voiceless. In terms of it, it is the Bilabial, the Labiodental, the Intradental, the Alveolar, the Post-alveolar, the Palatal, the Velar, and the Glottal. And, as you can see, there is a small chart, which describes, how the consonants are produced.

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Vowels

Jaws
- Continuum from high (open) to low (closed)

Tongue
- Continuum from front to back

Lips
- Unrounded with front vowels in English
- Rounded with back vowels in English
- Many languages use lip rounding as separate from tongue position

Now, just like the consonants, the vowels are also produced. Or, how are the vowels produced, that is also interesting to see. So, vowels are produced, by modifying, the shape of the oral cavity. Now, in consonants I restrict the sound, which is coming, from the oral cavity, or from the vocal folds. Either, in the oral cavity, or in the nasal cavity, I restrict it, in some way. And, that is how, the vowels are produced. So, restriction of airstream, produces consonants, but not restricting the sound, produces a vowel.

And so, how is vowels produced. They are produced by, modifying the shape of the oral cavity. So, if I modify the shape of the oral cavity, I get a consonant. Now, three factors, the influence the shape, or the type of vowel, which is produced. The height of the Jaw, the position of the Tongue. So, how high is the Jaw, that is one thing. The position of the Tongue, where the Tongue is. And, the shape of the Lips. So, what is the shape of the Lip.

These three will, actually determine, what kind of vowel, will be produced. So, Jaws, continuum from high open, to low closed. Tongue, continuum from front to back. So, front to back, type of movement. Open and closed, in terms of Jaw, and in Lips. So, you have, the Jaws, the Lips, and the Tongue. These are responsible for, producing the vowel. So, you have, unrounded with front vowels in English, rounded with back vowels in English. Many languages use, Lip rounding, in a separate form of Tongue position.

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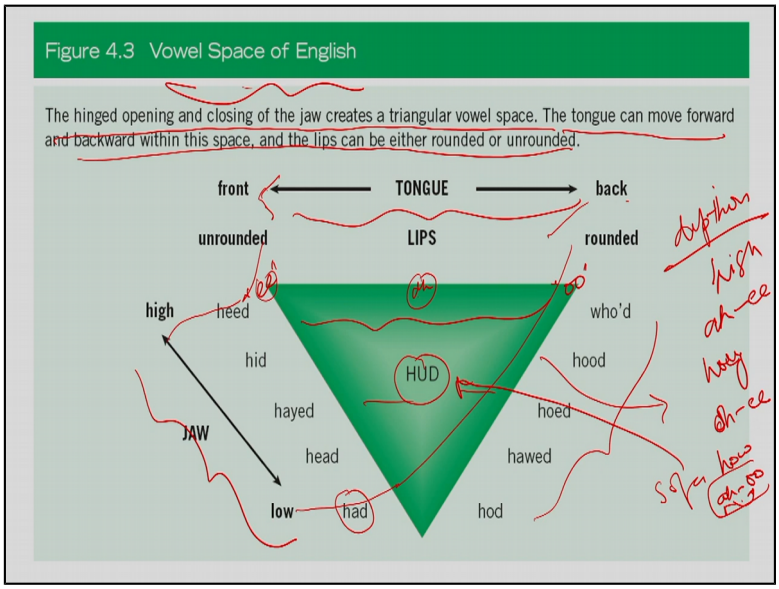

Now, before we come to this, let us have a look at, what this is all about. So, the Jaw, that that you see, this is the Jaw, that that is there, they move up and down, on a hinge. So, this is the hinge. And so, they move up and down. So, this is a lower Jaw, which actually moves, and makes the vowel sound, making the oral cavity, inside the mouth, smaller and larger. So, the way, it moves, it determines the oral cavity, or it determines the size of the oral cavity.

The rotating Jaw, produces, a triangular vowel space. So, the way, the Jaw moves, it determines the, or it makes the, triangular vowel space, which we are looking at, here. Now, the vowel, e e, is said to be high, because the Jaw, is positioned, high, closing the mouth. And, the vowel, i h, is

said to be low, because the Jaw lowers, to open the mouth. So, when I say, ee, the Jaw is high, but when I say, ah, in this, the Jaw comes down, and so, this is low.

The is low, in terms of Jaw movement, and e e is, high movement of the Jaw. The Tongue can also move, back and forth, inside the mouth. So, the Tongue can also do this moment, and that also produces vowel. So, the vowel e e, is said to be front, because the Tongue is pushed forward in the mouth. So, when I say e e, the Tongue is pushed forward in the mouth, and the Jaw is actually high. And, that is how, the e e sound produced.

Now, while the vowel o o, when I say that, the Tongue moves down, sorry, the Jaw moves down, and that Tongue is said to be back. When I say o, the Tongue goes inside. But, when I say e, the Tongue is moved towards the, forward direction. Because, the Tongue is pushed backward, in the mouth. So, o o, the Tongue is moves backward. But, when I say e e, e, e, the Tongue is moved, towards the forward section. Also, this is related to the movement of the Jaw also, as I said, there is a high Jaw movement.

So, when I say, the e e, the Jaw is high. But, when I say, ah, the Jaw is lower, or oh, the Jaw is lower. Now, the three vowel sound, ah, e, and o. ah, e, and o, marks the extremities of the vowel space. So, this is what is called the, vowel space. Now, this is the movement of the Tongue, from the front to the back. This is the movement of the Jaw, from the high, to the low. And this is the so, these are the two things, which are there, which can produce, the different vowel.

So, you have high in, high movement of the Jaw. You have, a h vowel like heed and had. And in in terms of the so, if it is front unrounded Lips, and high Jaw, you produce, heed. But, if it is back of the Tongue, and low Jaw, you have the, had. So, the a, and e, that is how, it is produced. So, a producing, and e producing, is dependent. So, basically, the Tongue, the Jaw, and they combined together, to form something called the, Triangular vowel space.

All other vowel sounds, fits in between, these three. So, the three vowels, which is, the ah, the e, and the o, marks the extremities of the vowel sounds. The ah, e, and o, are the one, which marks the three extremities, with ah, at the bottom centre. So, at the bottom centre, here e, at the high front, so a at the sorry, e e, at the high front. So, this is where, my e e would be. This is where, my a h, sound is. And, this is where, my o o sound is. And so, that is what it is. And, o o, at the high back.

So, high back, I have o o. In the bottom centre, I have the, a h. And, at the high front, I have the e e. Now, all other vowels, actually fit, within this three, fits in between, these three particular regions, which have been marked on this, particular triangle. Now, English has, one or more phonemic vowels, situated in the middle of the vowel space. A neutral, mid-central vowel, occurring in many unstressed syllables in English, is known as the, Schwa.

So, Schwa is another thing, which is there. The a, in about, or sofa, is a Schwa sound. So, what are these. So, these are phonemic vowels, which are situated in the middle of the vowel space. So, if something is situated in the middle of the vowel space, phonemic vowels, these are called the, Schwa sound. Now, it is a neutral mid-central vowel, occurring in many unstressed syllables. For example, the a, in sofa, is a vowel, which is situated, somewhere in the middle of this space.

And so, that is what, middle of space, in in terms of, both the Tongue, and the Jaw. And, that is how, the vowel is produced. So, vowel space in English. The hinge opening and closing of the Jaw, creates a triangular oval space. The Tongue can move forward and backward, within this space. And, the Lips can be, either rounded, or unrounded. Also, in addition to these, the way, the Lips, and the Jaw, make the vowel, we also have something called a, Diphthong.

Now, what is a Diphthong. A Diphthong is a vowel combination, that is perceived as a single Phoneme. So, one or two vowels, or a combination of vowels, when they occur together, and but when they are produced, a single phone, a single speech sound, that is called a, Diphthong. Now, English has, three Diphthong as in, a e, o a, n, ah, oh. For example, hi, how, and hoy. So, if I say, hi, I have the, a, and e, vowel coming in. I have the, hoy, h o y. So, Diphthongs, when I say hi I have the vowel combination, a, h and e e.

But, when I say Huawei, the vowel combination, o h n e e. And similarly, when I say, how, I have the vowel combination, a h n o o. And, when I say, how, it is these two vowels coming together, and that is what is called a, Diphthong. So, in English, they are 3 in number. Also, some other languages may have, Diphthongs. So, what are Diphthongs. These are combination of vowels, but they sound like a single phonemic sound.

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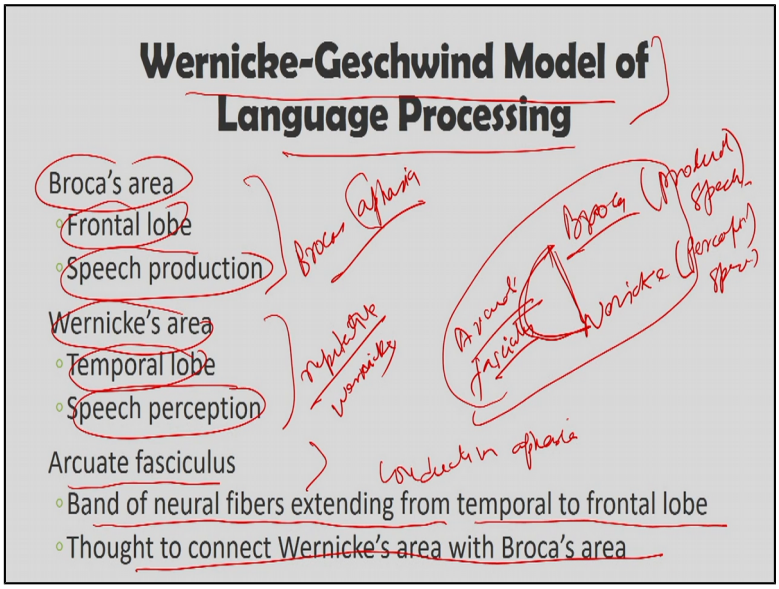

So, that brings us, to the end of, how the vowels and or the or the vowels and the consonants are produced. But, another interesting thing, is looking at the areas, which process language. And, so the speech areas of the brain, they find a good thing would be, to look at, or study the, speech areas of the brain. So, according to the Traditional Wernicke, as you know, there is the Wernicke area, and the Broca areas.

So, Broca area is speech production but, speech perception is done by, something called the, Wernicke area, in the brain. So, the Wernicke-Geschwind model, the Broca area, as you know, it is in the frontal lobe, where the speech production, and Wernicke area, is at temporal lobe, and speech perception. So, what is this Wernicke-Geschwind model of language production is. Now, according to the Wernicke-Geschwind model, Wernicke area is responsible for, speech perception.

The Wernicke area, perceives the speech. Broca's area is responsible for, speech production. The Broca area, produces speech. And, the art the Arcuate Fasciculus, is a band of fibers, which extends from the Wernicke to the Broca's area, connects speech perception, and production. The Geschwind model. Now, since when the model was produced, or the model was given, Neuro-imaging techniques did not exist. And so, the best possible deduction, or best possible theorizing was made.

And, these are made, in terms of people, who suffered from, several kind of aphasia, as either the Broca's aphasia, or the Wernicke aphasia. And, what this model says is that, the Broca's area, is an area in the brain, which helps in producing speech. So, speech producing. And, the

Wernicke area is in the is a brain area, which is used for, perceiving speech. So, it is a three dimensional model. And, the fiber, which connects the Broca area, and the Wernicke area, is called the, Arcuate Fasciculus.

And, that also leads to, kind of aphasia. And, this is the fiber, the band of fiber, which connects these two area together. And, that is how, the model is looked at. This is what the, Wernicke-Geschwind model of language production is. The Wernicke-Geschwind model explains, three common forms of aphasia. So, how it was developed. The model was developed, by studying people, which had certain kind of aphasia, or certain kind of speech problems. Now, Expressive or, Broca 's aphasia.

Now, Broca's area came into being, from idea that, there are something called, Broca's aphasia. And, what is Broca's aphasia. Broca's aphasia is a condition, in which, brain damage, leads to loss of speech production, without the loss of speech comprehension. So, people can comprehend speech, they can understand speech, when they are spoken to, but then, they are not able to produce speech. And, that is what is called the, Broca’s area, or the Broca’s aphasia.

Similar to that, you have, Wernicke, or Repetitive aphasia. And, what is this Wernicke aphasia. In this, what happens is, a condition in which, brain damage leads to, a loss of speech comprehension, and fluent but meaningless speech production. So, people are able to produce speech. They produce speech, perfectly. But then, there is no meaning of the speech. Because, speech comprehension is, not there. And then, you have something called the, Conduction aphasia.

What is this Conduction aphasia? It happens because, damage to the Arcuate Fasciculus is that, these are band of neural-fibers, extending from the temporal to the frontal lobe, thought to connect the Wernicke’s area, with Broca’s area. And, what kind of aphasia, is the conduction aphasia, it happens due to this. So, you have the Conduction aphasia, a language disorder, characterized by speech perception, and production capabilities, but with a marked difficulty, in repeating spoken language.

So, when something is said to you, you can produce it, you can also understand, what is being said, but if you have to repeat that word, you cannot do it. And, that is what is called the, Conduction aphasia. Or, that is because, the Arcuate Fasciculus, that has some problem in it. So,

that is how, the whole idea of Wernicke- Geschwind model of language production, has been talked about.

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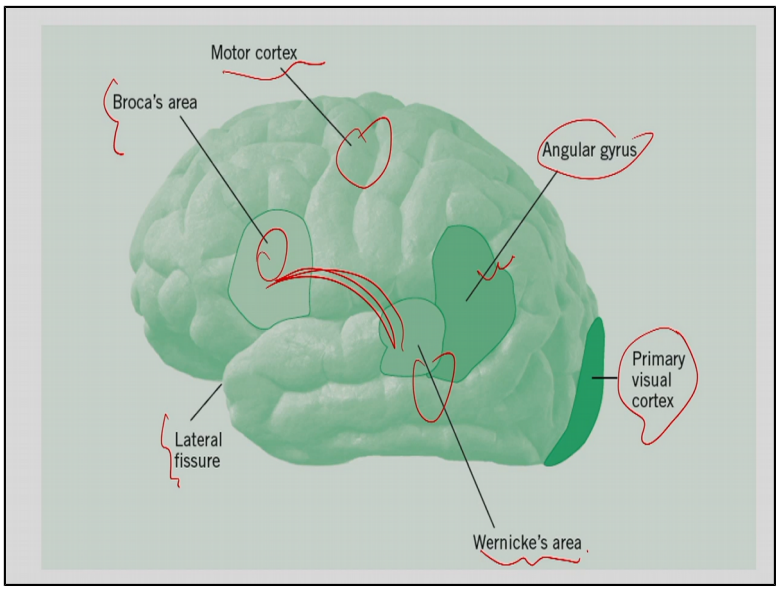

Now, so if we look into this, this is where my Wernicke area is, this is my Lateral fissure, this is my Broca area, this is the Motor cortex, this area is the Motor cortex, Broca area, Wernicke area, the Angular Gyrus, which is again, another region for, producing speech. And, this is my Primary visual cortex. And so, in conduction fiber, which connects, this and this, is called the, Arcuate Fasciculus, which has another reason, or this is how, the Geschwind model or Geschwind Wernicke model is talking about.

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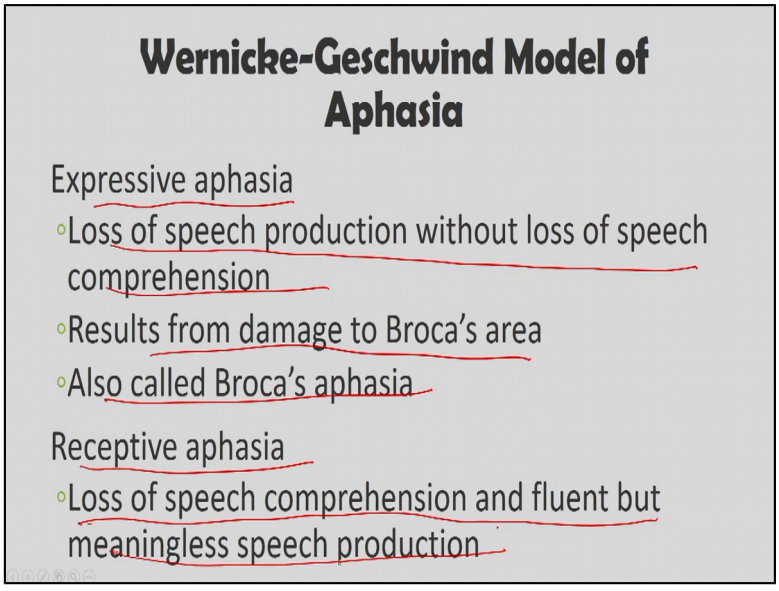

Now, Wernicke-Geschwind model of aphasia, we have Expressive aphasia, loss of speech production, without loss of speech comprehension, results from damage in the Broca's area,

also called the Broca's aphasia. You have Receptive aphasia, which is loss of speech comprehension, and fluent, but meaningless speech production.

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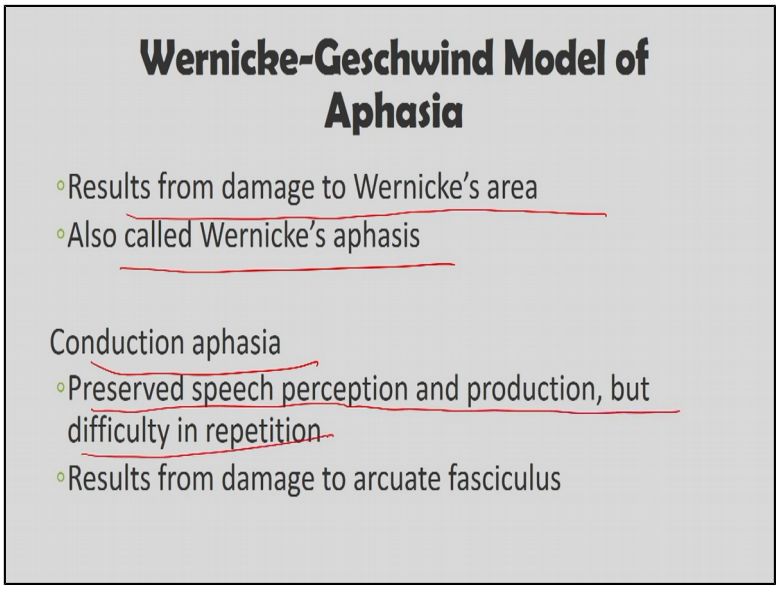

This is called the repeat the Receptive aphasia, and results from damage to Wernicke area, also called as Wernicke's aphasia. And similarly, you have the Conduction aphasia, which is preserved speech perception and production, but difficulty in repetition, and it results from damage to the arcuate fasciculus.

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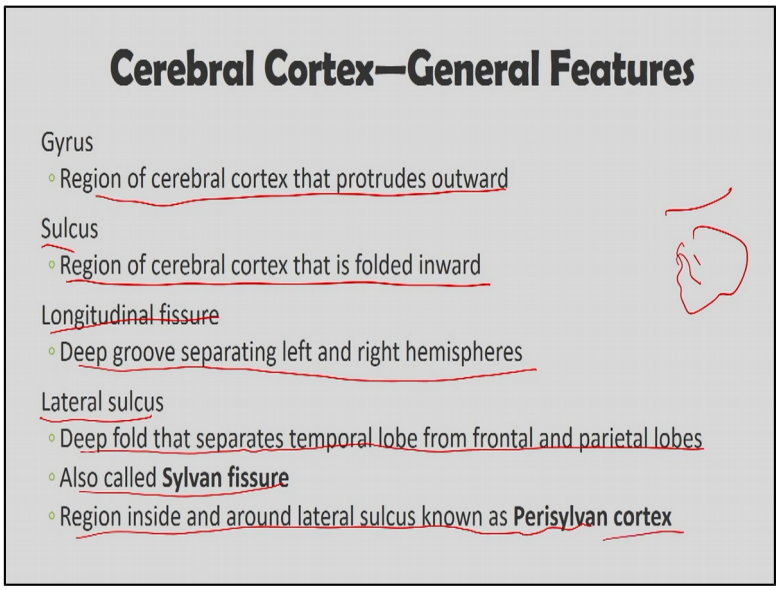

Now, beside the Wernicke area, and the Broca area, and that and the Arcuate Fasciculus, there are other regions of the Cerebral cortex, which are also responsible, for producing speech, or the Cerebral cortex, some of the regions of the Cerebral cortex, which are involved in, production of speech. So, let us look at, those regions. So, the Cerebral cortex, is the thin outer

covering of the brain, where most of the computations, that give rise to our conscious experience, and interaction, with the world, takes place.

So, that is what, the Cerebral cortex is. The outer surface, which is there. Now, the folding of the Cerebral cortex, leads to a series of ridges, and furrows, known by the Latin term of, Gyri and Sulcus. So, this this Cerebral cortex has some ridges, which are there. So, you have some folding's, in there. And so, this folding's are called the, Gyri and the Sulcus. The Gyri is a protruding region. So, what comes out, is the protruding region. If you see the Cerebral cortex, this is what, you generally see.

So, if you look into it, these are the Gyri and the Sulcus. So, this is what, I am talking about. So, that is that. So, the gyrus is a protruding region of the Cerebral cortex, and Sulcus is the region of the Cerebral cortex, that is folded inward. So, if you look at it, the invert fold is the Sulcus, and the protruding region is the gyrus. Now, the gyri and Sulcus, both are geographical features of, hills and valleys of the cortex. And, these are convenient landmarks to be located, for locating functional regions of the brain.

So, this Gyri and Sulcus actually tell you, where are the functional regions of the brain. So, region of Cerebral cortex, that protrude outward, and Sulcus is the region of Cerebral cortex, that is folded inward. Now, the temporal lobe, exhibits three roughly horizontal gyri, running in the parallel, named the superior medial, inferior temporal gyri, going from top to bottom. So, you have the superior gyri, the medial, and the inferior temporal gyri. These are the three gyrus's, which are there in the temporal lobe.

So top is the temporal lobe and in that you have 3 gyri's, which are out there. Now, Wernicke area is located, in the posterior superior temporal gyri. Similarly, the frontal lobe, that that you see, also has three horizontal gyri, which is called, the superior, the medial, and the inferior frontal gyri. So, you have superior gyri, the medial gyri, and the inferior gyri, even in the frontal lobe. So, if it is in the temporal lobe, it is the Wernicke area definition. If it is in the frontal lobe, it is the Broca area definition.

So, Broca area is in the inferior frontal gyrus. Now, the frontal and parietal lobes, are separated by the central Sulcus. So, the separation of the frontal and temporal gyrus, is in the frontal and the parietal gyrus, is in terms of the central sulcus, which is flanked by two vertical gyri's,

known as the, precentral and the postcentral gyri. The post central gyrus, on the parietal side, of the divide, in the somatosensory cortex, the region of the brain, that process the body senses, to keep track of what the various body parts are doing.

So you have the somatosensory cortex, which is the region of the brain, which looks at, what various regions of the brain are doing. And, it is in the post central gyrus. And, these includes the articulate test for speech. So, the somatosensory cortex, they also monitor, the articulator of speech, the various speech producing areas, or the various speech producing apparatus, which are there.

Now, the precentral gyrus, on the frontal side of the divide, is the primary motor cortex, the region of the brain, that program commands, to move the body, including the articulators for speech, also the in the precentral gyrus. So, in the postcentral gyrus, you have the somatosensory cortex, which are responsible for, maintaining articulators of speech. Similarly, in the precentral gyrus, you have the primary motor cortex, which is also responsible for, articulation of certain speech producing apparatus.

Now, the deep grooves, separating the left and the right hemisphere, is called the Longitudinal fissure, and in its inner surfaces, are covered with Cerebral cortex. So, you have, if you look at the brain, in between, or from a front to back thing, the region which separates the two brain together separate, is the longitudinal fissure, and it is covered by the Cerebral cortex. Now, included in the regions, in the supplementary motor cortex.

Now within this, you have the supplementary motor cortex, which is a brain region, that is believed to be responsible of programming intentional actions, and opposed to response to sensory input. So, you have the another interesting region, which makes its effect, on speech production is, supplementary motor cortex. Now, the anterior cingulate cortex, regions deep inside the longitudinal fissure, that is believed to be involved in, error detection and in monitoring conflict.

So, the anterior cingulate cortex region in the brain, which is responsible for speech production, or error detection in speech production. Now, that deep fold in the Cerebral cortex, that separates the temporal lobe, from the frontal and parietal lobes, is called the, lateral Sulcus. And that is that is that is there. So, region within the lateral sulcus, that has been implicated in

language processing is the Anterior insula. So, there is something called the Anterior insula, which is in in the anterior insula in the Lateral Sulcus.

And, that is also responsible for, producing languages. Now, the Sylvian fissure, the region inside, and surrounding the lateral sulcus, is referred to as the, Perisylvan cortex. And, this is a busy area for, language production. So, you have the longitudinal feature, the deep groove separating the left and right hemisphere. You have the, lateral sulcus, which deep fold that separates temporal lobe from frontal and parietal notes, also called the Sylvan fissure. And, region inside the round the lateral sulcus known as, Perisylvan cortex.

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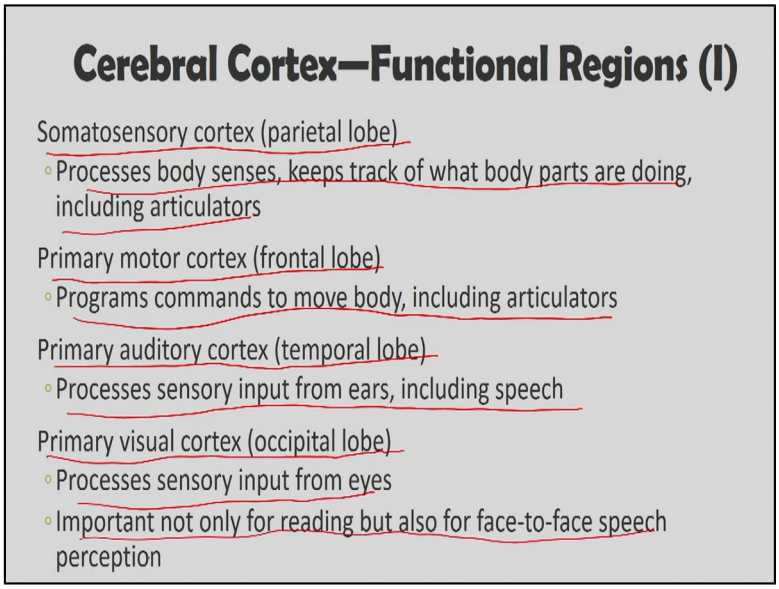

And so, these are responsible for, production of language. So, you have the Somatosensory cortex, which is in the parietal lobe, it processes the body senses, keeps track of what the body parts are doing, and includes articulators. You have the Primary motor cortex, which is in the frontal lobe, which programs commands and body movements, including the articulators.

You have the Primary auditory cortex, which is in the temporal lobe, which processes sensory input from ears, including the speech. And similarly, you have the Primary visual cortex, which is in the occipital lobe, and which processes sensory input from eyes, and important not only for reading, but also for face-to-face speech perception.

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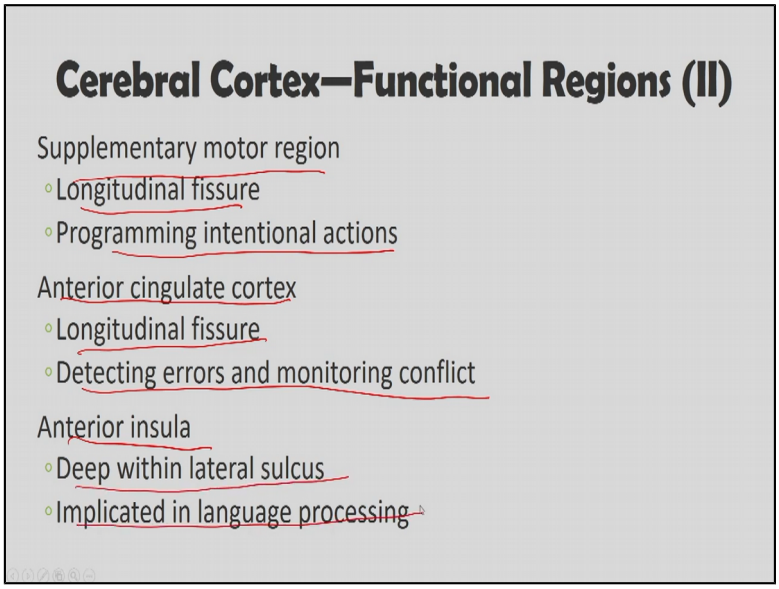

Supplementary motor regions are also there. Longitudinal fissure, and programming intentional actions. You have the Anterior cingulate cortex, which is the Longitudinal fissure, detecting errors and monitoring conflict. And, you have the Anterior insula, which is deep within the Lateral sulcus, and implicated in language producing.

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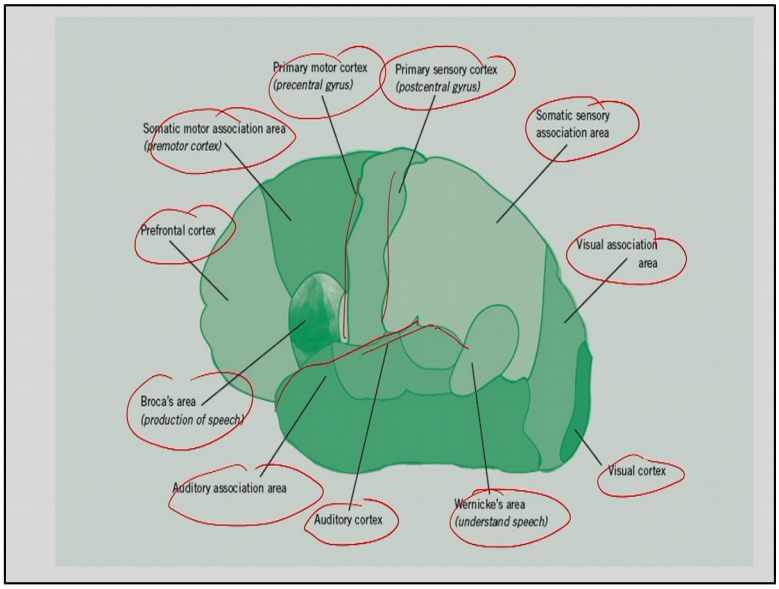

So, see these are some of the, functional regions of the brain. As, you can see, this is the Auditory association area, this is the Auditory cortex, the Wernicke area, the Visual cortex, the Visual association area, the Somatosensory area, Primary sensory cortex, Motor sensory cortex, or the Precentral gyrus, the Premotor area, the Prefrontal cortex, the Broca area. And so, these are the circuits, which are which we have been looking at. These are the divisions, which are there. And so, all these areas are, responsible for, producing speech.

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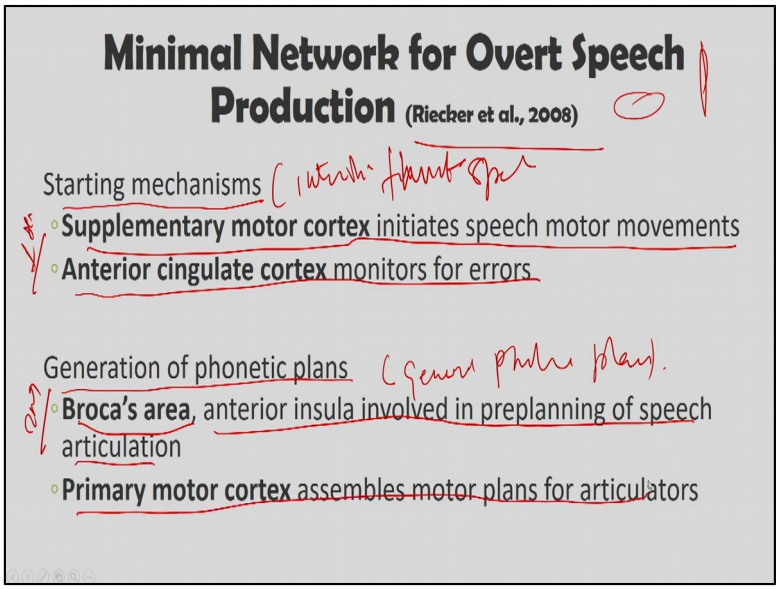

And lastly, we have something called a, Minimal Network for Overt Speech Production. Now, just like walking, talking is also, a routine activity. So, talking like walking, a rhythmic activity, with its repeating patterns of consonants and vowels. So, just like, certain acts are done in walking, certain kind of movements are done in walking, similarly, certain rhythmic activity,

are also done in talking, by repeating the consonants and vowels, patterns which produce, a sequence of syllables.

Now, it requires the exquisite coordination, of many muscles, to move the articulators, just the right amount, at the right time. So, when you talk, the right kind of muscles, has to be moved, at the right time, to produce the right amount of sound, so that, the vowels and consonants are produced. And, because of that, a syllable is produced. And, because of that, you are able to produce, the sound.

Now, many of the brain structures, involved in controlling locomotion, are also enlisted, for the production of speech. Now, Riecker and others, 2008, have identified the minimal network for overt speech production. The network is composed of, three functional systems. So, minimal speech production area, as produced by Riecker and others, in 2008, if they say that, there are three areas, which are there. The network is composed of, three functional systems, and compassing both, the cortical and subcortical structures, on both sides of the brain.

So, it closes both. So, these are the minimum area, for speech production, according to Riecker and others. Now, there is a starting mechanism, there is a generation of phonetic plans. And then, there is a coordination movement plan. So, the first functional system, consists of the starting mechanisms, involved, initiating, and maintaining, a continuous fluent speech stream. So, the first system is initiating and maintaining speech, flow in speech.

Supplementary motor cortex, initiates speech motor movements. And, anterior cingulate, monitors for errors. The system centres on the, supplementary motor cortex, and into the cingulate. The second functional system, that is there. So, this is my first functional system, this is my second functional system. The second functional system, is composed of the premotor components, that are responsible for generating phonetic plans, Broca's area, and for the Anterior insula.

So, it generates phonetic plans. And, what to be said. You have the Broca area here, which is the Anterior insula, involved in pre-planning of speech articulation, and primary motor cortex, assembles the motor plan for articulators.

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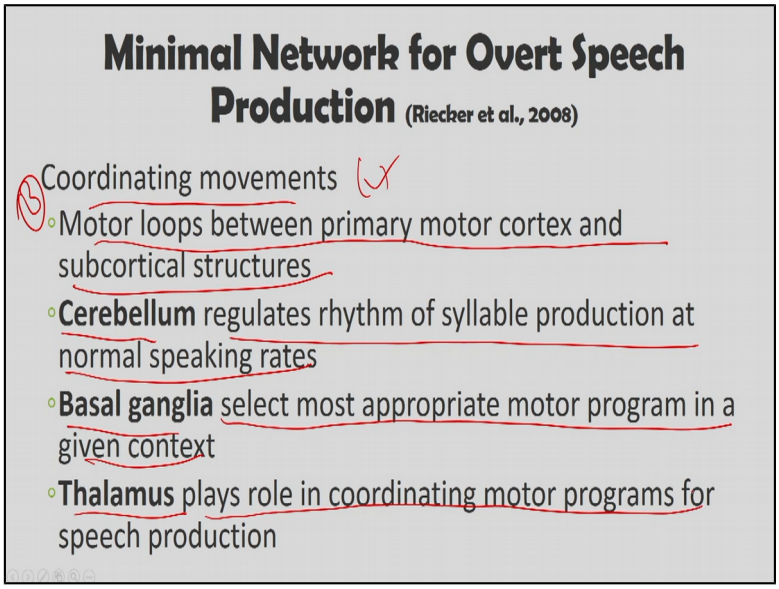

And, the third functional system, which is out there, it extends from the bilateral primary motor cortex, down into a number of subcortical structures. And, the system as a whole, is responsible for, coordinating movements. So, it is basically, the third system is for, movement coordination, of more than 100 muscles, in the respiratory tract, vocal tract. And, the face and eye, involved in production of speech stream. So, it is coordinating movement system, which is the third system, which is there.

The motor, loops between the, primary motor cortex, and the subcortical structures. Here, the cerebellum regulates, rhythm of syllable production, at normal speaking. Basal ganglia, which selects, most appropriate motor programs, in a given context, and then, Thalamus, which plays a role, in coordinating motor programs, for speech production. Now, beside this, one or more dupes for speech production, involves the cerebellum, is responsible coordinating movements. You have another motor loop; speech production runs through the Basal ganglia.

And, you have the Thalamus, which is another subcortical structure, that often observed, to be active during, brain imaging studies of speech production. So, that should bring us, towards the end of this lecture. What we did in today's lecture, is we started off, by looking at, how the vocal tract is composed of. So, what are the parts of the vocal tract. And, how the vocal tract produces speech sound. Then, we looked at, how consonants are produced, and how vowels are produced.

So, we looked at, different production systems, the consonant from, Manner of Articulation to voicing, to the place of articulation. And then, we saw, the three-dimensional space for

production of the vowel. So, that is what, we saw. And then, later on, we looked at, some of the areas of the brain, which is responsible for, producing the speech sound.

So, we looked at, not only the Wernicke-Geschwind model, but we also looked at, certain other cerebral areas, and how these areas, they interact together, to produce the speech sounds, that that that we generate. Now, upcoming lectures, we will continue this, in the next lecture. But, till we do that, it is thank you, and goodbye, from here.