Lecture 15:

Speech

Comprehension 2

Hello and welcome, to the course introduction to the psychology of language I am, Dr. Ark Verma from IIT Kanpur and we are in the third week of the course. As you know? We have been talking about speech production and comprehension this in this week, in the lab first three lectures I talked, about various aspects of switch production and in the last lecture I talked a little bit, about the motor theory of speech perception, basically trying to understand how, speech perception actually functions. In today's lecture I will continue, on the same plane and I will talk to you,

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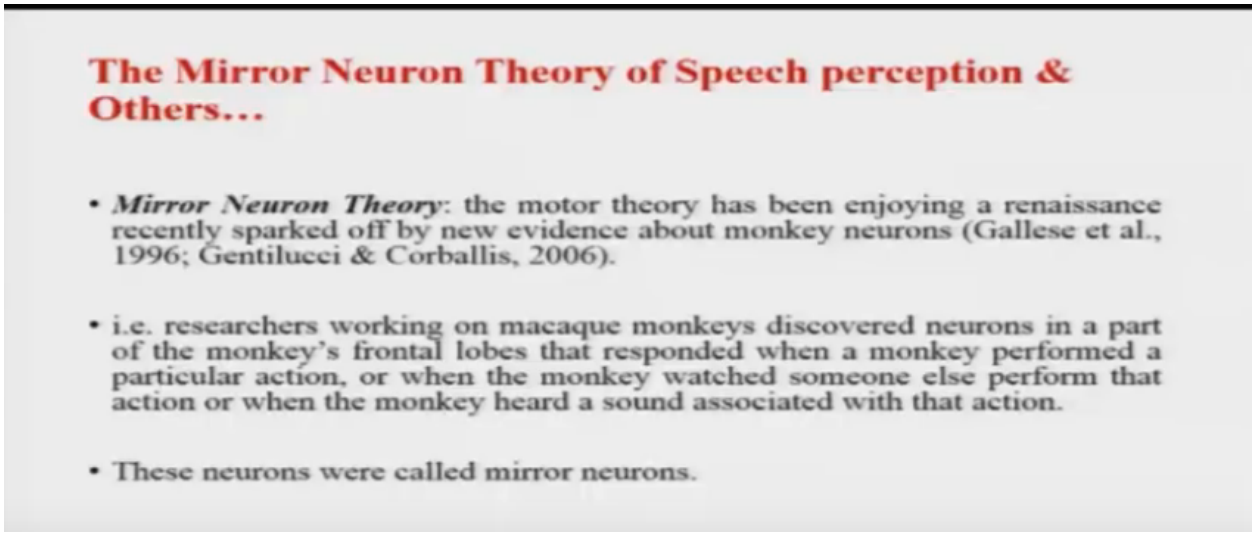

Further more, about the motor theory of speech production now also, basically something referred to as the mirror neuron theory. So, the mirror Neurons basically, are a set of Neurons, that have tried to explain how the motor theory might be actually instantiated in the brain, I'll come to that, in a bit and then we will also talk about some, other theories of speech production, that are in some sense, in let us say, opposition to or they are in some sense contrary, to the suggestions of the motor theory of speech perception. So, we will see, talk about some aspects of motor theory of speech production we will see, here some of the objections, to the modern theory of speech production. So, the criticisms that it has got, also then we will kind of also examine some of the other theories of switch perception. Okay? So, that will be, about today's lecture. So, let us start, now there is this, whole concept of mirror Neurons which is been around, for over 2to 3 decades now and it's one of the very popular concepts, in cognitive neuroscience and this whole concept of

mirror neuron basically comes from, basically first came from the research, that was being done with monkeys and it so, happened that, there was this researcher in whose lab, they had monkeys and they were trying to, you know? In a single cell, recording sort of a paradigm, wherein you cut open the brain of the mink, monkey and you insert a body electrode and that electrode records, the you know? Electrical activity, in the Neurons. Now, basically that electrode is in the electrodes are placed, that it can record activity from a set of Neurons or range, of these Neurons and what this, what they discovered was, that there were these particular Neurons, that were firing whenever the monkey was actually eating the food, also some of these Neurons actually fired when the monkey was observing, somebody else eating the food. So, there was this lab assistant or researcher that was there and there searcher was probably you know? After day of experimentation, gotten hungry, he was starting to eat the banana, then he heard this loud chirping noise. So, basically the electrodes were, also were basically being interpreted as some, sort of noise pattern. So, that when the electric activity is absurd, they just can look at it. Okay? Where is this coming from? So, the person is eating a banana and he hears this, you know? A Neurons firing and it kind of does this, again I didn't notice it, there is this bunch of Neurons, that not only, fire when the monkey is, itself, doing the action but they also fire, while observing the action. Okay? So, this these set of Neurons were referred to as, mirror Neurons and the basic function of the mirror Neurons that was, described was that of, imitation now, how do you do imitation? If you see me, waving this hand and if I, if you want to, wear the hand you have to kind of, you know? Be able to some of, some program in your head, should be able to tell you, how exactly it is that, I am waving my hand, this function, is basically what is, broadly achieved by the Mariners, are not really, a you know? Cognitive neuroscientist, to tell you a lot, detail about this but, this is precisely what might be happening.

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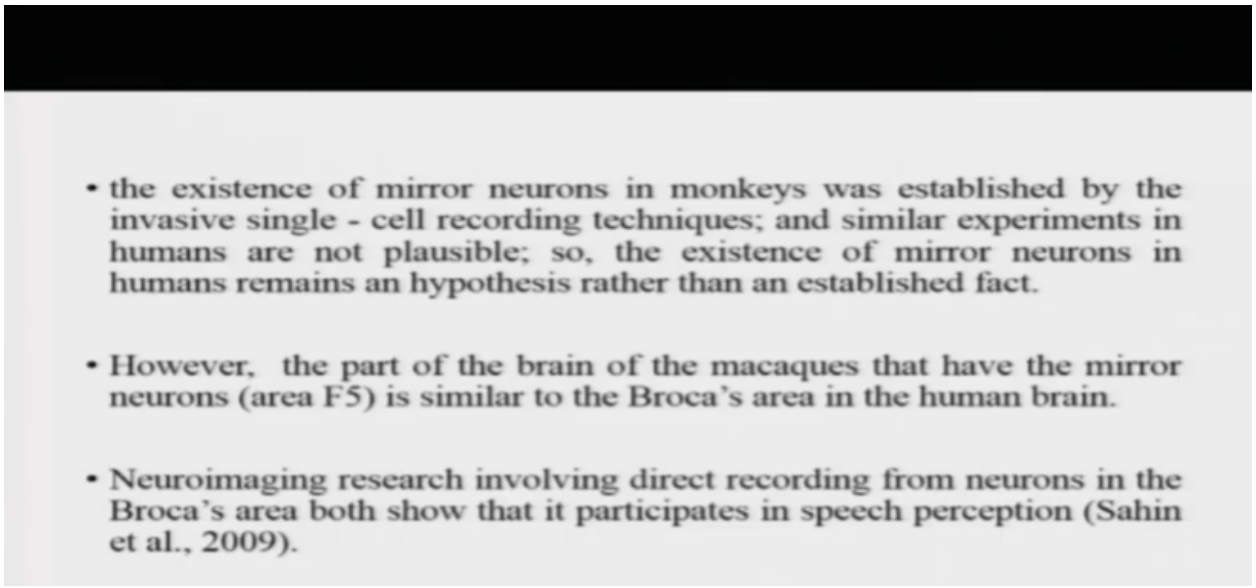

Now, the existence of mirror Neurons, in monkeys was, as I said, established by this invasive single-cell recording technique; and that's not really possible for doing with humans, you know? No committee would give you ethical clearance, for recording, activity by recording single-cell activity, by inserting the electrodes into somebody else's head, recently I had a friend come over and he told me that, for some patients where epileptic surgeries are do, they still kind of can, get the patients, you know? In a state where they can record this, well that's not, a nod that's not something that you can actually do. Okay? So, the part of the brain, of the monkey's brain, the part of the monkeys read which had, the mirror Neurons the especially the area f5 weather on is doing, is actually similar to the Broca's area, of the human brain the Broca's area is the area that, basically you know? Is responsible for production of speech. So, let us say, this is the area, which is in the inferior, frontal lobe, basically in the motor cortex itself and this is the area, that is supposed to be responsible for, controlling or all our articulatory processes, you know? All the motor activity related to production of speech, is handled by Broca's area. So, if you have a damaged in Broca's area you will probably not be able to produce speech normally or not at all Okay? We talked about that in a later lecture. So, new dramatic research involving direct recording from Neurons in the Broca's area, have was shown, that it participates in speech perception as well, usually it is, involved in speech production should be involved in speech production,- be production being a motor act but ,it has been shown by a new imaging research ,that Broca's area, is also activated while, somebody is listening to speech ,now that sounds a little bit similar, to what the mirror neuron would do, there was why the person is listening to

somebody speak, it is also, making up how should I be able to speak the same way. Okay? So, the mirror Neurons, in their way of imitation, probably would try, would try to recreate or slash simulate, the sound that you know? The person is hearing, researchers who discovered the mirror Neurons, have proposed that the mirror Neurons could be the neurological mechanism,

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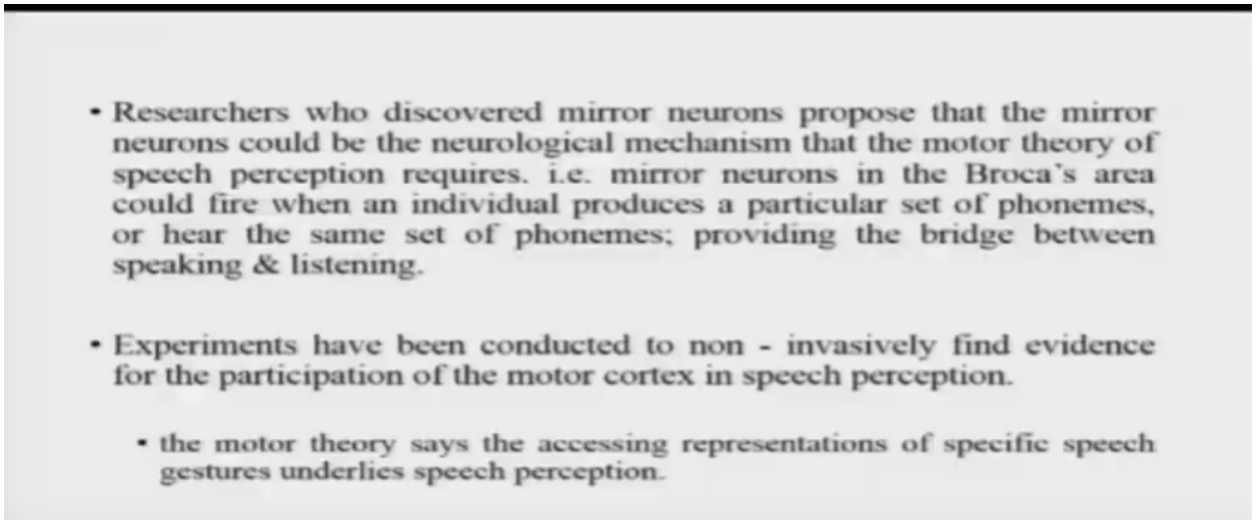

That the motor theory of speech perception requires, to instantiate in the human brain if you remember, from the last lecture, the motor theory of speech perception said, that ignored to really understand speech perception, one of the better things to do, would be to, make out what gestures, created the perception, the mirror Neurons could exactly, be the system that helped you understand or get closer to the gesture, that a person would have said, that would have you know? Made in order to create that particular sound. So, that's what the discoverers of May Neurons propose, they say the mirror Neurons could actually be the neurological basis, for the motor theory of speech perception to say whatever it, says. Okay? So, the mirror neuron in the Broca's area could fire, when an individual produces, a particular set of phonemes one or here's, the same set of phonemes providing the bridge between perception and production of speech or speaking and listening somebody. Experiments have been conducted to sort of in a non-invasive manner figure out, whether motor cortex participates in speech perception or whether we have a similar system similar to the mirror neuron system, now the motor theory

says that, accessing the representations of specific street gestures, is what underlies successful speech perceptions,

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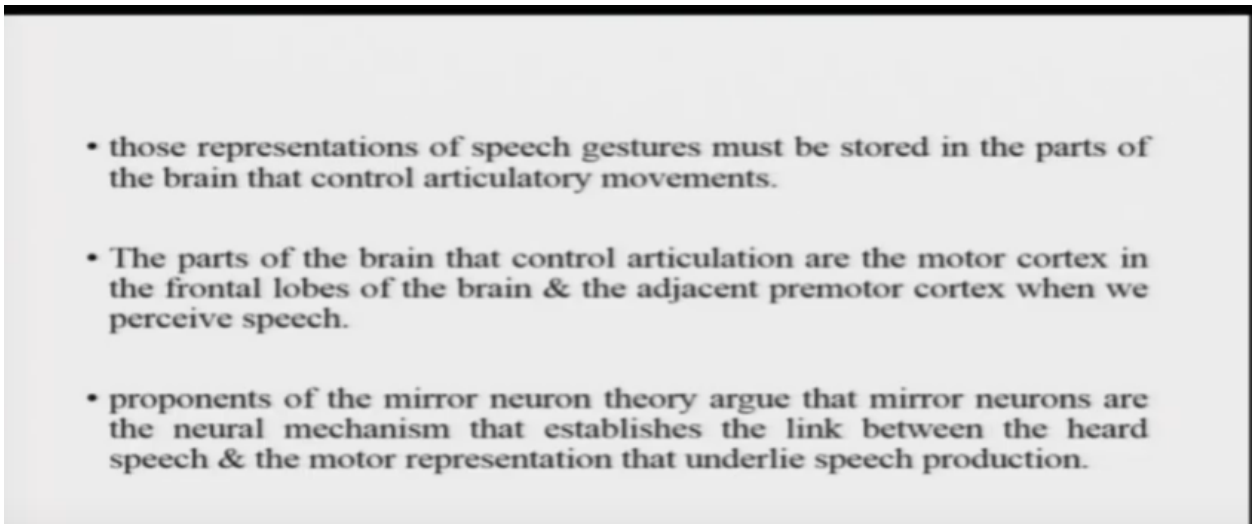

They did this experiment they want you to lose some of these experiments, the representations of speech ratios must be in some sense stored, in the brain part, there are controls or dilatory movements that is, the motor being motor cortex, Broca's area roughly, the parts of the brain that control articulation they're in the motor cortex, in the frontal lobes of the brain and the adjacent preemptor cortex when we perceive speech. Okay? Proponents of the mirror neuron theory argue, that mirror Neurons are the neural mechanism that established the link between heard, speech and motor representations that are small for producing speech. So, it's kind of trying to spell out, what the Assumption here is, that we're going to test.

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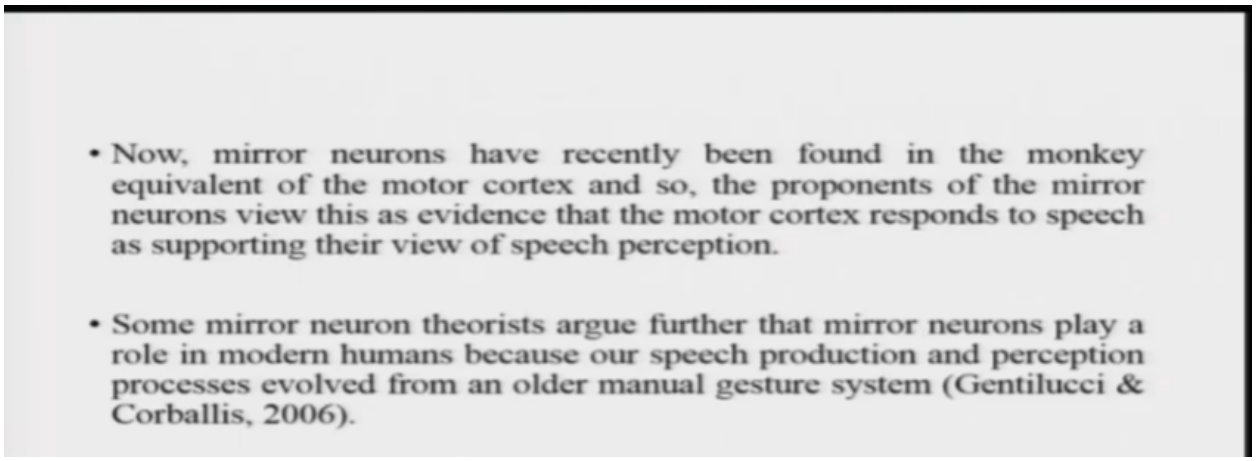

Now, mirror Neurons have also been recently found in the monkey equivalent of the motor cortex. So, there is some, sort of a confirmation that we have that, the humans also the, human brain also has the system very similar to that of mirror Neurons. Okay? The system might be more, the system might be more specialized as compared to the monkey neuron, but this is something, that is there, now some mirror, mirror neuron theorists inconsequently argue, that mirror Neurons must be, playing a very important role in modern humans because our speech production and perception, systems have evolved, from a more genetic, manual gesture system. So, there are theories, about language evolution, I don't know whether I've discussed, I don't remember anyone whether I've discussed, that in some detail, but the mirror neuron theory broadly talks about that, initially when we started to make manual gestures or make tools that led to making gestures and that led to eventually vocal gestures. So, the making of gestures, which by the way, is also something that you could assume, is very, you know? Importantly done by the mirror neuron system, if I make a, particular hand gesture, for you to be able to making to make the exactly, same hand gesture could, basically be being done by the mirror neuron system. So, because I made in your own systems were helping you do this, they are probably also now helping you to understand speech, that’s the logic that goes.

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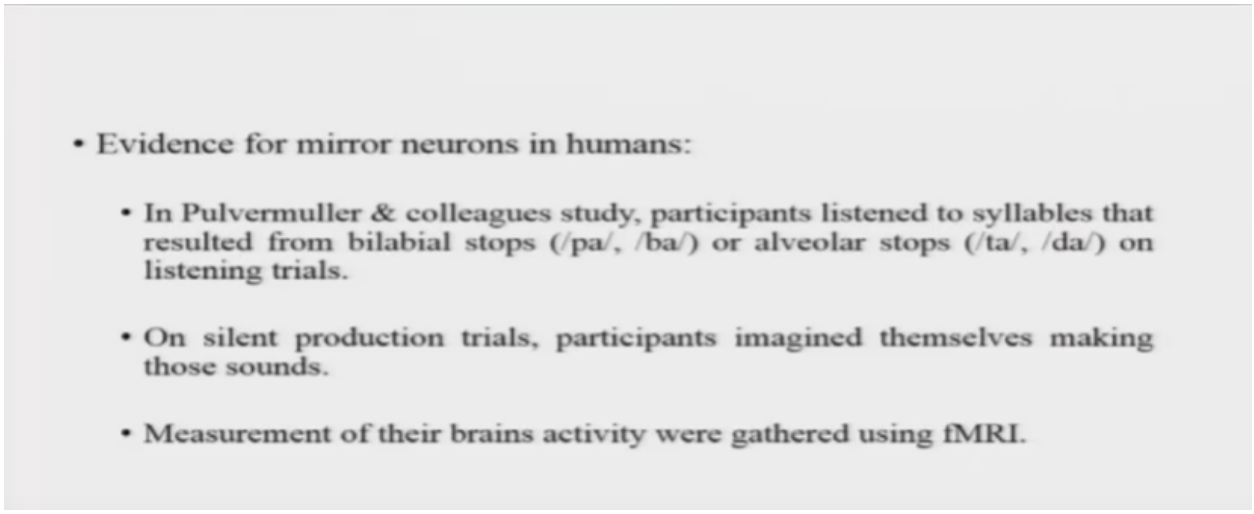

Now, is there any evidence for mirror Neurons in humans: So, yes they have done some experiences are saying pulvermuller and colleagues they did this experiment, very participants listened to syllables that were either maybe closest, pa and ba or alveolar stops ta and da. Okay? On silent production trials, participants imagine themselves; making the same sounds and neuroimaging brain activity was recorded,

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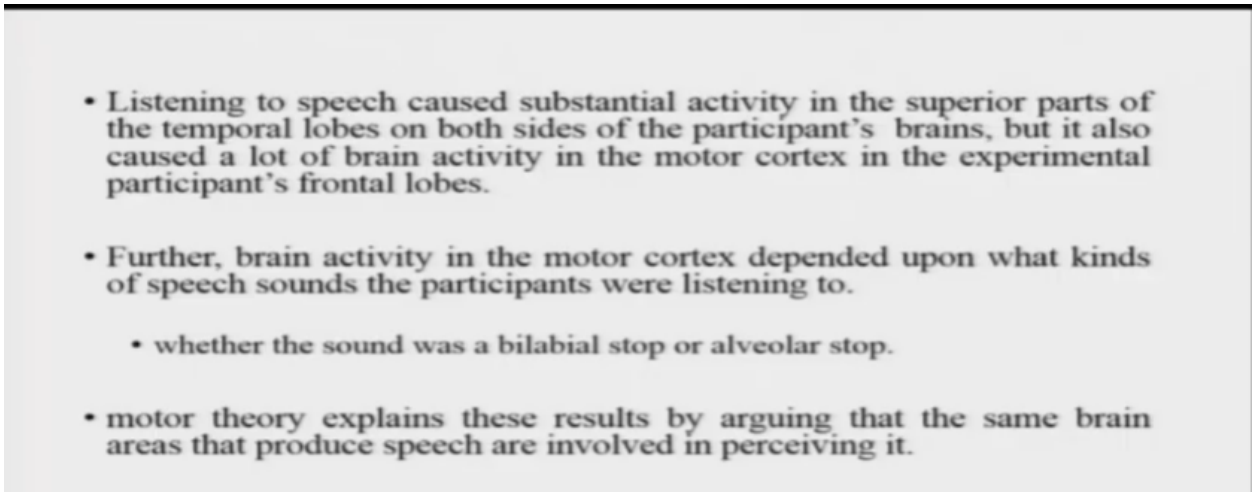

Also the same thing happened in listening trials. Okay? So, the two rails or trial in production, you're not really saying these but you're in your hedging ba and I cannot really show you where, what I'm thinking. Okay? So, listening to speech also caused substantial activity in the superior part of the temporal lobes, on both sides of the participants brain, but it also caused a lot of activity, in the motor cortex in the Parsons frontal lobes, those areas that were initially involved in silent production, brain activity in the motor cortex, also depended upon, what kinds of sounds were being produced? So, whether there's, these were the ballet will stop or the alveolar stop. Okay? Pa and ba, was ta and da because different regions. So, bind by basically involves you know? Conception of lips ta in da, inverse construction of air through now, you know? Your tongue at the back of your teeth. Motor Theory basically would explain the difference in these results, by arguing that the same brain areas that produce, speech were also involved in perceiving it.

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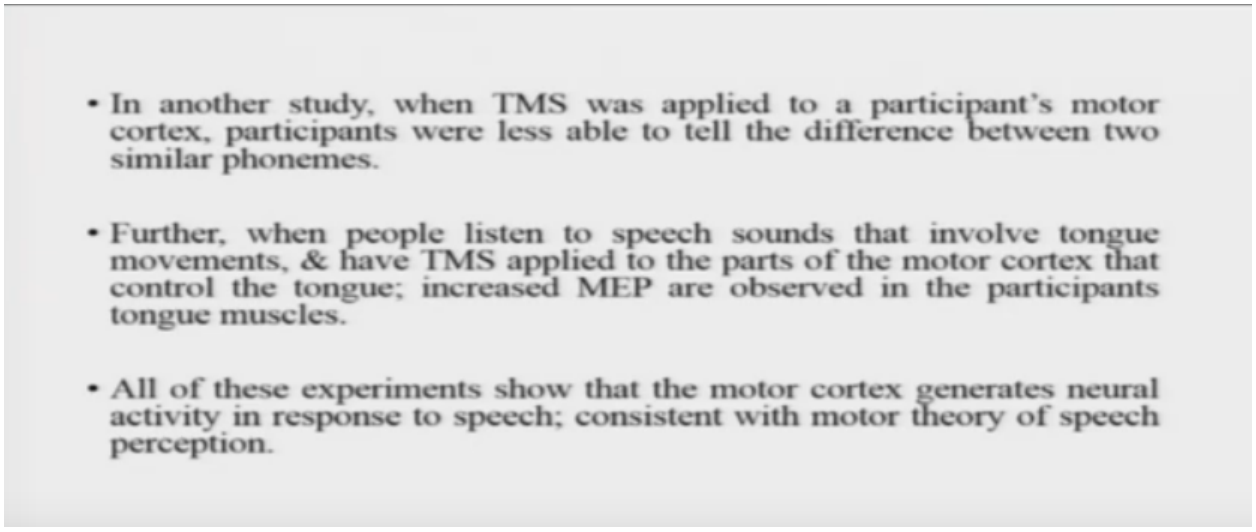

In another study, when TMS was applied to a participants motor cortex, participants who are less able to tell the differences between two sounding phonemes. The assumption here is so, TMS is a technique which you can use to temporarily, suspend brain activity in designated areas of the brain. So, when the suspended brain activity in the motor cortex, participant's perception of speech was also deficient, that is what is happening? Further in, in a different study when people listen to speech sounds that involve tongue; movements and have TMS applied to the parts of the motor cortex, that control the tongue the increased motor evoked potential are observed in parts whence tongue muscles. So, when they're listening

to people saying, sounds that are made using the tongue; movement they also receive a similar activity in the areas that control the tongue muscles. Okay? So, that's, that is something that could happen now, all of these experiments, the TMS experiment and the, second DMS experiment and pulvermuller, if my experiments, tell us, that it is possible, that motor cortex is generating some neural activity in response to speech. Okay? And that is the idea that they say is consistent with what the motor theory of switch production had to say. Okay? So, let us see this,

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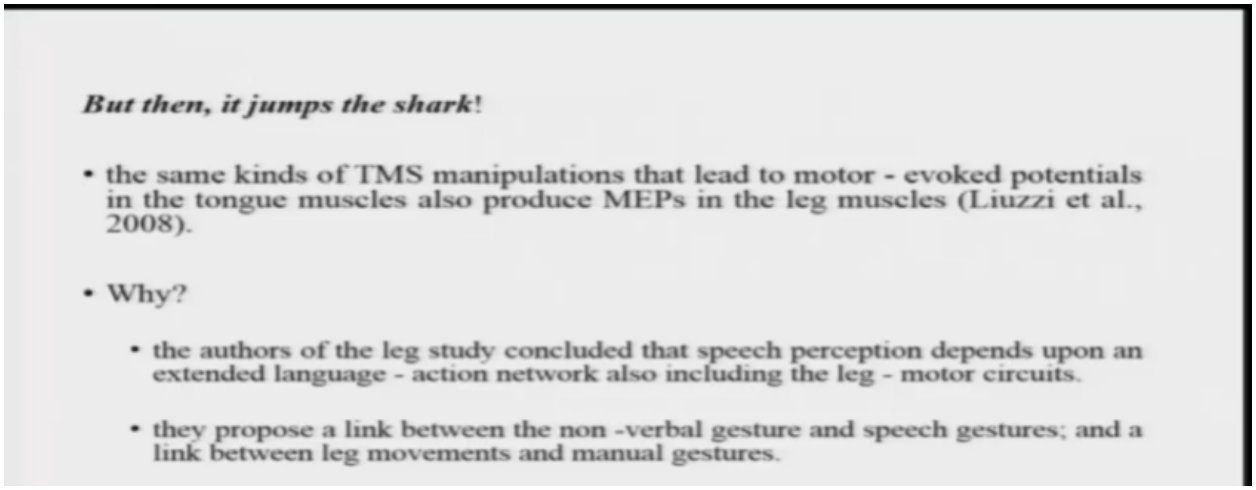

Now till here it is all fine, but say for example it probably seemed to happen and also I think Traxler feels that, is that, this kind of went a little bit overboard, it kind of you know? They probably stretched it a little too far and I will show you how, the same kinds of TMS manipulations that led to motor evoked potentials in the tongue, muscles were also found to lead to motor able potentials in the leg muscles. Okay? So, it's not that only the tongue muscles are receiving activity, is that the, leg muscles are also receiving activity how do you, reconcile these things you could say for example the authors say, of the study, they say, that speech perception probably depends on an extended Language Action Network and so, if there is going to be active in their tongue muscles, you can expect some activity in the leg muscles as well, they also proposed a link between the nonverbal gestures and speed gestures and a link between leg movements and tongue movements and manual gestures and so on. But, this kind of seems a little bit protracted kind does

not really seem, Al Right? So, what people have done is they've also questioned this entire TMS, MEP research and they basically has a say for example, things like you know? If you're experimental technique is not giving you exact results, there might be something wrong with the technique and then the findings that are coming out of this cannot be, completely trusted. Okay? So, that's, there's something on the other hand say for example if there is a, widespread activity in the entire motor cortex,

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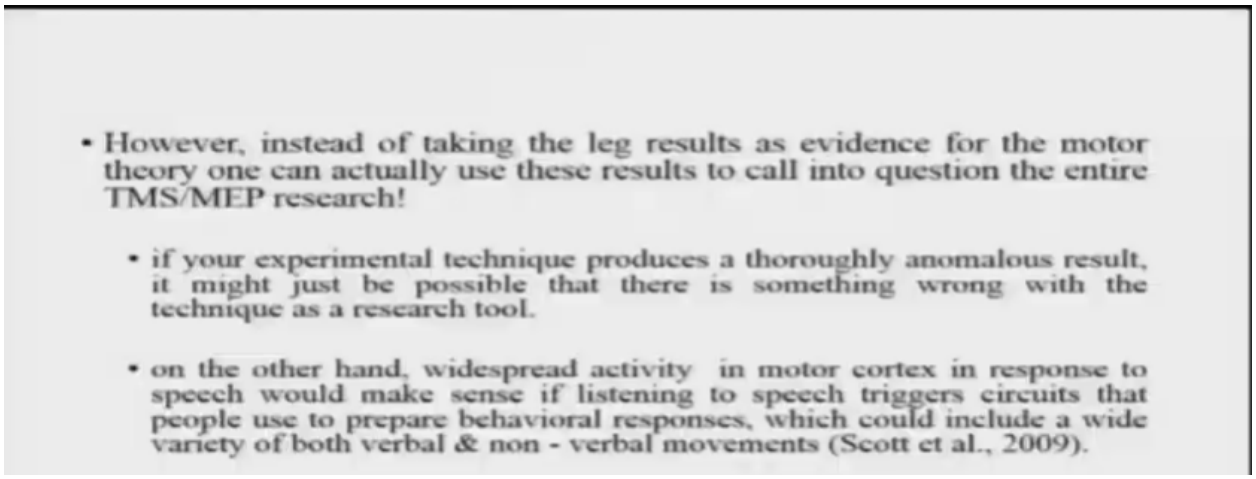

In response to speech, then basically you have to take into account as to what is really happening here, what kind of behavioral responses may be people, are people preparing to make behavioral responses which could then in you know? Involve a lot of wide where indefinitely verbal non verbal, assess so that could also be the case, that people it's not really, happening that you know? People are showing responses in the motor cortex because they're perceiving speech, but for a later thing, they are preparing for verbal behavioral responses and that is why, in preparation so, that the motor activity that is observed could be not, in response to perceiving speech. But it could be, in response to preparing to do something, you know? A speech is sort of, for action you know? You listen to something and then you want to act, you want to do something, you know? Or say for example, a lot of speech basically ask you to do something, come here go that those kinds of things.

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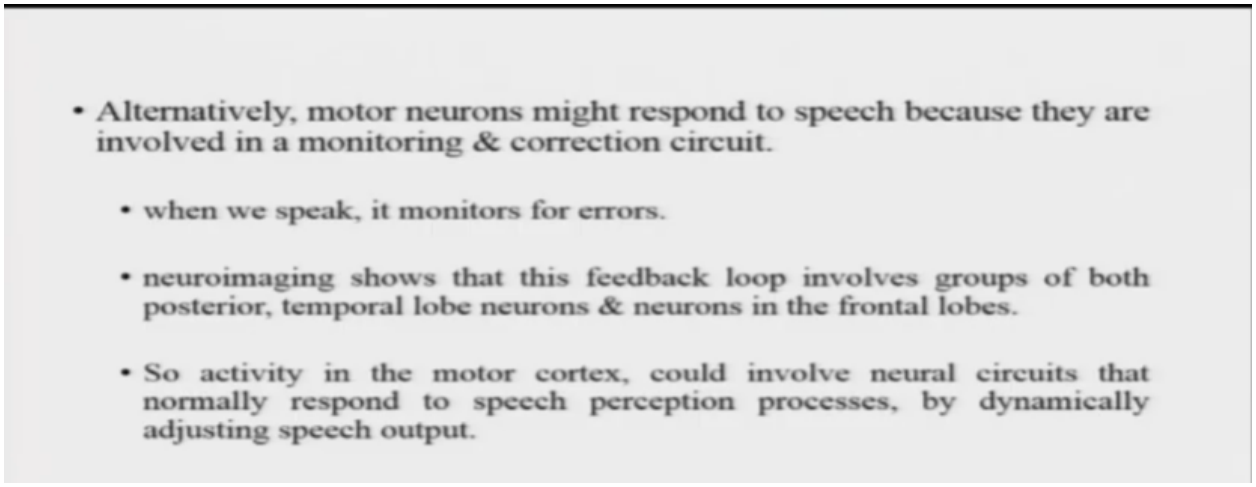

Now, an alternate could be, that the motor Neurons, might respond to speech because they are involving in a monitoring and a correction circuit. Maybe, the motor Neurons are not involved in perception of speech per say, but to monitor and correct speech, if you remember levels model there was a feedback loop, from once the phonological words were created and also after the sound was actually produced. So, maybe the mirror Neurons are kind of you know? Doing this part, they're kind of trying to do this. Okay? So, when we speak, the mirror neuron system is monitoring for error. So, that when we say something incorrectly, it can kind of adjust the speech output and account for those errors, correct those errors so to speak. Okay? So, the activity so it, said it's it could be said that, the activity in the motor cortex, that of you know? Mirror Neurons, could involve neural circuits that normally respond to the speech perception process, by dynamically adjusting speech output.

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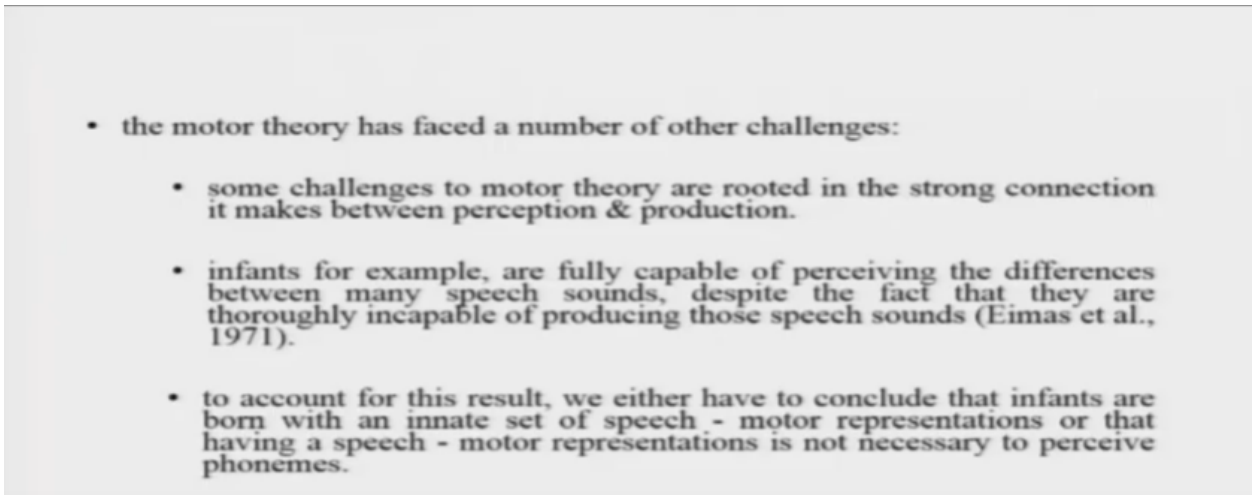

That's something that has been produced also, moving further there are other challenges, other kind of criticisms that the motor theory of speech perception, has failed let us kind of look into that. Now, some challenges to the motor, theory are rooted in the strong connection that it makes, between perception and production. If you read closely, what the motor theory of speech perception has to say, it kind of makes, perception of speech contingent to production of speech and vice versa. So, they say there should be a very strong link, between perception and production. But if you see, babies for example babies are capable of, you know? Doing categorical perception perceiving the differences in different kinds of speech sounds, although they are not able to produce, a lot of sweet sounds. So, the idea is, because of the connection, in a strong connection that the modern era or the motor, Theory switch perception makes between production and perception. How is it possible, that the babies were notable to produce, anything and the motor areas do not have programs ready for producing anything, can still perceive, categorically different kinds of phonemes. Okay? So, to account for this result, either we say that you know? Infants are also born with an innate, set of speech motor representations that they will, eventually use to produce these sounds or a simpler definition is that these two are not as, closely linked with each other, as the modern theory of speech perception has to say.

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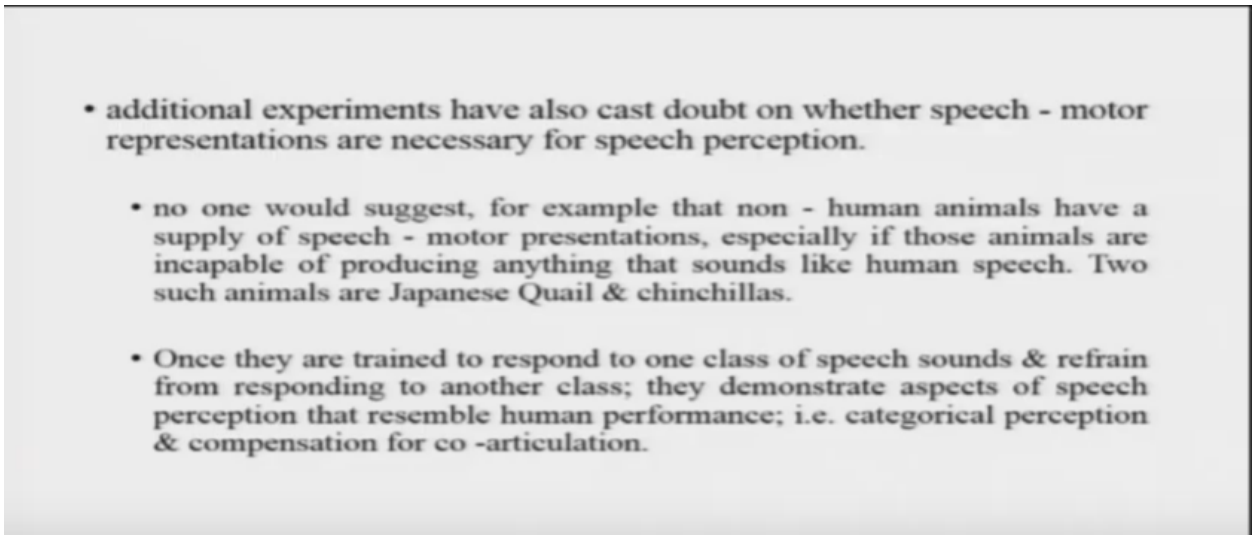

Additional experiments moving further, have also cast doubt on whether speech motor representations are necessary for perception of speech. Say for example it has also been shown, documented that on-human animal, squeals or change alas, do also have a supply of speech motor representations. So, you cannot really say that, because they also do categorical perception in very similar ways as humans would do. Okay? Once they are trained to respond to one class of speech sounds and refrain from responding to another class, they demonstrate aspects of speech perception that resemble human performance. So, it's basically, in the same way that humans would perceive speech sounds and these animals can also do that, so do these, animals have speech, speech motor representations, if yes why, do they not, speak like us, if no kind of too much to say, that these have special motor representations, much as, we have so, that's a bit of a you know? Stretch I would say. Now, because these animals lack the human articulatory apparatus, they cannot have speech model representations.

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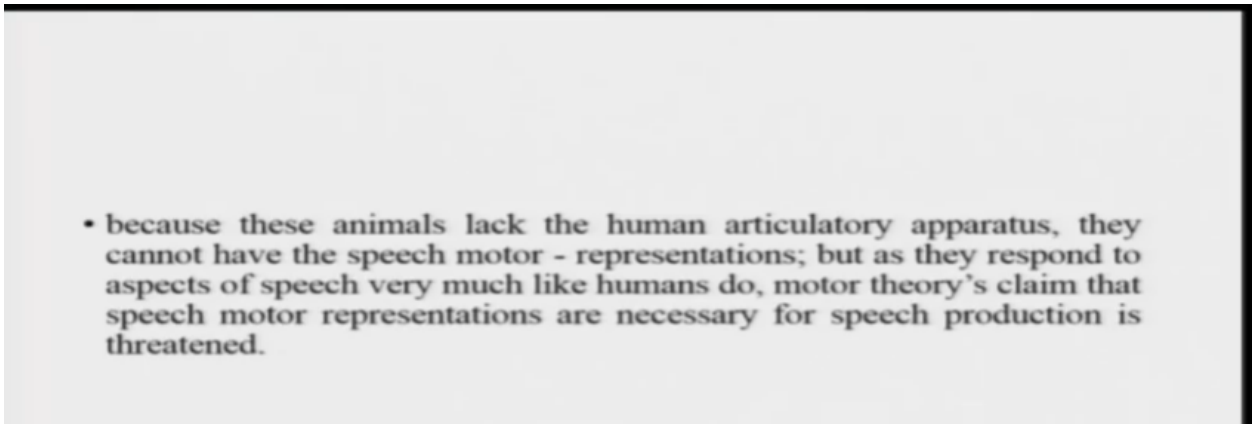

But as they respond to aspects of speech very, much like humans do, the motor theories claim that there is a very, strong connection between the speech perception modules and speech production modules, kind of feels a little bit over stretched.

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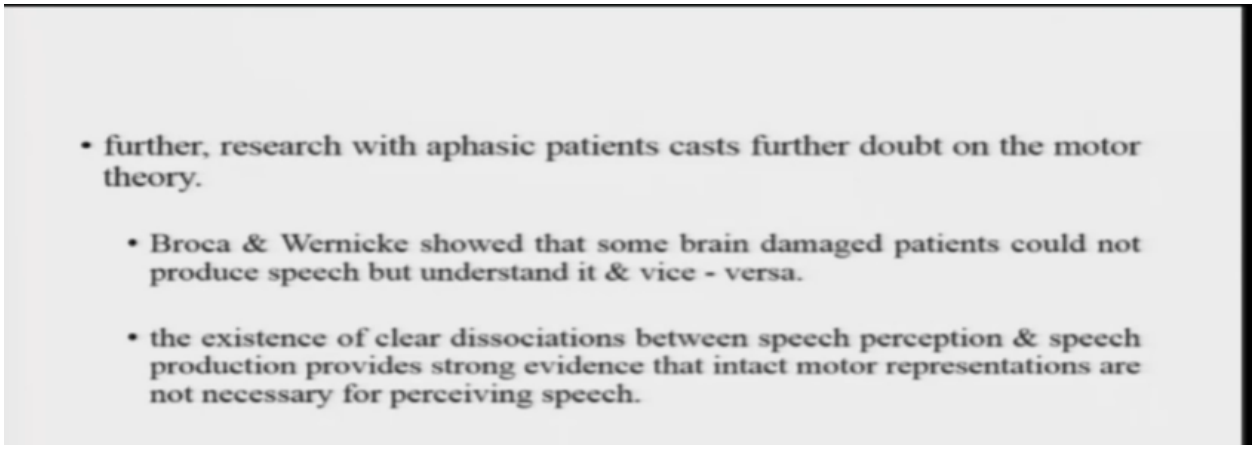

Further research also, the third class of evidence for this, further research with aphasic patients, also casts further doubts on the motor theory ok. Aphasic patients are patients which have, damage in the articulatory areas, the Broca's area is basically. Okay? And also, a different kind of aphasia could Wernicke's aphasia, I will talk about that in some of the later lectures, is where you have a problem in the

perception of speech area. So there's Broca's area, there's Wernicke's area, both Broca's area is the speech production, Wernicke's area from speech comprehension, what happens is? Sometimes this area is damaged, speech perception is running fine, sometimes this area is damaged and speech production is running fine. So, there is a sort of a double dissociation, that is mean, you know? Demonstrated telling us that, speech production and speech production and perception might not be as closely linked, as the motor, theory has to say. Okay?

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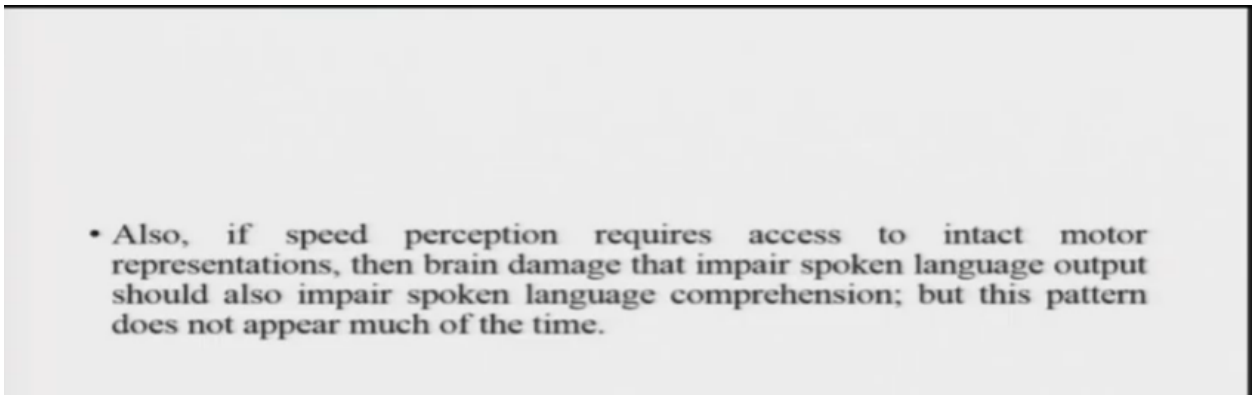

Also, at each perception required access to intact, motor representations, then brain-damaged patients who have impaired spoken language output, should also have impaired spoken language comprehension; which does not; appear to be the case most often. Okay?

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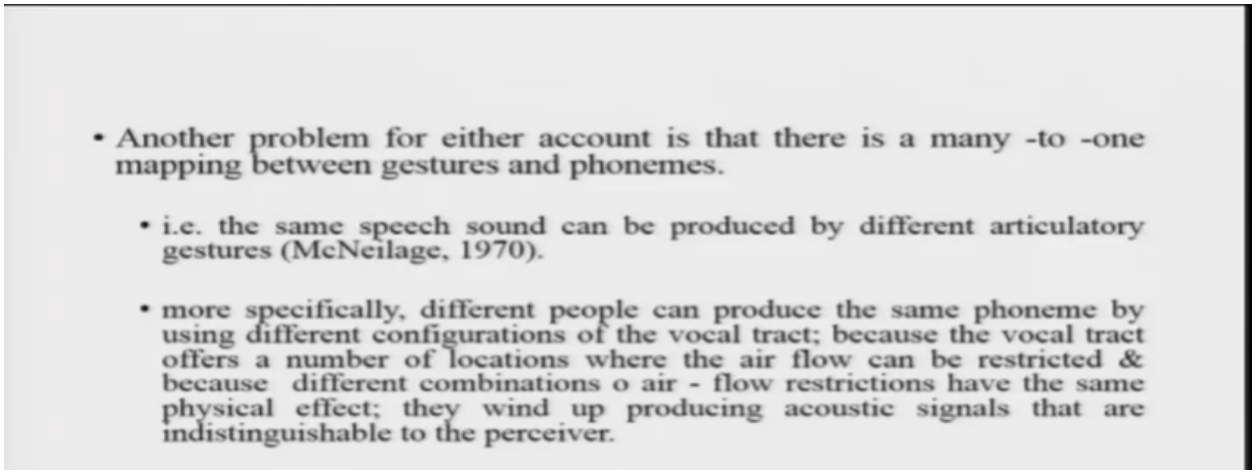

So, these are some of the doubts, these are some of the problems, with the motor theory of speech perception there's another set of doubts also, is that, there is many a times, there's usually, a many to one mapping between gestures and phonemes. So, initially if you remember I was saying and Alphin Lieberman has, proposed that gestures are more faithful to the phonemes, they are, better way to listen or identify different phonemes from each other. However, people have shown and they have demonstrated, that there is a many to one mapping with this. So, many different gestures can be used to produce one kind of funny and many different kinds of phonemes can be used and we basically produced by just the same gesture. So, there is this many to one mapping and now, this kind of complicates the story a lot, because how, will you then differentiate or you know? The whole premise of modernity kind of could work if, there are one gesture ,an done phoneme only possible, as soon as you show, that there are one gestures can create many phonemes or many gestures can create one phoneme, now you are in a soup, you know? You cannot really use the gesture, to decipher what funny was saying or the phoneme to decipher what gesture was made and that is also, one of the problems with this motor theory.

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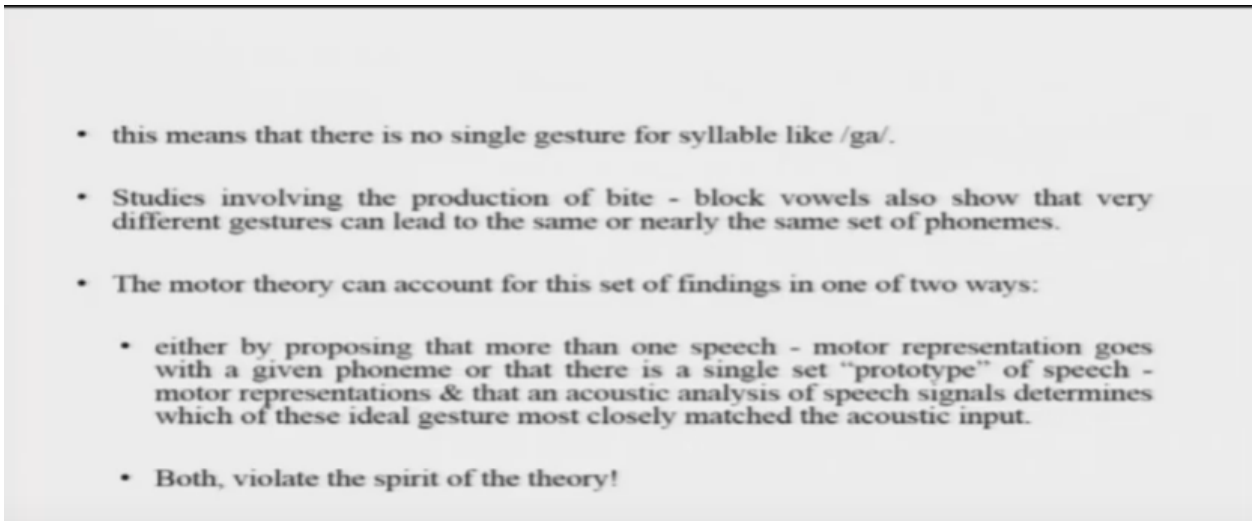

So, this means that there is no single, syllable for single gesture for the syllable like/ ga/ consequently studies involving the production, of the bite block vowels, bite block vowel says basically you give somebody something to chew and keep in their mouth, while they are producing lowers they also, kind of show that very, different gestures can lead to the same or nearly the same set of phonemes. You know? The thing I was trying to see, the motor theory attempts to account for this, in one of two ways it says either, more than one speech motor representation goes, with a given phoneme or there is a single set of prototypes of speech motor representations and that an acoustic analysis or sweet singles determines which of these gestures, would be correlated, both of them really kind of violate the whole spirit of this theory, of you know? Motor theory of speech perception and in that sense, only makes it weaker and not stronger. Okay? I think we saw, the motor theory of speech perception in some detail; you also saw some of the evidences, for and against either of, the you know? Either of the theories the beginning, what do we end up with? We end up with saying that maybe, the motor theory is not the best candidate theory, to explain how speech perception really happens, if that is not, there must be other theories.

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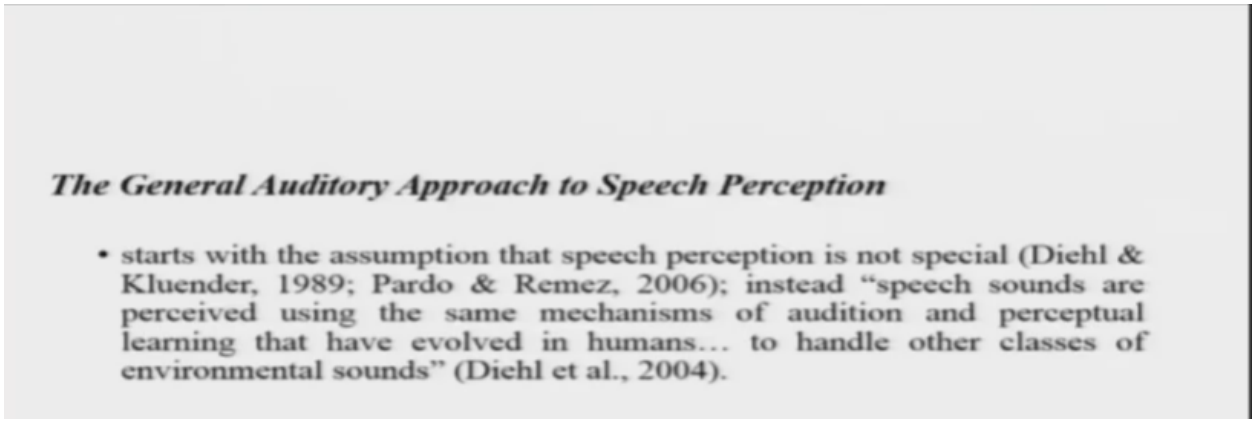

So, let us move, to another theory of speech perception that is the, general auditory theory of speech perception. On the general auditory theory of speech perception, kind of says that speech perception per say, is not really a very special

task, it's not really something, that needs a special speech module, as the motor theory people were saying. It says the speech sounds are perceived using the same mechanisms of audition and perceptual learning, that are, that have evolved in humans, to handle all other kinds of sounds. So, it does not really propose or postulate, a different speech processing module it says, speech processing, can also happen using the general auditory module, that is anyway dealing with all kinds of incoming acoustic stimulation, that's the idea.

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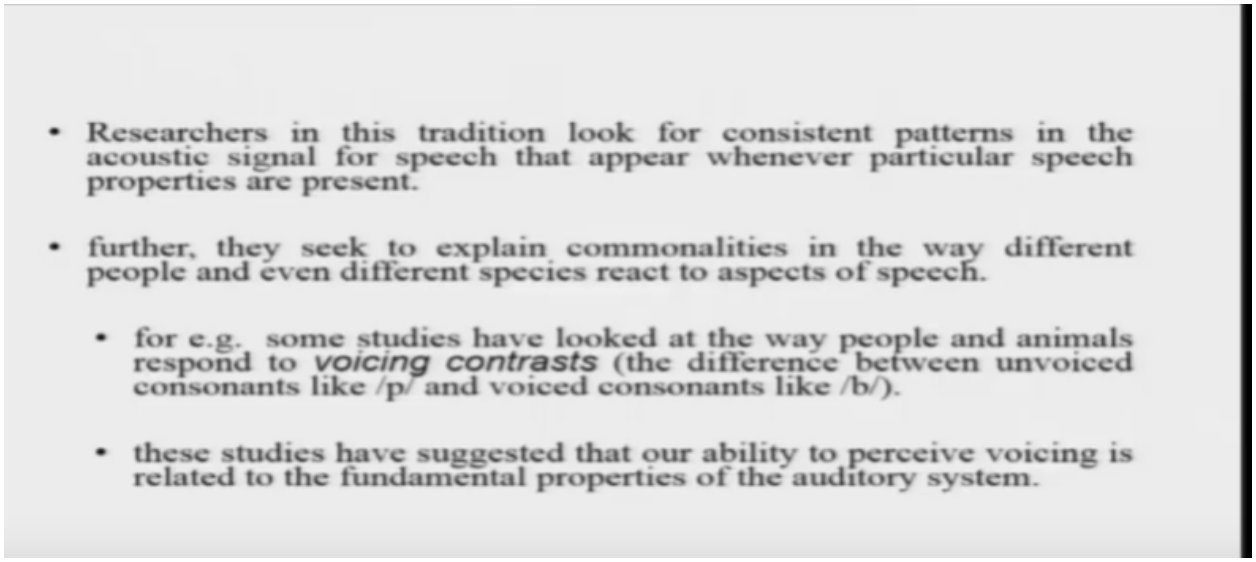

Researchers in this tradition have looked for consistent patterns in acoustic signal for speech that appear whenever particular speech properties are present. So, the idea is you're kind of now analyzing speech, in terms of how, common or how consistent; it is with, other modalities of perception of speech. So, they seek to explain commonalities in the way different people and even different species react to acoustic stimulation. Okay? So, some studies have looked at the way people and even animals, respond to voicing contrast I've, been telling you, about the pine by, example we said that Ba, is voiced by is not wise, that's the basic difference between these two sounds, both are say for example labial stops. Okay? These studies, have suggested that our yeah, these studies have suggested that our, our ability, to perceive voicing, is related to the fundamental properties of the auditory system, the fundamental property of the auditory system, is to analyze speech in

terms of these voice onset times and this is, the variation in those voice answer times, is what leads us to perceiving Ba, in Pa. So, the fundable property is what?

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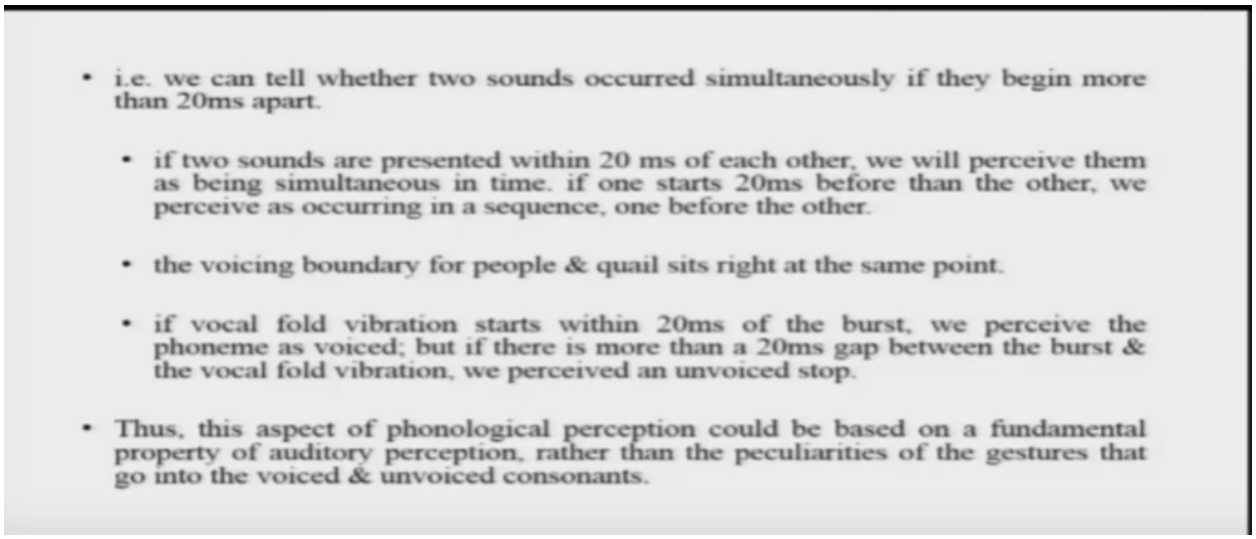

We can tell apart, to sound whether two sounds occur simultaneously and whether if they began more than 20 milliseconds apart from each other. If two sounds are presented within, 20 milliseconds of each other we will perceive them as being simultaneous in time, or maybe even as the same category, if one starts 20 millisecond before or after the other, we perceive them as occurring in a sequence, as different phonemes. The voicing boundary for people and quail is. Right? At the same point, if vocal fold vibration start within 20 milliseconds of the burst, we perceive the phoneme as voiced, as Ba, but if there is more than a 20milliseconds gap, between the and the vocal fold vibration, we perceive an invoice table it is, a Pa. So, exactly the same kind of way, both humans and quails are perceiving Ba and Pa, which kind of tells us that, it could be a very generic mechanism that, the auditory system has and one that we also share with other species of animals. So, this aspect of phonological perception then could be based on a very fundamental property of the auditory perception mechanism, rather than the peculiarities, of the gestures, that go into voicing and producing wise and unvoiced sounds.

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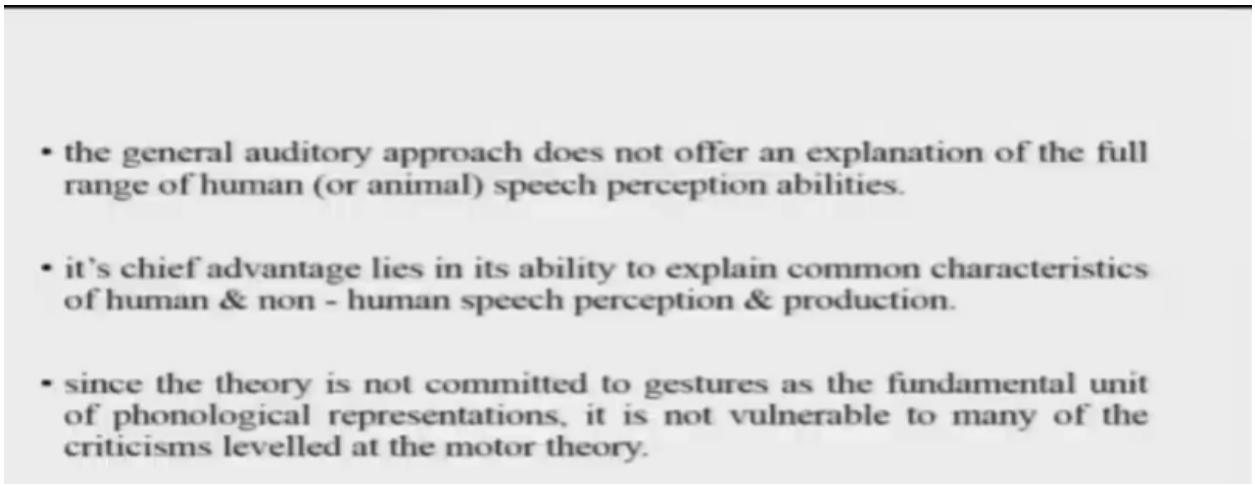

The general auditory perception theory, the general auditory approach also, does however it does not really, offer an explanation of the full range of human or animal speech perception capability, its main idea advantage basically lies, in its ability to explain common characteristics, of human and non-human you know? Speech perception and production. So, it's generic theory, in spirit, now since the theory is not committed to gestures, as the fundamental unit of phonological representations, it is not vulnerable to a lot of criticism, that we discussed, with respect to the motor theory of sweet perception. So, it kind of saves itself from all of that, moving further there's another theory of speech perception we can talk about before wend this discussion and that is the fuzzy logic model of speech perception.

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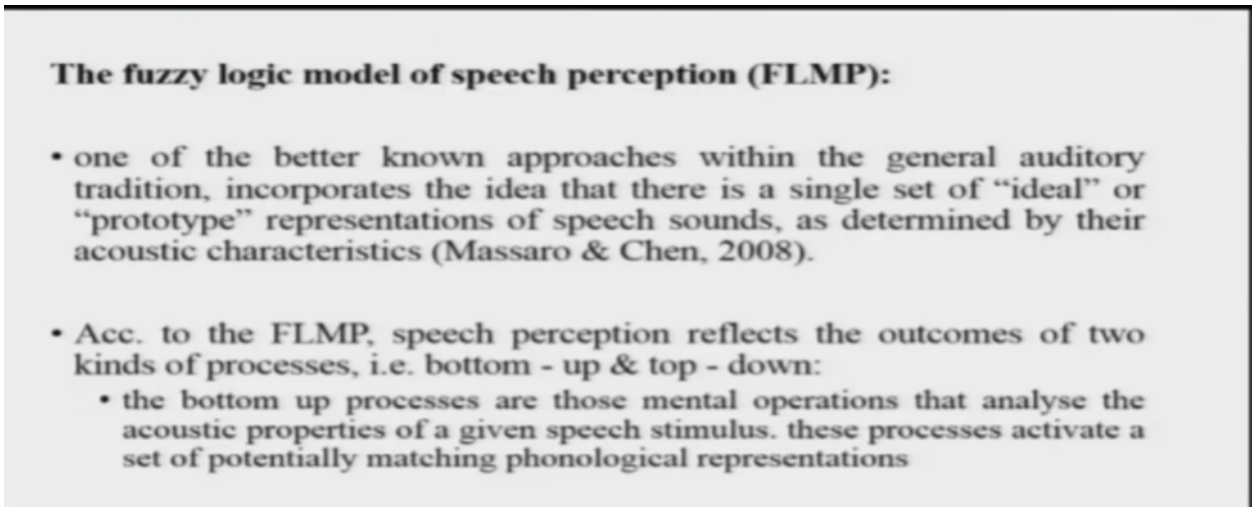

Now, the fuzzy logic model is a very, interesting model it basically says, that it kind of, is within the general auditory kind of theories. But it incorporates the idea, that single setoff "prototypical" representation for speech sounds are there, which is determined by their acoustic characteristics. So, there is a prototype version of different kinds of sounds and basically, what we need to do is? Figure out whether something is a member of that, prototype or not and that will helps distinguish between different kinds of sounds. According to the fuzzy logic model of speech perception, speech perception basically reflects the outcome of two kinds of processes, one is the bottom-up processes and the other is the top-down processes. Let us look at this in more detail, the bottom-up processes are those mental representations that analyze, the acoustic properties of given stimulus and these processes basically are responsible for activating a set of potentially, matching phonological representations. So, as soon as, you we rehearing the incoming speech stimulus, there is this process in your head, that is activating the matching speech stimulus as soon as, the match is made, you say, this you know? You recognize that speech sound and you have a way; to create there's been sound.

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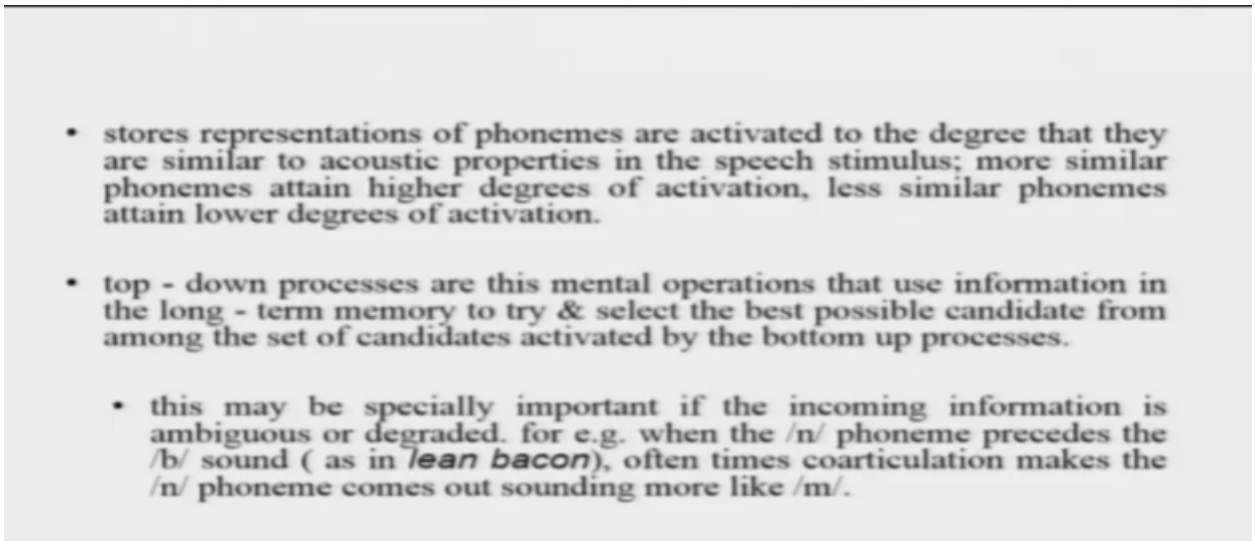

It stores, representations of phonemes, it says that stored representations of phonemes, are activated to the degree that they are similar to the acoustic properties of the incoming stimulus, more similar phonemes achieve higher, degrees of activation and less similar phonemes would receive lower degrees of activation that's how, the selection process really goes. The other types of process could be, the top-down processes, now top-down processes are mental operations, that use information in the long term memory, information from your experience, you learn, you to hear, so many things and that gets stored in your head and when the incoming stimulus is you know? You're hearing, you're trying to look for it, matching things in the long-term memory. Okay? And basically on the basis of that, it tries to select the best possible candidate, from among the set of candidates, activated by the bottom-up process. So, you could be hearing something and not being really sure, of what you've heard, so you look at, the context you look at, you know? Your long-term memory and you try and see yeah, this is what this person might have probably said, you know? Something that you would do, in a very noisy place or something that you do, if you have any disturbed phone line or so, to speak. Okay? So, this may be especially important if the incoming information as I am saying is ambiguous or degraded, when the N phoneme, precedes the birth sound. So, people say, lean bacon, you know? If you say lean bacon, lean bacon, lean bacon again, again sometimes there because of the coordination effects, people would perceive the nersound as the mrsound. So, some people would, report hearing lean bacon, instead of lean bacon. Okay? Because of coagulation other kind of speech and you know? Speaker specific effects. So, when yeah,

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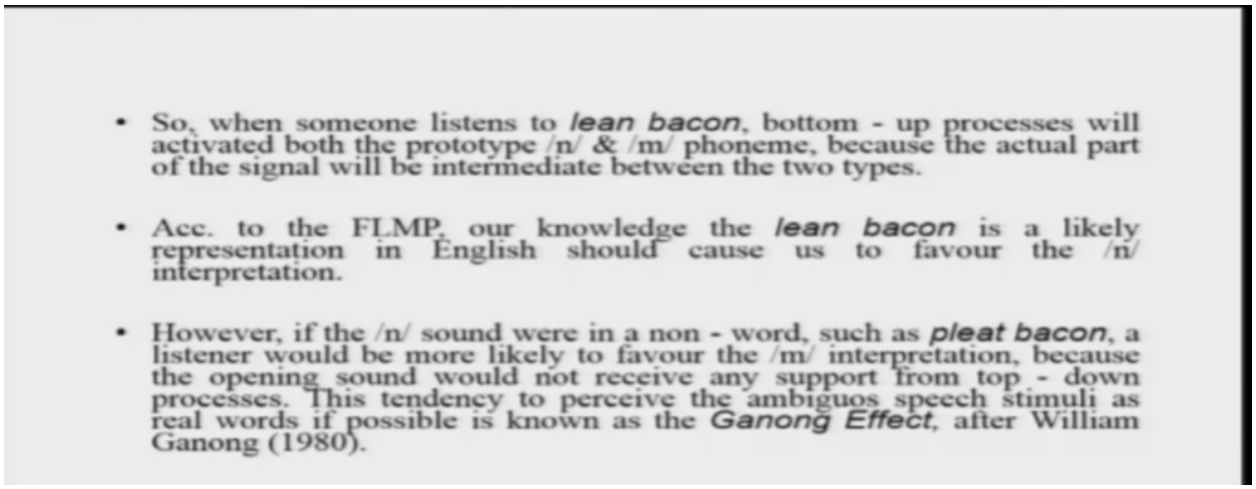

So, when someone listens to lean bacon, bottom-up processes will activate both the prototypes and an M and the top-down process will tell you, there is no such word called, ‘Lean Bacon’. So, this must be lean bacon and it kind of narrows, down to what exactly has to be said. Al right? So, according to this fuzzy logic model switch perception, our knowledge that lean bacon is the likely representation in English, should cause us to select better. Okay? However, if the end sound were in non words, such as split bacon, a listener would be more likely to favor the M, interpretation because the opening song would not receive, any support the end zone will not receive, any support from whatever is already stored in your head. This kind of effect, this tendency, to perceive the ambiguous speech stimuli, as real words, is referred to as the ganong effect. Okay? If you remember we had, a similar effect you know? Where we are talking, about speech errors, you know? That we produce more real words, even as part of, speech errors as compared to non words, similarly this is, in the, domain of perception, that if we are hearing something and if you are not really very sure of that, we are more likely to take an imp, you know? Take an impression, that this could be an actual word rather, than a non word, because people do not utter on words, usually isn't, it. So, this is, this also the fuzzy logic model of speech perception, can explain what is called the phonemic restoration effects?

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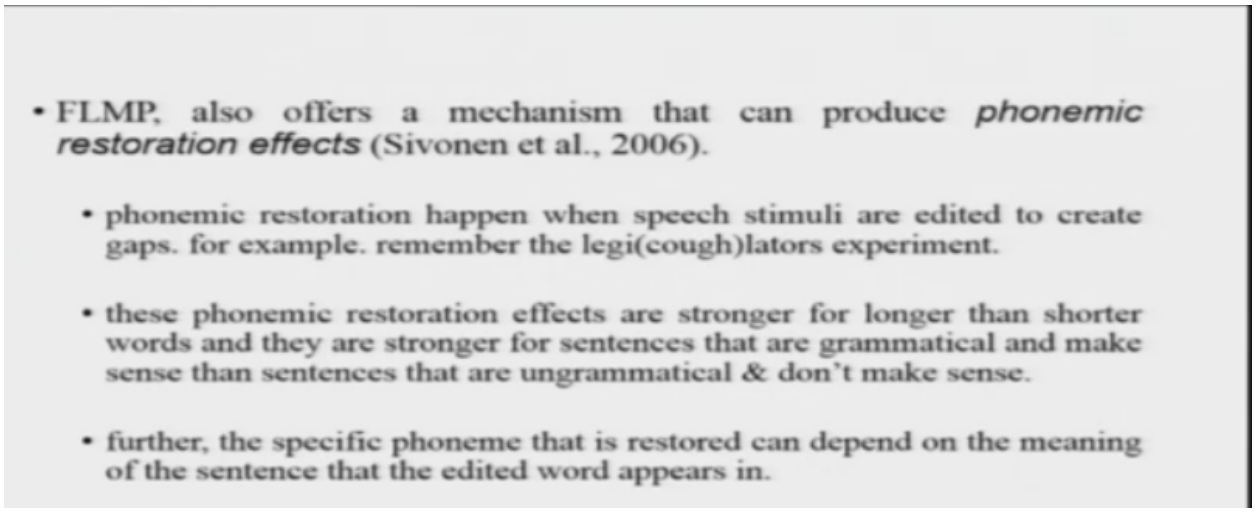

You remember what phonemic restoration, is phonemic restoration is if there is something missing in the signal, you try and fill up that signal, on the basis of your knowledge, you know? The top-down processes. So, there was this very, interesting experiment I can remember, where in there's this participant a batsman, has a headphone and the headphone, the sentence is going like you're the legislature's and something ,something, something and that exact, point where s sound is there, there is a huge cuffing sound. So, the participant basically, actually only hears leggy cuffing sound natures, there's no, s that the participant hears in the signal. But, when the participants are later us, all of them report hearing the s very clearly. How is it happening? It's probably happening because the top-down processes, as prescribed by the facilitate modular switch perception, are filling this up, you know? It happens all the time, when you're, in a very loud place you still kind of, maybe not exactly hearing everything cleanly, but you kind of still, make sense of what is being said, because there is also this aid of your long-term memory, you sort of know much, of what could have been said, what is the closest candidate that this person might be talking about and that, kind of really works. Al right? Okay? So, these phonemic restoration effects are stronger for longer words, than for shorter words, because obviously you get more time in judging and all of that and they're stronger for sentences, that are grammatical and make sense rather, than ungrammatical sentence, because the context, needs to be mostly intact, in order for you to be able to make these assumptions correctly. Okay? Further the specific phoneme that is restored can depend upon the meaning of the sentence.

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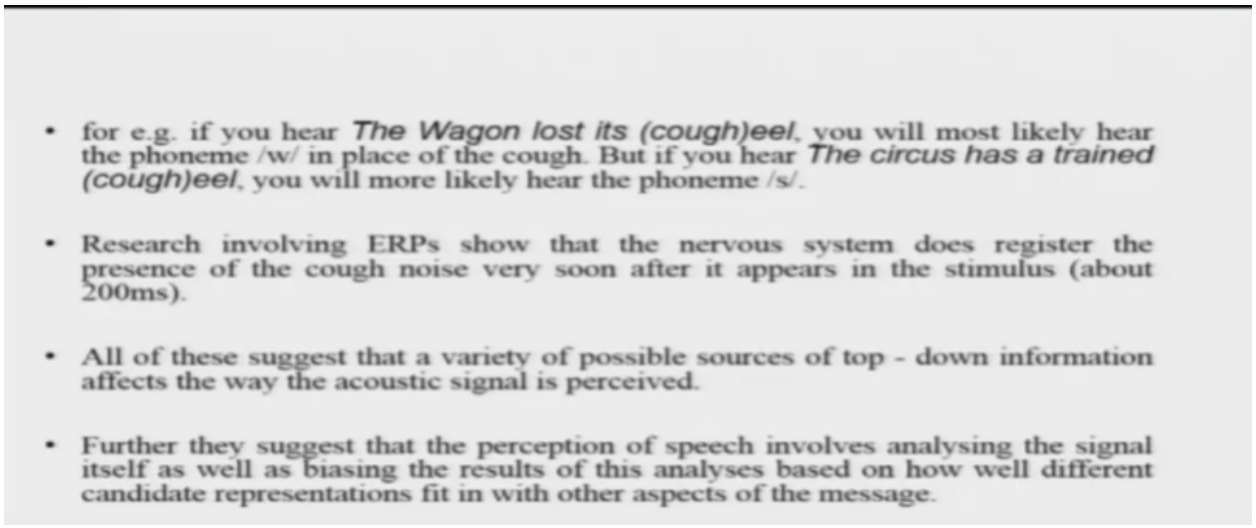

There is this example, for example if you hear the Wagon loss its e. Okay? What will you basically make, you probably a make that. Okay? Then because we're talking of the Wagon, we're probably going to talk about the V. So, wagon lost its V. Okay? But, suppose for example you hear something like the circus, has a trained, calf and E you will basically most, unlikely hear the phoneme S. So, if it's the circus, circuses probably have seals and I mean this is, this is an American you know? Text so, circuses probably have seen or you know? Different kinds of animals. So, you are probably more likely, to assume that seal would have been said, because the context necessitates see, you know? Only a kind of animal, that the circuses might have with an onset of S and with the, you know? I'm the ending e probably a C so, that's why you'll kind of you know? You'll be more biased, to going towards C rather than .V Al right? So, there have been a lot of research, researchers involving ERPs, have shown, that nervous system does, register the presence of the cuff noise very soon, after it appears in the stillness. So, it's not that, you're not hearing, the cuffing sound, you're basically getting around the cuffing sound. Okay? All of these cities that a variety, of possible sources of top-down information, may be getting scanned and it may be, affecting the way incoming speech is being perceived. Further they suggest that the perception speech involves analyzing, the signal itself as well as, biasing the results of this analysis, based on how, well different candidate representations are activated and they fit in the other aspects of the message, you saw in this example, the wagon law lost its, V versus the circus has a strained C, basically still fits in very well there with the local context, of the symptoms and the global context that it is a circus. Okay? Similarly the V Lee fits in very well, with the local context that it is a wagon. Al right?

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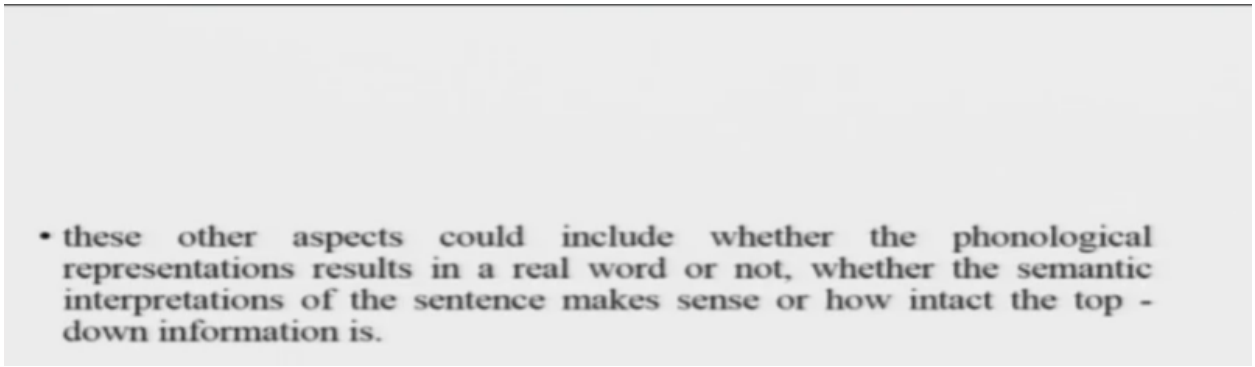

So, these and there are other aspects that could include other phonological representations, result in real world or not and whether the semantic interpretations of the sentence make sense and they all of these sorts of information, could be combined, together to amount to what top-down information is. So, basically what the fuzzy model logic, model of speech perception says, is that you're analyzing speech not really by a speech general speech perception model or something, you basically have a set of, possible candidates, the set of possible candidates basically are used to kind of activate, candidates for whatever you're hearing. So, this is the, bottom-up processes and the top-down knowledge, that you have, experience that you have with speech, helps you select the correct thing .So, a combination of the top-down and the bottom-up processes, is what is leading you to correct perception of speech, more often than not. Okay? So, this is, I think, all that I would have to say on, speech perception we had these two lectures, wherein we talked about a couple of theories, I think three or four theories, of speech perception and in a sense what you can kind of conclude, is that speech perception is rather sophisticated Act, it involves also, you know? On top of, kind of understanding the gestures and stuff, that might be partially true, but it also kind of involves other, process as well, you know? It's something that is genetically, available and it kind of probably needs some help from your, you know? Memory and your other kinds of analysis that you would be doing, on incoming speech. I hope this week, with respect to a speech production and comprehension was, intelligible to you and you would have, you know? Followed the lectures, if not, you can always ask questions in the photo. Thank you.