Bilingualism: A Cognitive and Psycholinguistic Perspective

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Module - 05
Bilingual Speech Processing part 1
Lecture - 11
Speech perception and comprehension: theories

Hello and welcome back, we were we will start module five today and this module will focus on Bilingual Speech Processing, speech processing as in auditory speech processing. So, we will divide the entire processing part into speech processing versus language processing.

In speech processing, we will focus more on the auditory processing and in within that too, more focus will be given on bilingual processing of the in terms of phonetics and phonology. So, basically the sound processing in terms of bilinguals and this part this module will be taking care of processing in both children and adults.

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So, let us start, Before we get into the details, a bit of an introduction. So, in our daily life, listening to speech is a skill that takes place very quickly, we are all the time listening to other people speak. We are also picking up various kinds of auditory signals

which are non-speech, various kind of noise and so on. So, whatever is not relevant for us at a given point of time, even if it is a speech signal, this will also be considered noise.

So, this is a skill for us to keep focused on a particular stream of incoming auditory stimuli and to keep the focus on and process it for understanding and later production, this is a skill. Now, this is throughout this course, we will talk about processing in terms of both comprehension and production. So, a human being is said to process 7 to 10 sounds per second and about 175 words in a minute, irrespective of the surrounding, how noisy or how less noisy the surrounding is.

So, now when we say speech perception, when we are perceiving sounds incoming acoustic signals, what it basically means? It means that there are a series of processes that are involved, starting with the very first stage where we are looking at the acoustic signals. So, we have at the very base, we have acoustic waves that be that builds up on an all when all encompassing mental representation.

So, when we hear our ears pick up not, we do not pick them up as you know words or sounds or sentences, they pick them up as acoustic signals. So, that signal gradually, going through various stages, ultimately goes to mental representation, a wholesome mental representation.

Right now, as I am speaking, this understanding of these words and the even the gaps in the words, you know where to segment, which that is because you know English language. If somebody who listens to me who does not understand English language, has no exposure to English language, will not be able to segment my continuous speech, segmenting in terms of where the word boundaries lie.

So, where-the-word-boundaries, this gap is nobody is really, you do not anybody who learn knows the language does not have to be told. Now, this segmentation and all of that happens at a much later stage. In the beginning, in the very first stage, we all we have is a series of or let us say deluge of acoustic signals. Now, ultimately that goes on to process and goes on to create the mental representation.

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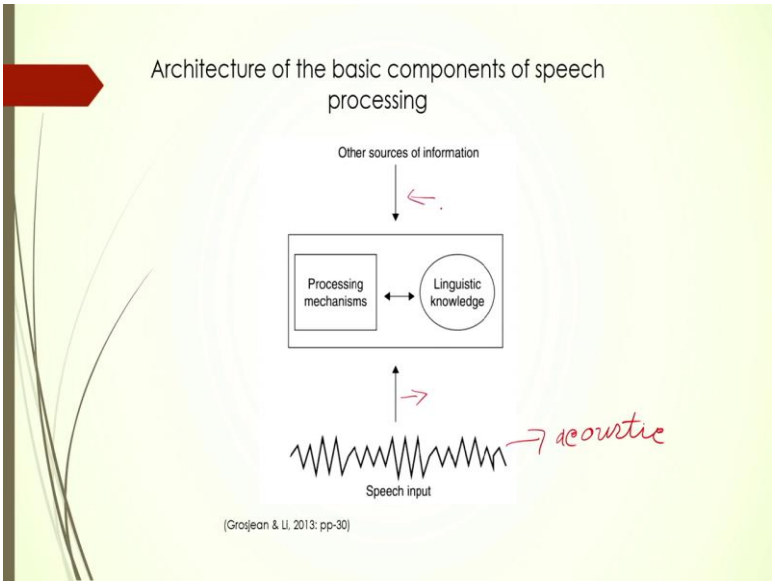

So, as we see, this is quite a complex process that takes place, starting from the acoustic signal till the final representation. So, this is a sort of a model that Grosjean and Li have proposed in 2013. This is how according to them, a speech signal that travels from the ear till the brain and how we understand looks like.

So, this is our acoustic signal that we hear, as I said now right now as I am speaking, I am not speaking in words or sentences, this understanding of words and sentences happens at a later stage. So, in the beginning, all we have is this waveform, this kind of a signals, acoustic signal and then this moves on to the next stage which becomes; so, there we have processing mechanism.

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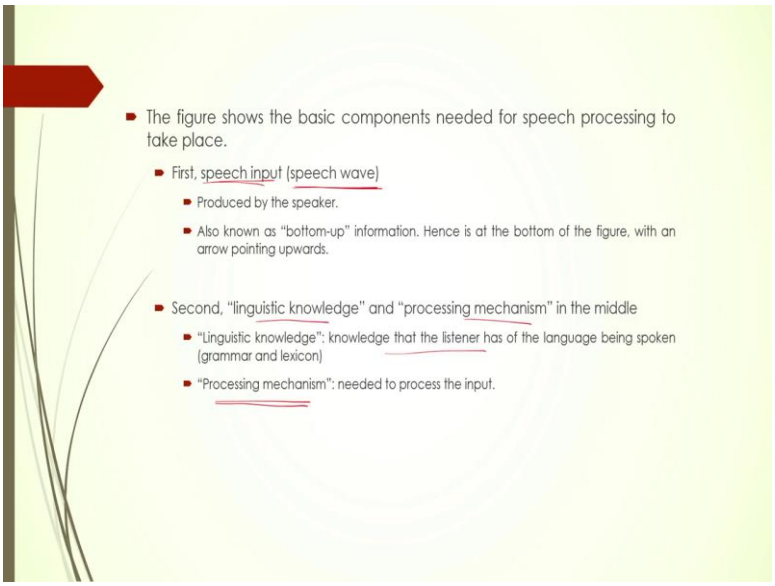

So, first and foremost, we have the speech input which we will call speech wave here. So, this is produced by the speaker, the somebody who is talking and there is a listener, there is a speaker. So, the listener picks up what the speaker says and that is the acoustic input, speech input right and this is also known as the bottom-up information.

So, in any kind of a conversation scenario, there are two kinds of information; one is the bottom-up information that is, the signal itself, whatever you are picking up from the environment that is the bottom-up information. So, in this case, our bottom-up information is the speech input or the speech wave. And then after that, the second stage is where linguistic knowledge and processing mechanism happen.

So, that is where they are in the middle level, these two things are there; linguistic knowledge refers to the knowledge that the listener has of the language spoken. Now, here comes a lot of differences across languages, across speakers of various types, depending on different different kinds of variables and so on.

So, linguistic knowledge, as I just mentioned somebody who knows English language for him or her, the linguistic knowledge box so to say, will be different from somebody who has very less, very you know sparse exposure to the language. So, in linguistic knowledge is a very important variable in speech processing and then of course, we have processing mechanism. So, there are various mechanisms that help us process the

incoming stimulus, incoming speech signal that ultimately gives rise to the that takes us to the next level, that is the, in this model the final level.

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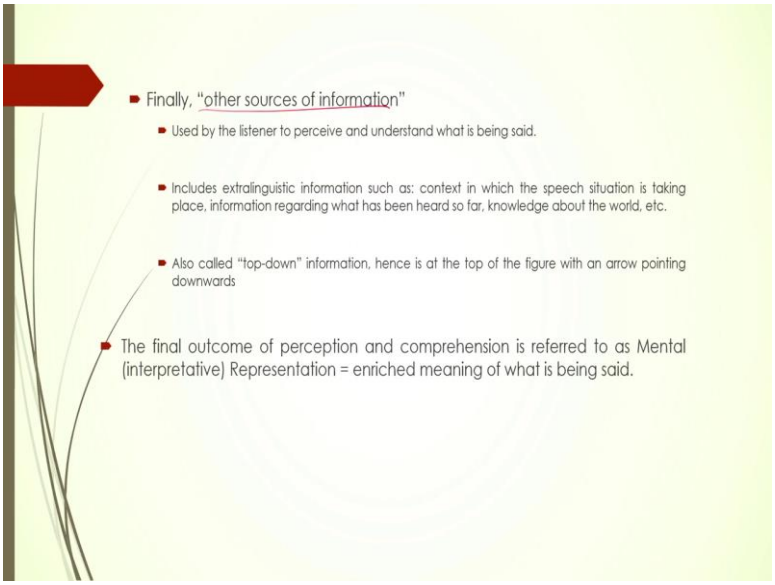

So, here we also have another level of information which is called other source of Grosjean and Li, all them other sources of information, that there can be many other names by others as well. So, this basically is used by the listener to perceive and understand what is being said, this is different from the bottom up information that we have, that we are getting from the environment.

So, this includes, what does it include? This includes the extra linguistic information. Things that are not part of that particular signal, but the overall knowledge of the speak of the hearer in this case, about the language, about the context in which the speech situation is taking place, information regarding what has been heard so far, knowledge about the world, all kinds of things.

For example, a sing simple sentence may not mean the same thing in two different contexts, right. So, that, that interpretation of the sentence in terms of x or y interpretation, x or y understanding, is based on this thing called other information, other sources of information. And this is also called top-down information, because this is coming from your already existing mental representation of events and people and things and so on; so, this is at the top of the figure with an arrow.

As you can see, this, the model shows; so, this, because this is speech input is bottom up, hence they have used an arrow like this. And because this other sources of information is coming from above, above as in, these are already existing in our mind. This is already there, our knowledge system has already all those information, what can be said, what, how a given input has to be interpreted, the context and all of that information.

So, it is already there in the mind, which is used by the speaker to interpret the signal, that is why it is used with a downward arrow, like this it goes. So, the final outcome of perception and comprehension then is called. So, after all of these things have taken place, the speech signal going through processing, depending on linguistic knowledge also taking into account the other information, finally, what we have is called the mental representation.

So, what we have, which is what the enriched meaning of what is being said, what is being said often is not the sum total of all the words, right? All of anybody who has slightest interest in language will attest to that even the simplest of sentences may mean different things or may have added colours to it, right; so, added colour as in added information, which is not there in the words themselves.

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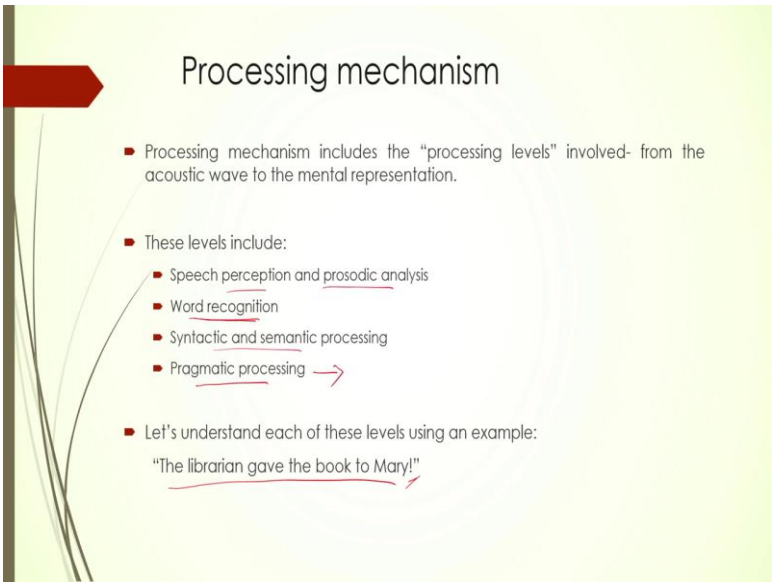

So, all of that will together create what we call an enriched understanding of the message, what is being said as in what is the message, what is decode, what is encoded and what is decoded. So, in the case of listener, this is the decoding part of the entire

process. Now, processing mechanism that we have talked about has various levels right; so, this is what needs a little bit of more attention; hence, we are discussing it separately.

So, processing mechanism has different levels starting with the speech perception and prosodic analysis, prosodic analysis as in analysing the speech sounds themselves. Then we also have another level of word recognition from sound to word and from word, then we have syntactic and semantic processing and finally, pragmatic processing. So, this is where our top down information comes into being; for example, it is quite common to use ‘aap’ for children in many Northern Indian states which is not the case in many other places.

So, for children we typically use ‘tum’ or ‘tu’ in different different scenarios. But in Northern India, it is very common for a small for the mother or any other older person to use up with a very small kid. Now, that information is important for interpreting certain ‘aap’ incoming stimulus in those circumstances. Now, let us have an example, let us understand this whole thing with an example.

‘The librarian gave the book to Mary’ and there is an exclamation mark here, librarian gave the book to Mary, right So, there is an amount of surprisal here, there is an amount of that something is unexpected, but it has still happened and that kind of a sentence this is; how do we know this? We know this because of the exclamation mark.

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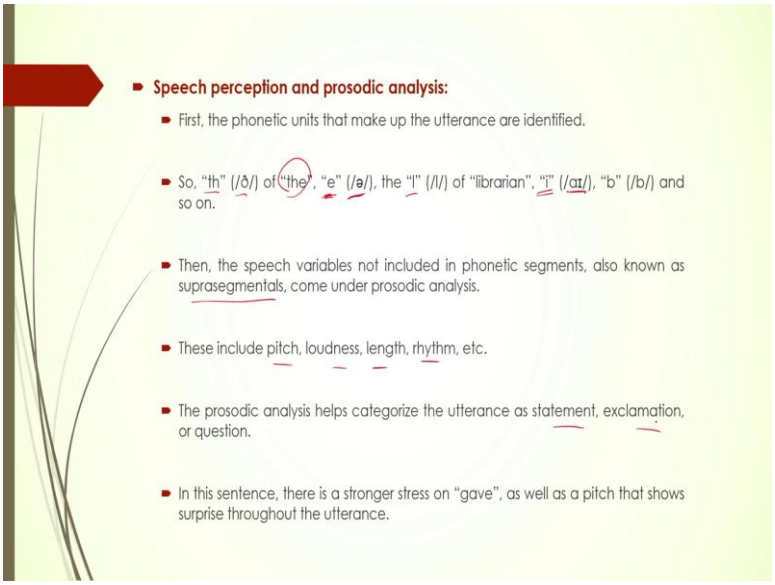

Now, let us look at each of these levels that are there in this particular small sentence. So, we say that the first level is the speech perception, as in, in terms of the phonemes that are there, the sounds of the language. So, in this case we have sounds like this, this is the phoneme, then in this particular word, then we have this particular letter representing this sound.

So, a this is /e/ the alphabet /e/ in English language in this particular sentence represents the sound /a/ that is the schwa sort of a schwa and then e, then i library and the i alphabet representing the sound i and so on. So, all of these sounds, all of these each of these segments are identified and noticed at the very beginning, in the very first layer of understanding, in the very first layer of perception of the speech sound, this is what happens.

So, we segment the entire incoming series of input into this each of the contributing phonemes. Then the speech variables not included in the speech segment phonetic segment known as suprasegmentals that also come under the prosodic analysis. Suprasegmentals are those aspects of speech which include pitch, loudness, length, rhythm and so on and so forth, those are the things that are not part of the sentence.

So, you do not have a representation of the suprasegmental in the in terms of the alphabets; so, they are just heard. So, they are also simultaneously processed along with the phonemes here. The prosodic analysis keeps helps to categorize the utterance as statement, exclamation, questions so on. So, remember, we talked about this that this sentence is an exclamatory sentence, the librarian gave the book to Marry right.

So, there is this different amount of stress and pitch and so on that is the part of the suprasegmental information in this particular sentence. That is only all we know about this is because there is an in the visual form, we know it because there is an exclamation mark. But when we hear it because we are talking about auditory processing, when you hear it, you also hear the difference in the pitch and loudness, length and so on.

So, those things are also processed; so, on the one hand, you have the sounds themselves as they are as they are heard and then the suprasegmental information. So, there is a longer stress on ‘gave’ in this particular case; if you this is auditory input, there will be a longer stress on the word gave and as well as a pitch that shows surprise throughout the sentence.

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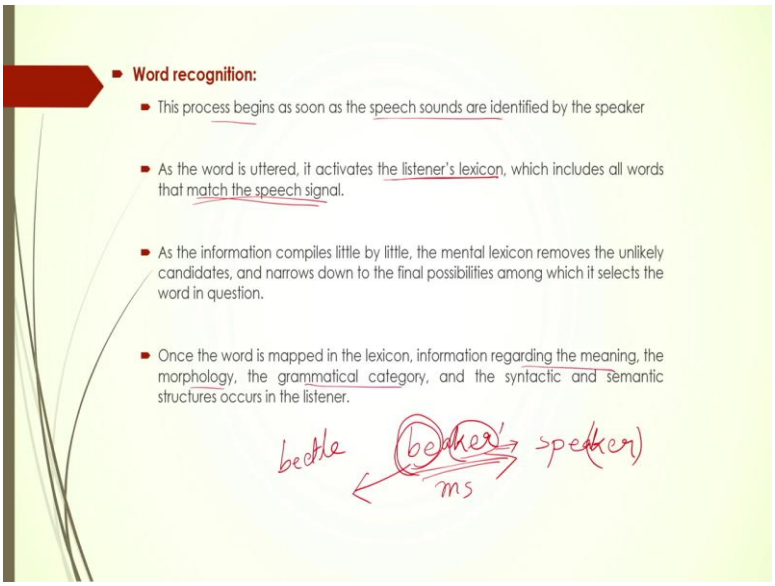

So, all of these things are markers of extra information, that happens at the very first level, then comes the level of word recognition. Now, this process begins as soon as the speech sounds are identified. So, we have identified the sounds, we have also identified the suprasegmentals that are important for us to make sense of the whole sentence and then now we go on to the word level.

As the word is uttered, it activates the speak listener's lexicon, as soon as you hear a word, your lexicon is activated, all the nearby words are also activated, all of that which matches the speech signal. So, when you hear the word 'gave', you can also have the possibilities that any word that sounds like gave also will be activated.

So, this matching the speech signal may be on phonological level in that in terms of sound, in terms of other similarities as well. Often, there are similarities in terms of semantics, in terms of other factors; so, they are all activated at that time. Now, as the information compiles little by little, the mental lexicon removes the unlikely candidates right. So, when we hear one word; so, for example, let us say a word like 'beaker', we will see this example later in the course.

So, a word like beaker when you hear, this is this the time course of interpretation of the sound is in terms of milliseconds ok. So, as soon as you have started hearing the word beaker, all the other candidates that are similar to the first phoneme of this word will be

activated. A famous study has shown that this also activates word like ‘beetle’ and many others, all of that which starts with b right; so, all of that is activated.

Now, as the processing goes on, as the rest of the word unfolds, we have come to this part beaker because this is, there are two syllables here. Now, when we are at the last syllable, this even, even now when we have almost in you know finished hearing the whole word, we will still see activation of similar words that have same final phoneme; so, a word like ‘speaker’ will also be activated.

And finally, the the brain settles down on the word itself, whatever it hears; so, all of these things happen in between. Now, once the word is mapped, finally, we have listened to the whole word and we have mapped it on to the on an existing representation in the brain, in the lexicon, mental lexicon. And then information regarding the meaning, the morphology, the grammatical categories, syntactic semantic structure occurs to the listener.

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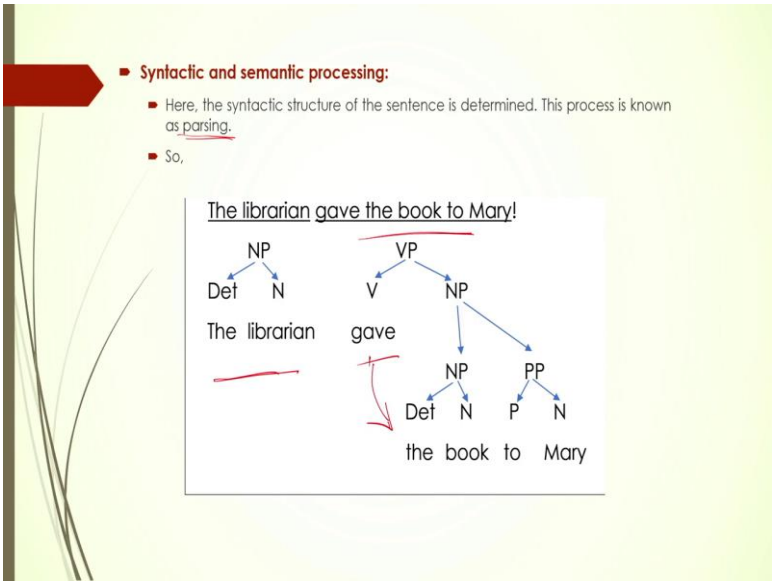

So, now we come to the syntactic and semantic processing part. So, once this this word level categorization has been taken place, going through all of that, you know, competing word candidates in terms of similarities, whether in the first phoneme or the last phoneme and so on. The mind has finally, recognized the word, mapped it on to its existing category in terms of grammatical information, semantic and other information.

Now, we move on to the syntactic structure that is the sentence; when syntactic structure is processed, it is primarily known as parsing. So, when we parse, this is how parsing happens. So, the librarian and then gave and then it takes this noun phrase, this we have verb phrase takes this noun phrase; so, this is how we parse the sentence.

This is the subject, this is the traditionally called, this is the predicate and predicate has a verb phrase and a noun phrase. So, this is how the parsing happens syntactically speaking in terms of sentence understanding, this is how we understand, this is how the mind interprets the incoming signal.

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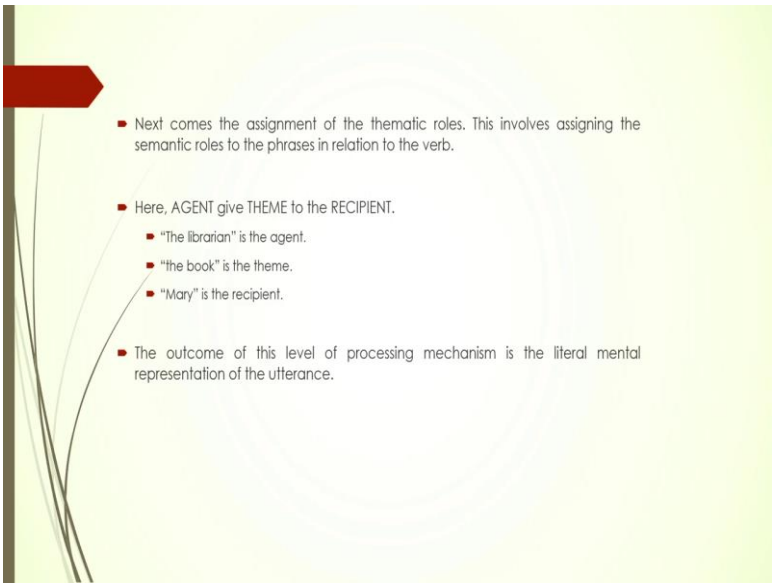

Next comes the assignment of the thematic role, this involves assigning the semantic roles to the phrases in relation to the verb. As I just showed you, the librarian is the agent here, the subject or the agent, the book is the theme and Mary is the recipient. So, these are the basic thematic roles in the assigned in this particular sentence.

So, the outcome of this level of processing mechanism is the literal mental representation of the utterance. After all of these processes, after all these hard work that the mind does on a simple sentence, what we have is only the literal interpretation, literal as in exactly what the words mean, what the entire sentence means.

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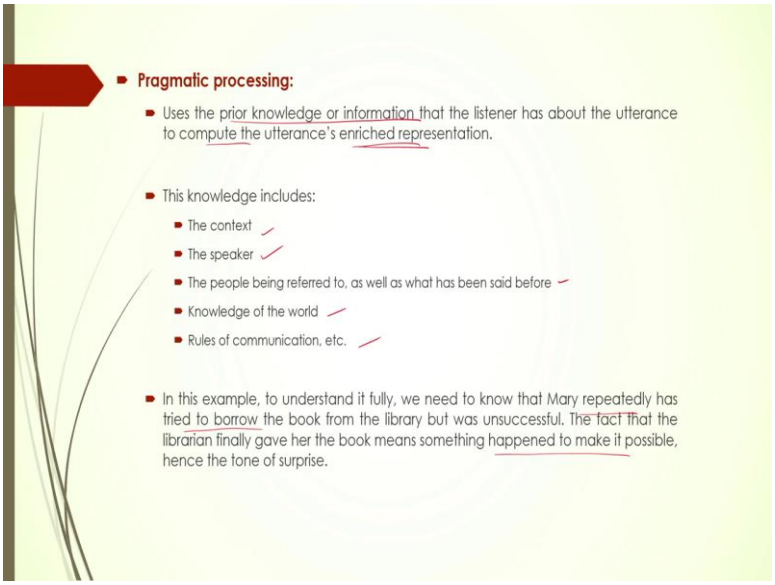

Next comes the pragmatic processing; after all of these things have been taken care of, remember we talked about the top down information; so, that is what comes into play here, this is where pragmatic processing. So, semantics and pragmatics are slightly different; pragmatics takes us to the point where semantics in context is analyzed right.

So, this uses the prior knowledge or information that the listener already has about the utterance. So, as a result of which the listener can take a call as to which of the interpretations need to be taken into account in this particular case. So, as a result of which we have what we call enriched representation. This is our entire representation; entire understanding of a sentence is not complete until and unless it has been checked, so, to say or let us say to be filtered by the pragmatic information; is this what it means or does it have a different meaning? The same sentence may be different in any other context depending on let us say the sentence. The Mary whatever we know about Mary or whatever we know about the librarian and their interaction in the past, all of that is used here in order to get the pragmatic processing done.

So, this knowledge, is pragmatic knowledge will can be broken down to the context, the speaker, the see in this particular sentence the speaker if the speaker differs, the meaning might differ. In this particular case the speaker might be jealous of Mary that he she actually finally, managed to get the book, that is also possible.

So, the knowledge of the speaker, speaker and his or her intentions and all of that also remains an important part of this processing, this part of processing. The people being referred to, knowledge of the world, rules of communication and so on; so, these are some basic parts of pragmatic processing.

So, in order to understand this particular sentence fully, we need to know that Mary repeatedly has tried to borrow the book from the library. However, she was not given the book, she was unsuccessful and that librarian finally gave the book means something happened to make it possible; so, all of these things are not told in the sentence right. So, this is based on what our understanding, sometimes real knowledge, sometimes you know a perception, this is what probably could have happened.

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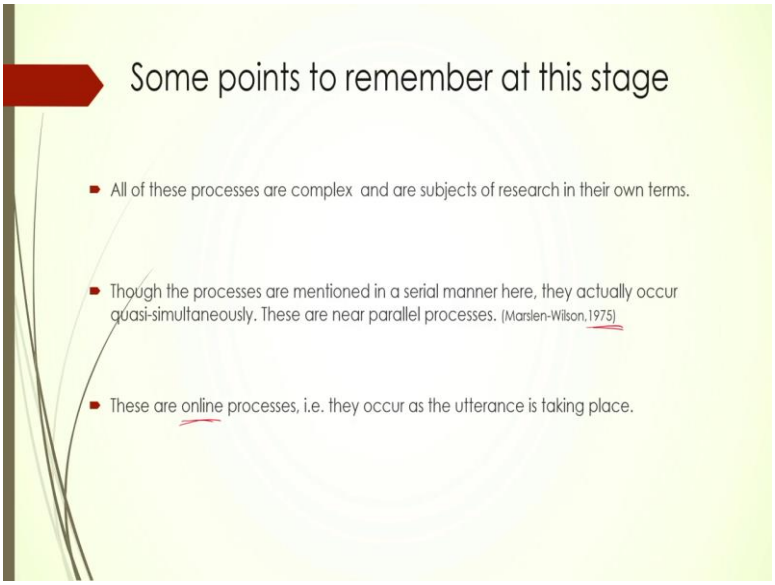

All of that together create what we call as understanding this particular segment, this particular segment of incoming speech signal. Now, at this stage, this model looks very simplistic the way they have the Grosjean and Li have put it, looks very simple.

However, we must keep it in mind before we move on certain points; one is that all of these processes that he talks about, be it at the segmental and suprasegmental level, be it at the word level, sentence level, whatever, all of these, each of these; each of these processes are very complex in themselves.

And there are each of them actually has a vast area of research devoted to them. And another thing is this model tries to show this as a serial process; so, after segmental and suprasegmental information, then the word formation information and so on. But more often than not, all these processes are at least nearly simultaneous, there is parallel processing that happens, which was found out way back and now we already know this.

So, even though a model needs to put it in that way in a, because we have a two d representation, we it is shown as a serial process. But we must keep in mind that they are not exactly they do not actually happen one after another, they happen almost simultaneously. Third is that this is an online process, online, by online, today online has a different interpretation, but here online means as the spoken signals are you know given out by the speaker, it the listener processes it simultaneously.

So, as the utterance is taking place, simultaneously the understanding or the processing of that signal is also taking place; so, that is what we mean by online in this particular case.

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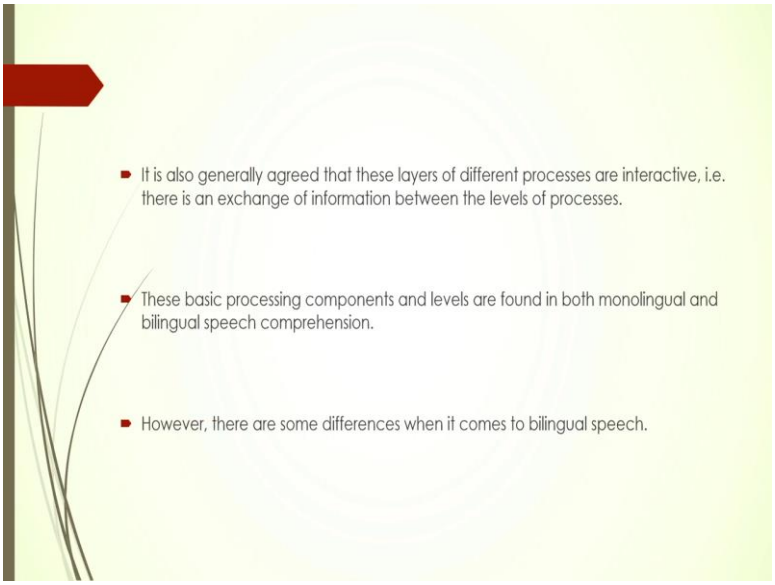

And it is also generally agreed upon that all of these different processes, different layers of processes, they interact, they are not separate processes so to say, they there is a lot of interaction and exchange of information between these levels of processes. These basic processing components and levels are found in both monolinguals and bilingual.

Because this is a model of what happens at the fundamental level, at the very basic level of speech signal processing, any kind of speech input that you process. So, that is true for monolinguals and bilinguals, multilinguals, whoever. So, at the root, they exist for both, but however, in case of bilingual, there are certain differences. But the base model remains the same with some differences, some incorporating some other features and processes in the bilingual's case in as opposed to the monolingual case.

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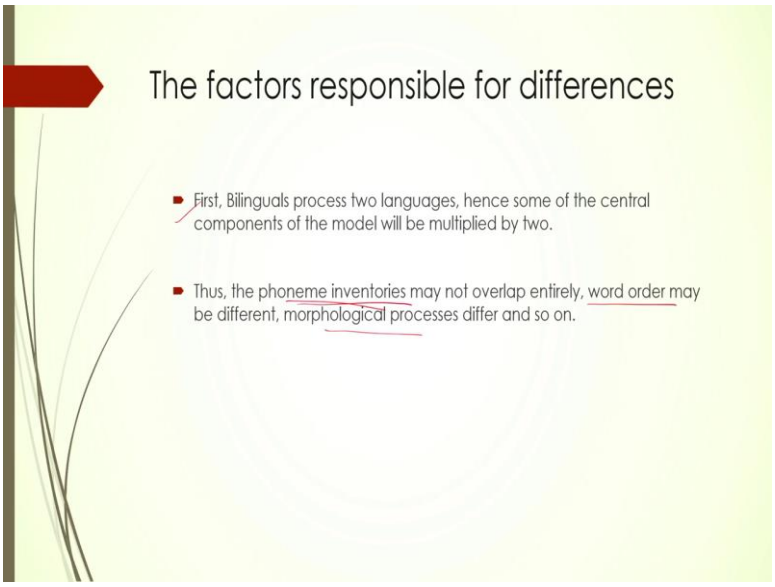

So, now let us now look at the factors that are responsible for that difference between bilingual and monolingual processes. First and foremost, of course, we know that a bilingual means he has two languages at his disposal. So, some of the central components as a result of which components of this model will change.

So, in case of one word, you will have two words or at least, in case of bilinguals, there might be you know whatever number of words are getting activated for a monolingual, it could be multiplied by two. So, at many levels of this model, things will be double, the multiplied will be by two. For example, the phoneme inventories may not overlap entirely. So, not all for what is phoneme inventory? Number of phoneme in a particular language; so, not all languages have the same number of phonemes.

So, in language one may have six phonemes, language two might have three or maybe it can have nine, there are all kinds of different languages have different kinds of different phoneme inventory. So, if there is no overlap, you already see there is a slight problem

here, there is a different inventory that you need to take into account. Word order similarly may be different languages have different word orders, there are different morphological processes, all of that are possible. So, as a result, in in case of bilinguals, many many levels will have two type two components.

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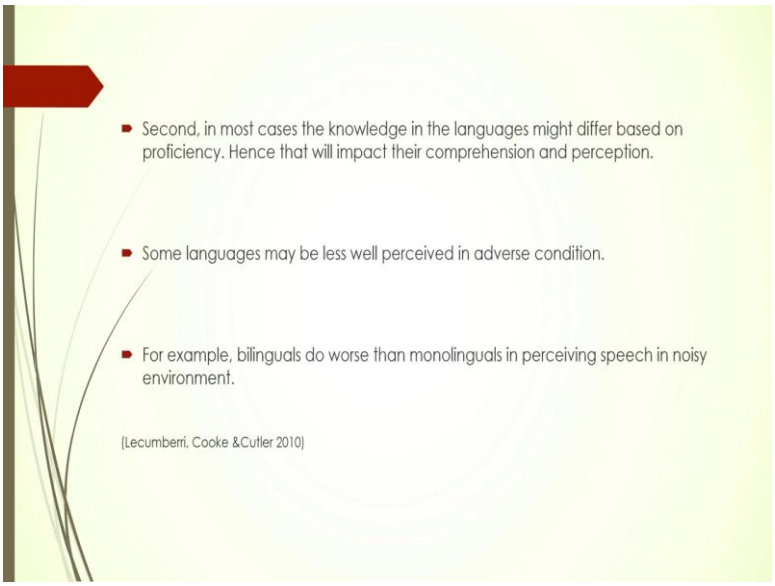

Secondly, in most cases, the knowledge in language might differ based on proficiency, all not all bilinguals are equally proficient in their L1 and L2. Proficiency will differ, sometimes L1 proficiency is higher, but it is also possible that L2 proficiency might become might surpass that or then that of L1 over a period of time, which is quite often the case in today's time.

So, that will also impact how the language processing happens, how the comprehension happens in this particular case. So, in as a result of which some languages may be less well perceived in certain situations. So, in one particular study with they have found out that bilinguals do worse than monolinguals in perceiving speech in a noisy environment.

So, monolinguals were better in perceiving speech in the noisy environment, bilinguals were not that good. So, these are areas which might get affected as a result of different proficiencies in both the languages.

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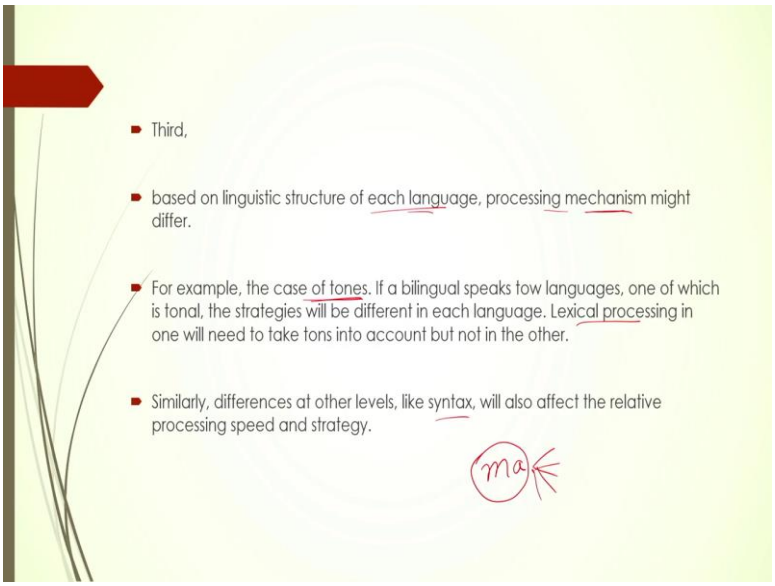

Third reason, based on the linguistic structure of different languages, each language's processing mechanism will also differ. For example, in case of tones, now let us say a person who speaks two languages, one of which is tonal, the other is non-tonal. Now, if you have tonal, if you speak a tonal language, tones are a very important aspect of processing.

So, it may not be seen in the, in case of visual representation, it may not be visible, but when you are speaking, when it is an auditory input, tones make lot of difference in processing those words. So, in this case, another language if you speak which is non-tonal, there is lot of different strategies to be put in place; so, lexical processing itself will be different. So, the, in case of tonal language, lexical processing will be different compared to the non-tonal language.

Similarly, difference in other levels like syntax will also affect relative processing speed and strategy. So, one language in case of Chinese, for example, the way this is written, this is in English, we can write it like 'ma'. But this can have four or four different or five different tones and with each tone, the word means a different thing.

So, that is, that amount of, that will delay the processing speed for one particular lexical entity, which is not the case for, let us say, a language which is non-tonal. So, that is what we mean by, if there are differences in terms of structural property of the language that will also add to the complexities of processing in case of a bilingual.

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Fourth question to be looked at is the utterances to be processed may be in monolingual or bilingual mode, we have already seen language mode. So, language mode, a bilingual, bilingual can have either monolingual mode or some intermediate mode or a bilingual mode. So, depending on what mode, what language mode is being put to use, again strategy will be different.

So, bilingual mode will be activated in case of when there are two, when there are code switching, when there are many other, an another person who speaks, another language or both are bilingual, constantly code switching and so on. This is a process that is unique to bilingual, this does not happen with monolinguals. So, again, this will have added processing cost for a bilingual.

So, which in bilingual mode, what happens? The second language is the non-base language is equally active or at least well or at least to a large extent active. So, as a result of which the processing will be affected to a large extent. So, that is another very important factor in case of bilinguals, which does not exist for monolinguals.

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Finally, even when only one language is being processed, a bilingual cannot entirely suppress the impact of the other language; so, we just talked about the mode. So, even if it is the bilingual is in the monolingual mode, the other language is not active, but even then, it is not possible to completely suppress the other language, non-target language, which we will see shortly.

Because the other language, the all of these, because of this entire co-activation process, each word co-activates the other possible candidates, competitors in the second language. So, even if that language is not being used, it will still be in a position to impact the another language processing; so, this is a unique problem with bilinguals.

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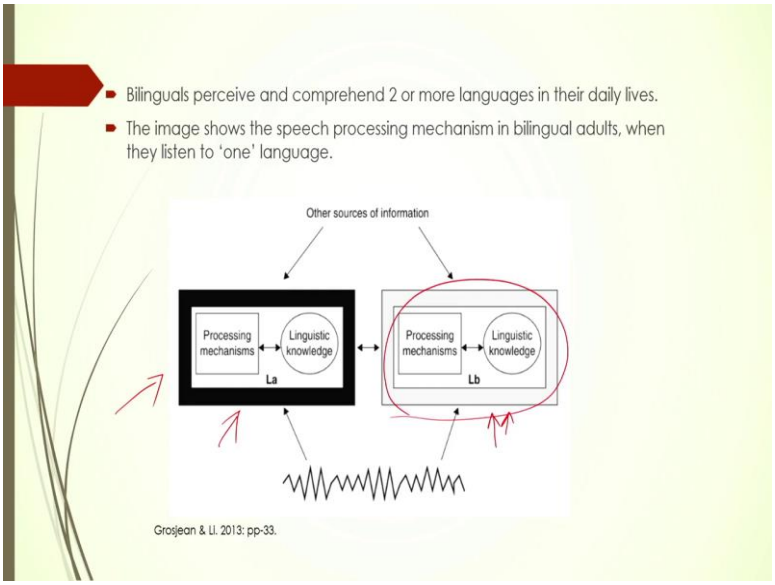

Now, now let us go ahead with how the model will now look for bilinguals. We have seen part of this in a monolingual setup and said that this model holds true for both bilingual and monolingual in the base level, in the skeletal structure. So, in now in case of bilinguals, this is how they propose. So, this is the more activated language and this is the deactivated language and hence it is in a lighter shade.

So, this image shows the speech processing mechanism in bilingual adults when they are listening to only one language. So, this is the language they are listening to and this language is for the time being deactivated; however, the same signal can be is also going there. So, this entire thing exists in the mind; it is not it is not going anywhere, it is there, but this language is not in use right now.

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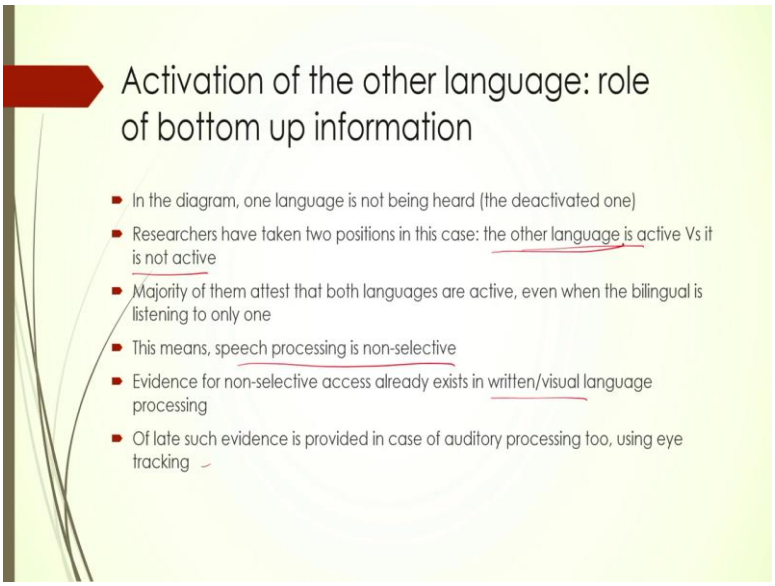

So, what happens in case of bottom-up information, what happens, how the activation level goes. Now, in this diagram, as we have seen that one language is not being heard, the deactivated one. Now, researchers have taken two different positions as to what happens when the other language is not being utilized, what happens.

One position say that only one language is active and the other language is inactive, but the other side of the story says that both languages are simultaneously active. So, whether this is a non-selective access or a selective access, we are going back to the same story.

So, majority of them, majority of the researchers, majority of the findings actually point towards the possibility that both languages, bilingual's both languages are active. Even when they are not being used at that given point of time, but they are both at the same time used; so, this means speech processing is non-selective.

Now, evidence for non-selective access is are galore, there are lots of lots of studies which have found proof in case of written or visual language processing. In case of spoken that is auditory processing which we are discussing today, there are some proof which have started coming in, proving that language processing is non-selective. Meaning both languages are active at the same time, even when the second language is not being used.

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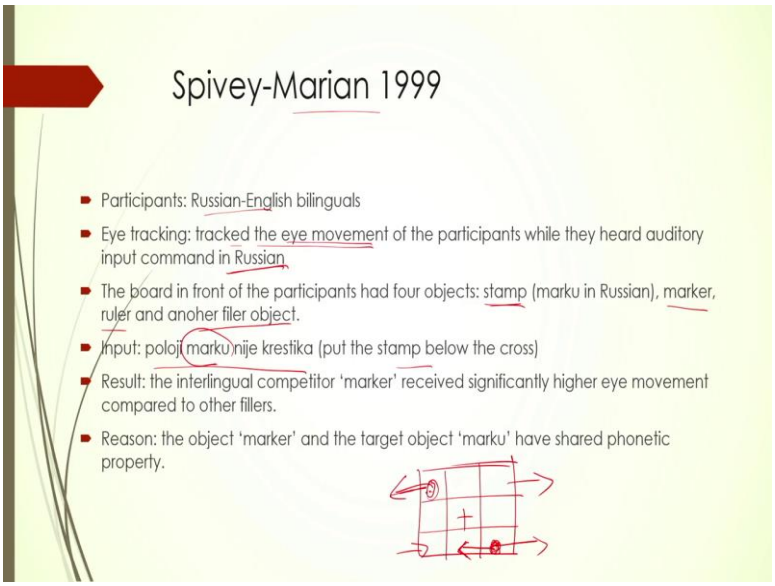

So, we will see some studies that have talked about it, one of them is the study carried out by Spivey and Marian in 1999. This was carried out on Russian-English bilinguals, this was an eye-tracking study. A lot of speech processing studies come from eye-tracking, because be eye-tracking has a paradigm called visual world paradigm. What happens in visual world paradigm is, the participant listens to an auditory stimuli and simultaneously looks at a particular at a display and sometimes they are also asked to carry out certain tasks.

So, move this here, pick that thing there and so on. So, as a result, you can check this eye-tracking mechanism with you know within visual world paradigm, gives us the opportunity to study how spoken, how auditory input affects your processing; so, that is why this is been used. So, eye this particular study looked at the eye movement of the participants while they heard auditory input command in Russian.

So, they had a board in front of them which had four objects; one was one is the stamp, there was a marker, there was a ruler and there was another filler object. There were four objects on a board; In the middle of the board, there was a cross, the board looks like this. So, there was stamp here, there was marker here, ruler here and another filler here and there was a cross like this. The input signal, one of the input sentences was in Russian, means the 'put the stamp below the cross'.

So, stamp was here, it was to be brought here, that was the command; so, there are various kinds of such commands. And now stamp is marku in Russian ok; so, put the stamp below the cross, the stamp had to be brought here under the cross, this particular position. What happened was the interlingual competitor 'marker', because this is a marker, received significantly high amount of eye movement compared to other fillers. What it means is that eye tracker picked up a lot of eye movement to this position where the marker was.

Now, the study was getting being done in Russian, the command was given in Russian. However, what has happened was because the word, the Russian word for stamp is marku, which phonologically is similar to marker in English, as a result of which this becomes a competitor, competitor of the target word in this particular case. So, even when the study was getting done in Russian, the other because this proves that English language was active, if it was not active, marker will not get any kind of attention, visual attention.

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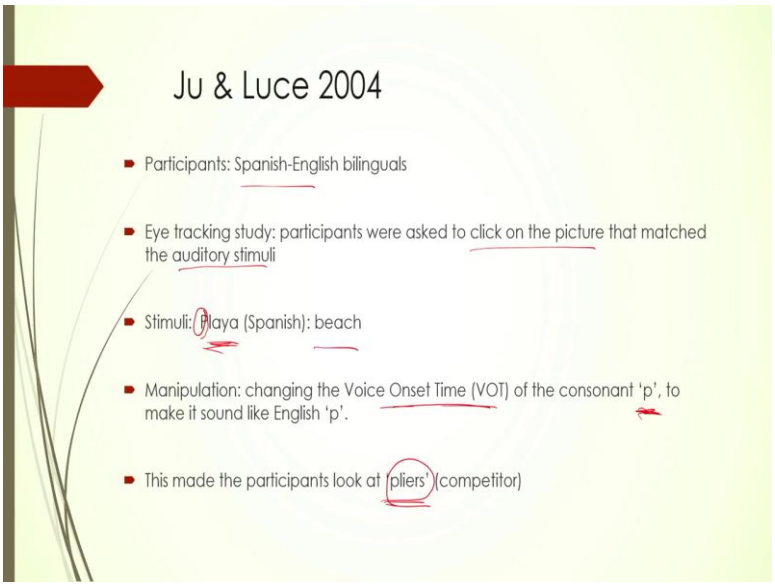

So, this proved that this is possible that the second language, the non-active language is still active in some sense. Another study looked at Spanish English bilinguals, this was again an eye tracking study and they were asked to click on the picture that matched the auditory stimuli. So, they were listening to an auditory stimuli and there were pictures in

front of them, they had to click on that picture. The stimuli was ‘playa’ in Spanish, which means beach.

Now, there was a crucial manipulation in this particular case; what they did was, they changed the Voice Onset Time of the consonant /p/. The letter p, the sound that it has in Spanish is different from the sound that it has in English. So, by changing the voice onset time of this particular consonant to make it sound more like the English sound, the are corresponding to this letter, they used the, them they gave this kind of auditory input.

So, the word was this, but this particular position part sounded like English, it did not sound like Spanish. And this is a very, very subtle change in the stimulus, input stimulus. They are listening to Spanish words, only thing is that the particular sound in that word has been manipulated with to make it sound like an English /pa/ sound.

Even that had the desired impact, meaning this made them, made the participants look at ‘pliers’ which was one distractor. In the same kind of display, they had beach, picture of a beach and the picture of pliers and another and there was a filler and so on. So the participants all looked at this the pliers also had managed to get a lot of visual attention because of this.

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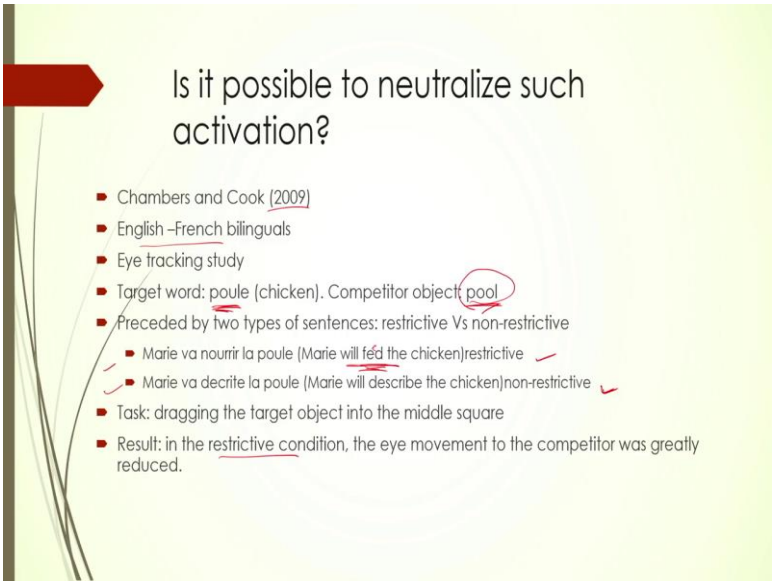

So, they connected it through this, the very subtle many manipulation with the sound also has, which means it is the English candidate words were already active, which was

just accessed by the manipulation. Now, is it possible to neutralize such activation or is it not possible? Is it, they are going to always you know interfere with your target language processing. Seems it is possible.

There has, there have been some manipulations and some kind of studies that have manipulated the conditions various kinds of contexts and try to see to what extent this activation goes or can we subdue the parallel activation. So, again in a study in 2009, this to this was used on English-French bilinguals eye tracking study. The target words were word was, this was done in French; so, target word was ‘poule’, which means chicken in French and competitor object, they had ‘pool’ in English.

Now, they, this, this word, the auditory input, they had, they were preceded by two kinds of sentences. In some cases, the word ‘poule’ in French was preceded by sentence like this, in some cases, the sentence like this. So, the difference between these two sentences is what they called restrictive versus non-restrictive.

Now, in case of restrictive is, the sentence will create a scenario where there are limited number of interpretations possible for the verb; so, in the first case, this is, Marie will feed the chicken. So, when you have a verb like feed, there are only few possibilities, there only animate objects can be fed, animate entities can be fed, right.

So, this automatically restricts your interpretation of the verb. On the other hand, if you have a non-restrictive sentence like Marie will describe the chicken, it is non-restrictive, you can describe anything in the world outside the earth as well. So, description does not need a particular set of dependent objects.

So, they show, they showed that if you change the sentences, the nature of sentences, thereby manipulate the kind of interpretation that it will have, in turn, will affect whether the English competitor will get visual attention or not or how much, if at all it gets.

So, they found out that in the restrictive condition, the eye movement to the competitor was greatly reduced; so, this is our restrictive condition. So, automatically, when you have fed here, automatically you cannot have a non-living entity; so, pool is out, that is why it was not. So, you can actually change, you can manipulate our mental mechanism with respect to how to allocate our visual attention by this kind of method, this was one interesting study.

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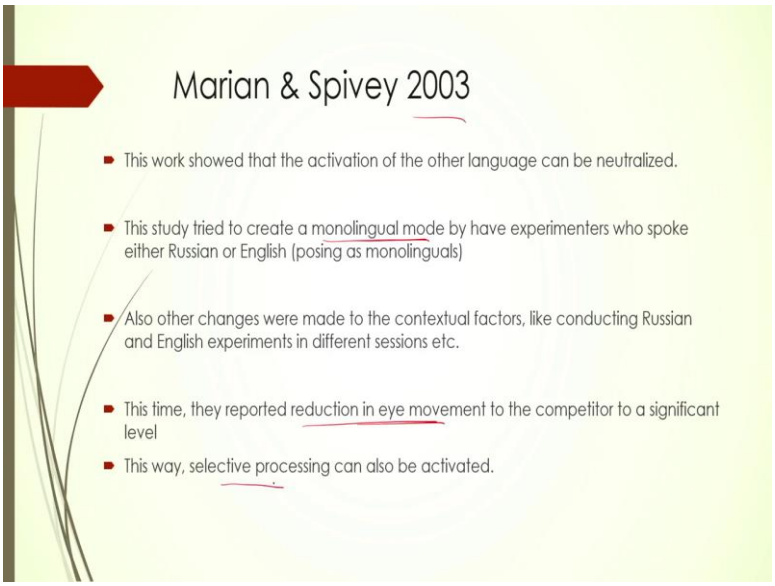

Another study, Marian and Spivey, wanted to see, the first study we talked about was Marian and Spivey Russian-English. Now, they wanted to fine check whether there were some contributing factors of the context within which the first experiment was done which facilitated the second language, the other language activation.

So, in order to take care of all of that, they changed the experiment setup and they tried to create a monolingual mode in the experimental setup. In the first case, there was as per their own assumptions, there was probably a bilingual mode created. Because the experimenters were talking in Russian and English simultaneously and so on.

And also, the experiments in Russian and in English were done with very less gap between them. So, they tried to take care of all of these contributing factors that they thought made the that they thought impacted the result, in two they carried out another study in 2003. And here, they changed a lot of things, they tried to create a monolingual mode by having experimenters who spoke either Russian or English. And they posed as monolinguals, like they do not know the other language.

So, there were two different experimenters; one was speaking in English, another spoke in Russian and both of them acted as if they do not know the other language. And other changes were also made. So, there was a lot of gap between the Russian experiment and the English experiment and so on.

And this time, they reported a reduction in eye movement to the competitor to a significant level. Now, this way, by controlling the conversation scenario, by controlling the experimental setup, selective processing can also be activated.

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So, we see both, we have proof for both selective as well as non-selective access. So, ultimately, that brings us to the point, the processing strategy, phonological processing strategy can depend on a number of both bottom up and top down factors. Bottom up, as in, given the different kinds of sentence, sentential context like the first study.

And in the second case, we have given a different top down information like the context of the experiment, the people who they interacted with, the kind of gap that was allowed and so on. So, by manipulating different bottom up and top down information, speech processing can be changed.

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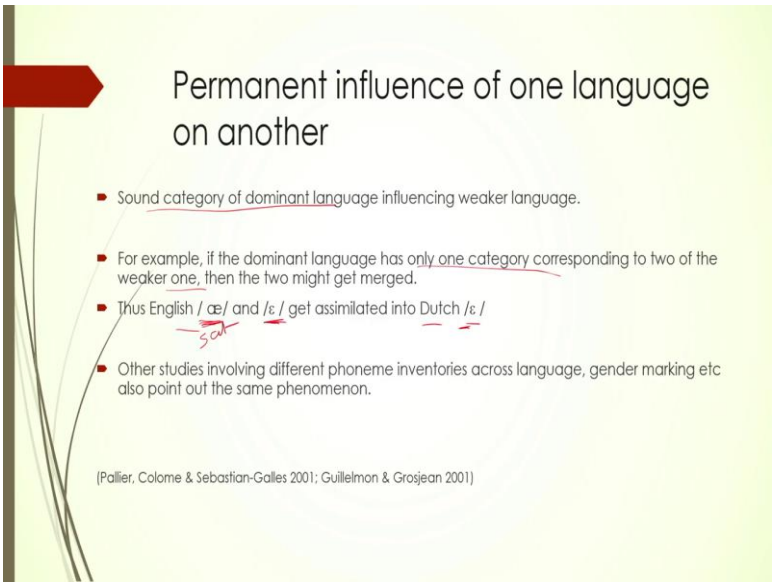

Now, that said, does it mean that there are no permanent factors that affect language processing. Is it only a transient thing? Is it only a non-permanent sort of sort of an input? Seems there are some factors which are almost near permanent that always exist and they influence the language in this way or that way.

One of them is the sound category of dominant language that influences the weaker language. So, which language is dominant and that will decide how the weaker language is impacted. For example, one study looks at how the dominant language has only one category corresponding to two weaker one, two might get as merged.

For example, an English and Dutch bilingual study was carried out. And so, this shows that English has two vowels like this; one is /ae/ like in sat, the word like sat, s-a-t sat, similarly, there you have /Ɛ/. This contrast does not exist in Dutch. So, what happens in case of Dutch is they merge these two vowels into one, merge both /ae/ and /Ɛ/ into /Ɛ/.

So, other studies also involving different phoneme inventories across languages, gender marking, etcetera also point out this kind of difference. So, if languages are different in terms of phoneme inventory, there are different kinds of grammatical marking system, etcetera. There are bound to be some differences in terms of impact of one on the other.

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So, now, let us look at a model of speech spoken one word recognition. Some general consideration before we look at the model. So, in the monolingual mode for a bilingual, this entire thing is about bilinguals. So, in case of monolingual mode of a bilingual, only one language node is activated. In case of bilingual mode, both languages are active, but base language network is more strongly activated. Right now, if I am speaking in English, I am in completely monolingual mode.

But if I now add another person and the interlocutor in the conversation, I and I still continue to speak in English. So, my base language will be still stronger, but the other language is active. Resting level of non-target language can be modified by many other factors like we have just seen; so, many other factors can have an impact on the resting level of non-target language.

And if an input unit has similarities in the other languages, then there will be that will lead to delayed processing. So, there are competitions, like we have seen marku and marker, Russian English and so on. So, there is that kind of similarities exist that will also have an impact.

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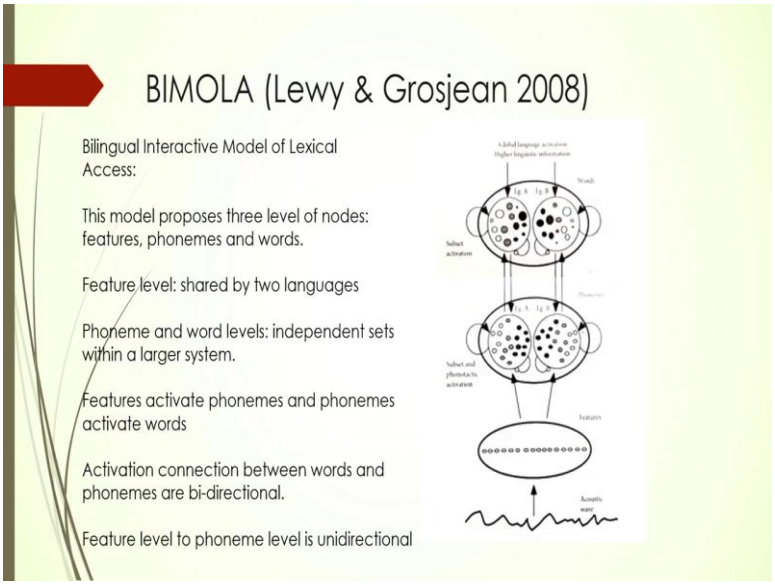

Now, keeping all of that in the mind, let us look at the model BIMOLA, BIMOLA ,either way you can pronounce; so, this is bilingual in interactive model of lexical axis. This model is similar to another model which we will see shortly; this is this model is entirely based on spoken auditory language processing.

It proposes three levels of nodes; so, at the base level, at the very beginning the we have features, feature level, then we have the level of phonemes and then we have the level of words. The these are the three levels of three nodes or three levels of processing. Now, feature level is shared by both the languages; so, these are the sets of features that both the languages are sharing.

Now, out of those features which are the phonemes for each language, then we have a different we have a bifurcated storage, let us say subset. So, within a larger set of this is the larger set within which we have two subsets for language one and language two, language a and language b. So, two languages are there; so, from getting from the features, you identify the phonemes and those phonemes can correspond to the phonemes of language of a and phonemes of language b, there we have a bifurcation happening at that level.

Now, again that there we have word level; so, word level also we have independent sets within the larger system. Similarly, words of language a and words of language b are they will create two subsets within the larger overarching category of words that the

bilingual has in his mental lexicon. So, features unlock; so, to say they activate phonemes and phonemes activate words.

Now, the diff the interaction between features and phonemes is one way it is unidirectional, but the interaction between phonemes and words are bidirectional. This is the activation can happen both ways; so, they are bidirectional, but in the base level it is unidirectional.

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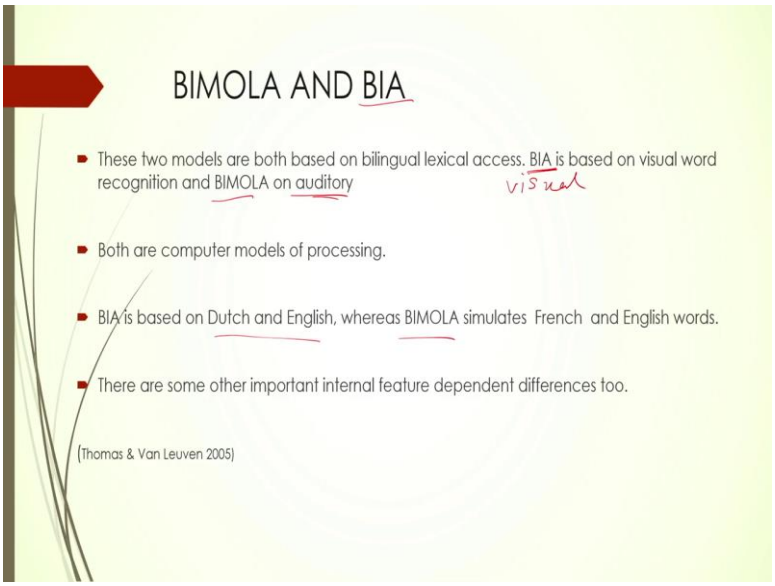

Now, as I was just saying that there is this model is similar to another model which is BIA. Now, BIA these two models both are based on bilingual lexical access, whereas, BIA is based on visual word recognition, BIMOLA is based on auditory input; so, visual versus auditory. This is based on visual word recognition and this is on auditory input.

Both of these are computer models of processing, computational model of processing and BIA is based on. So, it simulates Dutch and English bilingualism, whereas, BIMOLA simulates French and English words, these are the; these are the face level, these are the surface differences between these two.

However, there are some finer level internal feature dependent differences as well. BIA we will discuss later in greater detail when you talk about language visual language processing. So, these are some of the similarities and between these two and differences also.

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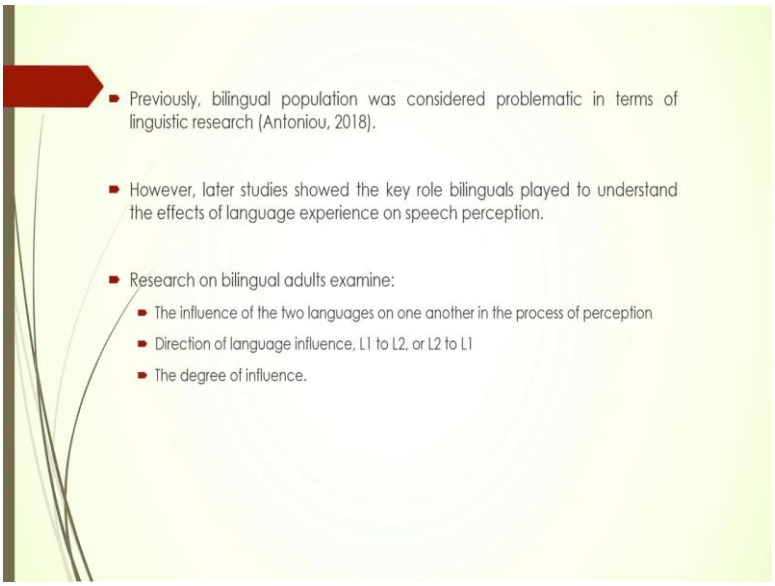

Now, let us go on to the real thing, that is the processing of bilingual speech by adults. Now, as we have said before also bilingualism was not always considered a good thing to happen to anybody, it was almost considered a problem, a mental confusion of some sort. However, in recent times we have seen how bilingual studies have become a norm rather than an exception.

So, when we talk about bilingual processing in terms of speech perception, there are three kinds of three areas, largely large broad areas that have been looked at. So,

influence of the two languages on one another, we have already seen some pointers to that, that there are some amount of give and take. So, there is an influence which could be either way from L 1 to L 2 or L 2 to L 1; hence, there is the influence of two languages on one another.

Then the direction of that influence, whether it is from L 1 to L 2 or L 2 to L 1 or if that direction is dependent on other factors; proficiency, dominance and many other factors. So, the direction of that influence and the degree of that influence; so, together this is come under the broader category of influence of one language on another.

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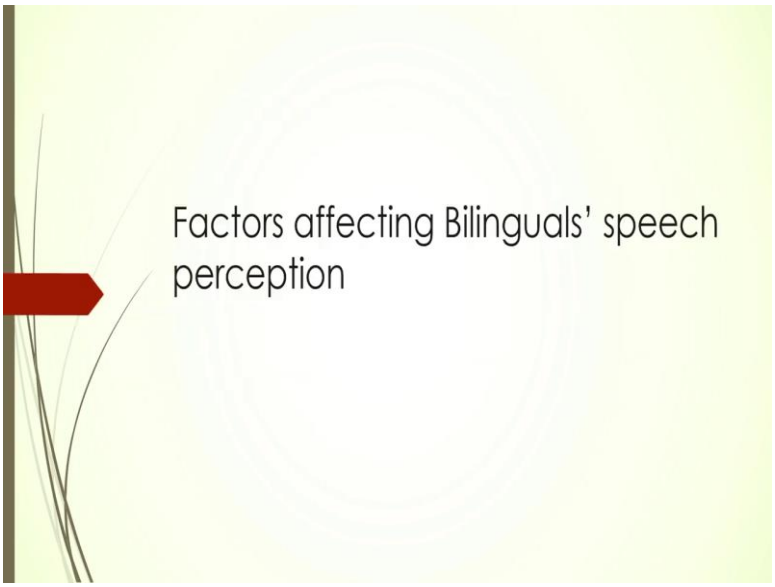

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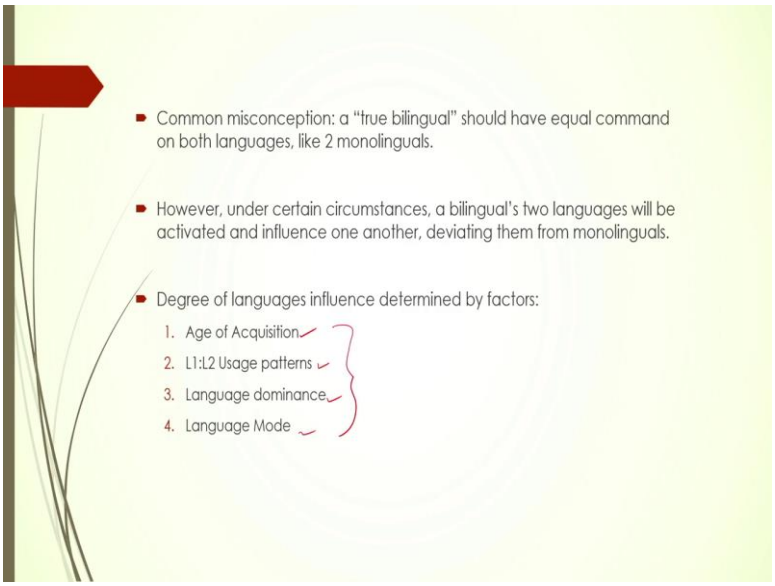

Now, there are many factors which will colour the outcome of these in terms of those questions that we have just asked, these are the factors. And bilingual's two languages are more often than not, we are not equally proficient in both languages. So, we are not like two monolinguals bilingual, bilingual is a completely separate category as opposed to a monolingual.

So, two languages will be active at the same time, they will influence each other, but the nature of that influence are based on or dependent upon certain important factors. Like age of acquisition, L1- L2 usage patterns, language dominance and language mode, these are the four most important areas, the four most important variables that have an impact.

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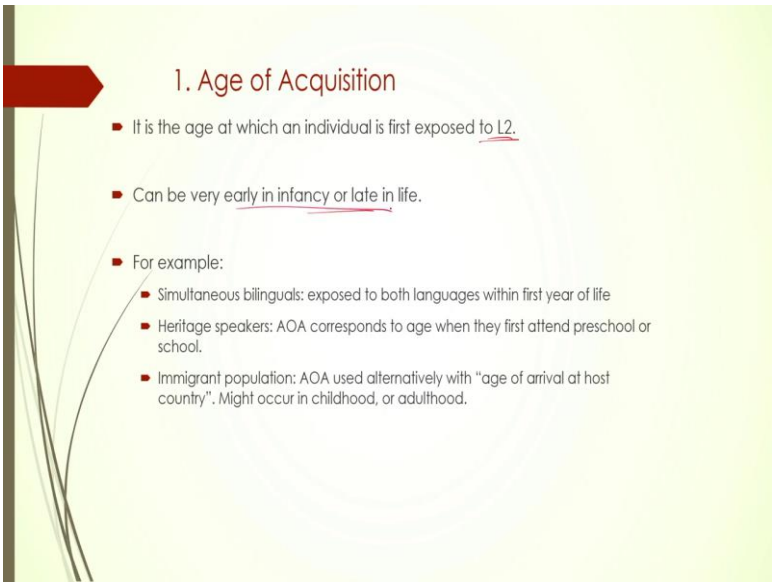

So, age of acquisition, age of acquisition is something is a variable that will come again and again in whatever area of processing we are talking about. Because as you have seen, language acquisition can happen at various levels, one can be a there can be simultaneous bilinguals, there can be sequential bilinguals. And today we also have many other categories within sequential bilinguals.

So, we have migrant versus non-migrant, we have heritage speakers versus non- heritage speakers and so on; so, there are so many types. So, basically age of acquisition is referring to when the individual is first exposed to second language. From it can vary from early in infancy to late in life. So, we have just said that there are all these categories possible, different categories like simultaneous bilingual, heritage speaker, immigrant population and so on.

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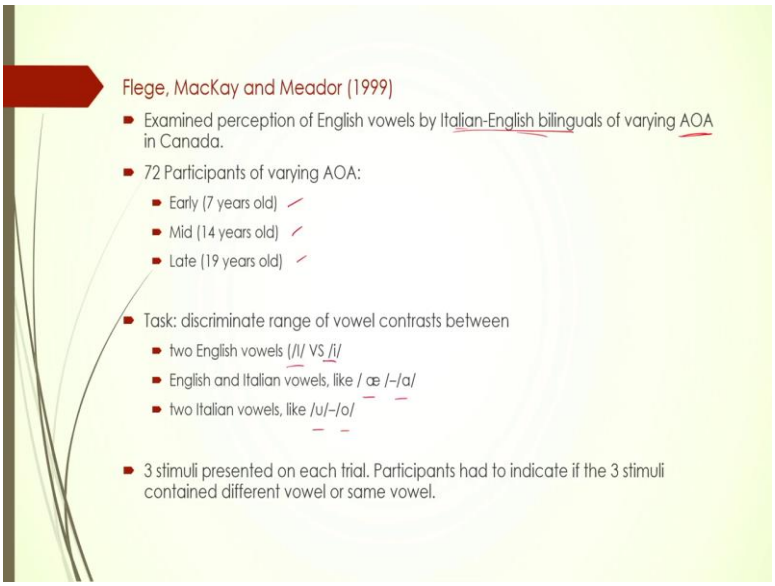

So, as a result of which all of these parameters are studied today. So, we will discuss some studies that have looked at these variables and how they impact the processing strategy. One of them looked at perception of English vowels by Italian-English bilinguals. So, English vowels, Italian vowels as well as across languages; so, vowel perception, perception of vowel in all of these languages by Italian-English.

These are these are people who have a different age of arrival in Canada, the study is based in Canada. They had participant groups, they had 72 participants and they had three groups early versus mid and late arrival of.

So, late arrival means late exposure to L1 as a result of which the number of years you have spent speaking or listening to the second language will greatly vary; so, that is why they have three different categories. So, the task was to discriminate a range of vowels; so, the contrast they had three kinds of contrast, two English vowels. Similarly, they had English and Italian vowels, difference between /ae/ an /a/; two Italian vowels like this.

So, they had series of such pairs of vowels and they were asked to discriminate. Whether and the goal was to see if they can discriminate the vowels and if there are differences in that capacity to discriminate across the groups. Across the groups in the sense of age of arrival in Canada; so, age of learning the second language.

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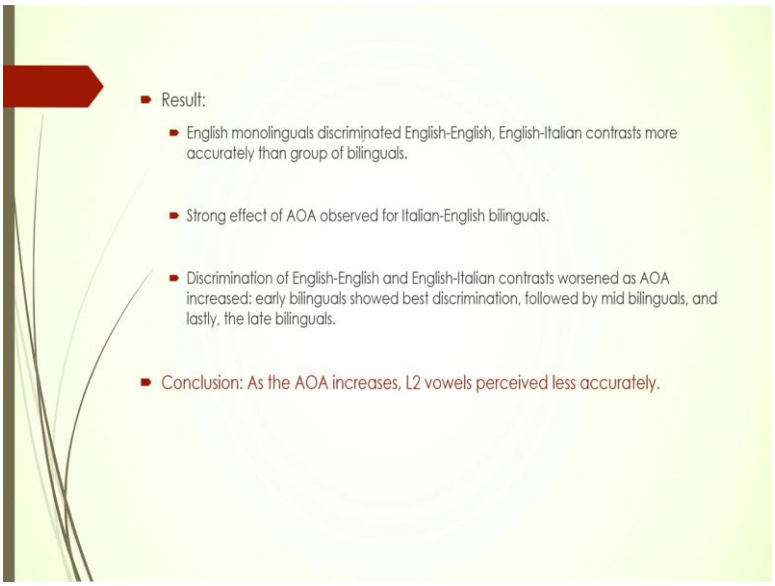

So, this is what they had done, the results showed that English monolinguals, discriminated English-English and English-Italian contrast more accurately than group of bilinguals as you can easily expect. Now, the strong effect of AOA was observed for English, Italian-English bilinguals that is also expected they will not behave like the monolingual English speakers. Now, what is the difference? Discrimination of English-English and English-Italian contrast worsened as AOA increased.

So, with different kinds of two English vowels as well as English and Italian contrasts were not done very well by the by the people who came later. So, as the AOA increased, meaning they have lesser number lesser number of years of exposure to the second language, they were doing much pretty badly in these contrasting, in this discriminating this kind of English-English and English-Italian vowels.

Early bilinguals showed best discrimination followed by mid bilinguals and then lastly by late. So, there is a strong correlation between the age of arrival or age of acquisition of the second language in this case and their performance in the vowel discrimination task. So, the basic conclusion here is that as the AOA increases, L2 vowels are perceived less accurately.

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Another study looked at Spanish-Swedish bilinguals, 41 Spanish-Swedish bilinguals and here the perception was on stop consonants in terms of their voicing contrast. So, either voiceless versus voiced consonants and they had to categorize them. So, the participants were like this 30 early and 10 late bilinguals.

So, age of acquisition, here you can see there are differences; so, starting from 1 year to 11 years and then 13 to 19 years. So, this kind of continua were created using Spanish-voiced and voiceless contrast; so, in Indian terms it will be /p-b/ and/[d-t/ contrast. Swedish also has this kind of contrast. So, these are all based on voiceless versus voiced stop consonants, task was to categorize if each of these continuum steps were voiceless or voiced simple.

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Result was native speakers of course, could show clear boundary for all of these contrasts, late bilinguals categorization deviated most from the native speakers. So, as if either later you start learning your second language, the worse your performance in this, in finding out the contrast between the stop consonants, which differed only in terms of voicing. Early bilinguals' responses were somewhere in between just like the previous study.

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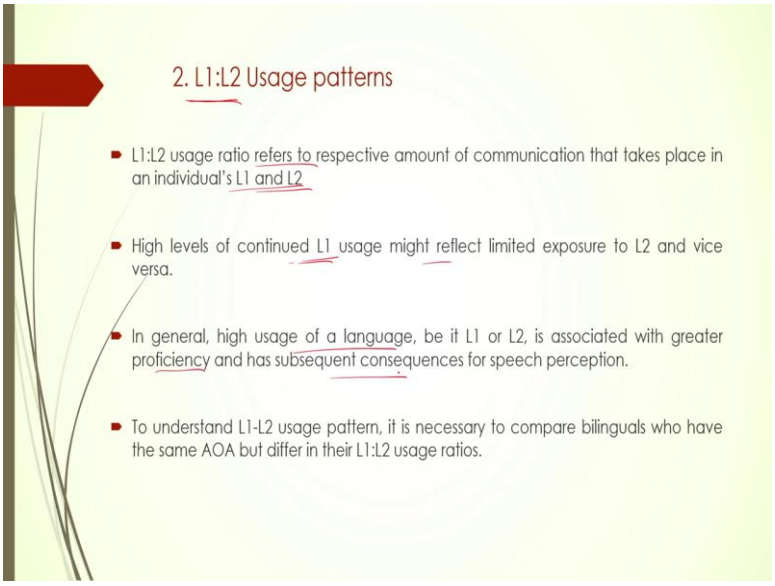

So, there is a correlation here also between age of acquisition and their performance in finding out the difference. The contrast between either in case of vowels vowel discrimination or in case of discrimination of voiced versus voiceless consonants.

Another parameter that have been studied that has been studied a lot is L1-L2 usage patterns. So, on the one hand you have the age of acquisition number of years that you have spent learning your L2. But at the same time there are other factors, there are finer aspects even within that, how often or how much and where do you use your L1 versus L2, that also has an impact. So, usage ratio refers to the respective amount of communication that takes place in an individual's L1 and L2, this is how you can define the usage pattern.

So, high level of continued L1 usage might reflect limited exposure to L2. So, you might have might go to a different country, but you do not really use L2 that much. So, even if you have arrived early in life, it is the three years, four years of age, but you can you stick to your own community. Let us say Chinese migrants into US keeping to themselves keeping within the Chinese community.

So, exposure to L1 is still very high, usage is still very high compared to L2 English, something of that sort. hypothetically that could be one situation. So, usage is that; so, in general high use of usage of a language is associated with greater proficiency and has, as a result, subsequent consequences for speech perception. So, this was as a result we have to compare bilinguals, we have same AOA, but differ for differ in their usage.

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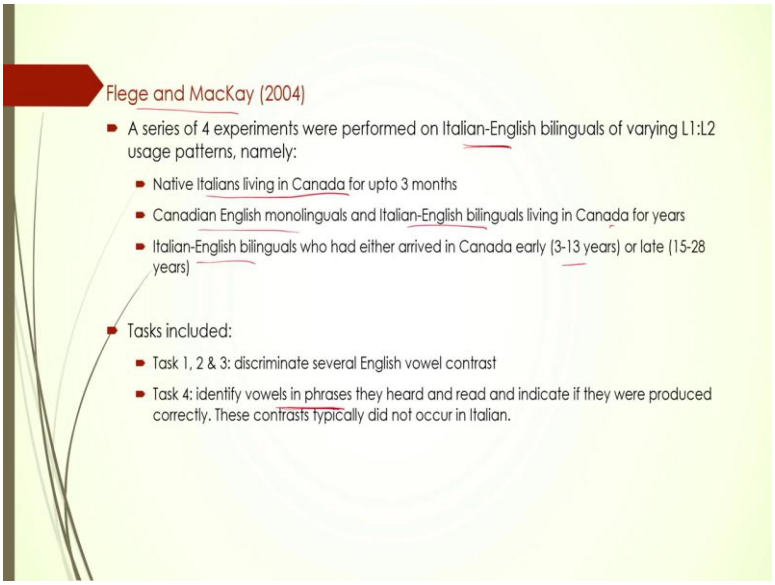

So, you can have the same kind of age of acquisition; however, on that on terms of in terms of usage, there might be difference. So, that kind of parameter have also been used in experimental studies. So, in a series of four experiments by Flege and Mackay, 2004, they had studied Italian-English bilinguals of varying L1- L2 usage patterns.

So, native Italians living in Canada for up to 3 months, Canadian English monolinguals and Italian-English bilinguals living in Canada for years and Italian-English bilinguals were either arrived in Canada early or late in life. So, the task was to discriminate several English vowel contrast and task this was task 1, 2 and 3, task 4 was identify vowels in phrases that they heard and read and indicate if they were produced correctly.

So, this was a series of four, contra four tasks and these contrasts typically did not occur in Italian.

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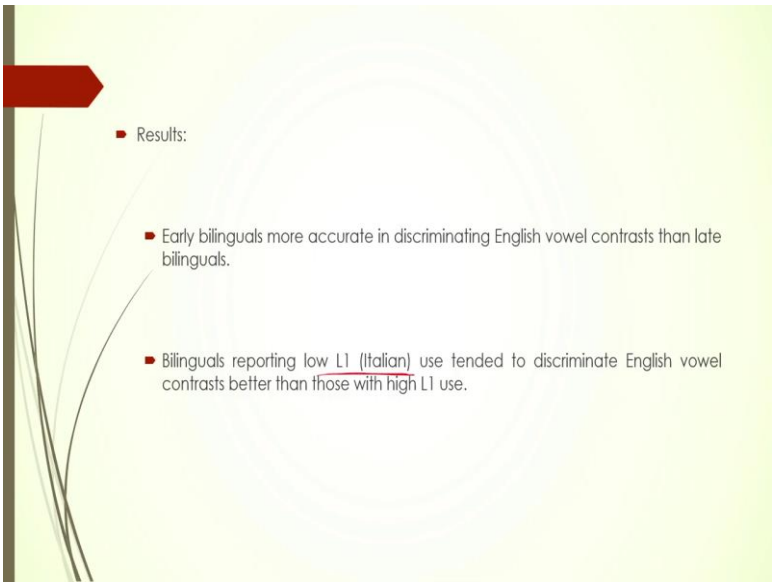

The results showed that early bilinguals were more accurate in discriminating English vowel contrasts than the late bilinguals. And bilinguals reporting low usage of L1, tended to discriminate English vowels contrast better than those with high L1 use. So, if your L1 usage comparatively less, than your L2 usage, naturally you can expect some better discriminatory capacity in your L 2, that is exactly what they found.

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Another related idea is that of language dominance; so, you see within proficiency. So, you have proficiency, you have usage pattern and you have dominance. There are so

many factors within the larger area of language proficiency. So, dominance is basically sometimes what happens in case of a bilingual your L1 might be dominant for some time, after a point your L 2 might become dominant.

So, dominance factor in a bilingual's language one or language two changes, it is open to change. So, it is the earlier held belief was that L 1 remains strong throughout your life, but today we know that it does not really hold that way; now, the idea of dominance has changed.

So, L1 may be stronger in the early part of life when you are learning your second language. But based on if you are depending on the context of use and the various other factors your L2 might also become dominant and L1 might become the less dominant language; so, this can change over a period of time.

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So, it is largely dependent on the environment; so, depending on the environment your language skill might change. For example, large number of us who to who use English for most of the time of the day, our dominant English becomes our dominant language, our L1 become the less dominant language. Even though we started with a strong L1 early in life.

So, this is this has also been studied in detail, we will look at couple of studies here. So, this particular study in 2015, they investigated the role of language dominance on to see

if Galician-vowel system becomes more Spanish like due to the extended exposure to Spanish. So, this study was carried out in some Galician region within Spain.

Participants were 54 Spanish-Galician early bilinguals; task was to categorize Galician front and back mid-vowel contrast in an identification task. What they found was that Galician dominant participants that the bilinguals who were Galician dominant, not Spanish dominant, these were Galician-Spanish speakers. They have established two separate vowel categories for front and back mid-vowels.

Thus, language dominance actually plays a very strong role with respect to perception of the perception of sounds also in a bilingual.

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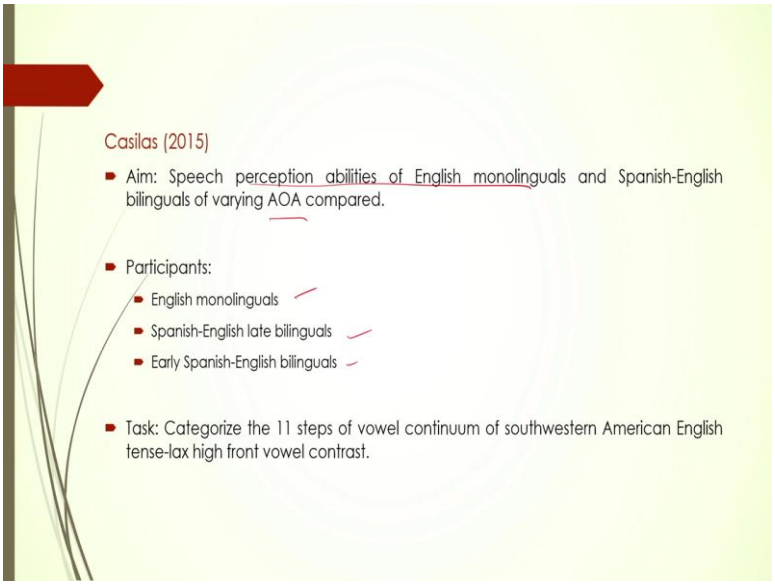

Similarly, another study looked at the speech perception abilities of English monolinguals and Spanish-English bilinguals varying in age of acquisition. So, participants were monolinguals, Spanish-English late bilinguals and early Spanish-English bilinguals; so, there are three categories within the bilinguals, early versus late. Task was to categorize the 11 steps of vowel continuum in South-Western American English, tense, lax high front vowel contrast.

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The results were English monolinguals and English dominant bilinguals were more consistent in assigning the categorical labels. Meaning they were they did much better compared to the Spanish dominant bilinguals who had a less sharp categorical boundary right. So, tense and lax those contrast, the Spanish dominant bilinguals could not perceive as clearly as the English dominant bilinguals.

So, English monolinguals and English dominant bilinguals placed greater weight on vowel spectrum properties than vowel duration. So, this kind of finer understanding of the sound segments were also based on the language dominant factor.

So, which language is dominant and accordingly your perception or comprehension of those factors will change. On the other hand, Spanish dominant bilinguals relied more on vowel duration. So, the strategy is also different not only the identification rate is less, but also the strategy are different.

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So, there are a few other factors also that we will discuss in the next segment; so, we will in the part one we will conclude the part one here.

Thank you.