**Bilingualism: A cognitive and psycholinguistic perspective**

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**Module - 06**
**Part - 03**
**Lecture - 15**
**Sentence processing**

Hello welcome back we are in module 6 and today we will start with part 3 of module 6.

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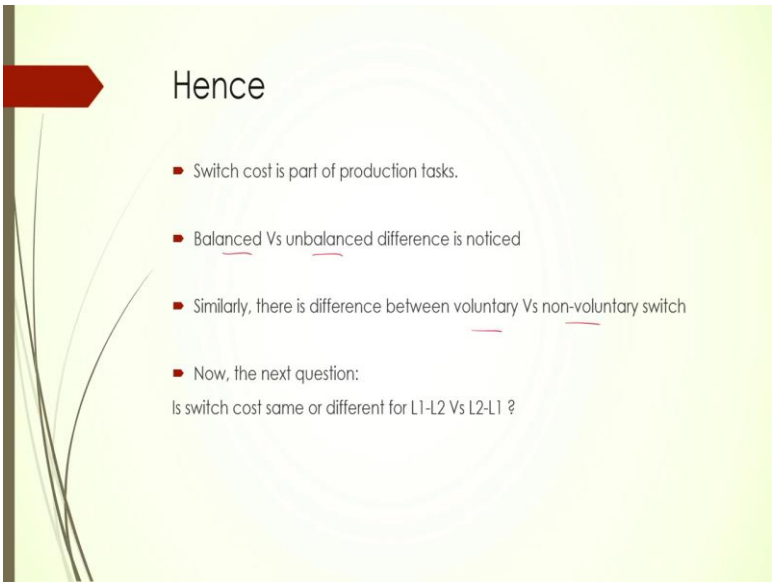


So, far we have through module 6 part 1 and part 2, we have looked at language processing at various levels at lexical level whether it is comprehension or production both have been covered till now. So, in the last part we talked about language production and the various factors that could be taken as variables that would have you know impacted the outcome in case of language production.

So, one of the last things that we discussed with part 2 was the idea of switch cost. So, what is switch cost? Switch cost is a term given for the difference in reaction time which compares the single language block versus the mixed language block production.

So, for example, if there is a picture naming task and so for the same picture to name the picture the time taken in the single language block as in the block in which all the items

have to be named in a single language that is called single language block versus the mixed language block.

In the mixed language block what happens? The same pictures could be named in either L1 or L2. So, there are cues on the basis of which one has to change from one language to another and that is called a mixed block. So, the difference in naming the same object in the same language, but in two different conditions is the switch cost. So, typical finding shows that in the mixed block the reaction time is typically higher.

So, this is taken as a switch cost because in the mixed block the participants have to switch between languages. So, L1 to L2 versus L2 to L1 like this going back and forth that takes a bit of more time and that is called switch cost. So, the switch costs again is a is an outcome that can be different based on various other variables. For example, we have seen that balanced versus unbalanced bilinguals will have a different outcome in these tasks also if the switching is voluntary versus involuntary.

In most cases in the experimental paradigm the cues are given. So, that is largely involuntary. There is a cue on the display on the basis of which the participant has to change from one language to another.

So, this is inbuilt in the design, that is what we call non-voluntary switch. But in some designs some experiments have also used the voluntary switching. So, where the participant decides in which language the participant wants to name the given object whether it is a picture naming or a digit naming or whatever.

So, as a result we also see difference between voluntary versus involuntary switching. Now, the next question is ok there is a switch cost. There is a switch cost that you see in both the languages which might vary depending on balanced versus unbalanced voluntary versus involuntary.

But is the switch cost same in both direction? Meaning is the switching from L1 to L2 and L2 to L1 will they will they be same or will they be different. So, do we see a switch cost from L1 to L2 exactly as the same as in L2 to L1 switching. So, that is what is the next thing that we will look at.

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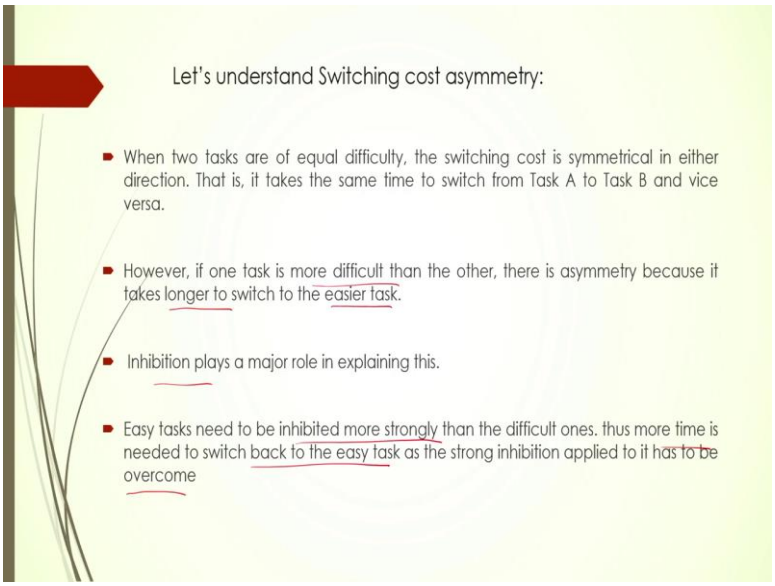


Now, before we move on let us understand what is switch cost asymmetry. So, the question that we asked was is it same or is it different? Is it the switch cost between L1 to L2 versus L2 to L1 is at the same are they different? So, in other words what we are saying is the switch cost asymmetric or is it symmetric. So, if they are same then it is symmetric. However, if the switch cost between L1 to L2 versus L2 to L1 are different then we call it asymmetric switch cost.

So, asymmetric switch cost is not only a matter of linguistics or language related experiments. This is a domain general term. So, what is switch cost asymmetry? Switch cost asymmetry is a notion that talks about that when there are two tasks which are equally difficult or equally easy. So, basically two tasks which are of equal difficulty then switching from one task to another will be symmetrical.

So, I am giving you two tasks, task A and task B and they are equally difficult in terms of whether difficult or easy, but there of equal difficulty then in that case switching from one task to another will not be very difficult. So, it will be symmetric whether you go from A to B or you come back from B to A it does not it will be symmetric cost.

However, if one of the tasks is more difficult then there will be an asymmetric switch cost. So, if A is more difficult than B then that will give rise to what we call asymmetric switch cost. Now, what happens in case of asymmetric switch cost is if one task is more difficult than the other there is asymmetry because it takes longer to switch to the easier

task. This almost sounds counterintuitive that it will it should be always easier to come back to easy task, but it is actually the opposite.

When there is one task which is more difficult than the other it is usually more difficult to come back to the easier task. Why is it so? This has been explained through the understanding of inhibition. Now, inhibition can does play a major role in explaining the asymmetric switch cost.

So, easy task need to be inhibited more strongly when what is easy is typically you need to inhibit this more strongly compared to the tough task because it is always ready because you are more easily that this task is more easily available to you. So, once you have you have utilized a larger amount of control mechanism on that task it makes it more difficult to bring it back to action that is why easier tasks are always more difficult to get back to.

So, that is why. So, the more time is needed to switch back to the easy task as the strong inhibition applied to it has to be overcome. So, that is the reason why it is always more difficult to come back to the easier task.

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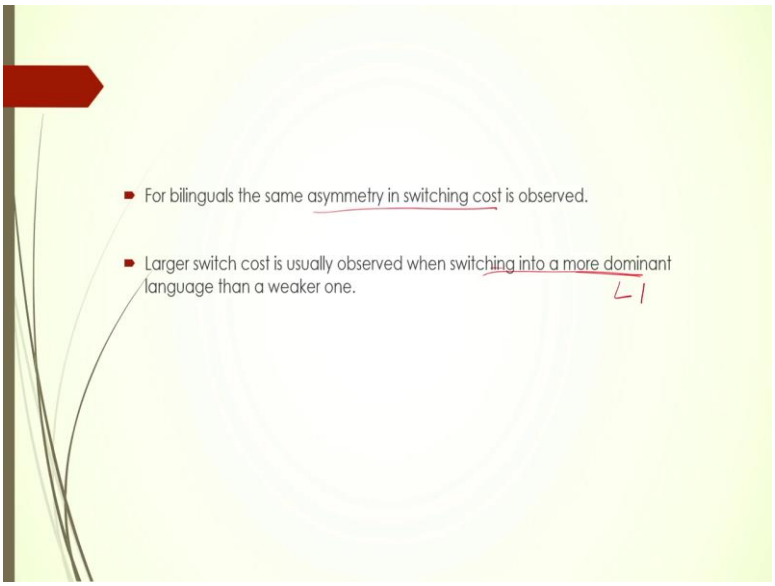


Now, with this basic thing, basic understanding in place now we come back to bilingualism. Bilingualism in case of bilingualism also the same asymmetries in switching cost is observed. You may ask why?

It is because bilingual in bilingual population very few people are symmetrical in the sense that they are balanced bilinguals. Most bilinguals will have one language which is stronger, one language which is more dominant which is you know usually is earlier acquired language and so on. So, this is why bilingual production studies also show a an asymmetric switch cost.

So, larger switch cost is usually observed when switching into the more dominant language. In more often than not this will be the L1. So, switching from L2 to L1 takes longer compared to switching from L1 to L2 typically because L1 is more often than not the dominant language.

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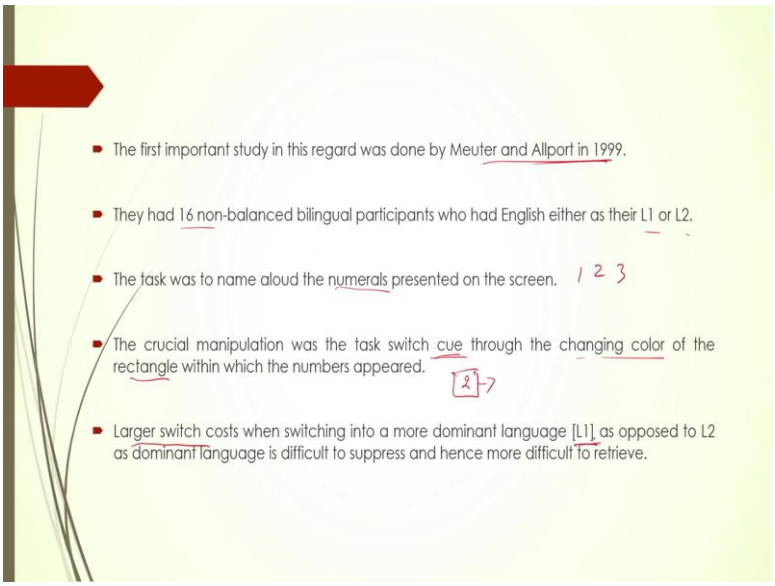


So, what how does asymmetric switch cost look like in bilingualism? It is asymmetric switch cost in bilingualism typically refers to the asymmetry between L2 to L1 versus L1 to L2 switch cost. L2 to L1 switch cost is always higher, that is the basic idea. Now, in this regard this has been studied at length by a number of researchers by a number of groups and one of the oldest one of the earlier studies was carried out by Meuter and Allport 1999.

They had 16 non-balanced bilingual participants who had English as either their L1 or their L2. Now, the task was in this case because we are talking about production. So, the task was to name aloud numerals presented on the screen. So, like 1, 2, 3 like this. So, they had to name them.

But the task was to switch between L1 and L2. And the crucial manipulation in this case was task switch cue. As I mentioned, there will be a cue in the built in the experimental design itself. So, the cue will appear in terms of a change of color or at the background, something of that sort. So in this case the changing color of the rectangle within which the numbers appear.

So, there is a sort of a frame within which there is like this frame sort of thing within which you have the numbers. So, this frame changes color depending on what color the frame takes, the participants are cued to use either the L1 or their L2. So, the findings showed that larger switch cost was reported when switching into a more dominant language L1 as opposed to L2.

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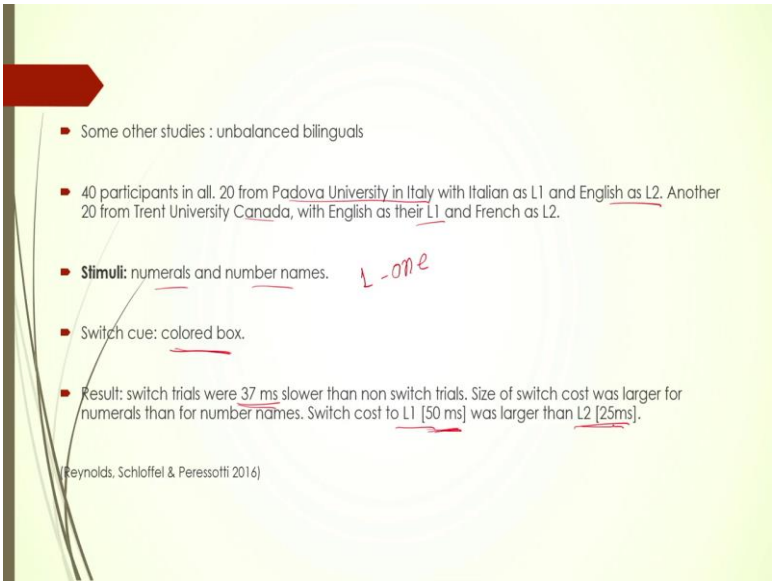


So, this is one of the first studies to experimentally verify that asymmetric switch cost is an important integral part of bilingual language production. Typically with unbalanced bilinguals.

There were many other studies. Another well-known study was carried out on two different groups. 20 participants were from one university in Italy, another 20 participants from another university in Canada. So, they had different L1 and L2. The manipulation here was basically in the first group, English was L2, in the second group English was L1. And in the first group, L1 was Italian in the second group, L2 was French.

So, these are the two groups that they studied and they had a series of experiments in which they had numerals and number names. So, 1 as in like this and number names as in ONE  one. So, that is how the differences were created. And again it was a production study. Switch cue again was colored box. So, depending on the color in of the box, they have to change from their L1 to L2 or L2 to L1.

The results showed that switch trials were 30s milliseconds slower than the non-switch trials, meaning that they took that they took longer. They were slower to respond in the mixed in the switch trials compared to the non-switch, the single language blocks. So, the size of the switch cost was larger for numerals than for number names and switch cost to L1 was larger than that of L2. So, switch cost from L2 to L1 coming back to L1 was 50 millisecond, whereas, the opposite way was only 25 milliseconds.

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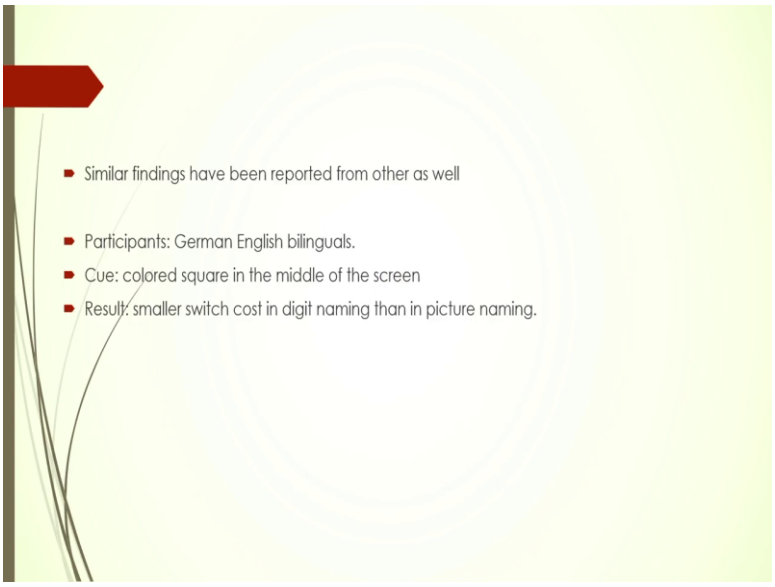


So, that is again a very interesting study that juxtapose two different groups with having different L1s and L2 as well as different types of tasks. So, the switch cost is manipulated by not only by the fact that these bilinguals were unbalanced, but also because of the different task conditions.

Similar findings have been reported from many other studies as well, yet another study on German English bilinguals found the same. Now, it is not only that all the studies that looked into this found the switch cost.

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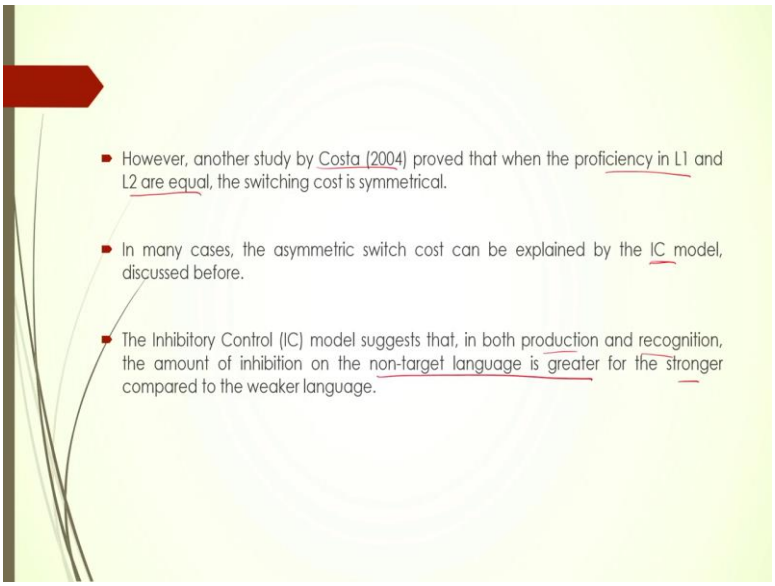


There have been also studies which set out to find out what exactly is happening and there some of these studies did not find the switch cost. One of them was Albert Costa's 2004, very well known work that showed when the proficiency in L1 and L2 are equal, the switch cost is symmetrical, which means in this case, let us go back to the task switching and switch cost asymmetry.

The basic idea is when one task is more difficult than the other, we see a an asymmetric switch cost. So, this is exactly what Costa found out that because they are both the languages were the proficiency the participants' proficiency in both the languages were similar. As a result of which neither of them was dominant or stronger and hence there was no switch cost visible.

So, the reason and then of course, because of many findings that talks about absent switch cost and also the absence switch cost is more common in comprehension studies than in production studies, but they do exist. So, because of all these varied findings, the it has been there has been attempts to explain as to what is happening.

One of the models that tries to explain it is the IC model which talks about the control mechanisms, inhibitory control mechanism. So, this model suggests that in both production and recognition, recognition is comprehension which we have looked at before.

The amount of inhibition on the non-target language is greater for the stronger compared to the weaker language. So, the idea that L1 is stronger and it needs to be inhibited more strongly and that is why it is difficult to bring it back, all of these are explained by the inhibitory control model of language production. So, this is one way of understanding this.

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Similarly, there are studies that looked at the inter-sentential switching cost in Spanish-English bilinguals when the participants had to read sentences word by word, this is the SPR model which we will see shortly. In this case, they did not find any switch cost difference.

So, there have been a lot of findings on both sides. So, sometimes there have been switching costs, sometimes there have been no asymmetry in switching costs and then these are the some studies that show us that different kinds of findings and one way of explaining that is IC model.

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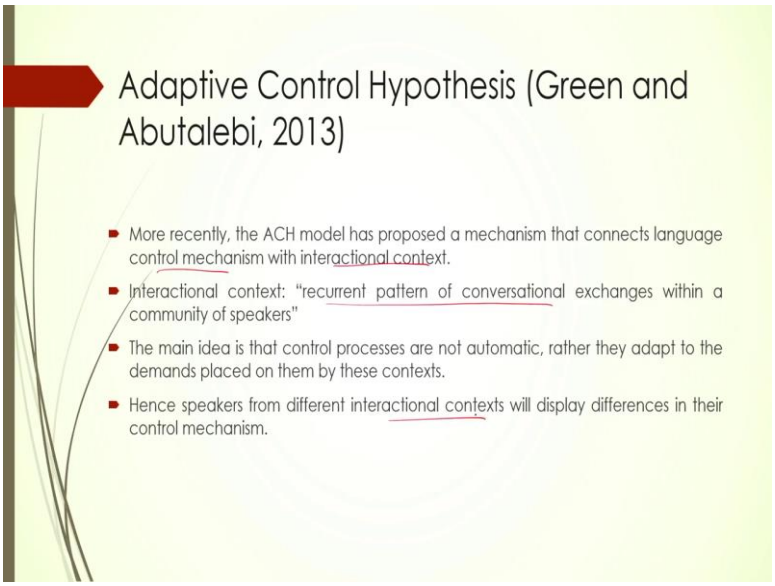


Of late, there has been another model that looks at bilingual language processing. It is a later version, they are quite a recent one 2013 adaptive control hypothesis by Green and Abutalebi. So, this model talks about the takes things a little further.

It takes things a little more towards the context of language use as in it has proposed a mechanism that connects language control mechanism with interactional context. So, yes, there is a language control mechanism, there is an inhibitory process in-built.

However, that is not automatic, that that system does not work the same way for every case for every kind of bilingual. So, that is what why I said that this model takes things a little one notch higher because this model talks about entirely how interactional context as in the kind of linguistic context within which the bilinguals have lived has and has a direct impact on the control mechanism exhibited by those bilinguals.

So, he makes he gives a definition like this international context, recurring pattern of conversational exchanges within a community of speak. Now, if I talk about Indian scenario in any Indian city in the urban setup, the dominant linguistic context will be a code switched context is very common to see that people can code switch between the local language, local dominant language and English. So, when we are in Guwahati, we will see a lot of code switching between Assamese and English.

In Hindi speaking areas, you will see lot of Hindi English and Chennai Tamil English and that kind of thing. So, this is a very common interactional context within which bilinguals perform, bilinguals typically live in. So, that is what according to this model has to be taken into account, because all bilinguals are not same and one way of looking at how one group of bilingual might be different from another group of bilingual is looking at the interactional context.

So, the main idea here is that the control processes are derived from the interactional contexts. So, depending on the kind of interaction, it will have different control process. Why one may ask?

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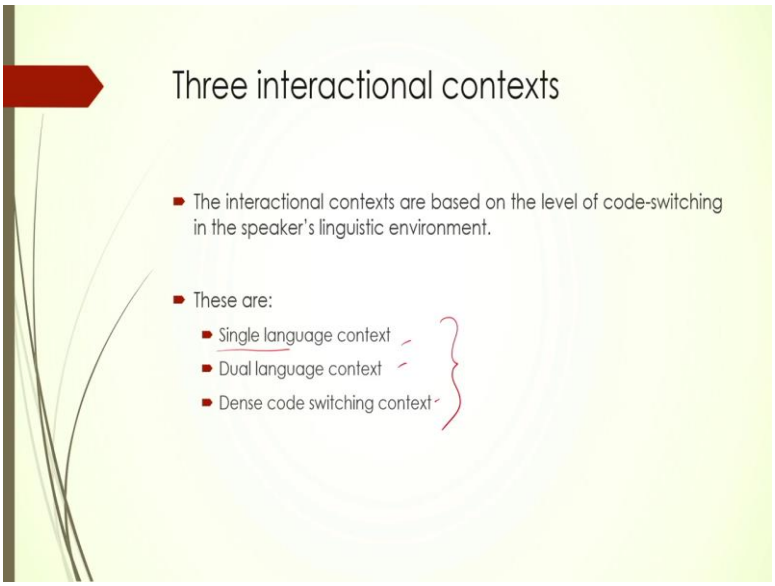


The reasons are here. So, he gives three kinds of context, three kinds of interactional context, all of these are bilingual contexts. Ok these are not single though even though it says single language context, it is not about monolingualism, this is about bilinguals. So, depending on the speaker's linguistic environment, we can have three types of interactional context.

One is called single language context, the other is dual language and dense code switching. Single language context is when we use only one language, a bilingual uses one of his language in one particular domain there is no mixing up of two languages. So, let us say L1 only at home and L2 outside home. So, in that case, there is no amount of

control process needed because there is no chance of the other language really getting into in the way of conversation. So, this is called single language context.

Dual language context is a context where both languages can be used in the same context, however, based on certain cues. Those cues can be the participants in the conversation and many other factors like that. So, this is as a result, this context places a lot of constraints on the speaker. The speaker has to constantly keep a watch for the cues, salient cues in the environment in order to choose the language to be used.

As a result of which the model says that, Abutalebi says that dual language context is the most demanding and challenging context of language use for a bilingual. And third is dense code switching context where one can code switch.

So, both languages are equally possible to be used in any given context with any kind any participant in the conversation. So, it is a dense code switched context where it does not really matter which language you use, both are possible. Hence, this also has less amount of demand on our control processes.

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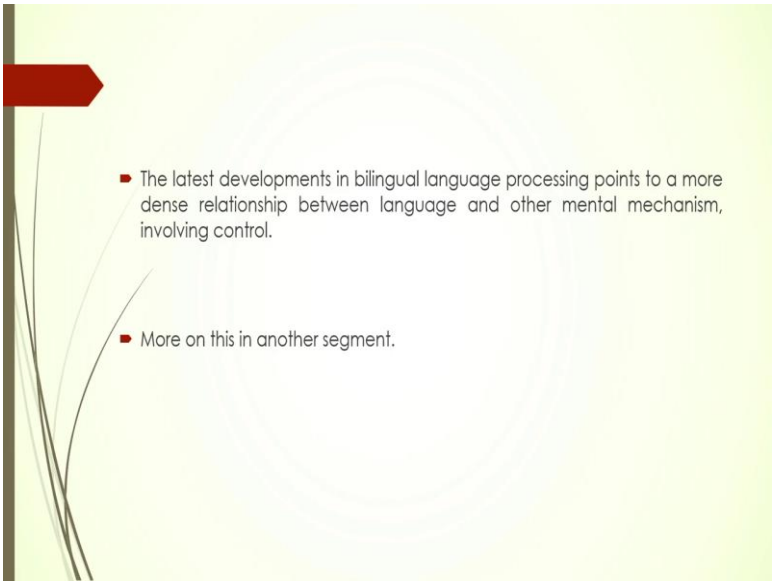


So, these are the three interactions and the latest developments in bilingual processing that is why points to a more dense relationship between language and other mental mechanisms typically involving control. So, we will talk about talk in a little bit more in detail in another segment on this.

So, here we will not get into the get into detail here because this takes us to the domain of control, language control and how language control and domain general executive control are connected, what are the finer aspects of their interaction, all of that we will discuss in a different module. So, this bit we will leave here.

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And move on to now the domain of sentence processing.

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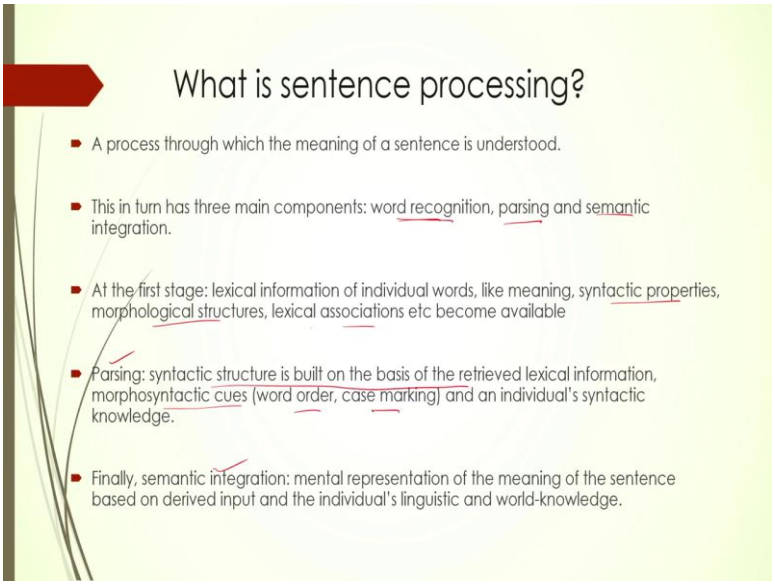


So, so far, we have been looking at language processing in terms of comprehension and production at lexical level, be it naming pictures, naming digits or reading and

comprehending all of that was at lexical level. Now, we will go on to sentence processing. So, first thing first, what is sentence processing? Sentence processing is basically a process through which a sentence is understood. When I utter a sentence like IIT Guwahati is a beautiful place, this is a simple sentence. Now, when we when somebody either looks at it in a written form or listens to it, there is a process that goes that the mind goes through to make sense of this sentence, that is sentence processing.

So, when sentence processing basically means that if we understand each of the words and then we understand how syntactically they are all connected to each other, what is the role, thematic roles and so on subject object, all of that and then ultimately what it means. So, there is there are these different levels of processing ultimately what is finally, called sentence processing.

So, sentence understanding is sentence processing. So, this has primarily three components like I was just saying, so, word recognition, parsing and semantic integration. So, in the first very first stage lexical information of the individual words like IIT Guwahati. So, what it means, what is the word, what is it what does it mean and then its syntactic properties, syntactic properties of all the words. So, which is the agent, which is the object, direct object, indirect object so on. So, all of this morphological structure lexical association, all of these become available to the sentence comprehender, the person who is processing the sentence.

The next part is what is technically called parsing. This is basically the syntactic structure is built on the basis of the retrieved lexical information. So, each of these words when we read, we have the entire gamut of lexical information that gets activated. On the basis of that, we now create the syntactic structure in our mind. So, based on the lexical information morphosyntactic cues. So, very often these are the ones that are very important criteria.

So, word order and case marking so on. So, for example, if I make a use a wrong case marked sentence in Indian language, then it will have a problem in processing. So, case marking and word order, if I, in Indian languages for example, the adjective precedes the noun when we have something like let us say, red building, red house. So, the red precedes the house, but this is not the case in French, in French it will be the other way round.

So, those things are to be are only taken into account and then based on also based on the individual's syntactic knowledge, ultimately the sentence structure starts to make sense in the perceiver's mind and finally, semantic integration. So, the meaning aspect of it. So, all of these go together and when we talk about meaning, it is not only the meaning of the individual words, but also this has to be understood in terms of the individual's world knowledge, what is possible.

So, a sentence like we have seen an grammatical, but semantically anomalous sentences before, well we talked about processing, we looked at the dog bit the man versus the man bit the dog. So, the both sentences are grammatical, but the man bit the dog is off, so to say, let us say. So, this is where the world knowledge and the processing part, they are in clash. So, there is a little bit of problem there and that is that happens at the semantic integration part of the sentence processing.

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So, all of these grouped together finally, create sentence processing. Now, while we said that there are these you know stages, now the problem, the research questions actually start there. Do we process these things at you know in a serial manner or do we process all of them together? Is it necessary that we will look at word level following with sentence level, following with semantic level? Does it really happen like that or is it a concurrent process? So, that is where majority of research has been focused on.

So, before we move forward, these are the depending on the aspects of sentence processing, we have different domains, focal different, focal domains within this sentence processing area. So, word recognition within sentence context has been a rather rich area of research, similarly mental representation of meaning in sentence processing and of course, parsing, parsing perhaps is the most commonly understood or let us say most salient type of sentence processing research that has been that has been around for quite some time.

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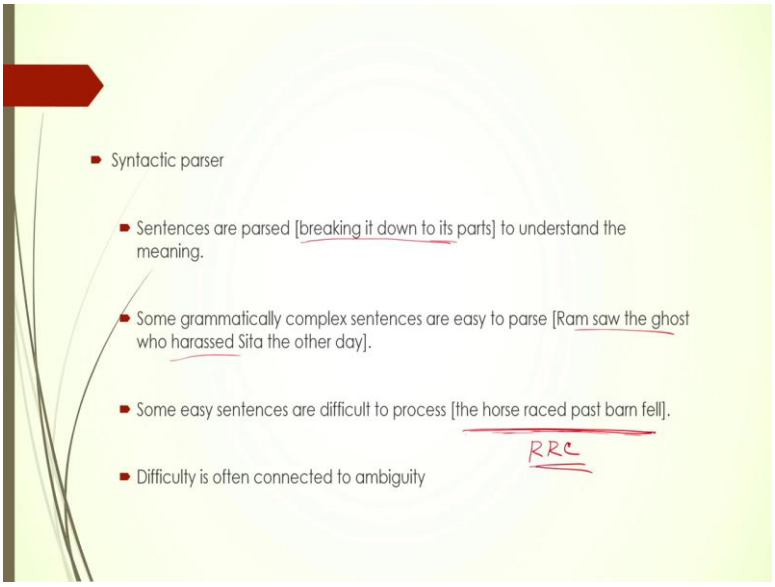


So, we will be talking about parsing, let us get down to understand what syntactic parsing is all about. So, sentences are parsed basically meaning it is broken down to its different parts. So, noun phrase, verb phrase and so on. and ultimately we understand the meaning. So, sometimes grammatically complex sentences can be easy to parse. So, a sentence like Ram saw the ghost which who harassed Sita the other day, it is a complex sentence because it has an embedded clause and so on.

So, it is a grammatically complex sentence however, it is quite easy to process the participants who are reading this sentence will not have any difficulty in understanding this sentence. That is what we mean by easy to process. However, sometimes sentences might be small and they might appear simple, but be very difficult to process. This is one of the textbook examples, this is an omnipresent sentence ‘the horse raced past barn fell’.

This sounds this looks like a simple sentence however. So, this has driven research for years.

So, this what is happening here is this sentence is ambiguous. So, ambiguity as a result of which has been an integral part of sentence processing research for a very long time. Ambiguity is connected to parsing difficulty. Now, what is happening here? Why is this sentence ambiguous is because we are not sure what this is something is missing here. What is missing here is it is called RRC Restricted Relative Clause.

So, the relative clause 'the horse that raced past the barn fell' should have been the sentence. But the clause 'that' has been omitted here. So, the relative clause here has been restricted as a result of which we call this RRC as a result of which we create ambiguous an ambiguous sentence.

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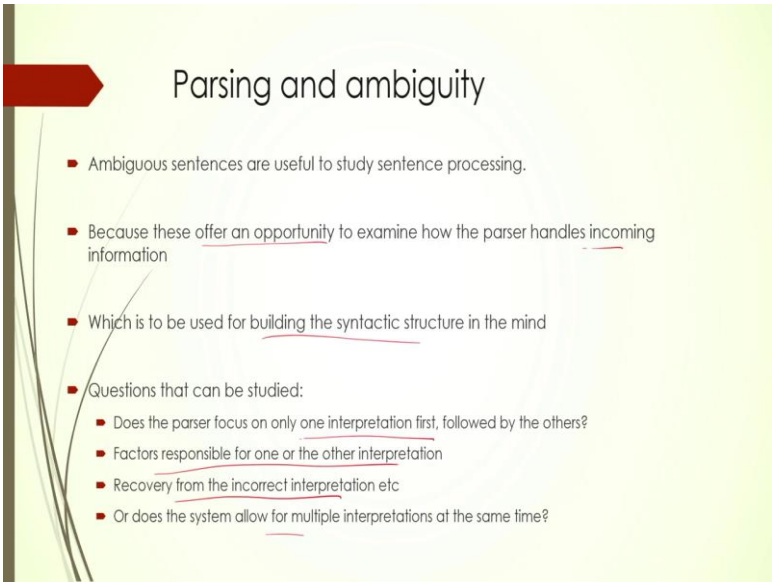


So, as a result of which ambiguity and parsing kind of have been together, had been handmaiden for a pretty long time. And the reason why ambiguity has been used in sentence processing research is that ambiguous simple sentences are not will not really tell us where the difficulty is.

So, when you have ambiguous sentences we are able to see exactly at which part the processor gets you know the person processing the sentence finds it difficult. So, what

are the target words, what are the target elements in a sentence that creates the problem, that creates problem in processing.

So, as a result of which ambiguous sentences are very useful. So, they offer an opportunity to examine how the parser processes the incoming information. Because you see this kind of sentence when you do a sentence processing analysis, they will appear one word after another and then at one point the flow will be disturbed.

So, this is how we check, this is how researchers check how incoming information is processed and what are the difficulties and then also how those difficulties are overcome as a result of which ambiguous sentences are studied. So, the incoming information gradually builds the syntactic structure in the mind. So, this is how we get to know.

So, the questions within which that can be asked is or in fact, the questions that have already been asked and lot of work has happened, these are some of them. So, does the person focus on only one interpretation first, followed by the other? So, do when we are when we are exposed to an ambiguous sentence, what happens?

Do we go ahead with the first interpretation that appears the simplest and then when that does not work, we come back and do a reanalysis and have the second interpretation done or do we have all the interpretations at the same time and then we kind of figure it out which is the best way forward.

And also the factors responsible as to why do we go for one or the other interpretation in the beginning and or successively. As I said. So, how do we recover from the incorrect interpretation and also does the system allow for multiple interpretations at the same time.

Primarily under all of these questions, the primary question is how what route does interpretation of a sentence take? Do we go ahead with the flow and take one interpretation at a time or both interpretations or multiple interpretations are active at the same time and how does the parser tackles that?

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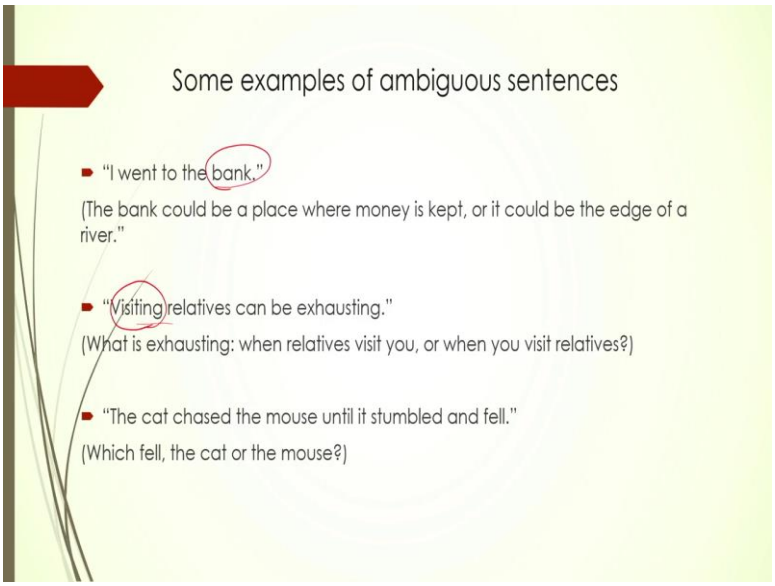


So, all of that are the questions that we that have been asked. So, these are some examples to tell you what kind of ambiguities are there. There are all possible types of ambiguities and that have been studied, just some simple examples. So, I went to the bank, here the ambiguity is because of the word here, the bank, the word bank, we do not know what kind of bank. So, you need a contextual information in order for you to process that information.

Similarly, visiting relatives can be exhausting. So, what is exhausting? So, the relatives visit you or when you visit the relatives. So, that is this is the problem here. This is the we call them the target word. So, this is the main word that is driving the ambiguity. Similarly, the cat chased the mouse until it stumbled and fell. So, we are not sure who fell finally, which fell the cat or the mouse.

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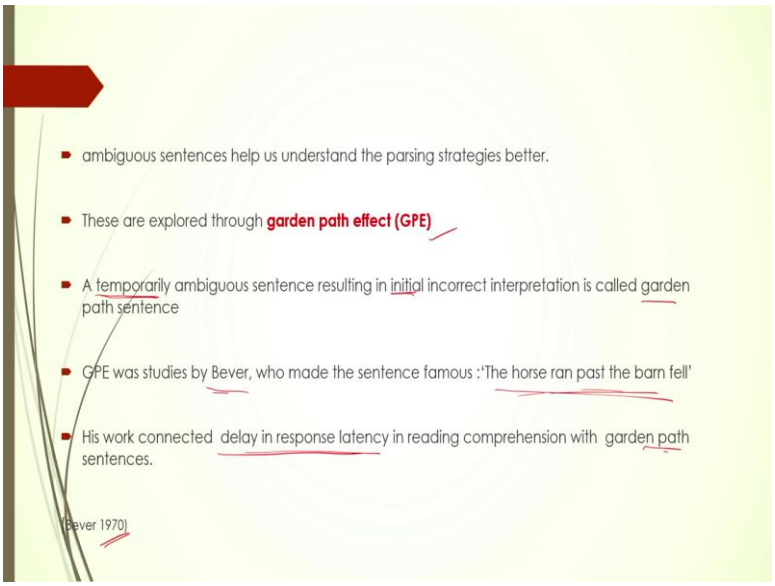


So, these are different kinds of ambiguous sentences. Now, ambiguous sentences and their processing and how we disambiguate them have been understood in terms of have been researched, in terms of in order to understand how parsing strategies differ, depending on different types of sentences, whether parsing strategies are different or not.

So, there are two kinds of effects that have been studied. One is called the garden path effect, pretty well known, very high frequency word, garden path effect. Garden path effect basically refers to a temporarily ambiguous sentence. This is keyword here, temporarily ambiguous sentence resulting in an initial incorrect interpretation, which is called the garden path sentence. So, basically it is the sentence takes us on a garden path and on a simplistic sort of an interpretation and then puts us in a difficult position.

So, this was initially studied by Bever who in 1970, who actually made this sentence very famous. The horse ran past barn fell actually comes from him, his work. So, he looked at this kind of sentences where you start with an interpretation and then kind of it leads to astray and then you have to reanalyse and reinterpret the sentence that is called garden path effect.

So, his work to start with his work started to connect delay in response latency in reading comprehension with garden path sentences. So, this kind of sentences if you give the parser, there will this there will be a correlation between delay.

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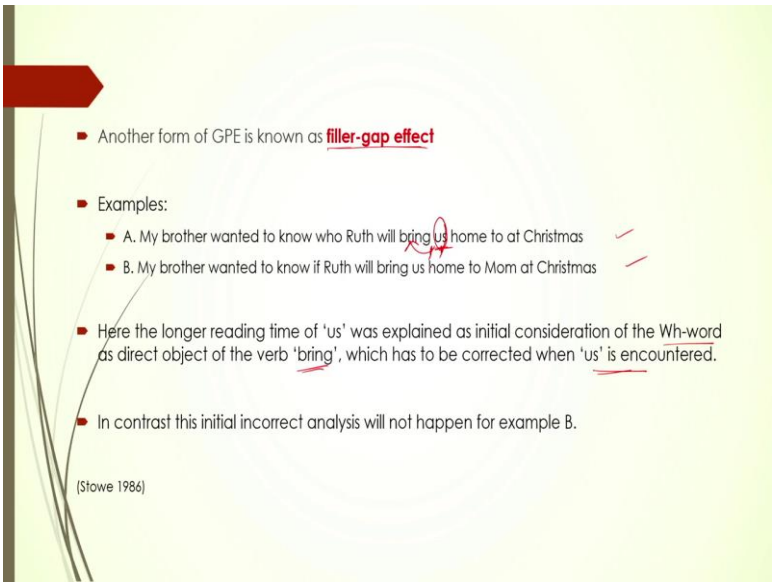


So, basically longer reaction time, that is one form of effect that is studied. Another form of effect that is studied is called filler gap effect. Filler gap effect, these are some examples that I have quoted from a textbook, in order to tell you is in a more easy way. So, my brother wanted to know who Ruth will bring us home to at Christmas.

Another sentence is: my brother wanted to know if Ruth will bring us home to mom at Christmas. Both sentences are complex looking and sounding. However, the second sentence is easier to comprehend compared to the first one, meaning the second sentence is easier to parse. The longer reading time for ‘us’ was explained as, the problem here is this the word target word here in this particular first sentence.

Why we why they take longer or where is the problem? Problem starts here. Because this is was explained as initial consideration of the WH word as direct object of the verb bring. So, this is connected to direct object of the verb ‘bring’. But then that is not how it works, then it has to be corrected when ‘us’ is encountered.

So, my brother wanted to know who Ruth will bring. Fine, this is fine. And then suddenly this appears and then this creates a problem, it creates a problem in analyzing the sentence and hence you need a reanalysis. So, this is what is happening here. In contrast, the second sentence has no such problem. There is no such problem with respect to a sentence that that does not really follow a simplistic analysis, simplistic parsing.

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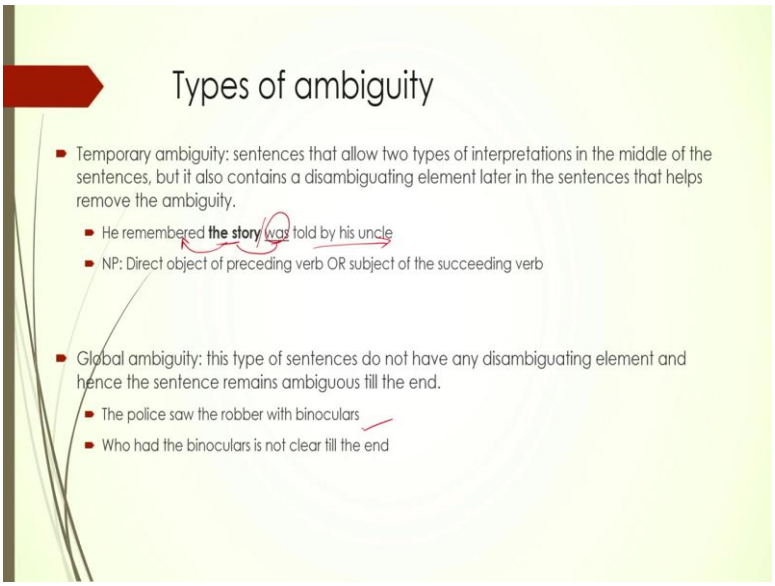


Now, after all of these ambiguous different times of ambiguity, let us look at how those are effects. Now, in terms of the types of ambiguity, there are two kinds of ambiguity. One is called temporary ambiguity, the other is called global ambiguity. Temporary ambiguity as the name suggests, its temporary.

The problem is temporary, it will go away after some time, that kind of a thing. So, these sentences allow two kinds of interpretations in the middle of the sentence. But as you read through the sentence, as you complete the sentence reading.

Gradually there is one component somewhere towards the end of the sentence that will disambiguate the whole thing. That is why it is called temporary ambiguity. The sentence does not remain ambiguous till the very end, it gets resolved sometimes. So, he remembered the story. So, you almost think this was this is where the thing gets over. So, he remembered the story, but then this again the word ‘was’ appears and this is why this end sentence is a little problematic.

And as you proceed to the end of the sentence, it kind of gets resolved. The problem gets resolved. So, NP is direct object of preceding verb or whether this is direct object of the preceding verb or is it the subject of the succeeding verb, that is what was not clear in the beginning. But as you read the whole sentence, that problem gets resolved.

Hence, it is an example of temporary ambiguity. Sometimes sentences have no disambiguating component in the sentence and that is why it remains ambiguous till the end. Again, a very famous sentence, the police saw the robber with binoculars. So, we are not sure who had the binoculars, the police had or the robbers had.

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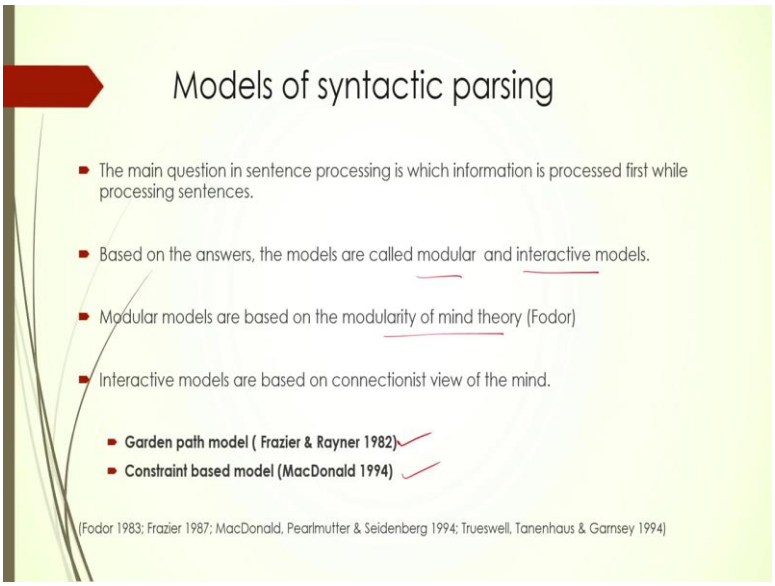


Now, based on all of these, we now have different models for understanding syntactic parsing. There are two primarily two models. The Basic question that derive that drives these different models is which information is processed first and which later or is there a serial processing versus a parallel processing of the different interpretations in a sentence.

That is what drives the two different models. Now, both of these models are also based on different ways of different understanding of how the human brain works. One theory is based on the modularity theory of Jerry Fodor, which says that the mind is modular in the sense that the brain has different modules, each has a different distinct function to take care of. So, language is one such module, it does not depend on any other module.

So, that is hardly any give and take between different modules, that is one. The other theory about mind is the connectionist model, which talks about that there is a lot of give and take that it ultimately the outcome is a result of a lot of interaction, connections between different neuronal networks. So, based on these two different ideas, there are two different models. These are called either called modular model or interactive model.

So, modular models are based on the modularity of mind theory and interactive models are connected to the inter connectionist view of mind. So, modular model is the garden path model and constant based model is an interactive model. These two models were given by two different groups. So, so garden path model was given by Frazier and Rayner, Keith Rayner and constant based model was given by Mac Donald slightly later.

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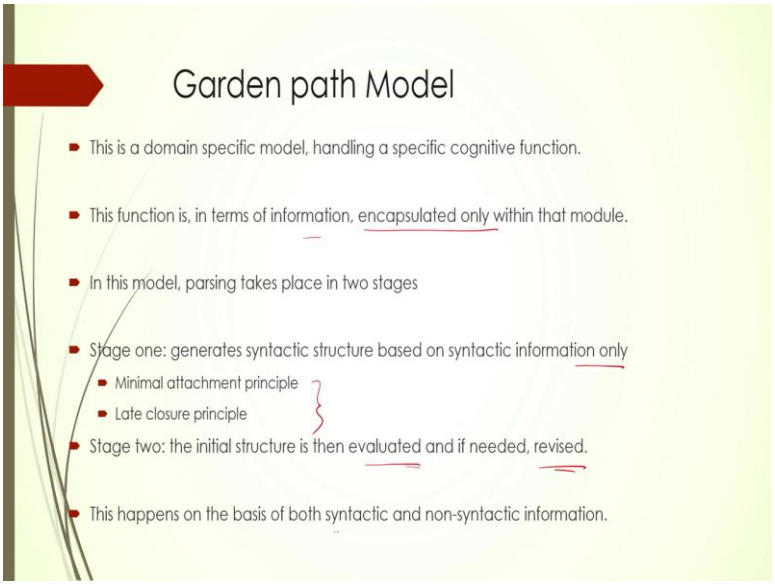


So, garden path model, this is a domain specific model as I was just saying that this is this handles a specific cognitive function, not the rather than looking at a function, how it interacts with other functions. This model talks only about one function at a time. So, this function is in terms of information encapsulated only within that module.

So, there is no not much of a give and take. So, in this model as a result parsing takes place in two stages because there is hardly any interaction. So, one particular understanding, one particular way of parsing goes on and then only later on, at a later stage reanalysis happens.

So, in the stage one, it generates syntactic structure based on syntactic information only, which again has two different principles to be taken into account, minimal attachment principle and late closure principle. And then in stage two, the initial structure is then re evaluated again and if needed revised. So, that is how ambiguity is taken care of. This is how ambiguity is resolved in by as far as this model is concerned. And this happens in on the basis of both syntactic and non-syntactic information.

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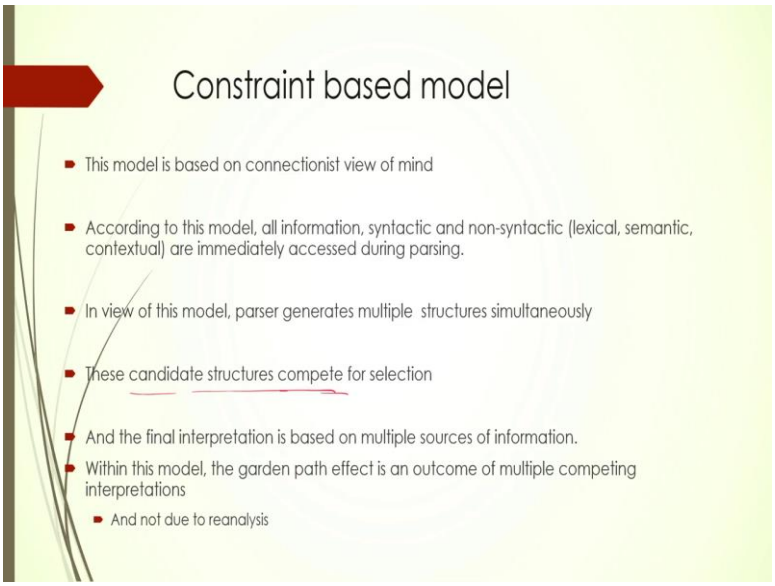


So, non-syntactic basically refers to lexical, morphological, contextual and other information. On the other hand, constraint based model is based because it is based on connectionist theory of mind. They say that according to this model, they say that all the syntactic, non-syntactic information, all of that are accessed during parsing.

So, it is not like you access only syntactic information, when it does not work, then you call on to the other processes and then they work together for a re-evaluation. In this model, as far as this model is concerned, everything is taken into account in the very beginning.

All of them are accessed at the same time and as a result of which, there is a parallel processing happening, meaning all the interpretations are simultaneously active and the ambiguity results as a result of that competition, not because you are processing only in one direction.

So, these candidate structures compete for selection and the final interpretation is based on multiple sources of information like all of these syntactic, non-syntactic. So, within this model, the garden path effect is an outcome of multiple competing interpretation rather than having a reanalysis at a later stage.

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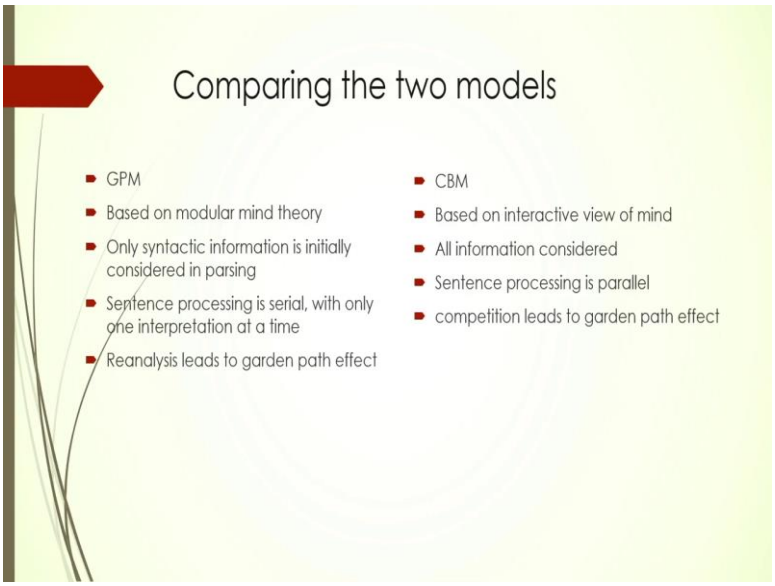


So, these are the two main models of sentence processing. That is here, we have put them together for better understanding and just comparing them.

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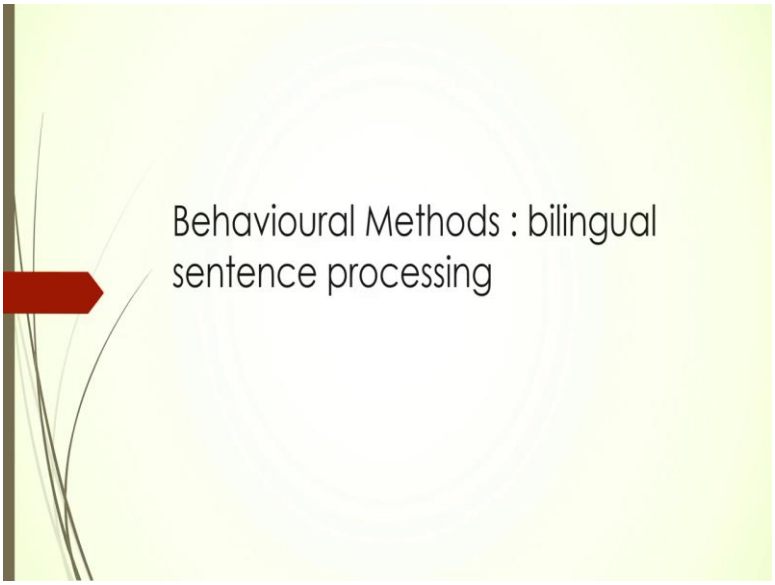


Now, the methods for studying sentence processing.

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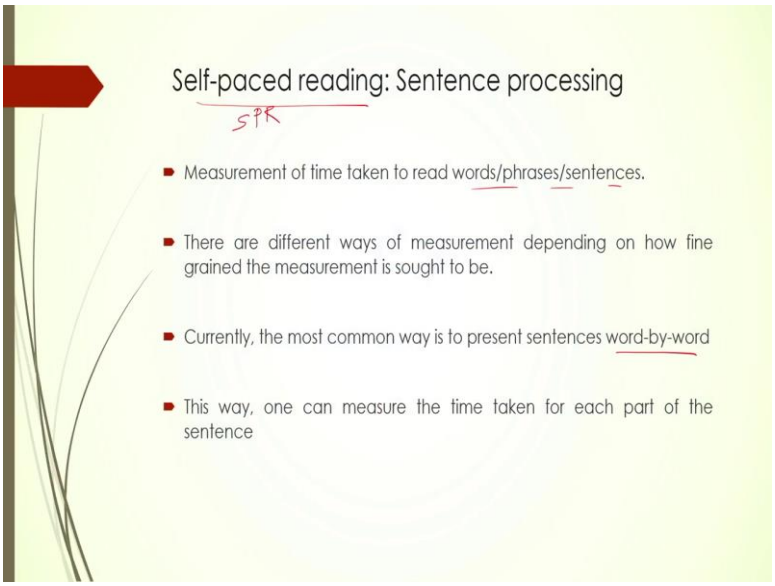


There are like in the lexical processing, here also we have behavioral methods versus non-behavioral methods. Earlier, mostly, it was behavioral methods that were used, but of late, we have seen a lot of usage of non-behavioral and behavioral techniques put in use together.

So, while the participant takes part in a behavioral task simultaneously brain imaging or eye tracking studies are also taken care of, they are also included. So, one of the most commonly used method for looking at sentence processing is called self-paced reading. It is also called SPR in short.

The SPR paradigm is basically self-paced reading. So, the person the participant reads sentences as depending on his or her own way of reading. So, the words, the sentences will be typically presented one word at a time. So, one word appears on the screen, the participant presses a key and then the next word appears and so on. So, this is be it entirely dependent on the person's, the participant's pace of reading. So, the measurements of time taken to read words, phrases, sentences.

So, how long do you take to read one word? Because the key press for after each word or sometimes they are also presented in terms of phrases, also its possible to use sentences, full sentences also is possible depending on the research agenda. So, it depend on this key press actually logs the time taken to read each of the, each of those components that is present on the screen. So, that is how it is measured. Though, as I said typically, most

common way is to present word by word and so, this way one can have a very good measurement of how much time you spend on reading each word.

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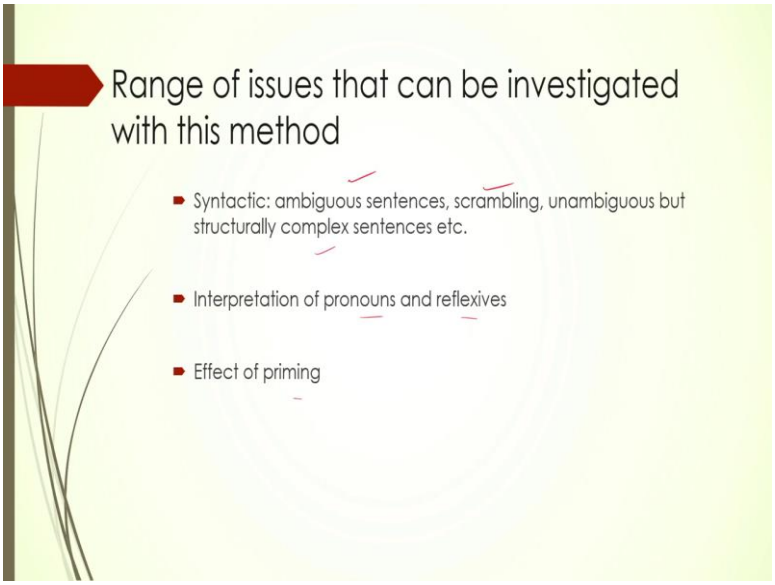


So, that is why self-paced reading basically, this is again a reaction time analysis. So, time taken to read each word. Now, if we have ambiguous sentence. So, we will know exactly where. So, typically the target word will take longer time for you to read. So, that is why this is a very useful methodology. And SPR paradigm has been used to study different kinds of processing.

Within syntactic, you have ambiguous sentences, scrambling, unambiguous, but structurally complex sentences and so on. And also interpretation of pronouns and reflexives, effect of prime, everything can be all of these can be studied and have been studied with using the SPR paradigm.

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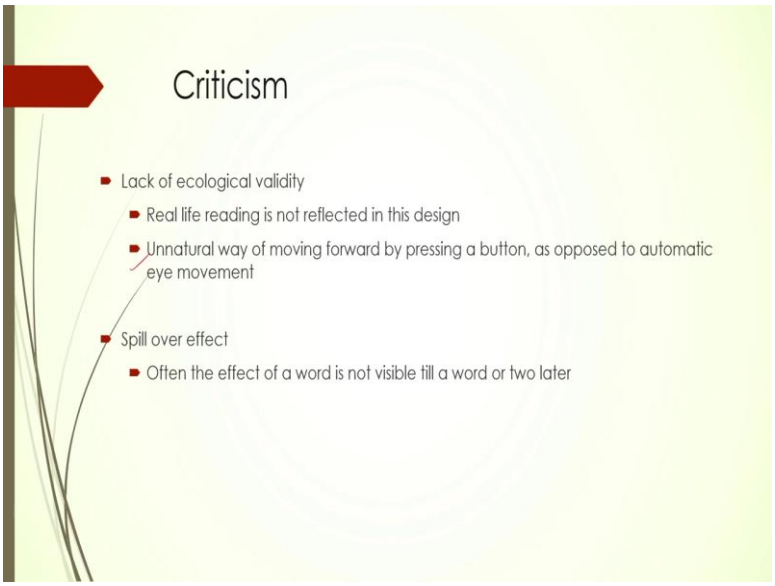


Of course, there are some criticisms as well against using SPR because one of the important criticism is the lack of ecological validity, ecological validity as in this is not really, this does not SPR paradigm is not similar to how we read in real life. In real life, we do not really read one paragraphs or sentences word by word so to say. Of course, we the eyes move from one word to another, but the parafoveal vision has the entire sentence.

In fact, couple of sentences within your parafoveal vision at the same time. Hence, there has been lot of criticism as to how it can be taken as an example of real life reading process. So, this is a very unnatural way. So, that is one important criticism. Another criticism is what is called spillover effect. Spillover effect in this domain, in this context, talks about that the effect of one word is not always felt immediately on that word.

It can also spill over to the to the neighbouring words. So, how do you take care of that? So, SPR does not really have a method to put a method put in place to take care of the spillover effect. So, the target word for example, the critical word in a sentence, it may take longer for the participant to process, but that effect may also be you know carried on to the next one or two words. So, that these are criticisms.

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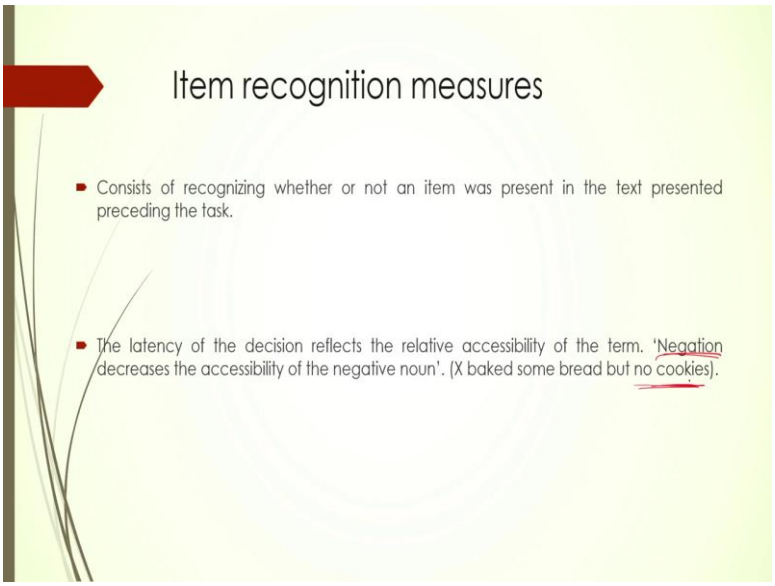


Another method for studying sentence processing is called item recognition measure. A lot of it has been used to understand the effect of negation in a sentence context. So, the latency of the decision reflects relative accessibility of the term. Typically, they will look at recognising whether or not an item was present in the text presented in the preceding task.

So, x baked some bread, but no cookies. So, if you ask, was the word cookies present in the sentence, after this sentence has been read and then the question is, was there cookies? Chances of you know the participant taking longer or being unable to say that cookies were there are higher. So, this is the effect of the negation on the retrieval process of the word.

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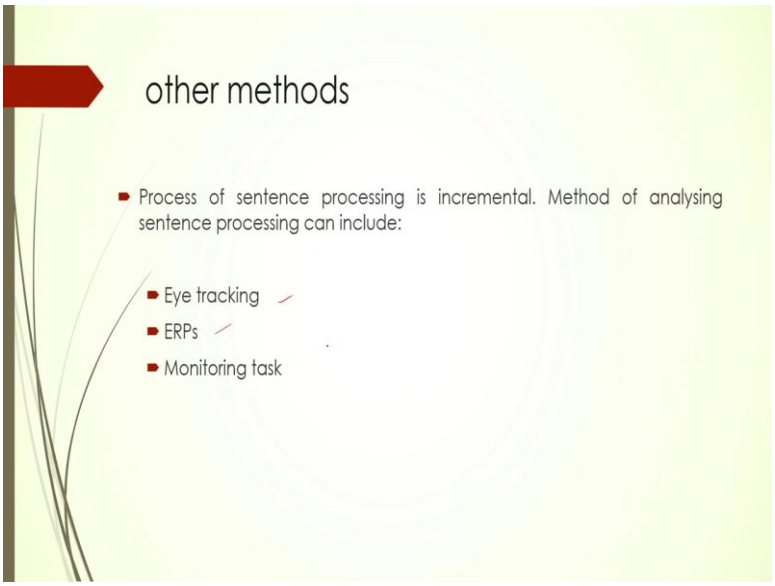


So, this is another line of research that has been there and then there are other methods as I just mentioned. So, there are eye tracking studies, ERPs and monitoring tasks.

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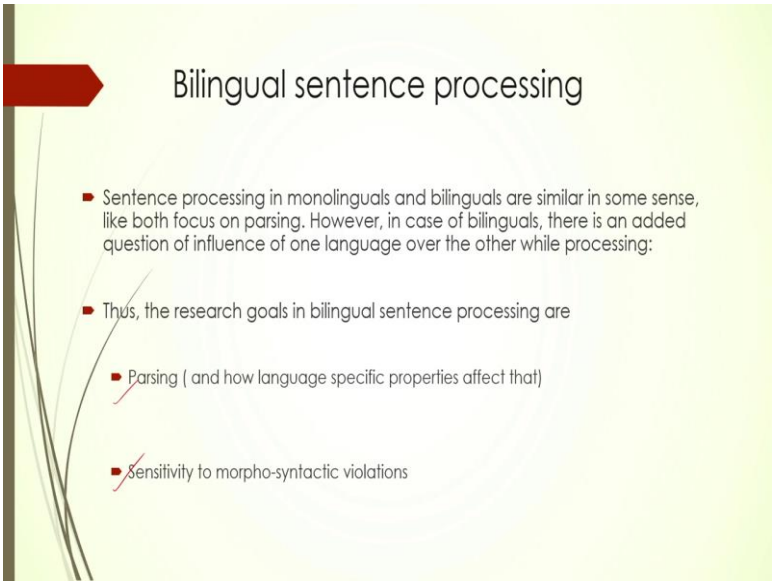


So, we will just look at some studies using all of these. Now, all of these basically we are talking about sentence processing in general, but our primary concern here is bilingual sentence processing. So, bilingual sentence processing is slightly different from monolingual sentence processing because in case of bilinguals, there is an added

question of influence of one language on the other. Does the syntactic structure of L1 have an impact on the that of L2 or is the process is the influence both ways?

These are the questions that only a bilingual will face, not a monolingual. So, even though bilingual language sentence processing and monolingual sentence processing are similar in many ways because they all use parsing, they all use the semantic integration and so on. However, these are the places where you have difference. So, the research goals in bilingual sentence processing as a result in these two lines parsing as in and how language specific properties affect that.

So, in one language one has certain properties, certain language two does not have those properties and then how the parsing strategies will be different or similar and so on. So, that is where within parsing that is what in case of bilinguals we check. Similarly, sensitivity to morphosyntactic violation in case of bilingual language processing.

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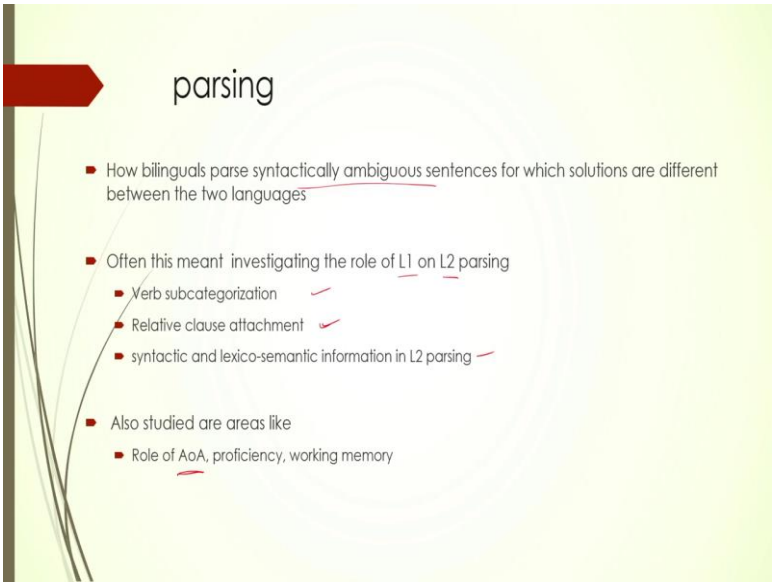


So, these are the two main domains that are studied. So, in terms of parsing, we will look at how bilinguals parse syntactically ambiguous sentences for which solutions are different in the two languages. So, L1 might have a one strategy for disambiguating L2 might have different strategies. So, how does that work out for a bilingual? That is one important area within parsing in bilingual language sentence processing.

And often this also means investigating the role of L1 on L2 parsing, taking these primarily these three, but there are many other areas possible as well. But these are the quite common ones. So, how work to sub-categorizations are different in two languages. Relative clause attachment difference and syntactic and lexico-semantic information in L2 processing.

So, these are some of the important domains. Also studied are area areas like we have also already seen that age of acquisition, proficiency, all of these working memory, they all they all have a very important role to play in lexical processing. Similarly, the same things are also studied in syntactic processing in case of bilinguals.

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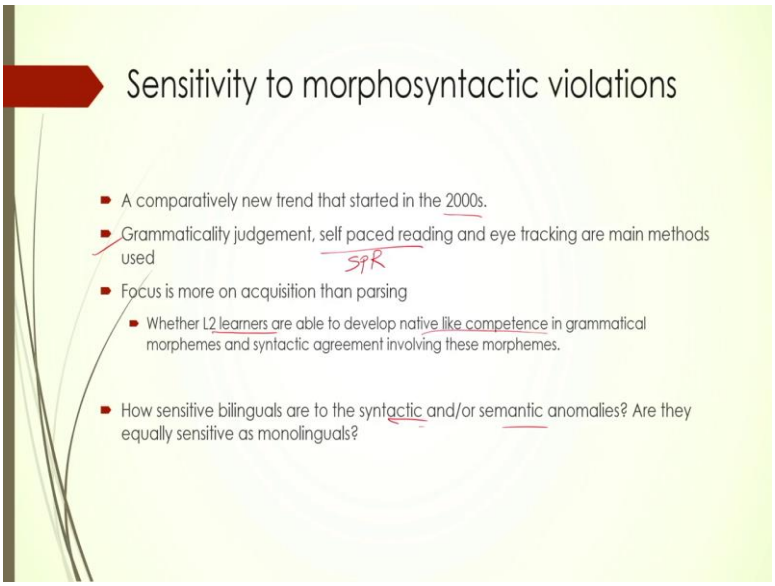


In terms of sensitivity to morphosyntactic violations, this is not a very old trend. This is comparatively new started in 2000s. So, typical methods will be grammaticality judgment, self-paced reading that is SPR which we have just seen, grammaticality judgment we have seen before and eye tracking are the main methods in this case. Focus is more on acquisition than parsing. So, the primary standpoint here is to check whether L2 learners are able to develop native like competence in grammatical morphemes and syntactic agreement involving those morphemes.

So, this is more about this is parsing alright, but looking at the parsing strategies from an acquisition point of view. Also, how sensitive bilinguals are to the syntactic and semantic anomalies depending on their L1 and L2. So, are they equally sensitive as monolinguals?

So, let us say a bilingual speaker of L2 like many of us we have our L2 is English. Now, is our strategy of disambiguating syntactic and semantic and semantically anomalous sentences same as that of an L1 speaker of English or not. So, that is another area of study within this domain.

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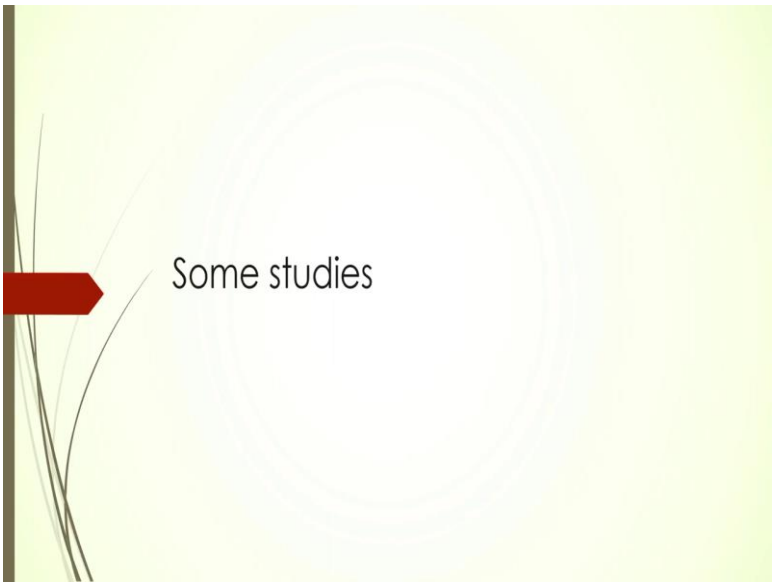


So, let us now look at a few studies that there is no particular order we will just discuss some of the important studies.

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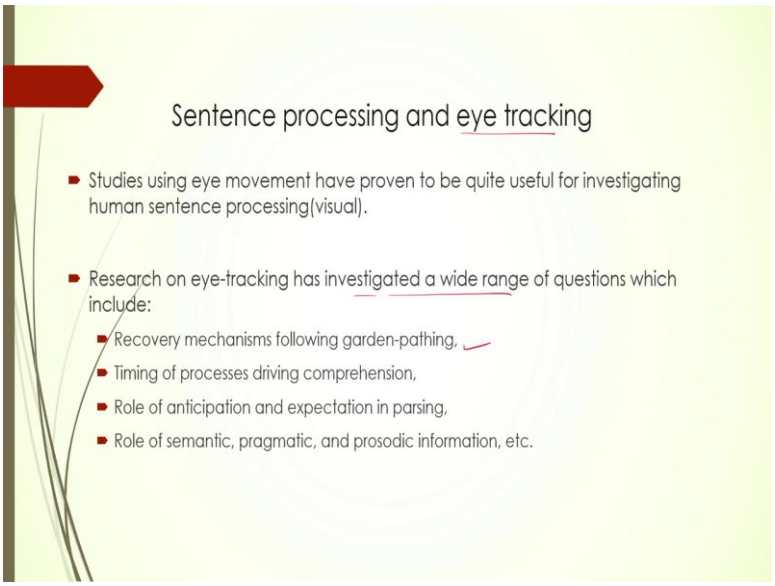

So, eye tracking has been used extensively in sentence processing research. So, typically they using eye tracking have investigated a wide range of questions. Sometimes they will look at recovery mechanisms because when you read a garden path sentence your eyes. So, the eye tracker tracks the eye movement as to where how it moves and where it stays for how much of duration, how many milliseconds do we spend on each word.

And once we have you know gone on the garden path and the interpretation is not really working very well. How does the mind reinterpret the whole sentence? So, that will be seen by looking at the tracking the eyes. So, do we come back to the initial part? Do we look at the subject again? Do we look at the verb again and all of that.

So, that entire mechanism can be very easily tracked by using an eye tracker. Hence, recovery mechanism following garden pathing is one. Timing of process driving comprehension, role of anticipation and expectation in parsing, role of semantic, pragmatic and prosodic information all of that can be checked through eye tracking.

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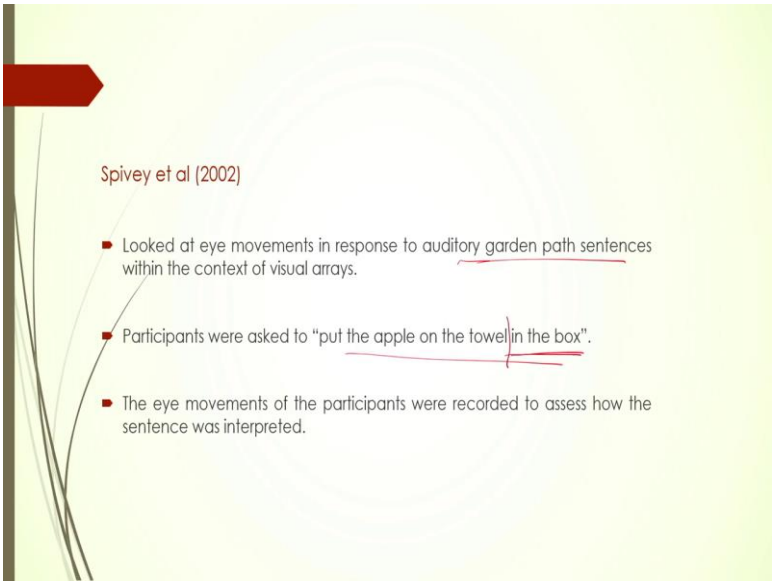


One important study in this regard is by from Spivey et al, they looked at eye movements in response to auditory garden path sentences within the context of visual array. So, eye checking studies as we have seen before also they use a paradigm called visual world paradigm where you listen to an auditory input simultaneously process a visual input, visual stimuli.

So, what they did was they had a garden path sentence which the participants listened to and then there were some displays. So, the sentence was ‘put the apple on the towel in the box’. So, till here it was fine put the apple on the towel. Now, suddenly after that then this appears as a result of what which we call it a garden path sentence.

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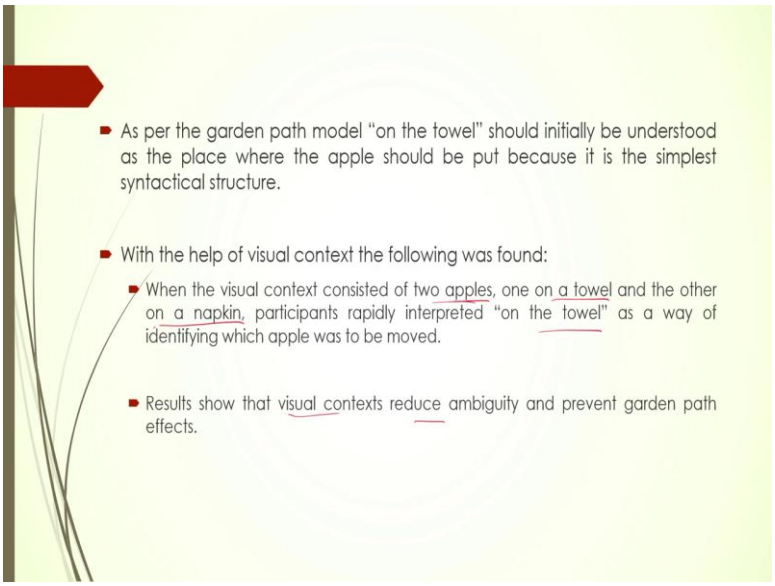


Now, The eye movements were recorded and as per the garden path model on the towel should initially be understood as the place where the apple should be put because they put the apple on the towel. This is the simplest possible infirm interpretation. However, because they had visual displays. So, what the visual context consisted of two apples. One was on a towel and the other was on a napkin.

So, participants rapidly interpreted on the towel as a way of identifying which apple was to be moved rather than the location where the apple has to be moved. So, they interpreted this finding by saying that the visual context often help reduce ambiguity and in rather than lack of.

So, if there was no visual display in this case it will be a garden path sentence. So, they will have difficulty in disambiguating. But in this case because visual displays were visual cues were there visual context was given.

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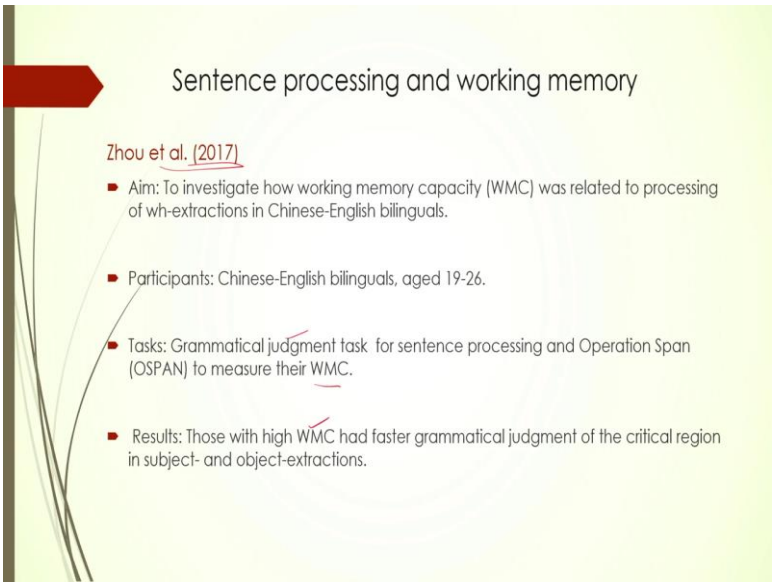


It was easier for the participants to disambiguate the sentence. And then the sentence processing has been studied connecting it with working memory as well. So, there have been studies that looked at that this is a pretty recent study and the task was grammaticality judgment task for sentence processing and operation span to measure their working memory capacity.

Primary finding of this study was that participants with higher working memory capacity had faster grammatical judgment of the critical region which was in subject and object extractions.

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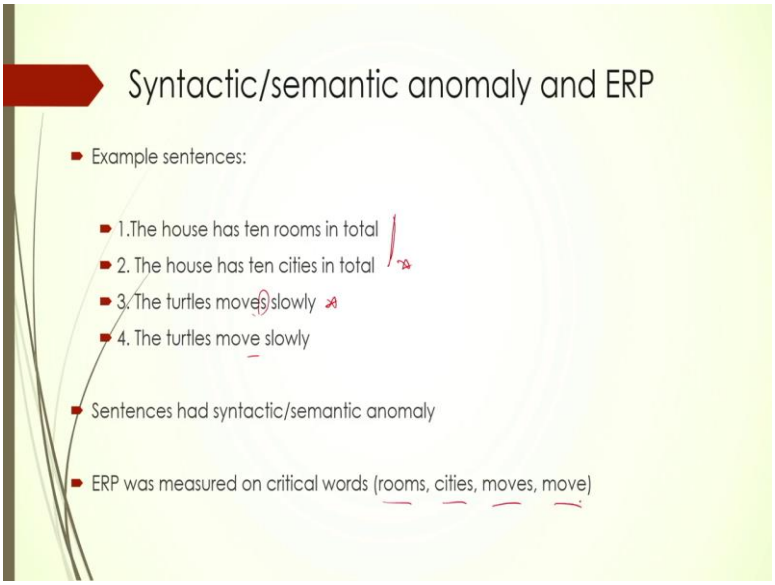


Similarly, code switching and sentence processing have also been studied where in the context of cognitive control using card sorting task which we have seen before. And they found that children with higher language skill exhibited greater moderating effect of cognitive control. There have been a lot of studies involving EEG and ERP. So, there has there are some studies that looked at the whether the monolinguals and the bilinguals have similar kind of ERP component or not.

So, the primary components, ERP components in case of syntactic and semantic anomaly are as we have seen before. In case of semantic anomaly we will see N400 effect. In case of syntactic anomaly we will see ELAN and P600 effect. So, the primary idea driving these studies are to see if the monolinguals and bilinguals have the those indicators similar or are they different. So, here are some examples. So, this is as these are these sentences are this is an anomalous sentence and similarly this is an anomalous sentence.

The house has 10 rooms in total and the house has 10 cities in total and similarly the syntactic anomaly. So, this is the turtles should move and not moves this is the problem here. So, the sentences were having this kind of anomalous component and they had done ERP on the critical wards. So, we have the critical words rooms, cities, moves and move in these four sentences.

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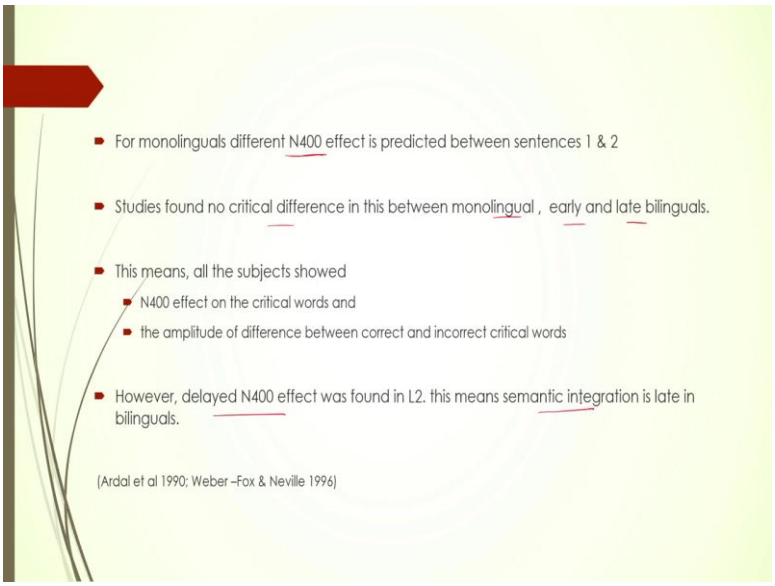


So, for monolinguals we already know that different N400 effect will be predicted in case of the normal sentence and as opposed to an anomalous sentence. So, there will be difference between N400 effect in case of these two and so, if they in the this study particular study they found out that there was no critical difference between monolingual early and late bilinguals in terms of having the N400 effect.

So, they did find N400 effect in both cases they also found a difference in N400 effect based on whether the sentence is anomalous or not anomalous. Till here there was not much of a difference. However, there was a difference in terms of delay. So, in case of bilinguals there was a delayed N400 effect compared to the monolinguals. So, this points to the fact that semantic integration in case of bilinguals, semantic integration takes longer as opposed to monolinguals.

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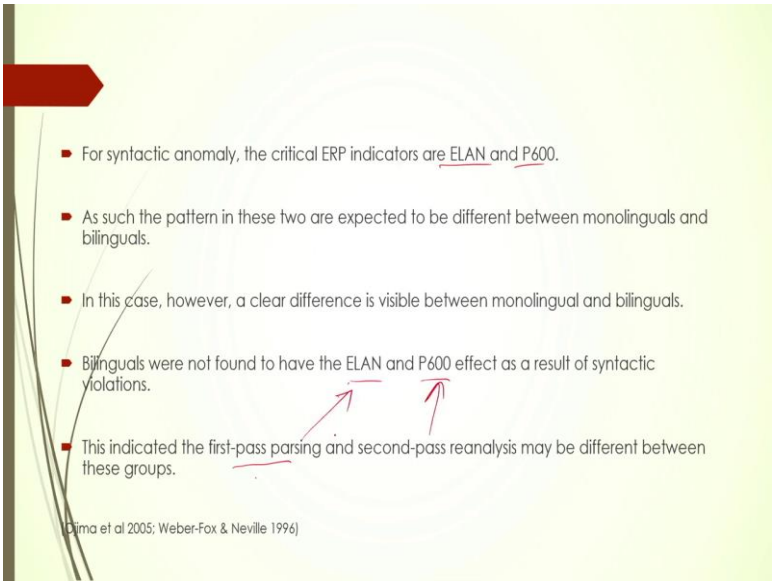


In case of syntactic anomaly of as I said the critical components are ELAN and P600. So, in the pattern in these two are expected to be different between monolinguals and bilinguals.

However, bilinguals were not found to have the ELAN and the P600 effect in this study. So, as a result of the syntactic violations. So, this indicated that first-pass parsing which is indicated by ELAN and the second-pass parsing which is indicated by P600 these may be different between the bilinguals and the monolingual groups. So, these are the there are some interesting differences.

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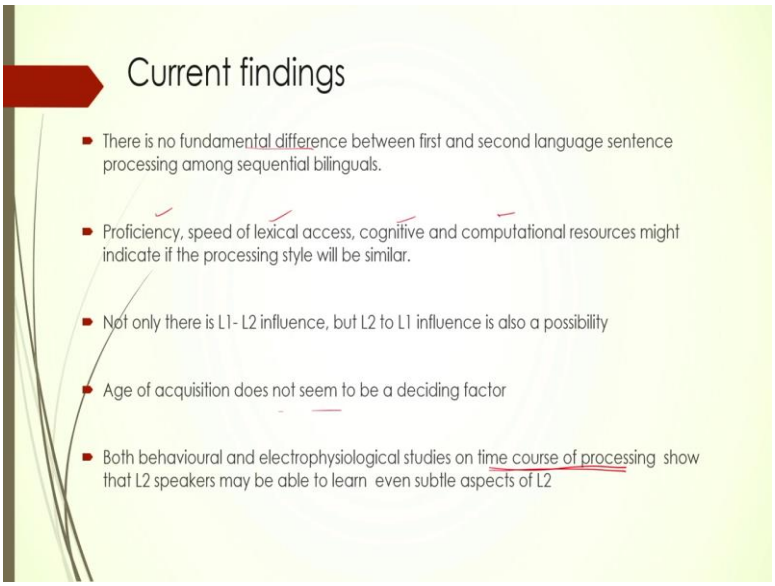


Of course, it is difficult to talk about all the studies in this domain. There have been in initial stages we found a lot of studies the reporting the impact of L1 on L2 sentence processing. However, of late the findings have there have been lot of varied findings to put it simply.

So, now, where as we as things stand we you can say that there are no fundamental difference between the first and second language processing strategies in case of sequential bilinguals also, because sequential bilinguals are the target because they learn their L2 later.

However, we do not see actually the not much of a critical difference and whether the difference will be there or not are based on certain factors. So, if we control for those factors probably the strategy and the strategies of processing will be similar. What are those factors? Proficiency, speed of lexical access, cognitive and computational resources and so on.

Some studies have found they have reported L1 to L2 influence. However, the opposite is also true. Age of acquisition does not seem to be a deciding factor anymore. And of course, both behavioral and electrophysiological studies on time course of processing. ERP shows gives us a very good output in terms of time course of processing and they show that L2 speakers may be able to learn even subtle aspects of L2.

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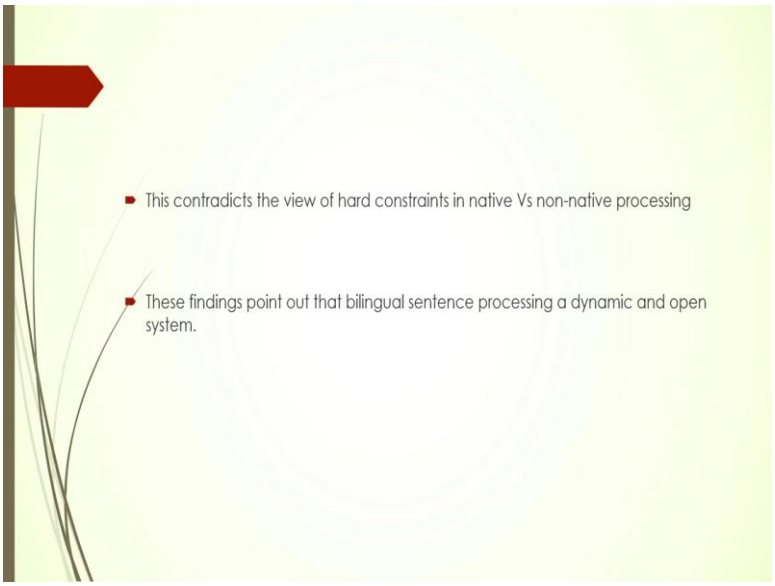


So, basically the take home point here is that there may not be much of much constraints, hard constraints in terms of native versus non-native sentence processing strategies. So, there this is a dynamic process is what we have finally we can say in terms of sentence processing.

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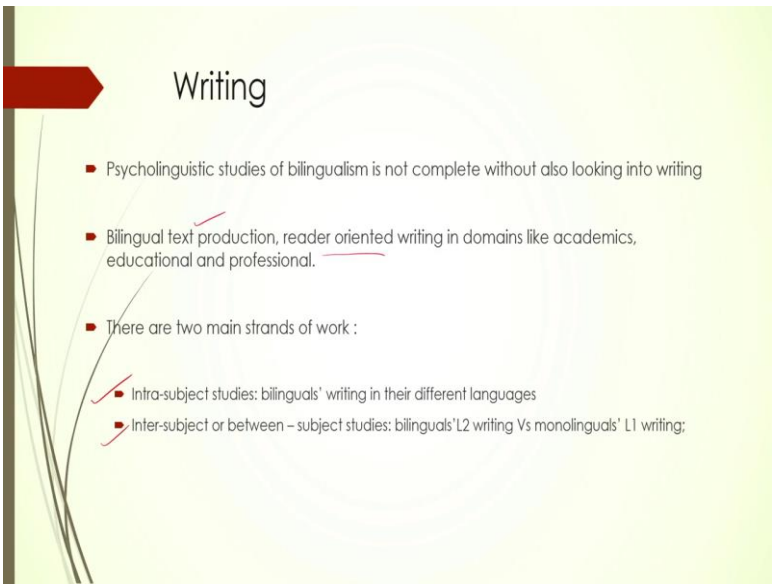


So, this segment we will complete with a very short and description of the writing processes. So, far we have been looking at reading or producing. So, either comprehending or producing sentences.

Now, writing is also a kind of production activity. It is not it is not a verbal activity, but it is a different method, but production alright. So, as a result of which we need to take into account the writing as a process as well. So, typically we look at bilingual text production. Bilingual text productions are those that are only those texts are considered which are reader oriented.

So, the writing that is meant for another person. The and there is a reader in mind and keeping in mind which so, basically academic writing, educational, professional writing and so on. So, those kind of writings by bilinguals are what is studied in this domain. So, there are two main strands of work when we look at writing strategies and the processes that are part of writing in case of bilinguals.

There are two different types; one is called the intra-subject studies. Intra subject as in within subject for the same subject. So, how the same subject, same bilingual person writes in his L1 versus his L2, are there differences in terms of different mental mechanisms involved, different strategies involved and so on.

The other is the inter subject or between subject studies where bilingual's L2 writing versus monolingual's L1 writings are compared. For example, to give you the same example again. So, my my writing in English language will be the strategy will the strategies be the same as an a monolingual speaker of English language writes. That is what is the in inter subject or between subject studies method.

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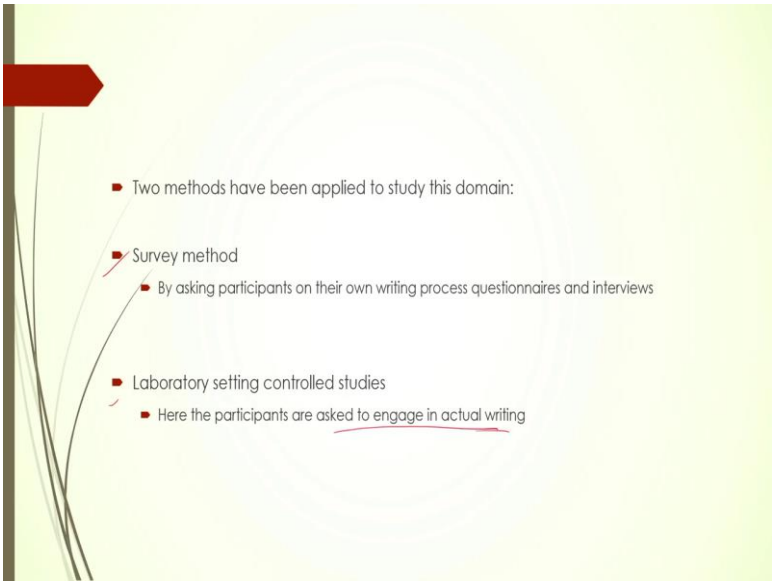

This is not a very old domain. So, there are studies that have taken place that are comparatively fewer studies, but those studies have different kinds of methods applied. These are survey method and laboratory method. Survey method is the one where you ask questions.

So, questionnaires are filled up or interviews are taken and that kind of a method, that is called survey method. And this also has laboratory setting in controlled studies where participants are asked to engage in actual writing. So, the participants will be given different kinds of cues, a different kind of settings and they have to actually write. And depending on that we get our data.

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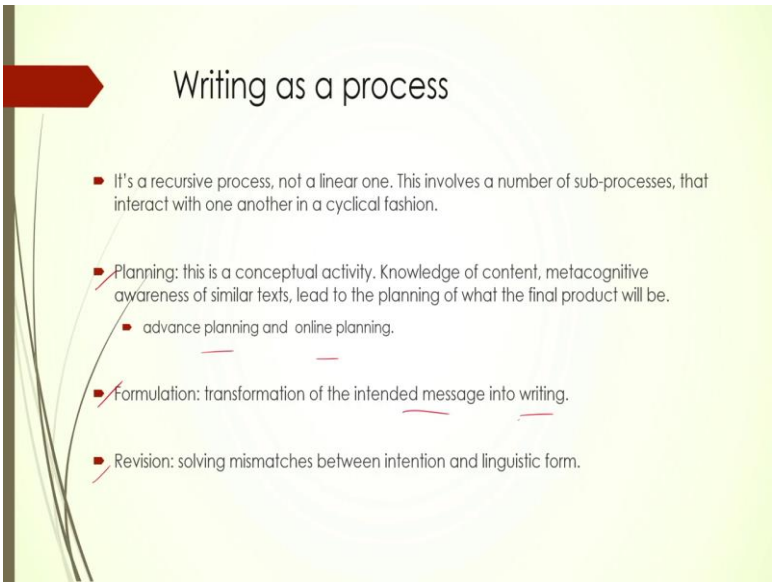


So, writing as a process, let us break it down. What it means, what is the process all about? This is a recursive process, writing in a recursive process its not a linear one, ok So, this involves a lot of sub-processes, however, it is a cyclic thing. So, when you write even though it is possible to break it down into three parts like planning and formulation and revision, it is not a linear process. Because when you plan, what does planning mean in terms of writing?

Planning means the conceptual activity, the idea, the thoughts, the concepts that will go into finally, the end product. So, the thought and the how you will match it to word and this will be a finally, put on paper. That is the first process planning. But planning even

though as anybody who has written a couple of sentences of original writing will know, will tell you that you can plan, there is advanced planning always.

However, sometimes we also plan on the go, online. As we write, continuously we are also planning. So, planning also is of two types advanced planning and online planning. And then formulation, this is the part where transformation of the intended message into writing happens and then revision. Revision as in whether you have been able to have a proper match between the intention and the output. Typically, it does not like if you have if you know about authors, this revision is a long process.

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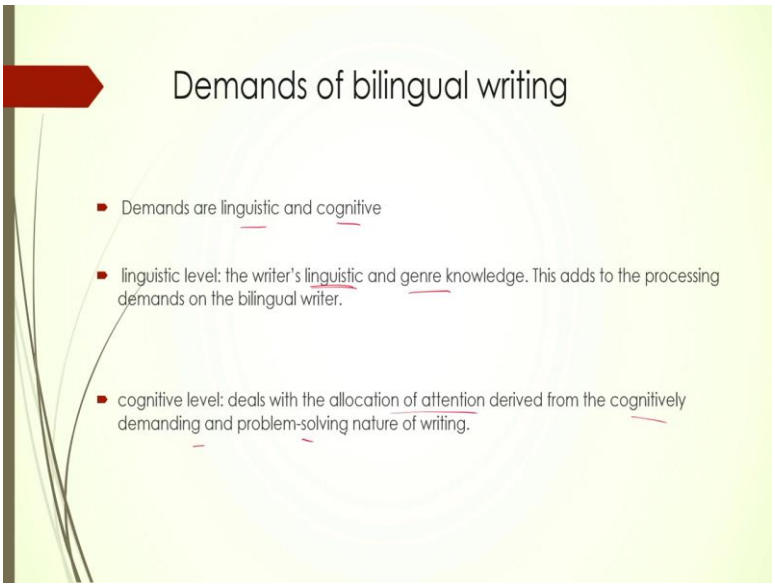


They often do not find the match proper and then they start over again. So, this is a cyclic process.

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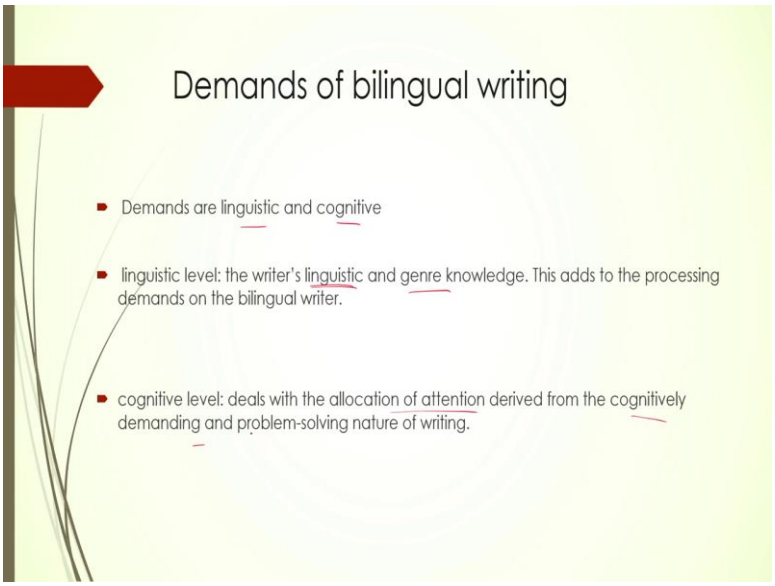


Now, demands of bilingual writing, when you are writing in a bilingual, the demands are of two types, the linguistic and cognitive. Now, the demands on linguistic level is basically the idea about the knowledge of the language that is linguistic knowledge and the genre knowledge.

Now, this adds a lot of demand to the to the writer because if any writer who writes has to be careful about what language to use, which will fit that particular genre. So, you cannot write in academic writing, you cannot use a language that is used for informal purposes and so on. So, those kind of demands are there.

At the cognitive level, the typical factor that has been studied is the allocation of attention. How much of attention is given to which part of the writing? So, this is derived this allocation of attention derived from the cognitively demanding and problem solving nature of writing is the other aspect of the demands.

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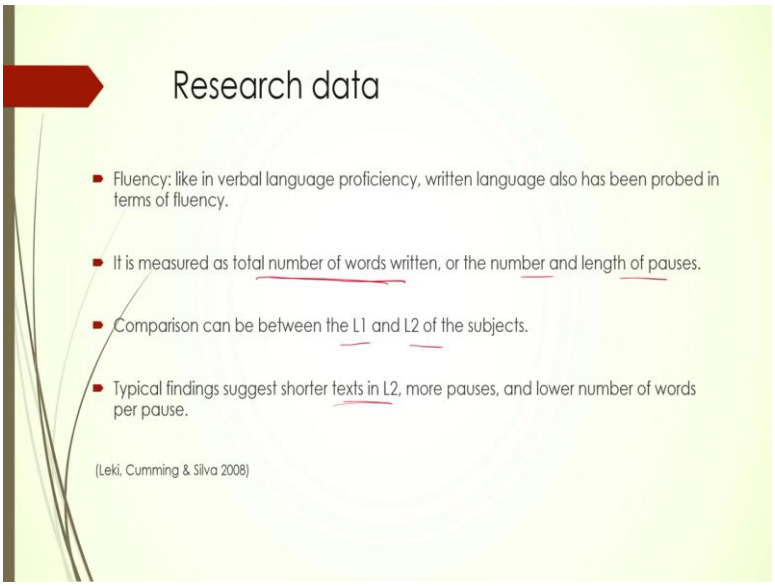


So, research typically looks at various measures. So, one of them is fluency. Like in for verbal language processing, we have looked at the idea of proficiency and how proficiency is measured also in terms of age of acquisition and so on. So, similar kind of verbal, similar kind of proficiency is also probed in case of writing research. So, how is it measured? In this case, it is measured as total number of words written.

Let us say how many words you write in 5 minutes or something or per minute, that sort. And then or the number and length of the pauses. So, how many pauses you take and for how long and comparison can be made between the L1 and L2 of the subjects. So, typical findings will suggest that shorter texts in case of L2, more pauses and lower number of words per pause as opposed to the L1, which is almost understandable.

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And in terms of attention allocation, the text generation is a process in both monolingual bilingual writing, where it is the process of transforming ideas into language. So, how much of text generation happens within a particular time frame is what is looked at here. So, findings typically suggest that bilinguals spend more of composing time in generating text.

So, 50 percent of composing time is used by monolinguals for generating the text as opposed to up to 80 percent by the bilinguals. Similar results were obtained in intra subject studies too. So, there were studies on Chinese scholars who are writing in English and they also found the similar kind of effects.

So, when they are writing in English, the time spent of composing time spent on actually creating the text was much longer. And in fact, they also found that and I quote, it makes it difficult to make claims about their research with appropriate amount of force. So, all of these are intertwined factors and they take they make bilingual writing an interesting domain.

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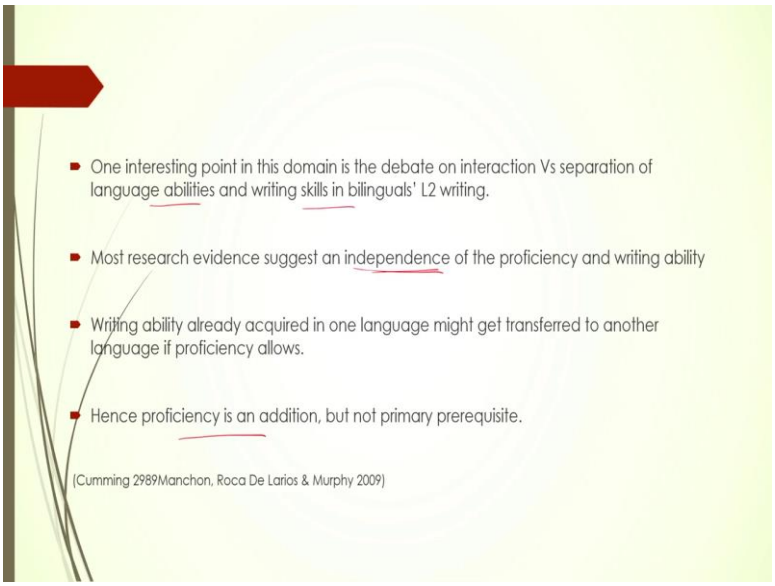


And another one interesting point in this domain is the debate on interaction and versus separation of language abilities and writing skill. So, how much of writing skill is based on language skills? Is it an entirely a matter of language skills? Do they interact and we say keep them separate as two different capabilities? That is another area of debate. So, a lot of research evidence suggests that an independence of proficiency and writing ability, ok.

Writing ability, if one person has writing ability already in their L1, that ability probably will be transferred to L2, given a certain degree of proficiency of course, but proficiency alone cannot guarantee better writer, guarantee, you know, production in terms of good writing, better writing in L2. So, if somebody is high proficient in L2, however, the person does not have any writing capacity even in L1, then suddenly he will not become a good writer in L2. That is what the finding suggests.

So, proficiency here in this case is just an addition, but it is not a primary pre-requisite. So, writing skill, most of the research in this domain, they differentiate between writing skill and proficiency. Proficiency is a is an is an editing as an adding additive, let us say, it is an addition, it is good to have high proficiency, but writing skill is something completely different.

So, this gives us some idea about the domain of writing as well in a nutshell. So, to say. So, with this, we come to the end of module 6, where we have looked at language

processing in terms of both at word level and as well as sentence level; in terms of both in terms of visual and auditory word language processing as well as writing. So, this is in a nutshell, the entire idea of bilingual language processing.

Thank you very much.