Bilingualism: A cognitive and psycholinguistic perspective

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Module - 03
Part - 03
Lecture - 08
Bilingual Memory Models

Welcome back. We are now at Part 3 of Module 3. In this part, we will look at various Bilingual Memory Models, as in, what is the relationship of language in terms of bilingualism with respect to memory, human memory system, what are the different ways of understanding this, what are the various parts of this interaction, what are the various models that is what we will look at.

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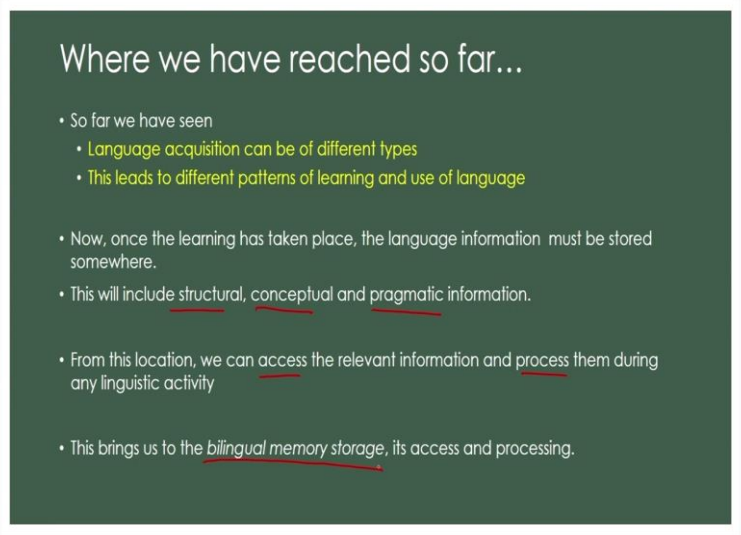

So, a quick recap here, where have we reached so far. So, we have seen that language acquisition can be of different types: successive and simultaneous. So, two different kinds of second language acquisition is possible and keeping in mind the type of acquisition it has been, the nature of that second language representation can also be different, there are different patterns of learning, different patterns of usage and so on.

So, there are lots of differences in terms of the type of second language acquisition or type of bilingualism, bilingual acquisition that has been that has taken place. Now, once

that learning has taken place, we have already looked at the learning part. Now, what happens after that? Once we have learnt, this entire knowledge system goes and sits down somewhere, right? So, it needs to be stored in some sense.

So, this information about the language must be stored in some place. So, this what will this storage include? This will include a lot of things, lot of information. For example, it will include structural information, it will include conceptual information, pragmatic information and so on.

So, we have seen already, structurally we mean the grammatical information or the lexical information and how the words can combine and so on. Conceptual of course, leads to the mental representation of the meaning aspect of language and then of course, pragmatic information, pragmatic information about the usage.

So, all of these different types of information is what we actually acquire. When we say I have acquired a second language and a third language, this is what we acquire, this is the if we break it down to into it is parts, these are the things that we acquire and once we have acquired it goes and sits. Sits in a place, there is something of a storage system there.

Now, once it has gone there, once it has been stored in a particular place we, of course, it is not that it goes and we forget about it. So, the way it is stored is very crucial, right, how it is stored and how we can access that information whenever we need. So, when in a bilingual scenario, when we code switch and code mix all the time, what happens is that all this all this parallel information are stored and we can go back and forth between them all the time. So, we access that information in the course of a conversation.

So, this access to the storage should be and is to be understood in a very well-defined manner. And, then not only we access we also use them, so, process them. Why do we need to access? We need to access that information for two things. One is when we understand or comprehend somebody else speaking, second when we speak ourselves. So, both for comprehension as well as production, or articulation as we are more familiar with, both of these kinds of processes needs to access this storage information.

So, this entire background basically now takes us to what is called bilingual memory storage. We have already seen that bilingual storage should include the structural

information, conceptual information, pragmatic information and it will the same as same kind of information which would be needed for both the languages and if there are three languages similarly another language.

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So, bilingual memory storage, how it is accessed and how it is processed. This is where we are now and this is where our journey begins today. So, memory; before we get into bilingual memory, let us quickly understand human memory system to in very brief. So, memory is something that we all are the word we are all familiar with.

For example, I have written here the familiar smell, a flower or something any very small trigger can bring back you know deluge of memories from your past, from your childhood, from a particular incident that must have happened somewhere or you know all these kinds of things we are very familiar with it.

So, what it basically happens what it basically means is that for example, a familiar smell may trigger an entire event or even an entire period of your childhood or not necessarily childhood by another time in your life, let say 10 years back, right. So, this is what we mean by memory.

So, this particular trigger takes us back to the storage system where we have kept all our memories intact. So, that is what it awakens. It awakens memory and in terms of in scientific term we call this long term memory; long term memory is a memory, part of

the memory system that has been that is more of a storage system, as we will see shortly or more precisely we call this explicit memory.

So, you see already we are beginning to complicate things, memory is not just one thing there are memories, that is not a one memory.

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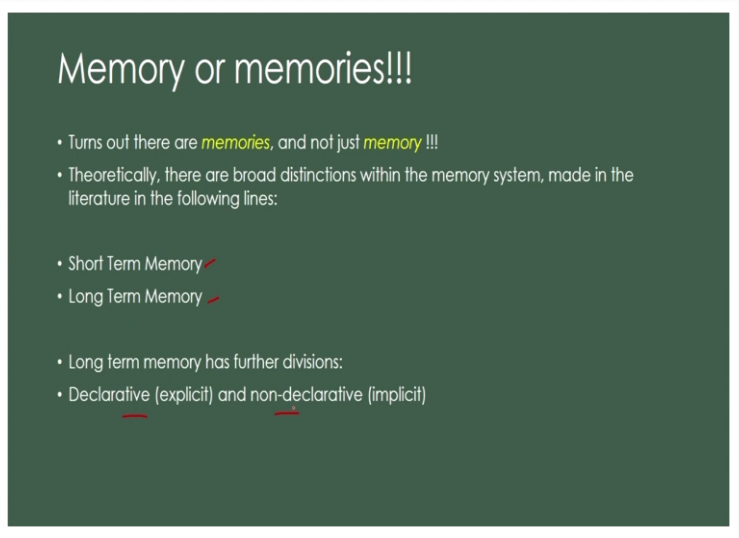

So, turns out there are memories and not just a memory, ok. So theoretically, in terms of psychology cognitive psychology there are broad distinction between how many types of memories we have, what are the you know the smaller aspects of it and so on. So, broad distinctions are between two, the short term memory and the long term memory.

And, long term memory has even further divisions declarative versus non-declarative memory. So, we already have seen that there are two kinds of memory system: one is long term memory that I was just mentioning the things that have been you know that we have kept on adding up and the that is a big storage of things, information and that includes all ours of information and experiences that is long term memory and short term memory is short term memory. We will see shortly what it is.

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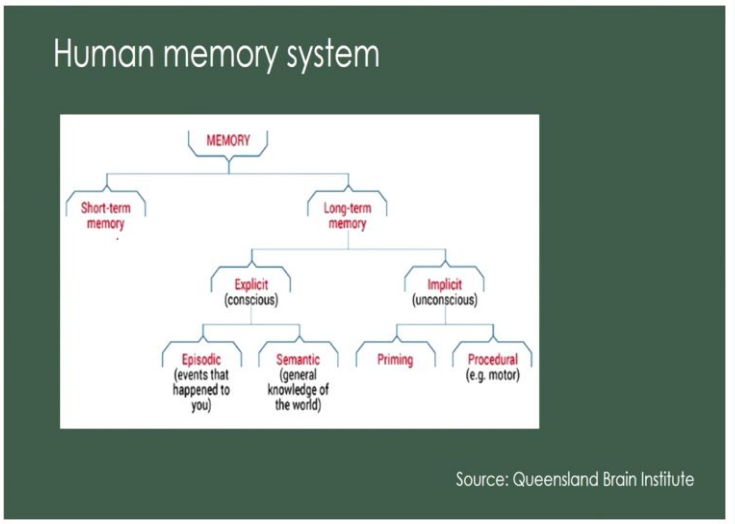

So, this is a simplistic representation of the human memory system as we have just said. So, there is memory and it has two broad distinctions between short term and long term and then long term again has explicit and implicit and again, they have their own divisions.

A good way of understanding memory is let say the banking system. All of us have bank accounts. So, there are two at least two kinds of deposits that you have. One is what we call the savings account and another is typically what you call term deposit, recurring deposit various kinds of deposits.

Now, what happens in deposits is, various types of deposits, you keep adding money to that. So, there is a storage of money that is there and that of course, increases over a period of time in interests and this and that. So, that is a corpus sort of sort of so to say. On the other hand, you have a savings account.

Savings account is typically what we all the time use for our daily expenses, paying the bills to buying vegetables and so on and so forth. So, that is let us call this the short term memory. This is something that is being used all the time. It is here and now, right. This is the one that is at your hand all the time.

Long term memory is some somewhat like those deposits that is there. That is there on over a period of time various kinds of interest depending on how many types of deposits

you have, different kinds of interest will accumulate and that will you know get into divers, it will be diversified into various types of long term deposits. So, this is somewhat like that. It is easier to understand in this way.

Now, long term memory again has like explicit versus implicit memory and then explicit has episodic and semantic and then implicit has priming and procedural.

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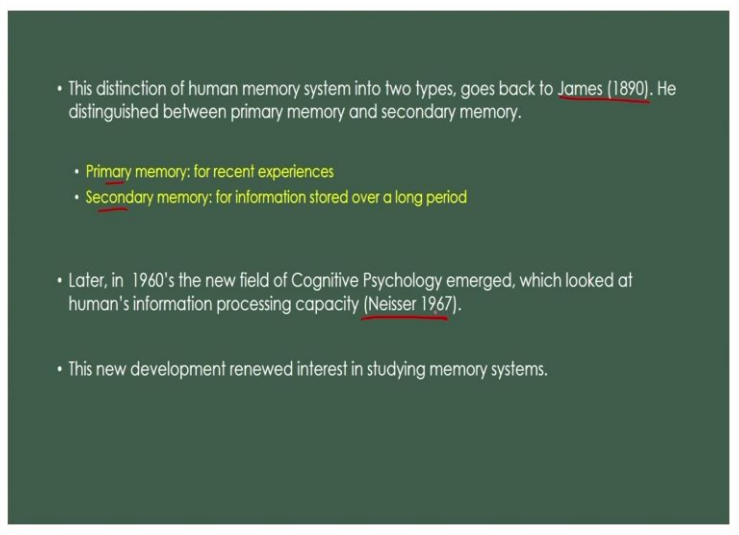

So, the distinction between these two types of memory systems, it goes back a long way. Pretty long way you as we see started with James 1890 in the writing where he first distinguishes between the memory systems into, he calls them primary memory and secondary memory.

So, the primary memory is for recent experiences; something happened that happened just 2 hours back, something that happened half an hour back, that is primary memory, recent experiences. And, secondary memory he calls for information stored over a very long period – over a long period, from your childhood till today the kind of information you might have stored somewhere back of your mind, is what the secondary memory was.

Later, much later actually as you see a 1960s was the time when cognitive psychology as a new field was shaping up and this is when this field was looking at human mind's information processing system as in how do we process information in, what are the

different types of interaction that information has with the storage system and so on. So, this brought the memory system again into focus.

So, this primary we owe it to Neisser, 1967. Neisser who looked at this for this particular aspect in a new way, starting with you know cognitive psychology perspective. And, then as a result, a lot of new studies new areas emerged and new way of trying to understand the human memory system also started.

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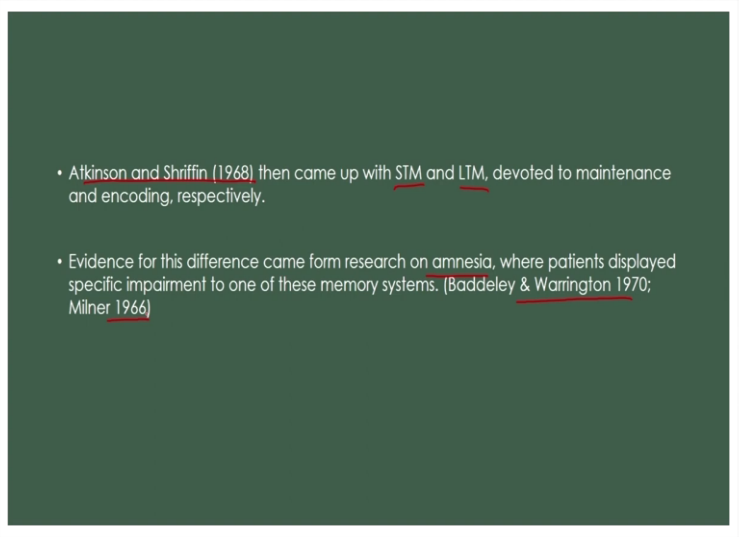

Around in 1968, most of the memory models go back to Atkinson's and Shriffin’s 1968 model of the human memory system and then he called it, as opposed to the as opposed to James, he called them short term memory and long term memory. This is short term memory and this is long term memory. So, he called them short term memory which he was he James called primary and secondary became long term memory, but the idea remains the same.

Most of today's memory models go back to Atkinson and Shriffin’s model, though there have been many changes many new additions and readjustments of various things, but the basic model still remains indebted to this 1968 model. Now, one might think what made them actually go for this kind of a division. Why do we really need two kinds of memories.

Turns out, there were a lot of research around late 60s and the a lot of research specifically on amnesia showed that in amnesia what happens that there is you know one kind of memory can selectively get disrupted. This is what the findings of that time showed and as a result this gave a lot of evidence. There were many studie,s two most well known ones are this one, Baddeley and Warrington 70 and Milner 66. There are many others also.

So, they found out that in case of amnesia it is not necessary that entire memory system will be disturbed at the same time. That is there is a possibility of one kind of memory getting selectively disrupted and this is what gave a lot of you can say incentive to studying the memory system in terms of two types of memory storage again.

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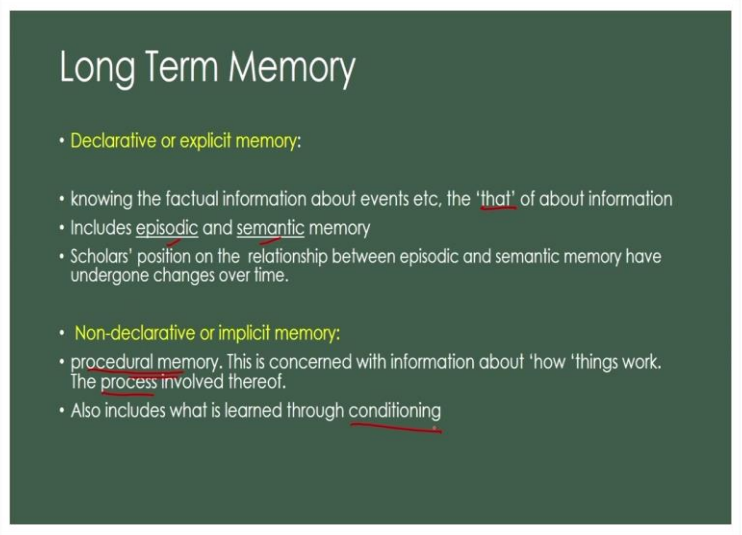

Now, that we already have long term memory, short term memory all of these things in place, let us look at them as slightly in slightly more details. So, long term memory has as we have already seen declarative or it is also called explicit memory and there is non-declarative or implicit memory.

Now, in declarative memory, this storage is basically about the information, about any event or anything for that matter any kind of thing including language. So, 'that' as many many papers have many books have called it, 'that' part of the information. So, what happened after that; what happened; how did you feel about that; where did it happen.

So, the information structure about various events that is what goes into declarative memory. And, now, declarative memory has two kinds again: that is episodic memory and there is semantic memory. We will see each of them one by one. Now, episodic memory and semantic memory were considered to be different and bifurcated.

However, recent findings show that there probably is a lot more of give and take between these two than we previously thought. But, nonetheless there are still some differences that remain and we will see that. Then we have non-declarative or implicit memory. Implicit memory is more focused on procedural memory.

So, 'how' the things happened? The processes that were part of that information. So, 'what' goes into declarative, 'how' goes into the non-declarative part. So, this is concerned with information about how things work, the processes thereof and so on and also information that are processed through learned through conditioning of various types, right.

So, those priming and conditioning, these kind of methods when you learn something through these methods, that information goes into our implicit memory.

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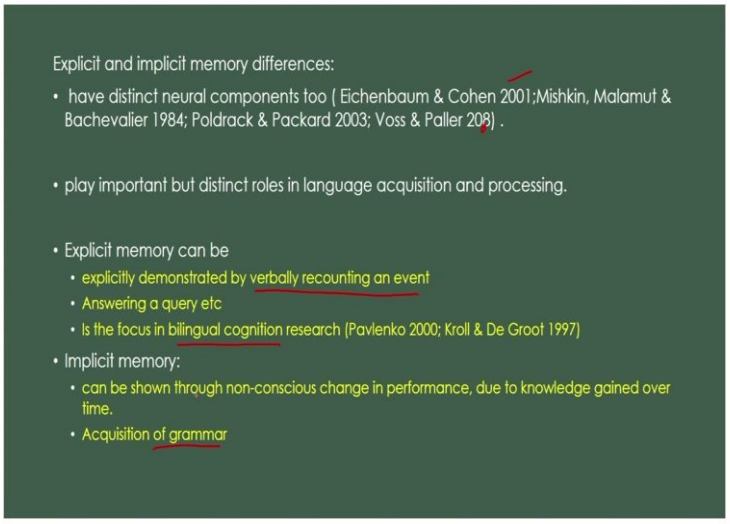

Now, there are some interesting differences that have come up, of late. There is one interesting difference comes from the neural components. So, explicit and implicit memories have different, distinct neural components. These are recent comparatively

recent findings. This should be 2008. Also they play in the distinct roles in terms of language acquisition and processing. So, we are more interested in language.

So, in terms of language acquisition both acquisition and processing, the different types of memory like declarative versus the non-declarative, also have distinct roles. So, explicit memory can be, in terms of language, it can be demonstrated when we verbally recount something, as you as you narrate something that this happened and then there is a whole narration verbally.

So, this is the connection between it can be verbally explicitly demonstrated. Answering a question and this is also why a lot of bilingual cognition research actually has been focusing on the explicit memory, both semantic and episodic. On the other hand, implicit memory, remember we talked about conditioning, learning through conditioning. So, that is where the learning of grammar comes in. So, acquisition of grammar has been often attributed to implicit memory.

So, this is basically because implicit, the very name suggests that it is not explicit. You cannot see. It is more difficult to demonstrate, right. So, how do we see? How do we judge? How do we check or experimentally speaking, how do we evaluate implicit memory? Typically through non-conscious change in performance.

So, there are experiments that are designed to check, over a period of time, as to how new knowledge has made has translated into differential performance over a same task. So, that is how implicit memory is typically checked, right. So, we have already now the basics in place, declarative versus non-declarative.

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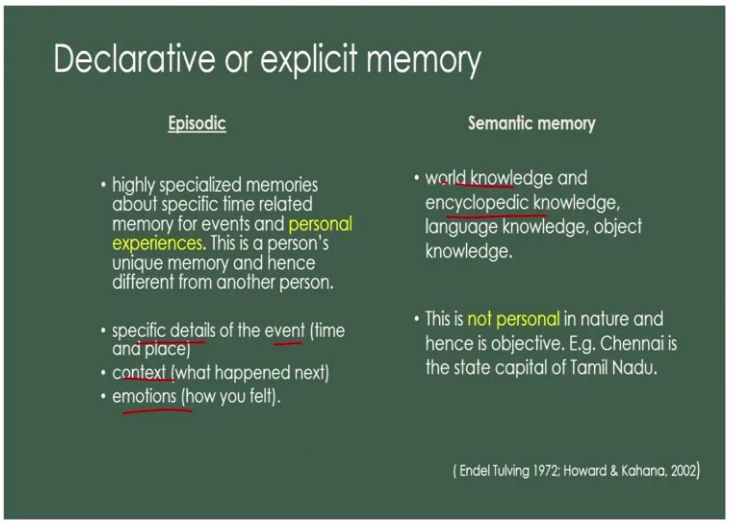

And, now we will see within the declarative memory as we have already mentioned that episodic and semantic memory are the two types within declarative memory. And both of these are heavily studied there is a lot of research going on in terms of each of these memory system's contribution to language acquisition, function, processing so on and how are they what are the interactions between them.

So, episodic memory is the highly specialized memory about specific time-related events memory for events and personal experiences. So, episodic memory, more often than not, talks about the entire gamut of information that you might have about a particular event in the past.

Now, this event in more often than not has a personal nature to it, it is subjective, subjective information something like your childhood. You know the kind of school you went to, what all happened there – these this entire gamut of information is part of what you call episodic memory.

In fact, there is one aspect of episodic memory which is called autobiographical memory, that is also there. But, we are now going into all of that details. The basic idea is that episodic memory deals mainly with a person's individual, unique experiences and that is why each person's episodic memory could be different from the other person. So, it also includes specific details about the event, time, place and the context and the emotions and so on.

So, first time when you learnt to drive what happened? First time when you hire a new cycle what happened? This is not the same for one for everybody there are different kinds of different layers of emotions and contextual information are there. So, that is all of them go to episodic memory.

Semantic memory on the other hand is more objective knowledge about the world. Both are different types of knowledge; subjective knowledge is also kind of knowledge. Semantic memory talks about objective knowledge, things that are there in the world, right. So, world knowledge, encyclopaedic knowledge, knowledge of language, knowledge about objects and so on.

For example, Chennai is the capital of Tamil Nadu, that information is objective information. That is true for everybody, it is not subjective. So, similar things they all go into semantic memory. So, this is as a result not a personal story, this is not a personal unique memory story. This is something quite common for everyone.

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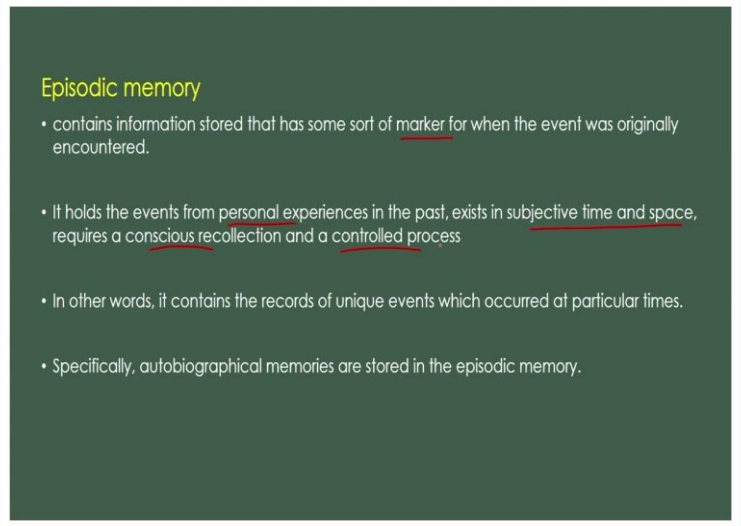

So, this is the primary difference between episodic and semantic memory. So, let us go at slightly more into detail, what we have already said. So, this contains information stored that has some kind of a marker for when the event was originally encountered. So, all the markers actually, markers about what we mean by marker? Marker is all the pointers.

So, the people involved, in the event itself, the context of the event, the emotions that were felt and you know what happened after that all of that. So, personal experiences in the past exist in subjective time and space, and requires a conscious recollection and controlled process ok. So, this is a conscious part of it that is why this is part of explicit memory and it needs a controlled access to it.

So, basically it contains the records of unique events which anybody, any individual encountered in a particular time. So, and as I had just mentioned autobiographical memories are also part of the episodic memory.

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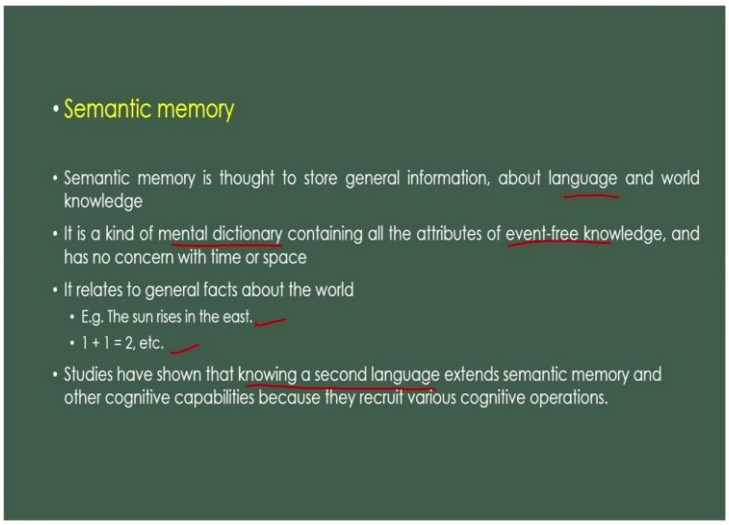

Now, we will go to semantic memory. Semantic memory is thought to store general information as we have just seen. It can be about facts of the world, information about various things; for example, that the parts of a computer for example, or this screen for example, that the knowledge about this exists already. It does not depend on personal interpretation. Nobody, no individual's interpretation is important there. So, it exists as world knowledge. So, that kind of information.

Information about language, all of that goes into. So, it is a kind of a mental dictionary ok, containing all the attributes of event free knowledge. So, what does event free knowledge mean? That this is objective this exists even without anybody else's interpretation or having anything to do with time, space, person, nothing. No context, it

is context free information. So, some of these are like this. These are all context free information they remain true what wherever they are.

Now, the relationship between semantic memory and second language acquisition has been studied, given various kinds of parameters. So, one of them is that they have shown that learning a second language and knowing a second language, extends semantic memory and other cognitive capabilities, because primarily because they recruit various kinds of cognitive operations.

We will see them towards the end of the course when we talk about the result of or the effect of, speaking more than one language, what are the cognitive effects that is. So, that is where we will come back to it in more detail.

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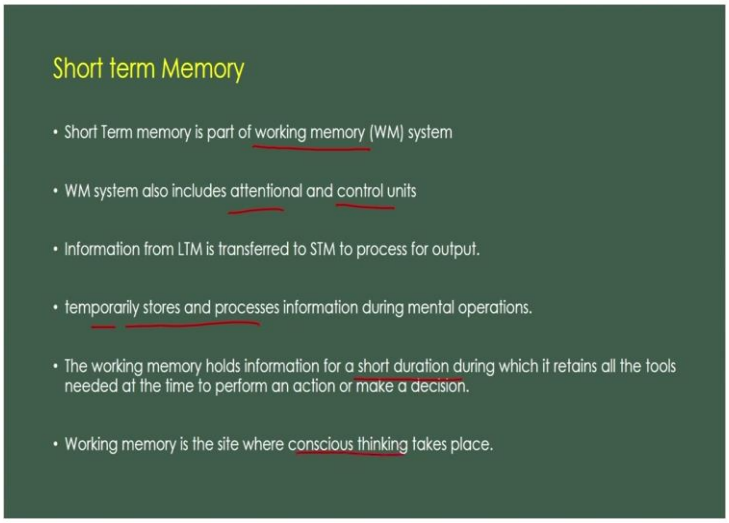

Now, let us go on go to short term memory. Now, short term memory is as I said, the savings account that is something you are using all the time and that is exactly where a lot of our language processing also happens. So, things that are part of our in a conversation for example, there are two three conversation partners.

So, I have to anybody who is talking in that context, must keep in mind the other person's point of view, the facts and you know objective stated by the other person in order to incorporate them in my part of the conversation. So, that is so, we are constantly updating and recalibrating basically, through our own understanding about processing,

be it comprehension, be it production. So, that bit of language processing is dependent on short term memory.

So, short term memory is part of what is called working memory. Sometimes short term memory and working memory are used interchangeably; however, there are subtle differences. Now, working memory also includes attentional and control units and that is why it has become a rather interesting domain of study, as to how language attention and control mechanisms are connected and how they can be, how they manipulate one another.

These are again this is another domain that I have discussed in my in another course. So, this is what brings us to short term memory and information from long term memory is transferred to. So, this is something like a transit house sort of a thing. So, information that are there in long term memory are shifted to short term memory, to be processed given a particular kind of task or condition or whatever kind of context.

Similarly, information that you are collecting through your sensory apparatus for the initially are stored in the short term memory and gradually they are shifted to long term memory. So, that is what basically short term memory and long term memory connection is.

So, this temporarily stores and processes information during mental operations. Either where you use when whatever information we are using right now is considered to be present in the STM part. But if you do not need them then they are pushed back to LTM. So, that is what.

The working memory holds information for a short duration, during which it retains all the tools needed at that time to perform an action or make a decision. So, this is not only about language, but about any other kind of action. And, this is the place where also where conscious thinking takes place.

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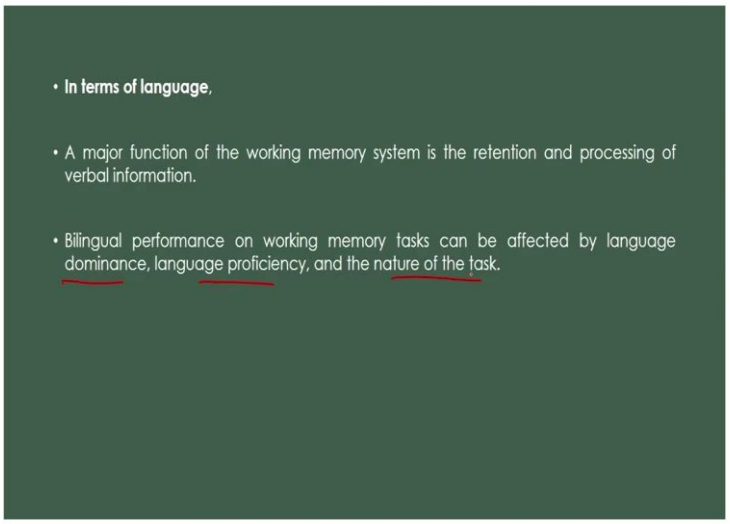

Now, in terms of language, a major function of the working memory system is the retention and processing of verbal information as I was just mentioning. Now, bilingual performance and working memory task can be affected by various factors. So, language dominance, language proficiency and the nature of the task. Let us just stop here and let's see what we mean by language dominance.

For example, a bilingual who has learnt the second language much later, we have already seen that if you learn your second language in childhood versus in adulthood, there are differences in your language competence, the how well you have learnt the language.

Now, another angle to this is the idea of language dominance. What happens is earlier the belief that was held was that L1, that is the first language is the stronger language. It also has larger vocabulary, you are more proficient in it, you are and also the L1 dominates L2, because your L1 most probably will be the one that you are using most of the time. L2 has a shorter domain of usage, that is the idea of dominance. So, what which language dominates your daily usage.

However, that may not be always true. Often what happens you change the context, you change the lifestyle of a person. Let say one moves from rural to the urban setup or you know you name it in a small town from a to a cosmopolitan town and so on. What happens is that chances are very high your L2 might be dominant. For example, many of us hardly get to use our first language.

So, more most of the time we will be using because the work condition demands that we use English most of the time. So, as a result it is quite possible that based on context, based on various other factors, lifestyle factors, either L1 or L2 could be dominant language. So, that is a very important aspect that shows its impact on language processing. That is the idea of language dominance.

So, just because the L1 was learnt first and L2 was learnt much later, but if during the course of time, during the course of your life your L2 has gradually become more dominant this will show in the experiments, all of which we will see. Language proficiency is straightforward enough, that which language you are better at. More often than not we will know our L1 better than our L2, that is pretty straightforward.

However, exceptions to this also are they also exist and then third is the nature of the task. The kind of experimental task that the subjects are put through, bilinguals take part in, on that basis also it differs. So, there are all these kinds of parameters on which bilingual performance on working memory task can be different.

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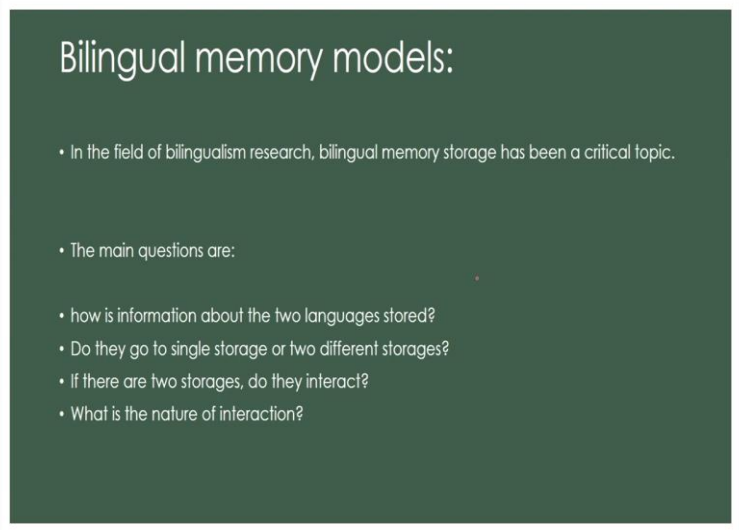

Now, let us now move on to our main agenda in this part, that is the bilingual memory models. Now, if bilingualism research for quite some time now, bilingual memory storage has been a very critical topic as we as we have started this part asking where do the information go. Does it all go into one storage? Does it all does it go in a bifurcate into two storage systems? Do those two storage systems talk to each other or do they

not? If they do talk, then what is the nature of interaction and all of that. So, that is what bilingual memory models are all about.

What exactly is happening in the brain, because these are all abstract things. There is no way you can you know see it, visualise it. There is no way to demonstrate it except through indirect methods. So, there are various kinds of experimental studies have taken place and on the basis of which various memory various kinds of memory models have been proposed.

Due to brevity of time we cannot discuss all of them, but we will just look at the most well known ones and the most landmark ones and also the experiments that trigger them.

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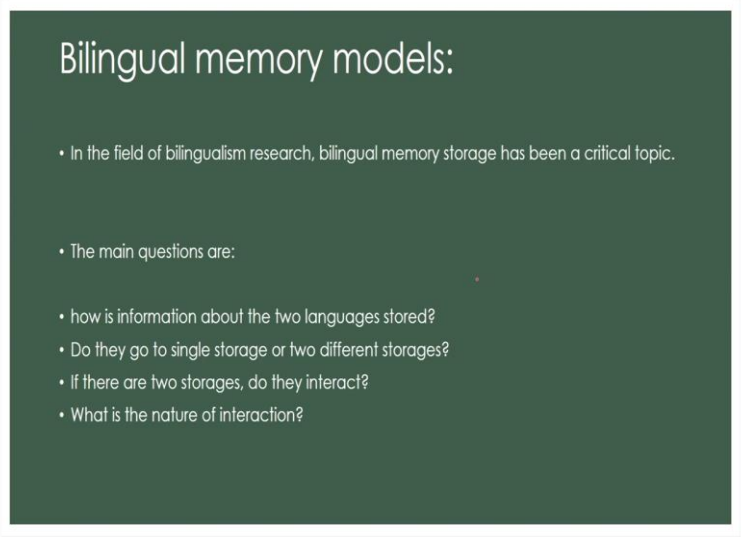

So, these are the main questions that are needed to be looked at.

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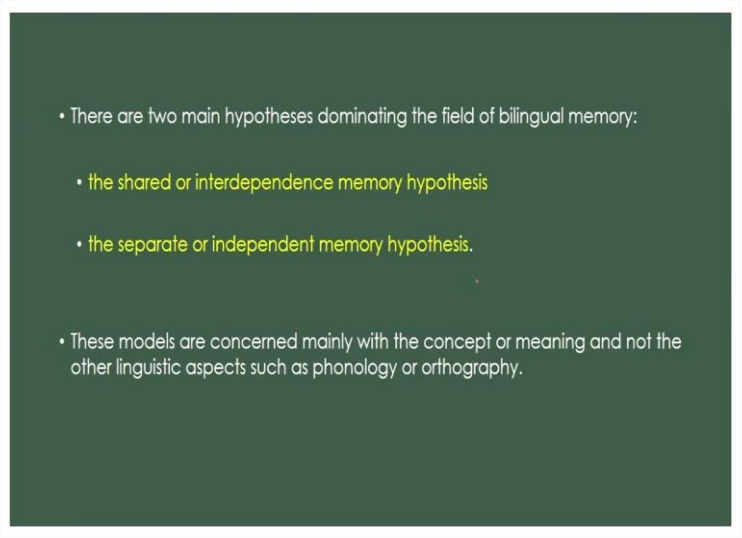

Now, depending on how you look at it, there have been initially, starting wit,h two different kinds of hypothesis two main hypothesis dominating the bilingual memory research. One theory says that the memory systems are shared, meaning that L1 and L2 go into the same house. So, they go to the same place.

The other theory says that, other hypothesis says that, the separate or independent memory hypothesis. So, interdependent versus independent, shared versus separate memory. So, these are the two first two differences that were projected, that were proposed way back.

Now, these models are basically concerned with the concept of meaning and not the other linguistic aspects such as phonology, orthography. Those things were are also now of course, newer models have taken them into account, but it is when it started the idea was to check where do the concepts go. Do we you know L1 teaches us some sort of some set of concepts, L2 teaches us a separate concept or what happens. So, initially this was the idea.

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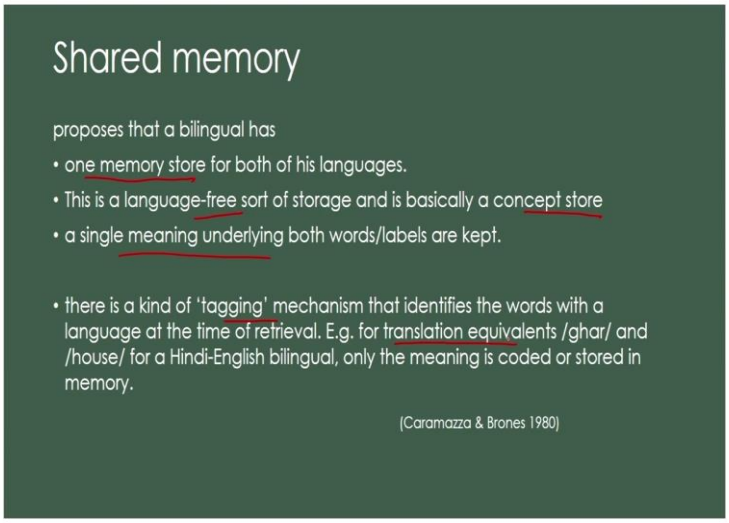

Now, shared memory the main points of shared memory hypothesis is that, there is one memory store for both of the languages. So, you have learnt let's say for a Hindi, English bilingual you have learnt the word 'ghar' and then the word the grapheme and the phoneme of the of the concept is at one level, but at the conceptual level you have an idea of what 'ghar' represents.

So, when you learn English and you learn the word house, you do not need to create a new concept for house, you already have that. So, this is what the shared memory hypothesis talks about. So, this is a language-free sort of storage language free as in this is an objective storage system. So, whatever concepts you are gaining from language one and if there are overlaps so, then there is no need to learn them again. So, basically this is a sort of a concept store. So, depending on the various kinds of inputs you create.

So, a single meaning underlying both words and levels are kept. So, single concept. So, the concept representing both 'ghar' and 'house' are the same, right. So, this is what the shared memory hypothesis talks about. And, then of at the concept level this happens and then there is a kind of a tagging mechanism that identifies the words with a language at the time of retrieval.

So, when we have to let's say we are when we have to comprehend one particular language or we have to speak in one particular language, that concept gets tagged with the language-specific the word and then then that is and then the next process follows.

So, this is the idea. So, the translation for translation equivalence this is called translation equivalents. So, house and ghar are translation equivalence meaning they are translation of one another. So, in this case for any kind of translation equivalence only one memory or conceptual aspect is stored in the memory.

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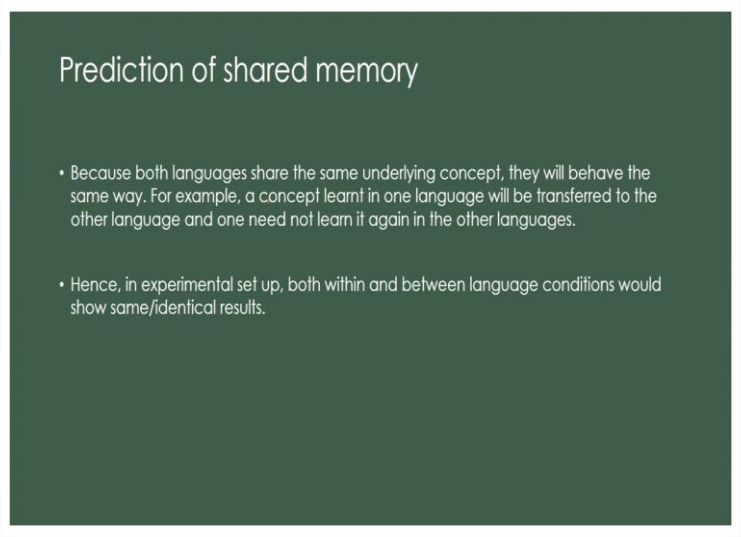

Now, if that is the case what would that predict? Every hypothesis would predict something, right. If this is what happens if this then that is what that is how the all kinds of this theory is go. So, if you have a shared memory what should happen? So, the prediction is that because both languages are sharing the same underlying concept, they will behave the same way if there is an experimental setup to check them cross linguistically.

For example, a concept learnt in one language will be transferred to the other language and one need not learn it again in the other language like this like the ghar and house concept I said. So, if you have let us you just heard the word ‘ghar’, your concept for ghar is activated and then another and moment later I hear the word house you do not have to work very hard that concept is already there you automatically recognize the word ‘house’. So, that is what it means.

So, if there is the same single storage, in experimental setup, both within language or and between language conditions will have same result.

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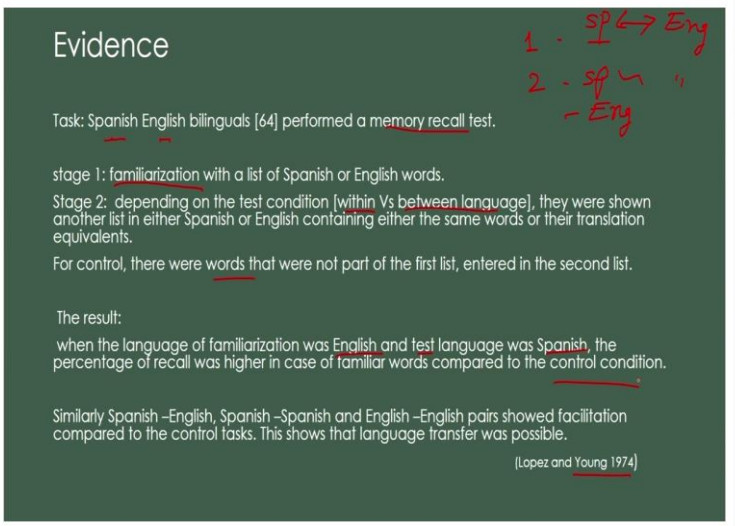

Now, what does this within language and between language mean, we will see now. I will be talking about only a couple of experiments because talking about all of them is out of scope here. So, the first evidence we will talk about is a very well-known study by Lopez and Young 1974. So, the task was they had used Spanish-English bilingual 64 of them. So, the languages were Spanish and English and the task was a memory recall test. Memory recall test they had to recall certain things. So, let see how it went.

So, the experiment was in divided into two stages: stage one is called familiarization. So, what happened in familiarization stage was they had been given a list of words in English or in Spanish right, and they had to look at those words and remember. Now, in stage 2 depending on test condition, now here comes the manipulation. This is what we have been we had just mentioned within versus between language condition. So, let us just see how it went.

So, stage 1, there was Spanish word and there were English words ok. Stage 2, now there are two possibilities. Let say you have seen only the Spanish word-list, you have memorized only the Spanish word list. Now, if we want to see within-language condition then in stage 2 we will again be given a Spanish list.

If we want to check a between-language condition the same people after Spanish they will be given a an English language list. Now, the task was the ok there is another list.

So, this and then second list and they have to say whether this list contains words from the previous list. So, that is why it is called the memory recall test.

Now, if that is the test so, the second list does the second list contain words from the first list? Simple task, simple memory task. So, for control or as we call fillers, there were also words that were not part of the first list. Simple very simple task, now the manipulation was here. So, Spanish, English here and Spanish versus English here. So, four conditions Spanish – Spanish, Spanish – English, English – English, English – Spanish, ok.

So, there are two between language and two within language condition. The result showed that language familiarization if the language familiarization was in English and test language was Spanish, the percentage of recall was higher in case of familiar words and which was in comparison with the control condition; control condition as in when these words were not part of.

So, whether it was English or it was Spanish the words were translation equivalent. So, if they had seen words in Spanish like let us say a word like ‘casa’ in Spanish which means house and then they will see house in English this also facilitated. So, even if they do not see casa in the next list they see house this was also reacted to very fast compared to recall was much higher.

Similarly, Spanish – English, Spanish – Spanish and English – English all the pairs. So, basically all the four pairs showed the same kind of result, meaning whether the word was present in the same language or when the word was present in different languages, in both cases the recall was faster, right.

So, what this means is that both in within language or in between language condition there was no difference, right. That means what; that means, that the shared conceptual store. So, you are seeing casa basically has activated the house and then when. So, when you see house, it does not really matter. You do not have to go anywhere else, the concept is already there for you to say that it is ok. I have seen this, right. So, this is what is about all about the shared hypothesis.

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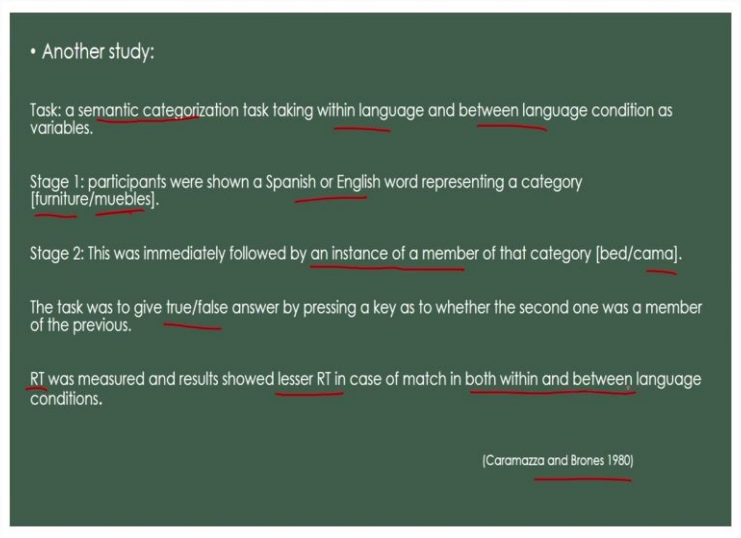

Another study also which is again a very well known study by Caramazza in 1980. This task was the semantic categorization task. So, semantic categorization tasks are typically of this type. So, you are shown an object, either in image or as a word, and then there is another word and asked whether they belong to the same category or not. It is very simple.

So, you see a flower and then you see a rose and then you are shown flower. So, ‘dose rose belong to the category flowers?’ that kind of a task is called semantic categorization task. So, they had again the same kind of within-language versus between-language condition and stage 1 again there were two stages stage 1 was participants were shown Spanish English again this was Spanish – English bilingual study.

So, Spanish – English word representing a category. So, furniture is a category. A category is that storage that mental conceptualization which includes a lot of members. So, category ‘furniture’ would include table, chair, bed, you know cupboard and all of these things. So, that is why it is called a category name.

Each category has many members. In they had both Spanish and English words representing categories. On the stage 2 was which was immediately followed by an instance of a member of the category. So, if you have seen ‘furniture’ then ‘bed’ appears or if you see ‘muebles’ see you see a ‘cama’ and so on.

So, again the same kind of manipulation just like the previous study. So, they had Spanish words Spanish category names, Spanish member, English category name, English category member and on the other way also. So, within-language and between-language conditions the task was to give a true false answer. It was a key press study. So, you give it to your true or false answer by pressing a key, as to whether the second was a member of the previous word.

So, whether bed is a member of the category furniture, it is yes. So, you press one key, if it is no then you press another key. So, naturally the fillers were all the 'no' answer types. So, you see furniture and then a word like tree comes in. So, you have to press no. There is another key. So, keys are always customized.

Reaction time was measured, RT stands for reaction time. So, reaction time was measured and results showed lesser reaction time in case of a match for both within and between language conditions. So, that is crucial finding that whether it was within language or it was between language,e in both cases the reaction time was smaller just like the previous study.

So, this kind of studies gave a lot of support to the shared memory hypothesis; shared memory as in shared memory of the conceptual storage. Now, these are the findings.

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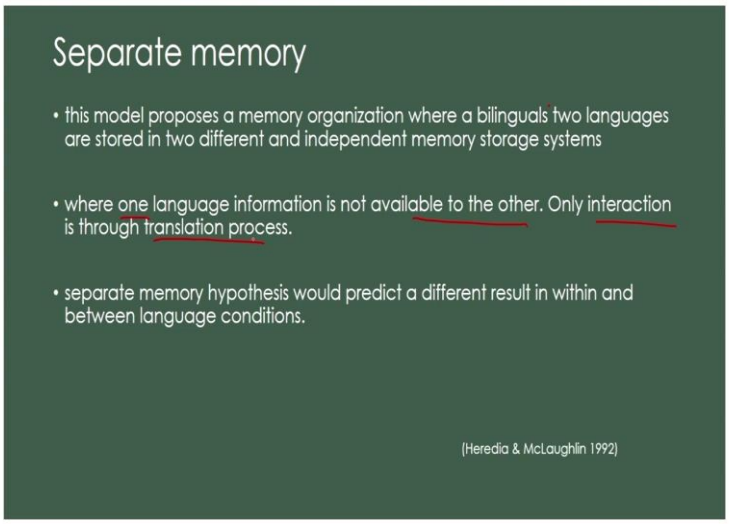

Now, let us move on to separate memory. Separate memory, as the name suggests, this proposes a memory organization where a bilinguals two languages are stored in two different places, ok and they are independent of each other. There is no dependency, there is no connection between these two storage systems.

So, one language information is not available to the other. Till now what we have seen is that one language information is made available to the other. How do we know that? We know that by seeing the facilitation across language, between-language conditions. So, if you have seen ‘furniture’ in English and you see ‘cama’ in Spanish, even that facilitates.

But, the separate memory hypothesis says that there is no such facilitation possible. Bilinguals two languages have two different storage systems and they do not talk to each other ok. Now, only interaction that happens, happens at the lower node that is in the translation process at the lexical level not at the conceptual level. Now, this memory this separate memory hypothesis would predict a very different result with respect to the within and between language conditions.

Within, what do you expect? We expect that if you if separate memory hypothesis is correct, then within-language conditions will facilitate, but between language conditions there will be there will be no facilitation. So, there because they do not; they do not they are independent of each other.

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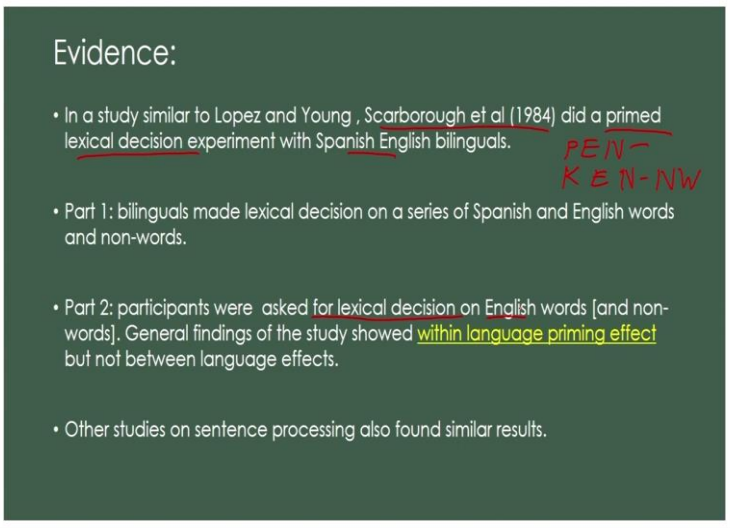

Evidence for this also comes from another study. So, Scarborough's famous one this particular 1984 study, they copied, they did a similar study like Lopez and young study and they did a primed lexical decision experiment. Lexical decision experiments are simple experiments where a letter string appears. So, few letters are put together on the screen and the subject, the participant has to decide whether this is a word in that particular language, it can be English, it can be Spanish any other language.

So, for example, let say this is a word in English language, but if you say if I write like this if I write like let say I do not know whether a word exists like this, but let us hypothetically say this is not a word. So, this will be a non-word, this is the word and this is called a non-word, technically they are called non-words.

So, lexical decision and task typically will have words and non-words appearing on the screen and the task is to say whether they are they are they this is a word, very simple task. Now, this was also a Spanish – English bilingual study and bilinguals made lexical decision on a series of Spanish and English words and non-words, right, on English words and non-words.

General findings showed that in this study they are the similar kind of thing. So, English and Spanish both English and Spanish were used. So, if you have; if you have seen English first, there will be they found within language priming effect. So, if you have if your first stage you did a lexical decision task on English and then followed by another task on English, there was a lot of facilitation, but if are two parts, one part had Spanish another part had English then there was no priming effect.

So, one language did not help processing the other language that is what the finding general finding is this, unlike the previous one. Previous ones we see that there is a lot of facilitation. So, language 1 facilitates processing in language 2 which does not happen here. There are many there are many other sentence processing studies also and they all showed similar kind of result that language 1 does not help in language 2 processing.

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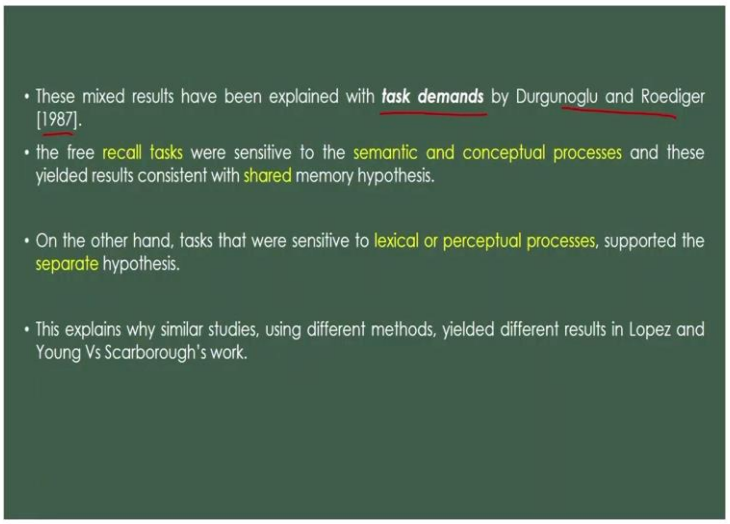

Now, this sounds quite interesting, because two kinds of findings, there are mixed results how can both be correct. So, one way of explaining this was by talking about the task demands, again a very important work. So, they said that the differences that we see is because of the kind of task that was given to the subjects. It is not because of anything else, but about, but for task demands.

So, for example, in case of free recall task, there are say whenever recalling free recalling there is no bondage of language lexical aspect of the word then you are more free and then you are automatically going to semantic and conceptual processes and these in the results consistent with the shared hypothesis.

However, when the task were dependent on the lexical aspect of language then we see a separate hypothesis proof for separate hypothesis. So, what happens here? There are two kinds of task: one dependent on the conceptual aspect of language some conceptual semantic this kind of aspect of the language, if that is the task then we see a lot of shared hypothesis proof and if it is based on lexical level, then we see separate hypothesis proofs.

Now, this explains why similar studies using however, using different methods will result into different kinds of findings.

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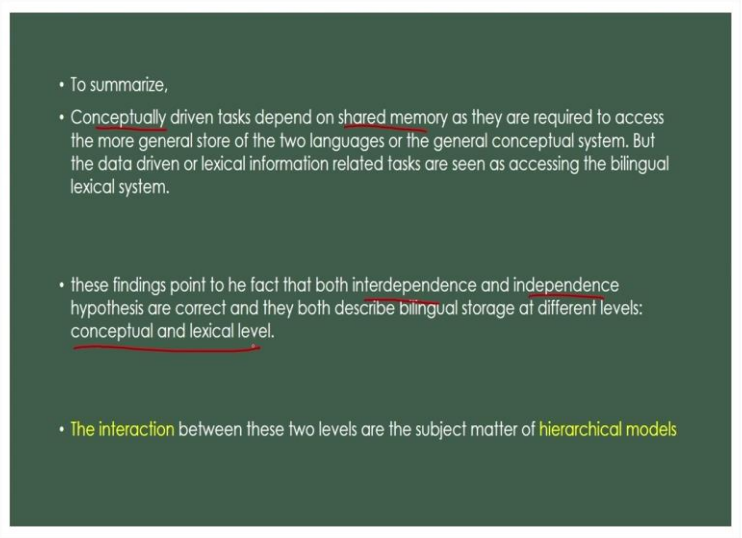

So, that sort of this proof to Scarborough versus Lopez finding. To summarize now we see that conceptually given task depend on shared memory and basically depend on the separate memory hypothesis. Now, these findings point to the fact that both the hypothesis are correct, that is the most important take home lesson from all of these different types of findings that both can be correct at the same time, because these are there are two different levels of processing that is happening.

Now, there are conceptual level processing and there are lexical level processing. So, this is the most crucial finding out of all of these. So, there the interaction, now how do they interact how do the lexical level and the conceptual level interact, is what is the matter of hierarchical models in bilingual language processing research.

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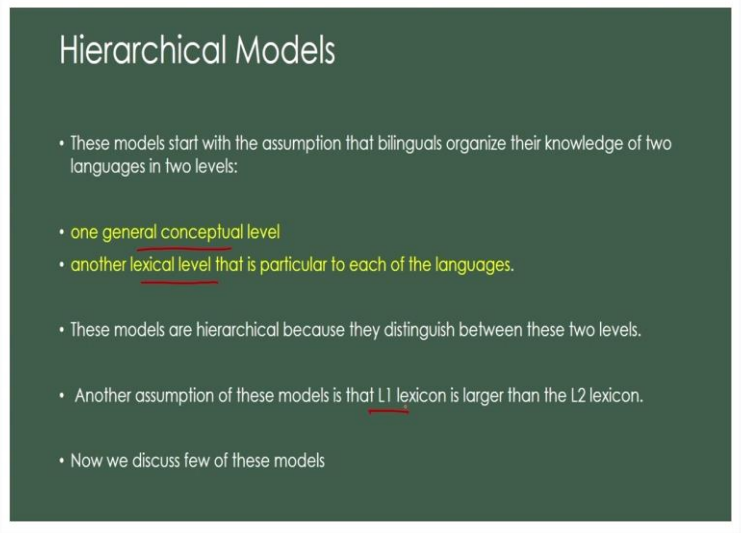

Hierarchical model why? So, they start with the basic assumption that bilinguals organize their knowledge of language in two at two levels, conceptual level and lexical level. So, general conceptual level is one and the lexical level is the other level. So, this is because there are two levels and these two levels are distinct from one another. Hence these models are called hierarchical model.

Another important aspect of hierarchical models is that L1 lexicon is larger than the L2 lexicon, right. So, what does it mean? It means that irrespective of the language pair, in its most common to find that vocabulary that we have in our first language is much higher than the vocabulary storage we have in our second language. So, these are two interesting foundational things about hierarchical models.

One, that conceptual level and lexical level are different and two that lexicons are not the of the same size.

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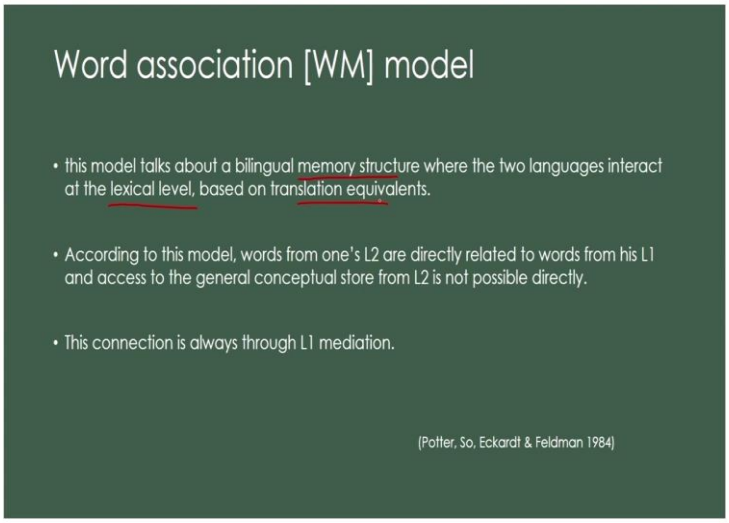

Now, there are various models. One of the oldest is called word association model or WM in short. Now, this model talks about a memory structure where two languages interact at the lexical level ok. The language, bilingual's two languages how do they interact? They interact at the word level, lexical level and this is based on translation equivalence.

Now, according to this model words from one's L2 are directly related to words in L1 and then because the L2 cannot access the conceptual storage directly.

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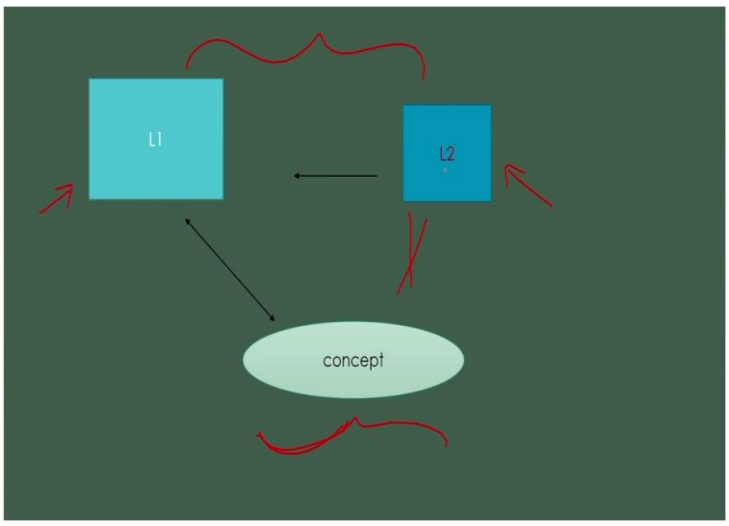

So, let us see this in a through pictorial method. So, this is your L1 this has this is much larger, the lexicon is larger as we have tried to show by different sizes. So, L2 has a smaller vocabulary that is the first thing. Now, this is the lexical level and this is the conceptual level, right.

Now, conceptual level is not accessible, this is not possible. L2 cannot access the conceptual level directly. This model says that L2 words are connected to L1 words through translation and then from L1, one has to access the conceptual level. There is no connection between L2 and conceptual level possible.

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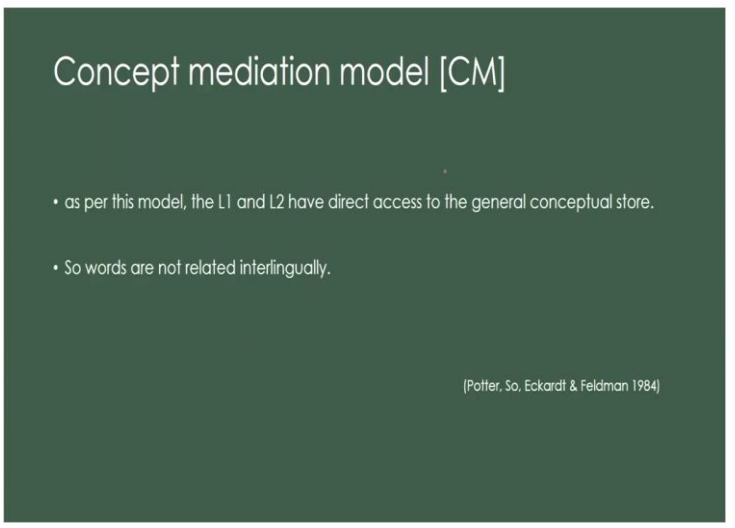

Another possibility is that what is called concept mediation model. Concept mediation model says that L1 and L2 both have access direct access to the conceptual store and words are, as a result, nor related not related interlingually.

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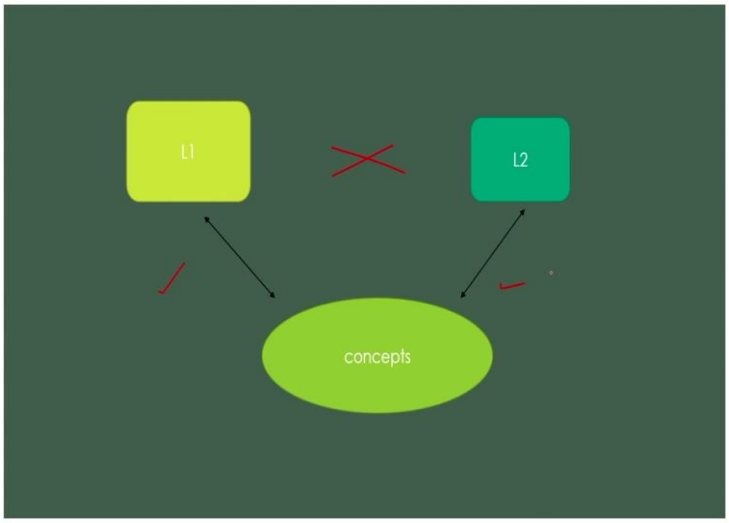

Again, we will see how this works. So, here you see there is no connection here this connection does not exist. However, this both these and this are possible. So, L1 also can connect to conceptual storage, L2 can also connect. So, this both of these are attributed to Potter et al study.

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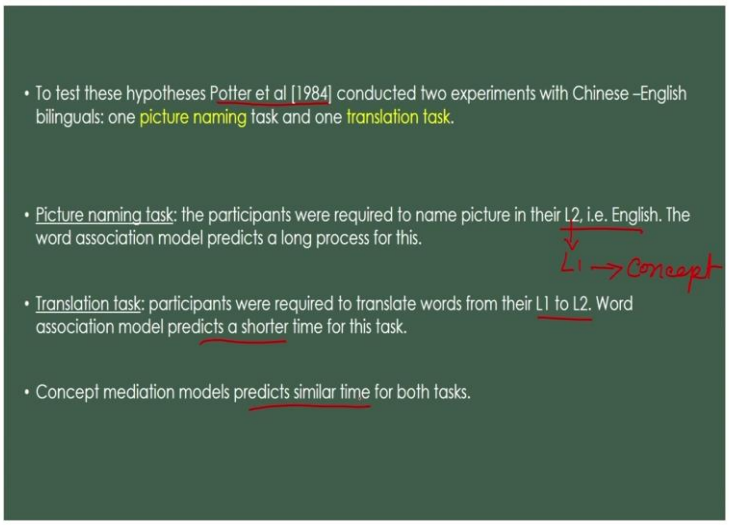

And, in order to find out what exactly happens to test these two hypothesis, they conducted two experiments. This is the most well known of the work 1984. This study

was done on Chinese – English bilinguals. There were two tasks – one was called picture naming, the other is translation task.

What happens in a picture naming task is there is there will be a number of pictures. Now, these pictures are not like photographs, they are line drawings. So, only the outline of the object will be there. So, very rudimentary sort of a picture will be there, right. So, these pictures will have to be named. So, you see the picture of a house, you call it a house if it is English language. So, this is a production study, because you are speaking out, right.

So, this is picture naming study. So, picture naming study what happens in picture naming studies, because when you are presented with a picture there is no language specific information that you are activating, right. You are seeing the picture of a house the way house is written 'h o u s e' or the how it sounds, nothing. None of that information is there. The picture goes execute directly to the conceptual storage, right.

So, then the task was to just to name them. Now, the participants were required to name pictures in their L2, in this case English. What do you think would happen if Chinese – English bilinguals are speaking in their English language and they are naming pictures? Now, in case of word association model, it should take a lot of time. Lot of time, why? Because the language output language is L2. So, from L2 he has to go to L1 and then from there he has to go to the concept, right. It is a long way.

So, concepts or in this case it was a picture. So, it is the other way round. So, concept to L1, L1 to L2, this should take considerably long time. So, that is one task. Another task was translation task, participants were required to translate words from L1 to L2, right. So, this is a simple task you see in L1 word and you have to translate to L2. But in this model the first model, word association model would predict a shorter time because that model says the connections exist at the lexical level. That is the inter-lingual.

The languages are connected at the lexical level. So, if they are connected at the lexical level, the translation should happen very rapidly. But, any task that requires them to them to connect to the conceptual storage, will take longer, right. So, as far as word association model is concerned, this the first task should take longer, second task should take shorter.

But, concept mediational model predict similar time for both tasks, because they are supposed to be both the languages are connected at the with the conceptual storage.

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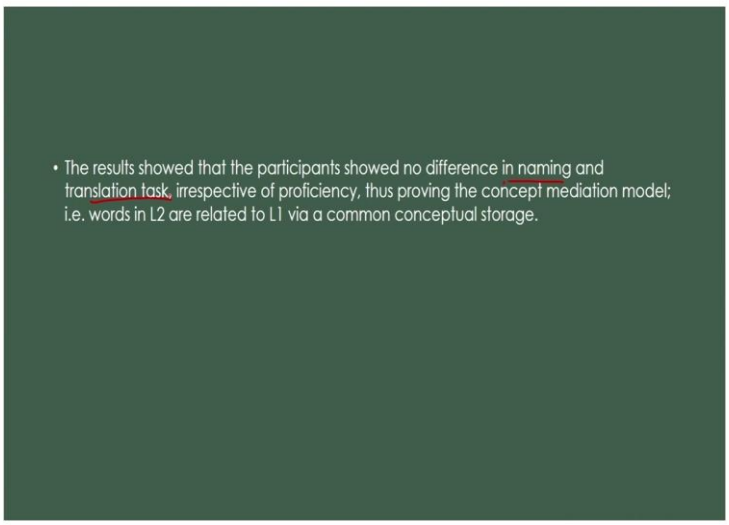

The result showed that the participants showed no difference in naming and translation task, whether they are high proficient bilingual or low proficient bilingual. So, irrespective of proficiency, the results were similar. So, thus this seems to prove that there is this conceptual storage is connected with both languages. So, thus proving the concept mediation model.

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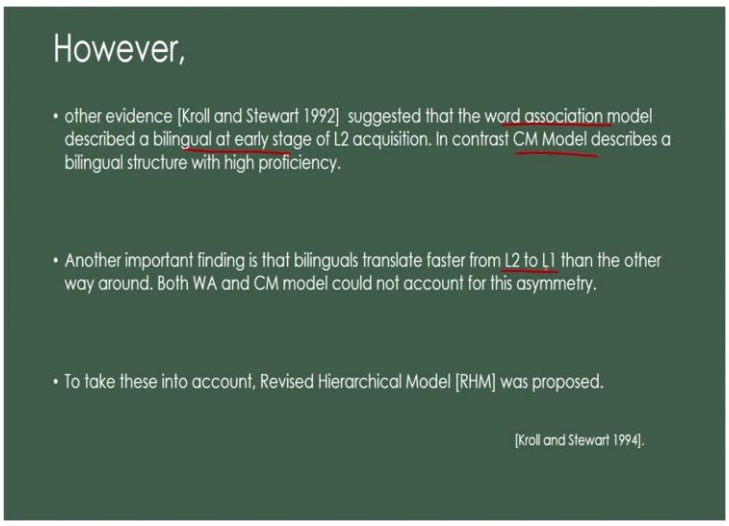

However, there are other findings that do not quite agree. One example is Kroll and Stewart 1992, they said that the word association model is that these two models are actually looking at a bilingual's proficiency at different points in time at different different points in the continuum, right. So, this is a word association model or the WM is a bilingual at early stage. And CM model is basically a bilingual when he has attained a certain level of proficiency.

This is almost this if we just sit back and think, this sounds like common sense. Where we are beginning to learn a second language, we automatically we would this happens almost unconsciously. We translate from one language to another and then go back. So, apple this is 'sev', apple is 'sev' and then you know already what 'sev' means and so on. So, that is exactly what Kroll proposed that the both models can be correct if we take proficiency into account.

Another important finding was also that bilinguals translate faster from L2 to L1 rather than from L1 to L2. The reason is that, this is how the language acquisition often happens. So, we learn L2 through our L1. So, we can translate, come back to L1 and then we understand. So, keeping these things in mind revised hierarchical model was proposed by Kroll and Stewart.

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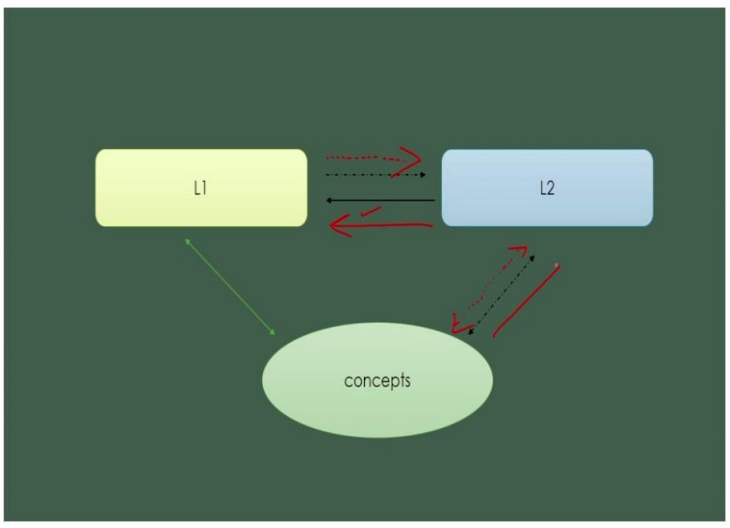

This is revised hierarchical model. This is sort of a combination of WM and CM. So, in this model, they say that languages are connected at both the conceptual level and at the

lexical level. So, there is a lexical connection between L1 and L2. Now, the L2 to L1 connection is stronger compared to the L1 to L2. So, the connection between L2 to L1 is stronger because we often learn our L2 through translating to back to L1.

However, L1 to L2 this connection is weaker. This is how we mark weaker connection. Similarly, L1 is connected to concepts in a stronger way. L2 is also connected, but in a slightly weaker way. So, this allows for a combination of WM and CM. But, and they say that as proficiency goes higher in in L2, this connection also can become a straight line. This can also become a strong connection.

So, basically this model says that languages are connected at both lexical and conceptual level. How strong the connection is, is a matter, of is a factor of proficiency. So, this is what basically means.

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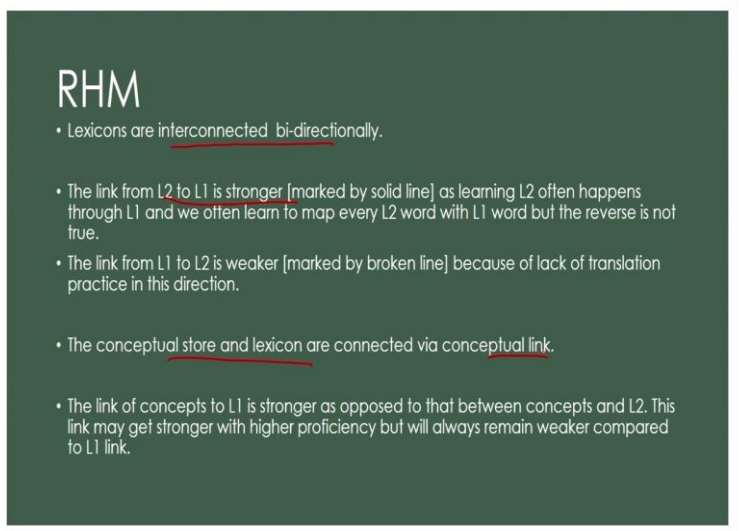

So, it is bidirectional connection. This the connection happens both way and this is something we have already said L2 to L1 is stronger and so on. And, conceptual store and lexicon are connected via conceptual link and so on. So, even though the bilingual as he grows higher in his proficiency in L2, the connections between L2 to conceptual storage might get quite strong and much stronger than before.

However, theoretically it is believed that it will probably always remain weaker compared to the L1 link. So, that was revised hierarchical model and that is something

that is relevant even today. It is one of the most well known and most cited models and lot of work has taken place within that entire paradigm.

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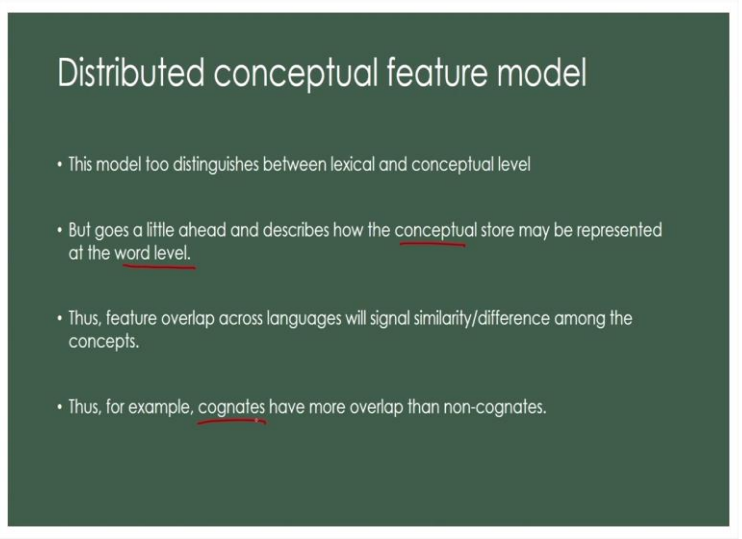

Another important model that also that came in similar vein was it is called distributed conceptual feature model. This is also a model that talks about lexical and conceptual level and their connections. However, it is slightly more nuanced, in the sense that it describes how the conceptual store may be represented even at the word level. So, earlier models talked about a very nice and neat distinction between conceptual and word level. This model says that some amount of conceptual representation is present at the word level as well.

So, as a result if there are feature overlaps between across languages, between languages that will mean similarity. And, if there are lack of overlap, then there is no then the similarity will disappear. So, basically the languages will be different. For example, one example that they give is that of cognates.

Now, what are cognates? Cognates are those words that have the similar form and meaning across two languages. So, those are cognates, right.

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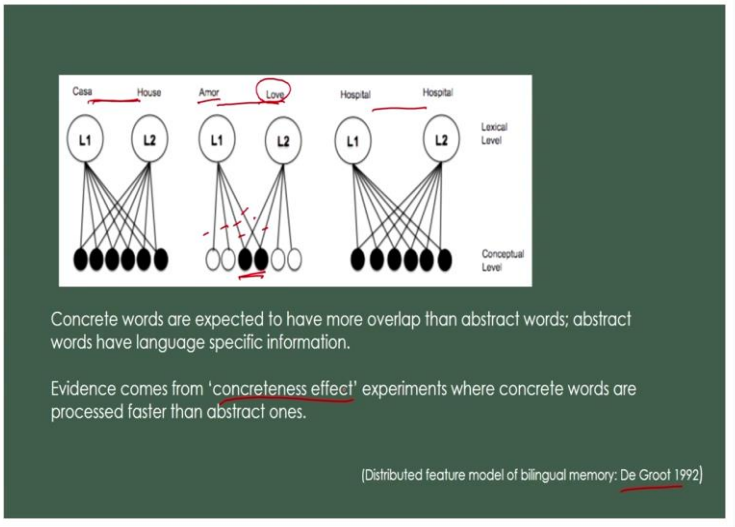

So, this is a representation of the model which was proposed by De Groot in 1992. So, this is how then they look at the connections. So, these there are three categories of words here. The first one is that of concrete words, second one is that of abstract word and this is a cognate. So, you see in case of cognates, that is a complete overlap for a word. So, any word in L1 is also the same exact same as in it is L2.

So, more often than not these will be concrete words because concrete words refer to concrete objects, right. So, there are chances are very high that the concept of 'house' and concept and the word 'casa', they go back to the same conceptual store in this same kind of mental representation as to what they represent, as to what it is. However, less overlapped typically are found in case of abstract ideas.

So, one example that they have given is that of 'amor' and 'love'. So, in English language, the entire gamut of usage of this word is not replicated one to one on Spanish. For example, there are various examples that they have given, that there are so many types of cases where the word love can be utilized. But, in Spanish that does not allow. Spanish does not allow the exact type of usage that English word love allows.

So, that is what they mean by a much shorter, much smaller domain of overlap and that is what. So, features are represented in the words. So, each word has a set of features and depending on how many, let's say there are 1, 2, 3, 4 features and there are only overlap in these then there is two cases then there is they are they are not too similar.

But, in case of these two words casa and house, the overlaps are on both four features let say and that is why we call it similar. So, evidence from this over this theory comes from what is called concreteness effects experiments, where concrete words are found to be processed faster than abstract words, because concrete words refer to concrete things and then hence they are much easier to process across two different languages.

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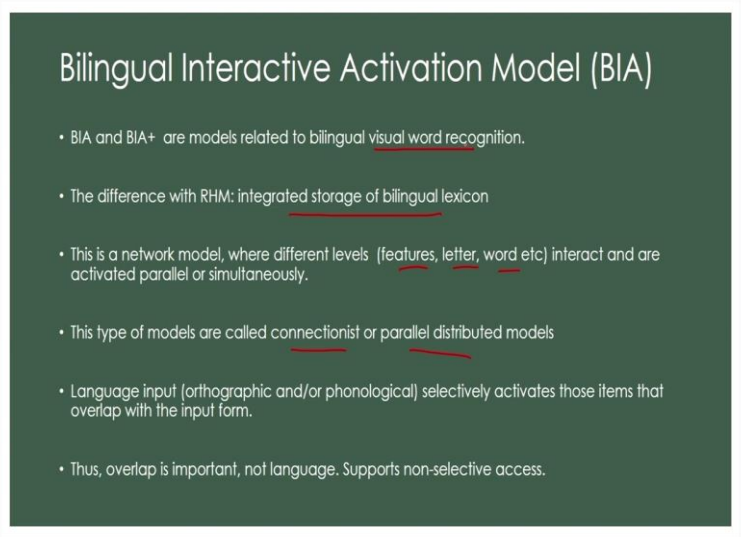

Another model that has been very influential, the BIA model bilingual interactive activation model then there is a BIA plus also, which has been which was is an updated version of BIA. We will not get into all the details, but roughly the BIA basically is a network model, ok. So, it has it is slightly different from RHM because this talks about an integrated storage of bilingual lexicon.

This is basically a computer model sort of a model and this is a network model and it takes into account various things like features, letter, word, moving on to language level. So, there are all these kinds of interactions that are possible and they are activated simultaneously in in parallel way. That is why this kind of models are called connectionist models or parallel distributed models. Quite influential model.

So, basically what happens is that language input this is the BIA is specifically designed for visual word recognition. So, when the input is visual, when we ‘see’ a word. So, what happens when we see a word this is what this is how the representation looks.

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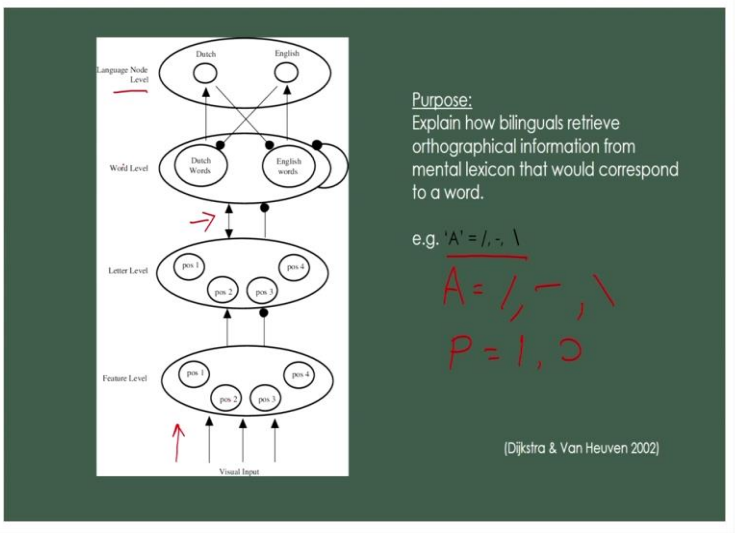

This is how BIA looks. Basically, this as I said this is a connectionist model. So, there are various. So, you see the input starts from here this is where the visual input is and they talk about the input in terms of first level is that of feature. For example, the letter A, letter A has this is A and this has features like this, this is one forward slash and then there is this kind of a dash sort of a thing and then there is a backward slash. These are the features of the later A, right.

So, visual input breaks it down to features and then there are all various kinds of positions. So, which position in the word they appear. Now, this as a result, this will activate all the A's in different positions in the word. So, this will inhibit the O's let say. Similarly, if there is a there is a display like which includes the letter P. So, it has a straight line and there is a sort of a hook sort of a thing. So, this these are the features.

And, then these features will integrate into the possible letters and those letters again will take us to the word level – what are the words and where all these letters can appear and then this gradually it will move up finally, to the language node level. So, this is basically about and at every level you see there are in there is interaction, right. So, these are positions and so on. So, feature level to letter level to word to language level. This is what the BIA and, BIA plus is slightly different, but basic architecture is the same.

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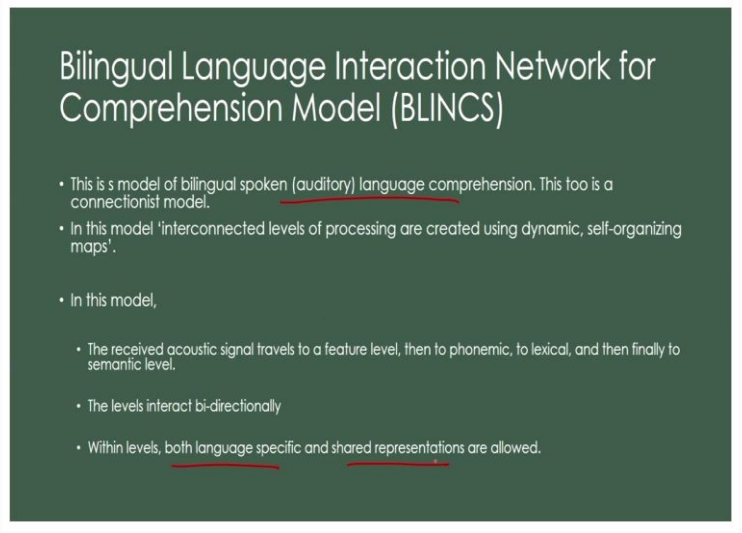

There is yet another model that this is in short called BLINCS: Bilingual Language interpretation Interaction Network for Comprehension Model. Both of these are comprehension model by the way, both BIA, BIA plus and BLINCS they are all comprehension models, there are also the production models. We will talk about this later in more detail when we discuss experimental work.

So, this is another comprehension model, but here this is based on auditory language comprehension, the previous one was on visual word recognition, visual processing and this is about auditory processing. So, this is also a connectionist model and in this model interconnected again this is interconnected levels of representation and processing that are created during using dynamic and self-organizing maps.

So, this is again this also works bi-directionally and within each level, both language specific and shared representations are allowed.

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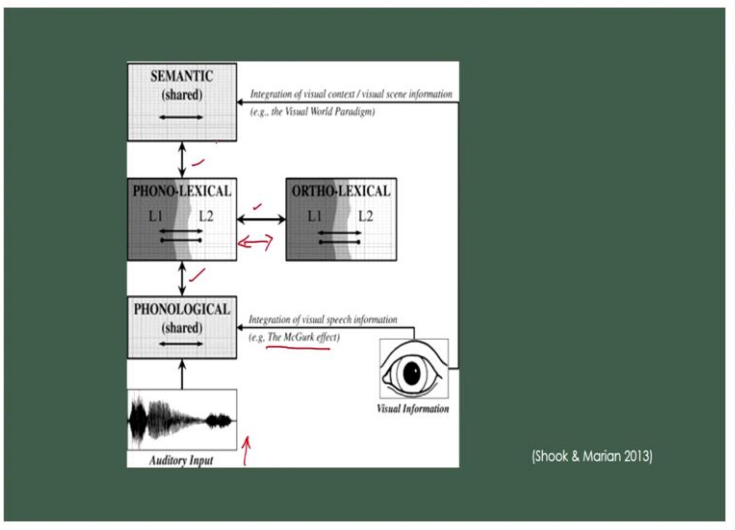

So, you see gradually as we have moved from shared versus this one there are. So, many other things are also being taken into account. So, this is auditory input. This in this case the processing starts here and as it moves to phonological level and then visual input is also taken into account that this also mentions the McGurk effect will not get into it now.

And, then in the next level it goes to phonological and lexical level and then orthographic lexical information and also coming into the picture. So, in in all cases you see this is bi-directional, this is bi-directional and this is bi-directional. So, lot of interconnected dynamic self-organized kind of manner in which the this model is supposed to work. Ok.

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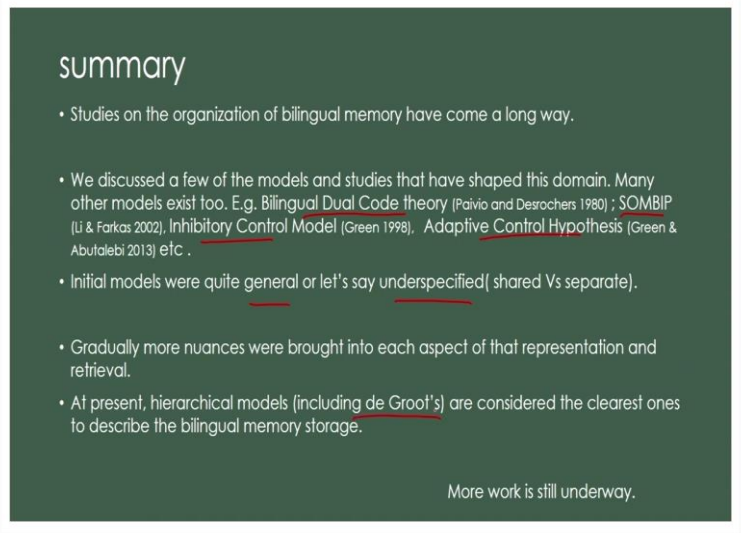

And, so, basically at the end of all of these what have we finally, what is the take home lesson is that first and foremost, the studies on the bilingual memory storage has come a long way. Starting with the very fundamental, very as many have called it underspecified. So, in the initial stages they were very general you know, under specified sort of models like they are either shared or they are separate, there are two different kinds of memory systems.

And, then there are then we have seen a lot of newer models and the that have now shaped this domain after this from this point onwards. So, we could discuss only a few; however, there are many other models. Most important among them better known ones are bilingual dual code theory and then sm SOMBIP, inhibitory control hypothesis, adaptive control hypothesis and so on.

We will try and bring them back when we discuss about processing later on, bilingual language processing, but so, we are not discussing them here. So, from the initial models which were mostly at a general level to today when we have models that talk about at every level what happens, what and what kind of interaction happens between different levels.

So, starting from features to words to phonological information, orthographic information and how each of these nodes interact with each other, they have now being looked at. So, at present, as it is as things stand today, mostly in the hierarchical models

are considered the clearest ways of looking at what happens, what is the exact true nature of bilingual memory storage. So, this includes the RHM and also the models proposed by De Groot, these are the ones that are most commonly cited ones.

So, this is where we will come to an end to this part of bilingual memory storage. However, we must remember that a lot of work is still going on and this is still as we say under construction, but as things stand today most mostly cited examples, most cited models are that of Kroll and De Groot.

Thank you.