Psychology of Bilingualism and Multilingualism
Professor Ark Verma
Dept. Of Cognitive Sciences
IIT Kanpur
Week – 05
Lecture – 21

Hello and welcome to the course introduction to the psychology of bilingualism and multilingualism. I am Dr. Ark Verma from the department of cognitive sciences at IIT Kanpur. This is the fifth week of the course and I just needed to conclude the chapter on comprehension processes in bilinguals and multilinguals. As you know, so far we have talked about the aspect of parallel phonological activation in bilinguals across their two languages but most of the research that we have actually reviewed has used the presentation of visual stimuli basically using the visual word recognition task or the lexical decision task. Now an interesting aspect of visual stimuli is that in order to be able to read the visual stimuli you will need to convert the orthographic representation to a phonological representation and then the phonological representation basically searches for the matching representation into a mental lexicon, maps it to meaning and so on.

However, this conversion is basically an indirect one in terms of how the bilingual mind processes the input from two languages. In that sense, it might be important for us, it might be helpful for us to actually look at some of these studies which are evaluating parallel or which are demonstrating parallel phonological activation in the bilinguals using the auditory presentation of stimuli. Indeed, a bunch of studies have presented auditory stimuli for investigating parallel phonological activation in the bilinguals. Most of these studies have used the eye movement tracking paradigm which was initially developed by Tannenhaus, Spivey-Knowlton, Eberhard and Sedivy that allows the investigation of online language comprehension.

Now this paradigm is typically referred to as the visual world paradigm and in this visual world paradigm typically what happens is that a participant is presented with auditory instructions and they have to react to the stimuli trying to understand the auditory instruction at the same time. For example, I could tell you, oh, lift that bucket for me. Say for example, if I am showing you a stimulus, I could basically, if I am showing you a stimulus, let's say it is composed of a table top and the table top contains four objects, I could basically look at you and I could tell you, oh, pick up that red apple from there or pick up that apple on the napkin or pick up that apple on the towel. Basically what it will allow you to do or basically what it will trigger you to do is, you know, if you are understanding the auditory instructions carefully, your eyes will move on the table. It will basically go from object one to object B, depending upon whatever the target object is in

my set of instructions.

At the same time, while the participants are going through the experiments in the visual world paradigm, they are wearing a headband and the headband basically carries equipment that can track their eye movements on the visual display. Now there are two versions of this visual world paradigm that are possible. In one kind of version, which is some of the older studies where actual real tabletop kind of displays have been used and participants eye movements have been tracked across real objects. In more, in later studies around 2004 and afterwards, when Jerry Altman and their group sort of took to the visual world paradigm, these studies would also be done using a computer representation where you basically have to move your, you know, cursor of the mouse on the visual display. Let's say if the visual display is divided into four quadrants, A, B, C and D and in response to the instructions from which you are hearing on the earphones, you basically have to move your cursor from point A to point B to C and so on and so forth.

Basically what is happening here is that we are, is that the experimenters are actually checking your online comprehension of the instructions and check, basically looking at how your eye movements are changing in response to these instructions. Now for monolinguals, this will be interesting because every time a monolingual is trying to understand or hear or follow spoken instructions, they are basically going to understand those instructions only in the terms of a single language and therefore there will be less of confusion and less of indecision, for example, due to the parallel phonological activation of the two languages. However, if bilinguals are doing this, if bilinguals are trying to understand the comments and basically, you know, follow those instructions being delivered through their earphones, they will basically need to understand or they will basically need to, you know, to handle the input that is coming from or the input that is being matched to their two parallel or co-activated mental lexicons. This is basically assumed to take a little bit more time than a monolingual and depending upon whether or not, remember that I have just told you a hypothetical scenario that if parallel phonological activation happens, this is what we should see. But depending upon whether parallel phonological activation across the two languages is happening or not happening, we can see that the bilinguals will take little less or more time in following the instructions and let's say moving the cursor around the computer screen or moving their eyes on the tabletop display towards target objects.

With the help of this technique, Tannenhaus and colleagues have actually gathered, you know, temporal information about the process of spoken language comprehension. Now using these studies, the authors have found that the visual context really affects the resolution of temporally syntactic ambiguities. Now, what are temporally syntactic

ambiguities? You might have heard of garden path sentences in one of my previous lectures on psycholinguistics. Garden path sentences are basically sentences where the thing is, where the exact meaning of the sentence is not very clear because it is ambiguous. Say for example, the horse that raced past the barn fell.

Now, if you are listening to the sentence, you are not going to be sure about what actually fell. Did the barn fall down or the horse fell down and so on and so forth. So these are some examples of temporally syntactic ambiguities and basically what these researchers using the visual world paradigm have sort of done is that they have utilized these temporally syntactic ambiguities tap into the online comprehension process of bilinguals. The idea is that the bilinguals actually use or take the help of the visual context, let's say the display that is in front of me or the visual screen that is in front of me to basically resolve these temporary ambiguities. For example, if I have a display and in this display there are a bunch of objects, suppose one of these objects is a candy bar, another object is a candle, another object is a tablet, another object is a bottle.

Now, if I am giving you an instruction for example, to pick up the candy and put it above the fork, say for example, a fourth object is the fork. So I have basically given you an instruction, oh pick up the candy and put it above the fork. Now, let's say if it's a tabletop thing. The meantime to initiate an eye movement to the candy, to the target candy because candy is the target object in my instructions. The meantime that you will observe or that participant researchers will observe from the participants to follow these instructions would actually turn out to be much longer if the display contains a distractor object.

Suppose that distractor objects basically shares the initial phonology with the target object. So suppose one of the objects is candy, the other object is candle. When the participants are looking to follow these instructions, they will actually take a little bit more time. This more time will basically be indexed in terms of the confusion or the ambiguity that has been created. However, if there is no such object, say for example, one is candle, the other is fork, the other is tablet, the other is bottle.

Now you can see among these four objects, there is no confusion. None of these objects share initial phonology and therefore the confusion will be much less. Now, just a moment, what is this you know idea or say for example, why are we talking about initial phonology and not the middle of the object or the end of the object? Now the thing is, if you notice, if you pay attention to this, you will see that the speech is a signal that unravels in time. It unfolds in time slowly and when you are trying to understand speech, what we are basically trying to do is we are basically trying to start listening and interpreting that starting from the initial voice onset and when you are trying to

understand this from the initial voice onset, basically what we are trying to do is, we are basically opening up the number of candidates from there. So for example, once I am trying to say, let's say, cap or catch or let's say if I am trying to say cat versus caterpillar versus cattle.

Now the thing is, when I start with this, when I say ca, I basically have a very large pool of objects that start with ca. So my search space in that sense from the mental lexicon is very large. When I say ca, then it basically becomes slightly narrower because co and ca etc. sort of go out of there and only the objects in my mental lexicon or only the items in my mental lexicon that start with the phoneme ca will be searched from and then ca, when I reach ca, so everything like cap and candle etc. will be switched off and everything that sort of has the initial ca sound will be searched upon.

So basically what happens is that given that spoken language comprehension is a matter of a signal being interpreted in unraveling in time, therefore what happens is that it takes a lot of time for individuals to follow these online auditory instructions and this is basically the fact that some of these studies have employed, have utilized to tap into this process and see whether parallel phonological codes for some of these target objects get activated and create a bit of confusion for these bilingual participants. Now an interesting, you know, and this is basically what I was talking to you about, that this insight that spoken language or say for example when you start understanding spoken language, it activates a bunch of candidates that shares phonology. This is basically the cohort model of lexical access which I have taught about in my course on psycholinguistics, you can go and refer there from Marslen and Wilson, you know, the model basically came from there. It is a very interesting insight that as I was saying has been employed. Now the visual context, if the visual context of a display has been found to have, you know, impact the participants eye movements while understanding and following these instructions, obviously this can be, you know, utilized to check for whether parallel phonological activation is there or not.

Now let's look at some of these studies in more detail. Now Marian and Spivey in 2003 employed the eye movement tracking paradigm referred to as I said earlier the visual world paradigm in three bilingual studies to investigate whether the activated cohort also included representation from the non-target language. Now this is basically what these, you know, researchers were after. As I said when you are a monolingual, the number of candidates that you will activate when you start, say for example if I am an English-speaking monolingual and I am saying candle, catalyst, cap etc.

etc. as in when I am sort of unraveling this signal in time, I am basically reducing the number of, you know, activated candidates and so on. But this I am doing as a

monolingual within the, you know, language set of English. Suppose if I, you know, and which is the fact that I am a Hindi-English bilingual, now when I am listening to instructions in English or I am listening to instructions in Hindi, every time I start with Ca, I can go either side. I can go to let's say capital, cattle, caterpillar etc. or I can go to say for example, Kaetha and this and that, Kaetha and all the sounds in Hindi that start with the initial phoneme K.

Now what will this do to my comprehension system is that it will sort of confuse this by making available activated candidates from both of my mental lexicons. This is basically the question that Marian and Spivey in 2003 were trying to answer through three of their studies which were performed using bilingual participants. Let us dig deeper into these studies now. Now participants in these studies included Russian-English bilinguals having a weaker English and their first language as I said was Russian. These participants were seated in front of a board with four objects in it.

For example, one of these objects could be a stamp. Now they were receiving instructions, let's say in a Russian L1 condition, they were receiving the instructions in Russian. For example, put the stamp below the cross: poloji marku nie krestika. So this is basically the Russian for put the stamp below the cross. In a L2 English condition, they will receive the same instructions in English.

The idea here is that whether as I was saying when they are listening to Russian instructions, corresponding English lexical candidates are getting activated or not. When they are listening to English instructions, corresponding Russian lexical candidates are getting activated or not. Now in a between language competitive condition, in addition to the stamp which is the mark you in in Russian, the board would carry an object whose name in the non-target language would share the word initial phonology with the target word. For example, as I said put the stamp below the cross and Poloji marku nie krestika is in Russian. Now marku nie is stamp in Russian.

So what basically could be done and what is precisely what these researchers did that with Russian mark you as the critical stimulus word, one of the distractors object that they kept in the display was a marker. Now marker is actually an English word whereas marku is a Russian word. Technically if the, if there is no parallel phonological activation, if phonological candidates from the non-target language are not getting activated, then there is no reason for the participants to get distracted by the presence of the marker in the visual object display. However, if both the lexicons are activated, if both the phonological candidates from both these lexicons are activated, then there is a chance that the participants might also get initially distracted with marku and marker, although they are different objects and they are from different languages. Now the

remaining two, you know, filler objects on the board were dissimilar from both the Russian and the English names of the targets.

Now additionally they actually included a control condition as well, where none of the three target objects names shared similarity with the name of the target object in either language. The authors also included a just a within language condition, wherein the target word and its competitor belong to the same language. See for example, when they are using, you know, when language is English and the target object is a marker, then the competitor object could be from within English and it could be a marble. So there is a within language competitor condition and there is a across language competitor condition. Here you can have a look at how the, you know, visual display look like from the Marian and Spivey 's 2003 study.

You can see here that the marker is one of the objects, the keychain is another object, the disc is another object and the stamp is another object. Now if they are listening to the Russian instructions, Poloji marku nie Krestika, then they will get distracted between mark you, which is the stamp in Russian and marker, which is marker in English or even if they are basically listening the instruction in English, let's say put the marker here or there somewhere and marku is Russian. If it is getting activated, they might initially get distracted with this. So these two are the critical objects here, marker and marku or stamp, whereas these two are not matching to either of the language conditions and therefore they are sort of, you know, just acting as filler or distractor items. Now the dependent variable in this paradigm was always the proportion of trials on which the eye movements were also made to the competitor object in comparison to the filler object.

So typically what happens is and if you look at the data that these guys plot is that they will basically plot the proportion of fixations on the target object versus the competitor object, target object, the competitor object and the distractor objects. Typically, what you would see in their analyses is that there is obviously a higher rate proportion of fixations on the target object but there are also relatively higher proportion of fixations to the distractor object as compared to the filler objects. Now given that these participants in our studies are also fixating on the, you know, competitor, the phonological competitor would give us a hint of the co-activation of this object's name in the non-target language during the spoken word recognition process, during the time when the participants are actually trying to follow the instructions and move the cursor around or say for example move the object around on the visual display. The three studies that were conducted by Spivey and colleagues actually differ from one another with respect to the care that was taken to prevent the participants from becoming aware that they were taking part in a bilingual experiment. Now remember in the current chapter as well as in the previous chapter we have seen that when participants become aware of the purpose of the study

they sort of will unwittingly already activate the non-target language and if they have already activated the non-target language we cannot actually interpret any of these results in terms of that whether there was parallel phonological activation or not.

Remember Grosjean's language mode theory, the idea is that if both languages are relevant in a particular task or in a particular context then both languages will anyway stay active and in that sense that cannot be interpreted as an evidence for parallel phonological activation. So in Spivey and Marian's 1999 study and Marian and Spivey's 2003 study the same bilingual participants participated in both a Russian L1 and an English L2 condition in separate sessions. Therefore, you know it is possible that in these two experiments the participants would have suspected the bilingual nature of these experiments and therefore would have unwittingly increased their activation level Hence we cannot really interpret whether parallel phonological activation was actually at play during these experiments. Now given that the participants both lexicons were active in order to be able to conclude that the recognition of spoken words is language non-selective, evidence of cross-language competent activation should ideally be looked under testing circumstances in which the participants have absolutely no idea that they are participating in a bilingual experiment or they are participating in an experiment where their bilingualism is being tested. Typically or the best situation for these experiments to happen would be that there you know the participants would be stay in the monolingual mode but while staying in the monolingual mode and sticking to the base language as Grosjean would say they are still amenable to influence from the phonological activation in the non-target you know language that will be the best test and this is basically what Marian and Spivey 2003 did because they installed the condition by testing different groups of participants drawn from the same population in an English L2 and a Russian L1 experiment.

Now let's move towards the results. In all of these three studies the bilinguals actually showed that within language and between language competitor effects were clearly present. They made more eye movements to within language and between language competitors than to filler objects which basically tells us that while obviously there is competition in you know in the within language cohort candidate item say for example between cattle and caterpillar and any everything that starts with CAT there is also competition across the language across for example there was also competition between marku and marker which are actually lexical items from the two different lexicons of the individual. Now control groups of monolingual English speakers actually showed competitor effects in the within language competition only ruling out the possibility that between language effects in the bilinguals might just have been an effect of poor stimulus selection. See given that these monolingual English speakers did not know any Russian obviously they will not be amenable to cross language activation from the other language

and therefore it and because they are not showing these effects and the bilingual Russian English participants are showing these effects we can actually safely say that the effects that are observed in this study are actually effects resulting from parallel phonological activation in the two languages. The within language effects converged with Tannenhaus and colleagues 1995 results and with also other evidence during speech recognition that the input activates not only lexical candidates from the same language but also set of lexical items similar to the target word which is as I was saying something that we have seen earlier as well.

Now the between language effects actually were the critical effects here. The between language effects actually demonstrated that the cohort of activated lexical representations using you know spoken or auditory input basically includes elements of both the target and the non target language. This finding therefore indicates that the spoken word recognition is also language non-selective and that there is parallel phonological activation due to auditory input as well. Interestingly the between language effects sort of varied between the different studies that were conducted by Marian and Spivey. Now for example whereas Marian and Spivey 2003 and Spivey and Marion 1999 observed them in both languages Russian English and English to Russian in a monolingual mode condition and they only materialized when the task was carried out in L2 English.

This basically implied that the competitors interference that was obtained was much stronger from a stronger L1 to L2 than from a weaker L2 to a stronger L1. Now this is interesting because what we are saying here is that the phonological codes are basically you know much more highly activated in your dominant first language rather than in your non-dominant or weaker second language. Also we are basically assuming some difference in strength here because we are saying that let's say assuming that both of these things are activated there is more influence from the dominant language to the weaker language than vice versa. So this observed asymmetry also is a very robust phenomena and has been replicated in later studies as well. Let us try and understand these effects in some more detail.

Now while in the previous lectures we have discussed the Sophia a model that includes phonological representations of different sublexical word units, phonetic features, phoneme clusters, it starts with care and you know cam etc etc. So all of these different units of you know phonemes. Now basically we can also going forward try and see if there are any other models that are explaining these you know non-selective phonological activation effects. Now in Sophia model whenever the auditory input is presented the corresponding phonological representations would first get activated then the activation would be transmitted to the orthographic as well as other phonological nodes and this is basically how the thing will move it. You can refer to the previous lectures where I have

discussed the Sophia model in much more detail.

Now it is plausible that this model can account for some of the phonological activation and the language non-selectivity observed in some of the studies we have seen so far, the Marian and Spivey studies. Another model that could possibly account for the language non-selective phonological encoding would be the bilingual interactive model of lexical axis which is also referred to as the bimolar model which was put forward by Grosjean in 1997. The bimola model was developed specifically to account for spoken word recognition and this was developed as an extension of the trace model which was a monolingual model of spoken word recognition. You can refer to the trace model from my previous lectures in the course introduction to the psychology of language. Now in this model the auditory features phonemes and spoken words are represented in three different layers.

Here the feature nodes are shared between the individual's two languages whereas the nodes representing the phonemes and whole word forms are organized into different language subsets. You can have a look at the representation of the bimolar model here. You can see that while the features are common across the two languages, the phonemes from language A and language B are separately organized so are the words from language A and language B. You can see that this model follows pretty much the same kind of activation mechanism, same kind of processing assumptions as well. So for example there is lateral inhibition within the level there is activation and inhibitory connections across the adjacent levels as well.

Now so as I was saying just like SOFIA in bimolar the activated nodes at different levels can activate and inhibit nodes at the adjacent level. Also there is within level lateral inhibition as we have seen in the SOFIA model. However, the bimolar model restricts lateral inhibition to units of other language as well. So this is an interesting difference between the SOFIA and the bimola model. Also in the bimolar model the two word subsets receive a different amount of top down pre-activation based on the external information that specifies the base language.

Remember according to Grosjean's language mode theory the base language is the one that is most contextually appropriate and that is the most active in any given situation. So already when you are starting in a particular context of conversation doing an experiment and so on one of the languages will be slightly highly activated as opposed to the other language and this is the initial assumption in the bimolar model as well. Now moving forward once a word or a phoneme in a subset becomes activated it sends a small positive signal to other words and phonemes respectively in the same subset. This way subsets corresponding to the target will always remain highly activated. Now in such a setup

once the model receives an auditory input it increases the activation of the phonological representation in both languages first at the language independent level of phonetic features or and from there higher up in the system.

So this is somehow I mean this is basically how they are trying to explain the parallel phonological activation in the spoken domain as we have seen. Now this model has been successful in being able to simulate two important effects. First is the unit similarity effect which is basically that a phenomenon that a unit for instance let's say a phoneme presented in one language and sharing properties with the unit in another language will also co-activate the latter. So as I was saying say if I have to speak something with ca and I started with ca say for example candle, cap, cattle and so on or say for example I started with in Hindi kamal, kokila and so on. Given that the initial features are shared across the languages the initial phoneme feature ca is shared across both the languages as soon as I say ca candidates from both the languages will become highly activated and this is basically the unit similarity effect.

The other very interesting effect that this model has been able to account for is the base language homophone effect. The idea is that in the base language if there is an item in the other languages let's say the non-target language which is similar to the or which is homophonous to the you know item in the base language it will basically become slightly more difficult to process or it will basically become more difficult to process this. So in some sense we have basically seen that parallel phonological activation also exists in spoken language comprehension as well and which basically sort of brings us towards the conclusion of this chapter where we are seeing that you know as in production in comprehension as well there is a parallel activation of both the lexicons of a bilingual. Both models Sophia and Bimola are obviously able to partially account for these effects although since Bimola was specifically designed for this purpose it seems to be the more favorable choice or for more favorable candidate to explain and understand these effects. With this I will conclude this lecture and I will move on to the issue the chapter on language control from the next lecture onwards. Thank you.