Language, Culture and Cognition: An Introduction

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Module - 08
Part - 03
Lecture - 20
Mental Simulation and its relation with language

Hello and welcome, this is the 3rd part of module 8. So, this is essentially the last part of this course. In this course, in this part of the course, we will look at Mental Simulation and its relationship with language. So far, we have seen language in its various facets in structure as well as in processing, and how various kinds of dynamic relationships actually play out while we process language and so on.

So, today we will look at mental simulation. Now what is mental simulation? Mental simulation refers to reconstructing, recreating an a kind of an event or an object or an understanding of an event and so on. So, once we have we have encountered a situation in life that gets represented in the mind in terms of the various modalities that are part of it.

And then this is something we have looked at through image schema and its ramifications. Now, what happens when we face similar situations again, either directly or indirectly? That same experience gets recreated and that is how we try to understand or we do understand those events. So, that is simulation, that is mentally a mental simulation, we simulate a particular scenario.

And so this is how we will this is what we will look at in this part. The structure of the lectures like this. So, first we will see the position of mental simulation in terms of cognition. And then we will look at various experimental studies, various evidence that we have gathered so far and how that what is the relationship of those evidence with the theoretical standpoint. And then because this is the last part of the course, we will also summarize the entire course.

Let us go back a little bit and let us refresh our memory a bit. We talked about we started this course with the question as to what is cognition and then we discussed various theories or in terms of what constitutes cognition.

So, in one of the most important and in fact, the most dominant theories of cognition talked about a kind of an abstract, amodal kind of a interpretation of cognition. So, this particular theoretical point says that human mind manipulates abstract, arbitrary and amodal symbols.

And this combination of manipulation and symbolic representation is what is the basic understanding of what cognition is. One of the most important aspects of this theory is that the mind has symbols which are abstract, arbitrary and essentially amodal. This we have discussed in the first part of the course.

So, and as a result of this, since the mind stores various kinds of symbols and then depending on the kind of action necessary that there is a manipulation and various kinds of combination of manipulations, and that ultimately results in what we call cognition. So, that is basically the early view of what is called the disembodied cognition.

However, the problem with this set this idea of cognition is that abstract, amodal and arbitrary symbols are not really connected to the real experience. They are abstract, they are the abstraction of what has happened. So, an image schema is just the skeleton of a of an experience. So, that does not have much connection with the real experience.

Real experience is far more varied, far more it has many more angles to it, many more modalities attached to it and so on. Hence abstract, arbitrary, symbol manipulation cannot be said to have a direct relationship with the real experience. This is beautifully put forward by Zwaan, in this ‘they are floating free in some mental ether and are therefore, essentially meaningless’.

So, it cannot be. So, it is essentially not tenable. So, the other view on this is that, modal representations play central role in knowledge. So, modal representations basically talk about the sensory motor representation; various modalities of visual, auditory, tactile and various other, all the five different sensory modalities, do play a significant role in creating cognition, in understanding, in cognizing per se.

So, starting from the ancient philosophers to empiricists, to nativist philosophers, many believed that images of experiences play a role in knowledge representation. So, it is it cannot be amodal, it has to be modal and there because the images, the entire gamut of feelings associated with it sensory motor input associated with it are also part of cognition.

So, as per this standpoint the brain captures modal states during perception, action. These are the two very important notions that we have been seeing till now. So, while perceiving something, as well as while being indulged in some kind of an action. So, the brain perceives those modal states in terms of those actions and perceptions. And then simulates the same to represent knowledge.

So, when one comes across similar situation again the same multi modal states that is the same multimodal sensory motor states are reactivated, and then an appropriate action is followed. So, we understand a new scenario by simulating a similar situation that we have already encountered. And then we already know what to do.

So, if you have if you have already played with rubik's cube and you find a new rubik's cube which is slightly different, but you still know you can still simulate the notion of how to play rubiks cube, what are the steps to be followed, how is the problem to be solved, then you simulate that knowledge while playing a new rubik's cube.

This is also true even when you are not doing, you are not indulging in the action yourself, but you see somebody else doing the same thing. For example, you watch your friend playing rubik's cube. So, you understand his moves by simulating the moves that you had earlier utilized.

So, this is how simulation really works. So, similar reactivation can also be used for inference, recollection and language; this is what our primary focus is. So, simulation is important not only from a perspective of understanding and inference, but also recollection and more importantly for our purpose in case of language.

A related notion with the aspect of simulation is that knowledge representation is situated. So, it is not only not abstract, not only it is a multimodal kind of a storage where we have all the information necessary, for visual, tactile, auditory and all other things, but also the background information.

So, the context and the context contextual relationship with those inputs are also important. So, there are two primary aspects to this: one is that knowledge representation is modal, is multi modal actually. And then that representation is simulated at a later instance for the purpose of understanding, recollecting, inferencing or using language. Simultaneously this representation is also contextualized.

In this regard, we have already discussed Harnad's theory about the 'symbol grounding problem'. So, let us just quickly recollect that Harnad argued that 'serious theories of cognition should look at symbols that are grounded in perception and action', that is what the symbol ground the very well known symbol grounding problem proposed by Harnad is.

So, symbols or any good theory of cognition needs to take into account the grounding, as in, the 'rootedness' of those experiences. Experiences and their understandings cannot be devoid of the real experience, of the grounding in reality that is what his theory essentially talks about. After Harnad, many other researchers have echoed the same theory and they have looked at various experimental domains to find proof for that.

So, one of the one of the most important names in this regard is Lawrence Barsalou. His focus has primarily been on language. So, and he argued that language comprehension should not be viewed as a disembodied manipulations of a symbol like language, this is the theory that was also given by Searle.

So, you cannot understand just because you can manipulate certain symbols does not mean you really understand language. So, same thing Barsalou also said that language understanding or comprehending language even production of language is dependent upon a manipulation of symbols that is related to the perception and action.

It is not like a computer manipulating symbols. So, after a Harnad and Barsalou's theories, a lot of studies have taken place a couple of decades now and there have been studies from both psychology and neuroscience as well as linguistics that have strengthened this domain.

So, what does Barsalou really mean, why how what does it, how does it really work that comprehenders need to activate or simulate the real life scenario real life scenario of a situation? He gives this example now famous: 'the pencil is in the cup' and 'the pencil is

in the drawer'. There are two ways that you can that he has given two possible scenarios, one is the pencil is in the cup and the other is pencil in the drawer.

So, when you read the first sentence the pencil is in the cup you look at this you think of pencils in this way, that this is how the pencils are arranged. Pencils in the drawer this is how you in some manipulation of this kind. So, basically the difference between these two is that the pencil remains the same.

However, in the first case, the pencil is in vertical position, in the second, it is in the horizontal position. As per Barsalou, this is this particular part of the information about the orientation of the pencil is an integral part of us comprehending the two sentences differently. We perfectly understand this sentence because we know what it is what it refers to.

Similarly, what it refers to and this understanding is takes into account the relative orientation of the pencil. This is what basically Barsalou talks about. So, he argued that a pencil's orientation as well as other spatial details should be an 'automatic by product' of a mental simulation. If you understand the sentence pencils are in the box or the on the in the cup, you automatically are able to simulate the orientation of the pencils, this is what he says.

So, understanding language and in terms of mental simulation, what are the primary what are the main important factors? One is language comprehenders construct mental simulations of the content of the utterances'. Remember, we have always focused in this course in the on the meaning part of it, on the conceptualization aspect of language, not so much on the structural part of it.

So, here also he talks about the mental simulation of the 'content' of the utterance not necessarily how the sentence syntax was formed. So, language is understood through sensory-motor simulations of the actions and events being described. Just as I just mentioned that we understand. So, 'he was playing football'.

The playing football the event that you are talking about is understood perfectly fine by anybody who listens to the sentence, because we are capable of simulating the same experience. So, that is what basically talks about that actions and events all are getting

simulated as we listen. So, data from various behavioral experiments as well as brain imaging studies have found proof for this assertion.

Now, what are these? There are mental simulation is not a homogeneous entity, it has various finer nuances within it. So, some of these finer perceptual details include motion, shape, orientation, distance and location and so on and so forth. So, when you are simulating an event or simulating even an object, simple object, that object may have its orientation, it has its shape. Similarly, it has a location you know close or far and this kind of locations and so on. So, these are the finer aspects of a particular scenario, that could be simulated that have been looked at through various experimental paradigms.

In this backdrop, the idea of an 'immersed experiencer' has been given by researchers. The idea of 'immersed experiencer' is primarily this that the person, comprehenders anybody who is listening to a sentence or a word or anything, who is comprehending a linguistic input, they construct mental simulation in which they virtually place themselves inside the described events.

For example, if you were reading a story or even imagine yourself watching a movie, any kind any movie, the reason why we empathize with the characters in a movie is because we almost consider ourselves transported into the scene. Similarly, for stories when we are reading about reading a story we given the descriptions of the surroundings of the protagonists, we almost consider ourselves as part of the scene as part of the event, so that is what is the idea about immersed experiencer. So, when we are comprehending, we are taking the we are considering ourselves inside the event described event, as a result of which we can be called immersed experiencers.

So, the person the comprehender is 'immersed' in that experience. This immersed experiencer view argues that 'understanding language about a described scene is akin to perceptually and motorically experiencing the same scene as a participant in it'. So, this is basically what. So, the simulation and the immersion of the experiencer inside that simulation is what the whole theory is about.

So, you are not only simulating the experience, but also simulating in such a way that the comprehender considers himself or herself inside that event. Of course, there are various facets to it we will see, which this is also modulated depending on the linguistic input. So, as a result of that immersion, objects mentioned in the sentences should be, in this view,

are mentally simulated as having perceptual properties reflecting the viewpoint of someone immersed in the same scene would take, reflecting for instance angle distance and so on.

So, if the protagonist in a scene is facing the sea, let us say, so, then the reader also reader of the story also is considering himself facing the sea. So, the same viewpoint is the reader takes the same viewpoint as the character. So, they will reflect the same kind of angle, same kind of distance, same kind of viewpoint, which side of the object is visible to him or her and so on. So, for example, reading a story makes us see the surroundings to the protagonist's eyes as I have just said and impacts how we perceive the scene.

So, there are many experimental paradigm that have found proof for this. There are two primary predictions of this immersed experiencer theory within the mental simulation idea.

One is that, comprehenders simulate themselves as participants in the described scenes. And then linguistic information about the distance of objects from a perceiver should modulate the perceptually represented distance of the simulated objects. The second prediction is that mental simulations are multimodal.

One is, that the reader or the comprehender is taking a perspective as the same as the protagonist in the sentence or a story or whatever the case may be. And secondly, it is that experience is multimodal, the mental simulation is multimodal. So, it not only includes visual, but also auditory characteristics of the objects, as we will see; visual as well as auditory characteristics of the objects.

So, after this introduction now let us go ahead with some of the findings in this regard. So, findings are of course, there is a large amount of literature, large number of data that have come out from the last couple of decades or more. So, we will divide those, it is not possible to do justice to all of the finding, but we will look at the major findings in this regard.

So, we will talk look at visual simulation, motor simulation, auditory simulation and even the use of personal pronouns having a an impact on the perspective of the simulation. So, these are the primarily these are the areas. So, there are the these are the different modalities. So, perception these two talk about perception, these talks about action and then even at the domain of pronouns we will see the impact.

Visual simulation: a large number of data actually come from visual simulation, comparatively less data we have from the domain of auditory simulation.

So, in terms of visual simulation there are many different aspects to it. If you just think about a scene that you were looking at, you can imagine how many different facets it can have. You can think about the orientation of an object, you can think about the shape of an object, the distance, the color and so on and so forth.

So, there are so many types. So, we will just try to look at some of these, this some of these finer aspects within the visual simulation. One of the most well known and quite famous studies in this regard about implied orientation and shape of object that is implied in the sentence structure, in terms of visual imagery is this.

Basically what this do is this study is primary focus was on trying to find out if the sentence can modulate your simulation. So, the way a sentence is projected, the way a sentence is created, does it have an impact on the way we actually visualize that particular object, that was the idea. If so then we will see some interaction between these two things.

So, the study went like this. So, they had a sentence and image matching task. Sentences were like this. There were many pairs of sentences, one was like 'the man hammered the nail on to the floor' and 'the man hammered the nail into the wall'. Similarly, there were many other manipulations of this particular structure.

After this, an image of the manipulated object was presented, which is either compatible or incompatible. Let me explain what is happening here. First, the subjects will read a sentence like this 'the man hammered the nail into the floor', and then there will be a picture of an image and the subjects had to decide whether that particular object was there in the sentence or not.

So, for example, when you listen 'the man hammered the nail on to the floor'. And then you look at the picture of a nail, you will the answer will be 'yes', yes the nail was mentioned in the sentence, but if you see the picture of a tree he will say no the picture was not. So, this is the task, but the task over task is this.

But, the manipulation is in this case that the manipulations are the 'yes' trials, yes trials are those where there is a match. There is a match, as in, that the sentence mentions that

particular object. Now, what was the basic hypothesis in this case is that compatible conditions will have less reaction time than the incompatible ones. What does this mean?

Let us think of the sequence. So, first they read the sentence and then they look at the object and then they there is a key press yes/no kind of a reaction. So, they say yes or no. Now, compatible condition will be let us say this is the sentence and the image represented here is that of a nail.

So, it will be an yes trial this will be a yes trial. Now, the interesting manipulation in this case was they will have this sentence and this will come once with the nail, once with the nail that is oriented vertically, in another case the nail will be oriented horizontally. The hypothesis was that if the orientation of the object aligns with the way the sentence talks about it, then they will take the participants will take less time to say 'yes' to that.

However, if the orientation is not compatible with the sentence, then they will take longer to say yes. In both cases the yes trial is the target trial. And because this is an experimental set up, there is also a equal or known number of 'no' trials, but the no trials are not the target trials, the target trials are yes one is compatible condition, the other is incompatible.

Compatibility basically refers to similarity between what the sentence says and what the object really represents. So, in case of when they are the same orientation, subjects took less time, RT is for Reaction Time, that is how long you take to give your answer. So, the subjects took considerably lesser time in when the object was in the same orientation as the sentence simulated.

So, this is one of the earliest studies of language helping us, helping comprehenders simulate a scenario. So, the when the man have when we read a sentence like the man hammered the nail into the floor, we are automatically simulating the orientation of the nail. Had it not been the case, it would not impact the judgment on the object, this is the hypothesis if we if the sentence does not simulate, for example, if you if it has nothing to do with how we look at the nail, how the nail was it should not have any relationship whatsoever with the judgment of how the nail whether it was a nail was present or not, but they did find a strong reaction, strong compatibility effect, which means that if they are similar they took less time which proved the other the point that actually we are simulating the subjects were simulating the scene in their mind, and that is how they understood.

So, results verify this hypothesis. Similarly, there are many other similar ones for example, ‘the eagle was in the sky’ versus ‘the eagle was in the nets nest’. In both cases the same object the bird was the same, in both cases there were the there were this was the eagle. But, in one case when you say that the eagle was in the sky is you already imagined the eagle with the wings spread.

In the other case, the eagle in the nest will have the wings drawn in and then you show them the picture of eagles in different, either with the wings open or closed and there will be the same kind of reaction time differences were found. So, participants in each of these sentence picture matching task were asked to just see the object.

They were not asked to do anything else just look at the object and then say whether it was there in the sentence or not. So, even when you are not actively helping them simulate, we are still simulating this is what the major point of this line of research is.

So, language mediates simulation, by simply changing one part of the sentence we can simulate an entirely different scenario. And the fact that we do simulate, is reflected in this kind of findings. So, in this case also the critical manipulations were ‘yes’ trials match and mismatch were in terms of shape and orientation.

There are many other studies also in the same line, which all found the same kind of answer. So, basically the first the sentence comes and then the object matching, object which has to be matched comes. So, it is a sequential trial, it is one thing follows after another, so the prime and then the target.

Yet another domain of research within visual simulation is the condition of visibility, whether it is clearly visible or not clearly visible and so on. A very interesting study by Zwaan and his group demonstrated that language comprehenders mentally simulate the visibility conditions of a described scene.

So, it is not only the orientation or the shape of the object, but also the visibility condition, which means even a finer detail about the object is simulated. So, for example, they use sentences like ‘through the fogged goggles, the skier could hardly identify the moose’ and there were many other sentences like this.

And they what they found was, participant responded more quickly to a blurred image than to a high resolution image of the mentioned entity. You see, it is a very very significant finding in the sense that the sentence says that the skier could not see because his goggles were fogged, he could not see the moose clearly.

If the comprehender, if the reader or the hearer of the sentence, is not putting himself in the skier's shoes there should be no difference in him identify. In fact, the high resolution image should be easier to identify than a than a blurred image; however, the reverse happened, reverse happened after reading a sentence that talks about a blurred image, the participants actually found the blurred image far more quickly. They responded far more quickly to a blurred image, this is what is a proof of simulation.

Similarly, yet another important group and they studied that the experiment in what they did was their experiment explored knowledge retrieval during use of words to think of an object.

So, so far we have seen about shape, orientation as well as visibility, how clearly visible or not clearly visible the object is. In this case they talk about, they say if a thinking of a word makes you simulate the whole thing, because conceptual knowledge is rooted in perceptual and action based representations.

So, one such aspect of knowledge is the spatial information, as that is something very very important, that information is extremely important for us to help, to decide how to interact with an object, how far it is you know how closely you can see the thing and what the other such aspects of the scene.

So, they did a 'inside versus outside' perspective study and its role on object recognition. They use sentences like this, there were three perspectives: one is inside, one is outside, one is a mixed perspective. Inside perspective use sentences like this: 'you are eating in a restaurant'. So, what is happening here is you are eating in a restaurant automatically simulates a scenario where you were inside that scene.

Outside perspective, 'you were waiting outside the restaurant' and then mixed perspective they are used, 'we are walking toward and entering a restaurant'. So, this is a mixed perspective. What was the task? Task was to identify is the if the probe word, that is the target word for us, is a part of the object.

So, is table a part of restaurant? is sign a part of restaurant? and so on. So, first the sentence that basically creates a scene within which the subject is either inside or outside of the scene and then they have to simply decide if the probe word is part of that

The prediction was, if linguistically described perspectives affect the availability of conceptual information, then there should be a perspective that is outside versus inside and part-location interaction.

So, if the object if the way linguistically the scene is described makes it has an impact on how you retrieve information about that particular object, then we will see an interaction. So, by putting you inside the restaurant, does it make you look closely, does it create a closer interaction between the subject and the objects inside that scene or does it have no impact.

This is what they tried to find out, simply by using language sentences in different ways. Nothing is there was no other the task given to participant was simply to say ‘ok you read this sentence and then you see the word and you may tell us whether this object was this word is part of that object or not’.

The result showed effect of perspective on the availability of conceptual knowledge. So, if you have read a sentence, you were eating in a restaurant and then you were given a word like table you were quicker to identify. However, if you are eating inside a restaurant and the probe word is a sign, then there is a the inhibition, there is a longer time that you take.

So, by this, they have proved they proved that the way linguistically mediated conceptual information is simulated, it affects the way you perceive words and their connections. Similarly, there is yet another interesting study in this regard: Horton and Rapp they look at shift in accessibility as a result of occlusion in the narrative.

So, when what is occlusion? Occlusion is coming in front of or creating a distraction, creating a occluding the view. So, you could see something and then something comes in between the viewer and the object and you can no longer see it clearly. So, if that kind of a scenario happens in the narrative, how does it impact the identification of the object?

This is how the idea, this is what the question that they asked. So, the perceptual availability is the question here perceptual availability hypothesis talks about if the object is perceptually available to the protagonist, the reader will readily identify. So, this is again taking us back to the experiencer immersed experiencer. So, the if a particular object is perceptually available to the story the characters in the story, then the reader also will have the same kind of understanding.

They created stories this particular experiment was carried out by using stories when the subjects read the story line by line. So, these are the five till here the story goes like this. So, Russ was in the hospital recovering from minor surgery. In the bed next to him was an older man named Marty. A television was attached to the ceiling between them. At Marty's side was a tall vase of flowers. Till here, the story goes like this and then it has it takes two turns, one is called the blocked version, blocked story, the other is the unblocked story.

There are two types of continuations; the story had two parts till the 5th sentence, Russ's friends had only given him a get well card. So, this till here it is the same story and then there are two types one is the blocked story continuation, where a nurse came in and drew the curtain around, a nurse came in and attached a monitor to Marty's bed, right?

There is a problem here this is the second sentence this should be the one a nurse came in and basically the nurse comes in and puts a curtain around, and then because she needs to take some do some to do some to she wanted privacy, while she did an examination. In the other scenario the unblocked scenario is, the nurse comes in and attaches a monitor to his bed and then she needs to take blood pressure.

So, this basically there is a scene somebody is in the bed, hospital bed and somebody else has come there. And now, because there is there are two possible scenarios; in one scenario the nurse comes in and blocks the view of the protagonist, in another case the nurse does not block the view.

Now, the target question was did Marty have a vase of flowers, was there a vase of flowers?

Now, if the reader of the story is viewing the scene as Marty is, then in the first case if the scene is blocked they will not be able to the viewer will also think of a blocked scenario. So, readers were as a result of this, the readers were slowest to respond in the blocked

story, because Marty cannot see if the scenario was blocked because the nurse came in and pulled the curtain.

The readers were also slow to respond whether the vase was there, because their situation models reflected decreased perceptual availability; because the protagonist in the story had a decreased perceptual availability, similarly the readers also behaved the same way.

Similarly, visual distance is yet another aspect that has been that has been that has been worked on by Bodo Winter and Bergen, Benjamin Bergen.

In this case, the task was to decide whether the object was or not mentioned in the sentence. Again it is a 'yes' trial, but the manipulation was in the sentence itself. So, reading a sentence would lead the reader to automatically perform a mental simulation of the event. The more similar a subsequent picture is to the readers mental situation the more the reaction will be facilitated.

So, these are the kind of sentences that they had. 'A frisbee in your hand; versus 'a frisbee in the sky', in the first case frisbee is closer. So, the distance is being manipulated here. So, in this case it is closer, in this case it is far. Similarly, you were looking at the milk bottle across the supermarket or this is a far condition or you are looking at the milk bottle in the fridge which is the near condition.

So, they manipulated various sentence pairs that basically looked at the same object, but in two different distance condition far and near. So, basically pictures showed objects in far and near condition. The situation sentences created either far or near conditions and then the pictures came in, they also had a far and near condition, which was basically manipulated by redoing their sizes.

Now, one important thing to be remembered here is that they the researchers in this case looked at objects that are token invariant. Token invariant basically refers to objects in the real world that display relatively little variation in sizes across exemplars, basically those objects that do not typically differ in sizes in the real world.

So, a cricket bat remains the same shape and size wherever you go in the world. A football the ball used in the football game remains the same size. So, basically if you decrease the size of a football, then it creates the understanding of a distance. So, you were looking at

the football from a distance versus you were looking at it from a close up then it is near to you that is the were the pictures were manipulated.

Again, but here what happened was mismatch condition had higher response latency as well, but in the match condition you have a lower response latency when there was a match like we have seen before.

So, if you have a if you read a sentence that talks about far distance, like you have 'you see the milk bottle across the supermarket' and then you see an object the same object that the bottle of a milk in a in small size then you recognize it much more quickly compared to if it is far if it is near to you.

So, if there is a match the time is less. So, this shows when reading sentences about distant objects, comprehender simulate smaller objects. So, when you think of distance you think of the objects in a smaller size. So, this is also in terms in keeping with the earlier findings.

Now, let us move on to auditory simulation. So, we not only simulate the visual aspects of a scene that the sentence talks about, but also the auditory information, how is that? Experimentally, speaking how is that carried out in case of both simulation of motion as well as other spatial features, like distance. In case of auditory simulation these are the two domains that have been studied primarily.

So, in one study while the study was basically reading and making sensibility judgments whether the sentences are meaningful or not. So, the participant listened to an auditory stimuli, conveying motion towards, up away and four kinds of motions were integrated in the sentence.

And then the auditory stimuli were bands of white noise manipulated to create the impression of motion. There were two things that are happening simultaneously. One is the participant listened to the white noise, there was through their earphone, through their headphone, they listen to a noise that the noise was modulated, it was doctored in order to make it sound make it sound like there were four different motions that were depicted.

One is the noise is going away from the participant, noise is coming closer basically by manipulating the amplitude. Similarly, they also manipulated it to make it sound like the sound is going upward or the sound is going downward. So, basically manipulating the

sound , auditory input through the headphone, which simulates which creates an imagery of four kinds of different motions. Simultaneously, there were sentences that conveyed motion in four directions, all similar same four directions.

They had to do a sensibility judgment task ,simply read the sentence and say whether the sentence is meaningful or not. In this case, participants were faster in the mismatch condition.

This is a very interesting finding, in this case we do not see a facilitation of the match condition. So, when they are hearing a noise that is coming closer to them and they are also reading a sentence that mentions something moving closer to the subject, to the agent, then there is a there is a problem, then there is a higher reaction time as opposed to the mismatch condition.

In the mismatch condition, they hear a sound going away from them, but the sentence depicts a movement towards them, this is the mismatch condition. In this mismatch condition they were much faster in reacting. Now, the how the researchers have explained for this, explanation for this finding is that conflict arises when auditory perception system is required to process two stimuli at the same time.

What is happening in this case? Till now, we saw there was a there was a prime a sentence will be displayed first and then after that they have to do a judgment task. So, in that case we see a facilitation, that if you have already simulated a 'near' object and then you see an object that appears to be near even quicker to react.

However, in this case, both the stimuli were given *simultaneously*. So, you are making the perceptual system busy with two different tasks at the same time. Now, when that happens there is a conflict and that conflict is seen in the reaction time. So, the sound of the motion described in the sentence and the sound of the auditory motion stimulus are in conflict with each other, because they both are using the same perceptual system.

Yet another study of by Winter and Bergen 2014 talked about this is again a sentence-sound matching task. What they did was participants read sentences and subsequently heard sounds of objects or animals that were either mentioned in the sentence or not, similar kind of design. So, the participant's task was to verify whether the sound they heard was of an entity in the mentioned in the sentence.

Just like the picture and sentence matching task before. So, you listen to the you read the sentences and then hear a sound and then say then you have to say whether the sound was present in the sentence or not. Manipulations, again the same kind of manipulation sentence mention two kinds of distances, sound volume basically refers to the again the distance. If it is loud it is nearer, if it is not loud it is very far.

So, sentences were like this, this is just an example there were many such sets. So, 'someone fires a handgun in the distance'. So, this is a 'far' condition. 'Right next to you someone fires a handgun'. So, these two kinds of sentences is creating two different is simulating two different kinds of perception of the sound.

If somebody fires a handgun right next to you, the sound will be much higher much louder as opposed to when it is far away. What is the result showing? Matched condition yields significantly shorter response latency. Again in this case, one thing follows another the sentence follow sentence precedes the sound.

So, when they listen to a sentence 'right next to you somebody fires a handgun' and then you hear a very loud noise of a handgun you say yes this was there, but if you have the reaction time is much shorter, but if you hear a very faint kind of sound of the handgun you take longer, this is what the finding says.

So, facilitation effect was seen. This study points out that simulation is multimodal. So, not only it is visible in terms of simulation is a impactful only when in the visual domain, but also in the auditory domain.

So, it is basically multimodal. So, simulation is not only a present not only is simulation proven through these experiments, but also that the simulation is multimodal

So, these are the hypotheses that we started with. So much so, that even the use of personal pronouns can modulate the way simulation really works. So, several studies have found that personal pronoun such as 'you' or 'she' can modulate the perspective of a mental simulation. In one such study readers mentally embody an actor's perspective, alternatively readers might also mentally simulate the events from an onlooker perspective.

So, what perspective you take? See till now we were looking at the perspective taken by the protagonist being the same as the perspective taken by the reader. This particular study

actually manipulated that by manipulating the pronoun system as used in the story. So, in this case they in the use two experiments examine the role of pronouns by manipulating that.

In one case, ‘you’ is or ‘I’ is used in another case he is used. So, when third person pronoun is used the perspective taken is that of an onlooker, but when you use a first person or a second person pronoun, then the perspective taken is that of the protagonist. So, even a simple change of pronouns shows that language mediated simulation actually is activated when you comprehend language.

So, language actually the structure of language the sentences, in this case they mediate the simulation, mental simulation of the event not only in terms of visual, auditory, but also in terms of the perspective taken by simply manipulating the pronominal system.

And then comes the motor simulation, so visual simulation auditory and so on. Now, we come to the motor simulation and in fact, in simulation literature, a large number of data actually comes from motor simulation and very interesting findings too. So, in a series of sensible in this particular study, series of sensible and nonsense sentences were used and the participants were asked to determine, as quickly as possible, whether each sentence made sense this was the task.

So, they read sentences and then the task was to read the sentence and just say whether it is meaningful or not whether it is sensible or not; obviously, that is the task there are two kinds of sentences used meaningful and meaningless. What are the sentences? But the sentences that were used were manipulated in terms of movement.

One is ‘open the drawer’, ‘put your finger under your nose’ and so on. In this case the implication is that there is an action *towards the body*, when you open the drawer and open a drawer there is a movement of the hand towards your body towards the body of the agent the speaker.

Put your finger under your nose and many such other possibilities that imply that simulate a scenario where the movement is closer to the body.

In other sentences which they call ‘away sentences’, ‘close the drawer. So, when you close the drawer, your hand moves away from the body, ‘put your finger under the faucet’ and so on.

Similarly, they also had these meaningless sentences because the task was to judge the sensibility of the sentence. So, the meaningless sentences were like boil the air and so on.

The manipulation here was the button press which was very cleverly manipulated. So, once first they had the sentences and then they had a button box. Button box had various different buttons, but the manipulation was that in certain cases the critical is in this case also the critical is the ‘yes’ trials. So, the meaningful sentences are the critical trials not the meaningless sentences this is just a filler. So, meaningless sentences were a filler, they are distracters.

But, the critical trial were the meaningful sentences. Now, the test was to see if you read a sentence that implies a movement toward the body and then you have to, subsequently, perform an action that is either similar to the sentence or opposite to the opposite to the movement that is mentioned in the sentence, is there an interaction.

So, if a sentence says that you close the drawer which means the sentence is implying a movement away from the body and then you have to perform a task for which you have to move your hand away from the body also, then there is a compatibility these are similar kind of actions.

So, you are already simulating an away movement and then you are carrying out an away movement. So, then there should be a compatibility. So, this is how cleverly the response button was created. So, the buttons that you in they were manipulated in two ways. In one case in some of the cases the ‘yes’ button was near to the participant, in some cases the yes button was.

It was they used a button box and in let us just imagine something like this and there was in one in some cases the yes button was this, in some cases the yes button was this. And the middle button they had used for moving the sentences. So, they started the experiment by moving the middle button.

The result showed the action-sentence compatibility effect. Meaning, if they say if they read a sentence that talked about and movement away from the body and they had to press the far yes is far button, then there was compatibility, meaning they took lesser time. This was a facilitation.

So, in now we have seen a lot of data and lot of studies both in terms of visual as well as auditory as well as motor movements that are that can be simulated through language. Now, we have seen that there are two possible kinds of impact. Simulation is there, but does simulate simulation mental simulation facilitate the effect, facilitate then subsequent action or does it inhibit the subsequent action.

So, there are two possible effects of that simulation. So, the studies represented so far show a dynamic relationship, as you as the sentence unfolds the simulation also unfolds. So, between depicted aspects in the linguistic input and the reaction of the participants, this is dynamic. Often, we see a facilitation effect and we describe the findings in the light of activation of the same networks.

However, there are also findings that show a reverse pattern. So, often we see facilitation, but also sometimes we see a reverse pattern. These two different kinds of findings can be understood in terms of these two effects, one is called the compatibility effect, the other is called the interference effect.

Two things happen in case of simulation and the reaction of the participants, the way they interact it is dynamic. And this can have two different types, two different manifestations, one is the compatibility effect, the other is the interference effect.

So, compatibility effect is that when that we have already seen a sentence depicts a scenario and then something similar has to be processed, we see a compatibility effect.

So, in order to perform a motor action, one must activate neural motor structures responsible for that type of action. If understanding a sentence leads to increased or decreased activation of the same neural structures, then the this should result in quicker compatibility actions. Performing an action as well as perceiving images depicting actions should be facilitated by either facilitated or inhibited by language.

So, action-sentence compatibility effect we as you have just seen the opening the drawer versus the closing the drawer, there are many other such studies as well. So, action sentence compatibility effect or it is also called ACE. This effect shows the extent to which motor representations are activated for language understanding.

The main idea behind this is that, if language understanders perform motor imagery, using neural structure dedicated to motor control, then understanding sentences would actually facilitate, that we have already seen.

So, this is the explanation for that why do we see the compatibility effect? Because reading a sentence, understanding a sentence has already activated the motor perceptual domains in the neural networks in the brain that is already active. So, subsequently if we have to perform an action it shows compatibility effect.

So, similar studies where there in another study. So, there is sentences are like this 'Andy handed you the pizza', 'you handed Andy the pizza'. So, in two cases the movement of the hand with respect to the body is opposite. Similarly, they have they just like the drawer example, we have also they had equal number of meaningless , similar kind of study because it was a sensibility judgment and we see compatibility effect just like the previous study. So, what is basically happening is that understanding language depicting an imagery or action, activates the neural structure

The opposite also happens, when does it happen? This is how opposite of inter compatibility effect works out. This is, however, this is closely related to the compatibility effect, this is not something different, it is not a separate function at all.

This is the same part of the same process, but the crucial difference is that, this is the crucial difference. The same neural structures are required to do various tasks at the same time, when we have that prime sentence first and then the target object follows, there is a facilitation.

However, if you are making the same neural structure busy, at the same time for doing two different things, then you see interference. Either way it proves the fact that you are simulating, perceivers or comprehenders simulate the scenario and subsequent as a result of which, the neural network is active at that time doing processing exactly that.

So, like understanding language and performing the perceptual or motor task require the same neural structures to perform different task at the same time. So, when do we see interference effect? When you give the same task to somebody who is do already doing something else. So, this is simple if you were eating and talking, often people choke, same kind of things we see.

So, if you are making the neural network do the same at the same time, we are making them do two different things we will see interference.

Interference effect again it has been seen in various domains. One of the most interesting is the domain of visual interference effect. The study of visual interference actually goes back a long way, Perky effect was seen in 1910 probably. So, what is Perky effect?

Perky effect shows that, in her experiment she showed that visual imagery affects visual perception. So, while you were imaging imagining something and there is simultaneously the object present in the screen, you will think you are still imagining this is what Perky's finding was.

So, the experiment was like this: the participants subjects were asked to imagine something, while staring at the blank screen and the blank screen that was presented in front of the participants. So, they were told to imagine a leaf or a banana or something.

As the participant is busy imagining looking at the blank screen, the object that they have been asked to visualize, is actually projected on the screen, gradually, first under the threshold of perception and gradually it gets higher resolution and becomes more and more clear. However, the interesting aspect of this is that the participant thinks even when the object is clearly visible in the screen, he or she thinks that he or she is still imagining the object.

So, this is what the famous 'Perky effect' is visual imagery can affect visual perception. This is the same paradiagm that has been utilized in many subsequent research experiments, many permutations were later on carried out. So, these findings show that perceptual system, in particular the visual system consciously engaged in process of, in engaged in the process of natural language processing.

In this regard there is a rather famous study by Richardson et al in 2001. What they showed was language processing language about concrete or abstract motion along different trajectories in the visual field. Now, we can talk about visual imagery that a sentence depicts.

So, 'the Frisbee is in the sky', frisbee in the hand and so on, but you can also depict notion both in terms of a concrete sentence as well as in terms of an abstract sentence you can actually depict kind of a motion.

For example, sentences like 'the poacher hunts the deer' or 'the ship sinks in the ocean'. Sentences like these simulate a scenario that has an orientation that has a movement across either on the horizontal plane or on the vertical plane.

So, what they do is, that the sentences that create abstract motions along different trajectories in the visual field. Sentences were given some subjects heard sentences whose content had implied visual characteristics. So, they hear these sentences, while you hear this sentence the simulation will help you imagine. So, there is a visual imagery already accompanying the understanding of the sentence and immediately they had to do a task.

The task was like this. So, first they hear the sentence and immediately after that they had to do a judgment task that whether the object on the screen is a square or a circle.

This was the simple task, there is no connection whatsoever between the sentence or on with the image on the surface, but the manipulation here is very crucial. So, in one case the poacher hunts the deer this implies the horizontal arrows move like this, arrows do not usually do not typically, arrows do not go in the vertical scenario, vertical orientation.

Now, if you have if you have heard this sentence and then subsequently you have to do a judgment task, you have to do a identification task, whether it is a circle or a square. Now, the crucial manipulation was that if you have heard the sentence 'a poacher hunting a deer' and then these two objects appear on the horizontal plane they will take more time to for the judgment.

If you have this kind of orientation after the sentence then time taken will be less and this is exactly what they found. So, in a sentence like 'offended' even abstract notions like offense offended, 'lifted' so on and so forth. Also simulate kind of a movement either on

the horizontal or on the vertical plane. And then subsequently, immediately after that, if they are required to utilize the same visual field for a different task then there is an interference effect that is seen. Similar kind of interference we also see in terms of motor activities, motor interference effect

This is in case of cross model methodology, this is a rather well known very famous study by Benjamin Bergen.

And he has done many versions of this; this is a image-verb matching pair as similar. So, there are different kinds of possibilities. So, there are stick figures, doing various things three kinds of and they call it affector. They use different kinds of affector: hands, legs and mouth and the there are pairs, there is one image and then there is an a word, there is a verb.

The task was to say whether there is a match. So, this is a match scenario this is a match scenario for example, the character is hopping. So, if you see a character hopping and then you see the word hop it will be an yes answer. But, the critical answers were actually the 'no' answers the mismatch was the main target here.

So, they had two different kinds of mismatch condition, one is the same affector is being used, but they do a different task. So, in this picture is showing hopping, but the word says 'punt'. There are two different things that the affector same affector is doing.

Similarly in this picture the character is scratching his hands, but if you give the word a 'juggle' then there is a mismatch. What they found was, that subjects took longer in cases of mismatch when they shared the affector, rather than when they did not. So, for example, both this case and this case are mismatch conditions; however, similarly this.

So, this is a mismatch because the person is screaming this is also a mismatch. So, you see the picture of the stick figure screaming and the word appearing after that is 'kick' there is absolutely no problem. The subjects took considerably less time to say that they do not match; however, most critical was this, this particular pair.

This particular pair, because in this case the affector in this case the mouth, in this case the hand, in this case the legs the affector remains the same. So, that in the image it is doing one thing, in the word it is doing another thing.

There is a conflict, there is a tussle and as a result of which we see an interference effect in terms of longer reaction time. So, all these studies, whether it is compatibility effect or it is interference effect, we see that sentences or words basically simulate we simulate a scenario.

And on the basis of that the simulation, automatically leads to a neural activation and then depending on what kind of task has been given. If it is task is subsequent to the prime, then we see a facilitation and if it is simultaneously happening or happening in quick succession then we see an interference effect.

So, either way, we understand that comprehenders simulate the object or event presented in the sentences and evidence is both from compatibility and interference effect are evidence of the same hypothesis. So, this language driven mental simulation is multimodal, as seen through visual and auditory modalities.

So, this is about simulation and its relationship with the with language, language comprehension.

So, this is the last part of the course. So, let us go through a quick summary of what we have done so far from the beginning. So, module 1 we talked about the background, the theories of cognition and cognitive exploration into the nature of language and knowledge.

2nd module talked about conceptualization as a process and within that process we looked at the relationship between language and the mental functions, the expressions.

Module 3, we further we took the exploration further in the same conceptualization process, but we looked at the issues from the perspective of Frames and how Frames make us understand various different conceptualization of the same event or the same situation and so on. So, seemingly irreconcilable standpoints can be understood through the use of Frames.

Module 4 looked at again looked at the embodiment hypothesis in terms of image schema and how it interrelates with the language structure and language understanding.

Module 5, we looked at language acquisition, language learning and how this process also like the previous parts, this aspect of language also has relationship with various non linguistic factors. So, primarily the social cognition and other such modalities.

Module 6 talked exclusively about the brain relationship of language with the brain and language functions.

Module 7 looked at language and attention in terms of how the two processes drive. So, this is a this is a two-way traffic how attentional mechanisms and language has a dynamic relationship during processing.

And last, the module 8 has executive functions. We looked at executive functions through various language systems. We also talked about various critical debates, and today we talked about simulation in terms of language comprehension, how simulation is an integral part of., so, basically when we talked about language having relationship with brain, with social cognition, with attention and executive control, all these things ultimately basically lead to what we call simulation. So, simulation basically means recreating the entire experience and you see this recreating of experience has such an important role to understand language.

And thereby we can conclude, safely, that language is a process that can be fully understood if and only if we take into account the background cognition. So, all these processes refer to the, what is famously called, the ‘background cognition’ of language. So, we need to understand language with respect to or at the same time looking at the background cognition.

Thank you very much for your attention, this is where we close the course.