Language, Culture and Cognition: An Introduction
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Module - 07
Part - 3
Lecture - 17
Sentence Processing

Welcome to the part 3 of module 7. In module 7, we are looking at the relationship between attentional mechanism and language processing. Language processing in various domains of whether it is at word level, at sentence level, whether it is in terms of semantic or word level processing and so on lexical level processing and so on.

So, in the last part we have had a look at a detailed look at the visual world paradigm and the visual search paradigm and how these 2 paradigms are utilized for establishing the relationship between or let us say exploring the relationship between language processes and visual attention. So, we looked at language mediated visual search, we also looked at how the top down processes also affect language processing and so on.

In this part, we will look at to some extent the Sentence Processing aspect of language; language within language processing, we will look at sentence processing and with respect to the attentional deployment how much attentional network is affects language processing and what is the relationship and so on.

So, because we have already looked at the visual world paradigm using the eye tracking as a method, this segment we will look at eye tracking in a very brief manner, but we will look at more in terms of the ERP and fMRI and other and such neuro and neurophysiological studies.

So, fMRI and ERP are both brain imaging studies. So, we will look at how these domains of research has increased or enhanced our understanding about this particular domain of relationship, between language and other cognitive mechanisms. So, we will look at comprehension, speaking, reading and cultural variation with respect to this.

Before we move on with the actual research, a very important aspect to keep in mind is the idea of automatic processing. Now, automatic processing is an area of research that has slightly different tone and tenor in terms of cognitive psychology versus psycholinguistics.

So, in terms of cognitive psychology, a distinction is made between automatic and voluntary processes, on the basis of the engagement of attention and effort. So, whether or not deliberate attention is utilized as a guiding principle for certain processes or not, and if there is a deliberate deployment of attention then there is also an amount of effort that is included in that.

So, whether or not we include these 2 processes into a certain kind of a task, it decides whether the process is automatic or it is voluntary. This is how cognitive psychology looks at it.

So, automatic processes refer to those processes that are voluntary that are involuntary, sorry. Once the process starts, it ends on it is own. It is some kind something like a ballistic process as per Logan 1980. So, if you are interested you can go to this particular paper and there is a detailed discussion there.

So, this means the such processes are not dependent upon any other cognitive apparatus like memory. So, when it comes to memory there can be memory restriction and there are various other aspects of memory, similarly attention or any other perceptual processes. So, automatic process as a as per definition of automatic process, in cognitive psychology, is those processes that we are capable of carrying out without these other mental or cognitive apparatus.

But, in this course, we are interested more in terms of how does it affect in language processing. So, which aspect of language processing is automatic or involuntary or which processes are voluntary. So, the moment we say voluntary we are automatically bringing in other apparatus like attention.

So, the moment we focus our selective attention to something that makes it automatically voluntary, because we want to do we want to process that information and, we have already seen that. In the last part, part 2 we have already seen that a lot of language processing

aspects are actually voluntary in terms of deliberate shift deliberate employment or deployment let us call it deployment of attentional mechanism.

So, we have already seen that it does make use language processing does make use of other mental mechanisms. But, now, we will see whether sentence processing as a distinct area is also as dependent on attentional mechanism or not.

Now, certain things about linguistic processes have already been observed. This has been around for a very long time. First and foremost, a large aspect of linguistic processing appear to be automatic. What does it mean by that? When we listen to an any linguistic stimuli for example right. Now I am speaking, anybody listening to me will automatically process whether or not a deliberate deployment of attention takes place. This is this is something that is understood, this is something that is that is given.

So, it automatically activates knowledge; knowledge that we already have about a particular domain. So, whatever I am talking about automatically one listens and the signals are carried forward to the brain and that gives rise to the spread activation which we have already seen.

So, each word is capable of giving rise to the frame within which it is understood, each word also gives rise to all the lexical entities that are somehow similar or attached or related, associated with that particular lexical entity and so on. So, this part is automatic.

So, meaning is derived even if it is task irrelevant. So, you understand until and unless I am speaking in a language that you do not know, if the language is shared and we are talking about things that are commonly understood, then meaning generation is taken for granted. Meaning is derived anyway, you understand you cannot say one cannot say while listening to any linguistic input in a language that you know that you will stop understanding the meaning of the sentence, right. So, that is or that is again automatic.

So, there are there have been studies that look at whether you know even if there is no the task in the lab situation, the task does not demand you to understand the meaning of the sentence, but look at the structure of the sentence in the subject still activated the meaning. So, meaning generation is automatic. It is derived automatically as soon as you listen.

So, linguistic processing can be initiated without deliberate efforts and attentional deployment. This is very crucial because the initiation of the processing is automatic. It seems to be automatic at lexical level, at semantic level even at a syntactic level. So, when you are listening to a sentence whether the sentence is grammatical or not you will not take much time to actually understand that. So, that bit is taken for granted as automatic, so it can be initiated without deliberate effort.

In this regard, Chomsky's influence has been enormous in terms of the modularity aspect. So, Chomsky if you if you recall we talked about Chomsky and his theory of innateness hypothesis and how syntactic processing has some kind of a primacy, how syntactic processing is the sanctum sanctorium of linguistic processing, how syntax is paramount and so on.

So, Chomsky's influence led to studies a actually a deluge of studies dedicated to finding primacy of syntactic processes. In fact, that is that trend continues even today. So, that is leading to the binary of structural versus semantic processing. So, semantic processing in terms of parsing.

So, what does parsing mean? When we listen to a sentence we listen to the entire sentence and we part by part we try to make a sense of it. So, the structurally there is a parsing that happens in terms of subject and predicate and so on and so forth. So, that part is as far as Chomsky is concerned in terms of his transformational grammar this is automatic. This does not need any other kind of influence.

Shortly after Chomsky's theory came in for Jerry Fodor seminal work in this domain brought language processing within strongly within the ambit of automatic processing. So, on the one hand Chomsky is talking about Chomsky is talking about the innateness hypothesis that syntax is not dependent on semantics and so on and so forth.

And, then Fodor's work talks about modularity. Modularity is in the brain has different modules to process and language is one such module which, automatically if you believe in the modularity theory, it means that language processing is not dependent upon any other cognitive apparatus. So, Chomsky and Fodor and a lot of other researchers were focused on the automatic aspect of syntactic processing, because syntax was paramount in Chomsky's paradigm.

So, sentence processing appears automatic and unconscious. Thus it is understood to be a process that does not require the help of attentional network and this entire idea is dependent on the, based on the process of parsing as we have just said.

However, in the initial this was the initial trend of research. It is only recently that sentence processing has started to be looked at from the in within psycholinguistics has started being looked at in terms of it's relationship with other mental mechanisms.

Not necessarily getting into that semantics and syntax dichotomy, but looking at the language processing, sentence processing as a whole and how it probably can be connected with or is it connected with and if so to what extent? – these are the questions that are being asked only recently. So, this area of research is very comparatively new.

Now, what we know some of the things that we know of course, that is one disclaimer here this domain of research is though comparatively new, it has already created a wealth of data.

A vast range of studies looking at different aspects of this understanding whether sentence processing is automatic or how much and where within the processing you know the temporal window, within the language, within the sentence processing where the attention deployment actually starts where it ends and how much and so on and so forth.

It is a very rich area of research and it is not really possible to give you a sense of the entirety of it, but we will see some of the important findings. So, some important findings in this domain that point to syntactic processing seems to be automatic, but semantic processing is not because when it comes to meaning you need to pay attention. This is a very very important study by Friederici in 2011.

Similarly, selective attention to different aspects of sentence modulates brain networks. So, if you are paying selective attention that is dedicated attention to certain different aspects of sentences and depending on which aspects of sentences and what kind of selective attention, it actually has the capacity to modulate brain networks. This is yet another very important finding in 2009.

Additional cognitive load in terms of dual tasks and dual task also affects sentence processing ah. So, dual task as in while processing sentences if there is yet another task

given to the participant, like remembering something. So, basically increasing the cognitive load of the participant, it has been seen that sentence processing gets affected, which means if sentence processing gets affected due to increased cognitive load, which means sentence processing is not automatic.

So, there are certain very very important findings in this domain which of course, when we see them together, that brings more questions than answers, but these are certain some of the important landmark findings. So, these suggest, that certain aspects of linguistic processing are part of strategic processing and hence attention can modulate these processes.

So, not if not in the entirety of linguistic processing, but certainly certain aspects of sentence processing do depend on strategies of certain types and if there is a strategy in place, then there has to be attentional mechanism also in place. So, these are the some of the findings.

So, in terms of sentence processing, ERP studies and in auditory and visual sentence processing has been a very rich source of information about the knowledge in this domain. So, both in auditory and in visual sentence processing, as in, when the subjects are given an auditory input in terms of listening to sentences or there they are given a visual sentence like they will be reading something that we have already seen in part 2.

And, then ERP components basically is the result that we see, that reflects the different aspects of processing. So, ERP component is, what is ERP component? ERP is the result, is the output of the EEG as a machine so ok.

So, I think let us see this first. So, language processing with respect to visual attention engagement is what we have seen already using eye tracking, right. So, eye tracking is as a methodology uses the movement of the eyes as an indicator of the processing strategy that the human brain is employing at given any kind of a task.

Similarly, in terms of brain potential and cortical activation, language and attention relationship is probed using EEG and fMRI. So, whereas, eye tracking looks at the visual attention engagement; EEG and fMRI looks at brain potential. So, this is seen through EEG and cortical activation is seen through fMRI.

Brain potential with respect to EEG is refers to the brain signals the electric signals that the human brain generates and the EEG machine picks up those signals and it goes through an amplifier and the resultant ah what we see ultimately is a is a sine wave that is displayed on the computer. So, that is our signal. So, this is the event related potential. So, the given a task what the kind of output that we get is the ERP signal that comes out of EEG machine.

So, these techniques show in real time how the brain potential works out, what are the various brain regions that get activated, how do they respond to various kinds of manipulation in the sentence structure and so on in real time. So, as the participant is looking at or listening to sentences of various types depending on the manipulation in the experimental setup how the brain potential changes. So, this is what we can see.

And this is of course, seen in both comprehension and production. Comprehension as in when you understand a part, when you are listening to something and trying to understand mind versus production when you speak out. So, in those case both cases these are used.

So, ERP studies have been used in both auditory and visual sentence processing, while you are listening to something as well as when you are looking at a sentence and reading it out and then understanding. And the various ERP components then reflect different aspects of the sentence processing.

ERP component – so, what is ERP component? ERP component is a positive or a negative going brain potential that has certain fixed latency. So, this brain as I said the output of the ERP is a sine wave. So, there are positive going waves and there are negative going waves.

So, these are the 2 kinds of waves that are basically the output and there are certain components within this output at certain fixed latency, that is what are the indicators which are used in ERP. So, these are N400, P600 and so on. So, N400 is the peak which happens at the negative going wave at 400 milliseconds. Similarly, P600 is the positive going peak at 600 milliseconds and so on.

So, there are certain typical brain mechanisms that are associated with these ERP components. So, when there is a semantic anomaly, N400 is found. Semantic similarly when you have a syntactic anomaly we see a P600 effect and so on. These components are time locked to the critical word.

So, basically when you are listening to a sentence exactly at the time when you are listening to the critical word in the sentence or a critical part of the sentence that is when it is locked. And the typical tasks will have some violation of the critical word, like if you are if you have a semantic violation or a syntactic violation and so on.

So, we will see some experi.. examples now. Before we move on let us just learn the names of these there are the most commonly realized ERP components. So, as we have seen already ERP components are the positive going and negative going brain potentials, usually with a fixed latency.

Now, latency here refers to the average time span in milliseconds always, now after which the wave shows a peak. So, P600 as I said at 600 milliseconds. So, it is the positive going wave; N400 on the other hand this is a negative going wave. So, these are some of the important components ERP components that are typically used. MMN is mismatched negativity, LAN is late anterior negativity, ELAN is again early LAN, N 400 and P600 we have already seen.

For example, let take this for example, so N400 is found when a parser that is the person who is looking at the sentence finds a word that violates semantic or pragmatic aspect of the sentence. So, if a sentence like this 'I like my coffee..' had it been with cream or let us say extra sugar this would have been a perfectly fine sentence. So, the brain expects something like this.

But, if you have a sentence like 'I like my coffee with dog' this is where the N400 effect is expected. So, the moment this is the critical word in the sentence and this is the part where the brain will show the N400 effect. That is how N400 effect works. So, this is what a semantic anomaly or pragmatic anomaly looks like.

Similarly, P600 effect is seen if there is a problem of integration at the syntactic level. That is the sentence violates the grammatical rule of a sentence structure in a given language. So, this basically effect reflects reanalysis.

So, when you are reading a sentence and you have come to the critical part and it does not really follow the rules of the language of that particular language. Then you need to reanalyze the sentence, say something there is something wrong something is something needs to be relooked turn needs a relook. So, that is when you see a P600 effect.

So, these effects are fixed and they are they are already connected to certain kinds of difficulty to the brain phases while processing sentence. So, take a sentence like this the 'bread was in the eaten'. Till here the first sentence is ok the bread was if this part was not there the sentence is still ok, but when you have created an anomaly in the sentence structure, there is a P600 effect that is typically found.

Similarly, N100 is yet another brain potential that indicates initial identification of sounds and therefore, is a component of early phonological processing. This happens remarkably quickly because it peaks at 100 milliseconds. So, identification of sound happens extremely quickly. So, the phonological processing is basically extremely quick.

Similarly, ELAN is at about 100 to 200 millisecond and is assumed to indicate word category identification. So, you see how it goes. The at the initial stage N100 reflects the identification of the sound, within 100 to 200 millisecond word category identification already happens.

So, there are these various kinds of components ERP components that are connected to various styles of processing and difficulty in processing and so on. However, there are some recent studies that have found that this kind of a watertight compartmentalization probably is not always possible because the distinction is not always clear.

There are some recent findings that show that P600 effect has been found in case of semantic anomaly as well and N400 in case of morpho-syntactic anomaly. So, the allocation of N400 for only semantic anomaly and so on, probably does not work given various kinds of task conditions and other things. So, this is what we have as a background with respect to ERP.

Similarly, fMRI: fMRI we have seen before this is also a very useful method towards understanding the cortical activation in case of language processing in real time. Remember, we talked about fMRI the principle on which fMRI works is that it shows the activation level in certain cortical regions, in terms of the blood oxygen level. So, it is called bold signal, blood oxygen level dependent signal.

So, basically the area of the cortical area of the brain that gets more oxygen reflects more activation at that level and which basically means that area is active while processing the particular part of the sentence or the word or whatever. So, studying attentional network

in the brain using this method has shed light on several dedicated cortical networks for different types of attention.

It has also shown important brain areas responsible for various important brain areas as well as cortical networks. So, fMRI has been a very very useful tool for us to look at the attentional deployment in humans with respect to various kinds of tasks.

So, for example, with the remember we talked about attention having various components – orienting, alerting, engagement, disengagement and so on and so forth. So, in terms of orienting, brain imaging studies have found that these are some of the areas superior parietal, frontal eye field and superior colliculus are involved in the orienting of attention.

So, when we are trying to orient attention remember Posner's cueing task. So, whether it is an external stimuli, that is, bottom up process or it is a voluntary orientation these are the areas within the cortical region that are found responsible for orienting.

Similarly, we have alerting. So, right frontal and parietal cortex are involved in alerting responses. So, on the one hand we have seen orienting and then we have alerting. Several sub-cortical areas also like the anteriors these are some of the areas. Anterior cingulated, lateral ventral areas so on and so forth have been found bound to be crucial for executive control of attention that has been that is the work of Posner and his group.

Similarly, studies have also shown that some other domains of cortical areas are involved in partial attention. Remember, we talked about attention in space and so on. So, there are various brain regions, basically cortical as well as subcortical areas, that are responsible that are activated while we either orient our attention or alert our attention and then there is an executive control mechanism of that attention.

So, there are various areas.

Now, in terms of sentence processing, sentence complexity has been found to modulate left hemispheric language areas like the classical areas of Broca's and Wernicke's areas, similarly the left inferior frontal gyrus as well as their homologous right areas. So, these are the areas that have been found to be affected by sentence complexity, right. So, sentence complexity can affect or modulate hemispheric areas.

Similarly, processing of auditory sentences have been found to activate anterior superior temporal lobe bilaterally, that is, in both the hemispheres. So, processing while processing auditory sentences this is the effect that we see.

The processing of negative and affirmative sentences again so, the sentences in terms of whether they are affirmative or they are negative, sentences in Hindi there have been a very interesting study by Kumar et al in 2012, that used fMRI and this they found activations in inferior frontal gyrus and so on, for both types of sentences.

So, brain regions are active whether it is a one what are the brain regions that are active whether in it is a an affirmative sentence versus it is an a negative sentence and so on that has also been looked at by using fMRI as a method.

The left temporal lobe showed selective attention during processing of negative sentence. So, you see there is a selectivity there while processing negative sentences, left temporal lobe showed selective attention. So, these are some of the findings with respect to this.

Similarly, certain grammatical features, more importantly like prosodic features like pitch, typically are understood to be a mechanism to shift of attention. So, depending on high pitch if the a sentence has some high pitched words that we tend to listen to them or pay more attention to them in a given even a given discourse scenario.

So, prosodic features like pitch can mark sentential segments for higher focus and therefore, it is possible that they may engage attention directly. This is already understood that pitch affects your attention, if you high pitched part of the sentence gets more attention. So, in because of that it is possible that pitch prosodic features like this can engage attention directly.

So, there has be the this particular study in 2012 carried out a study that manipulated pitch and semantic congruency of a spoken sentence and found that a common fronto-parietal region was active during processing of pitch induced focus and tasks that demand spatial attention.

So, there has been a study that could connect the pitch modulation affecting attentional attentional mechanism in the brain; this evidence suggests that language and attention can use often use a common neural network during processing in some context. So, not all in

all context in this particular case the pitch is has been the manipulating factor and in this case it has been found to be engaging similar at brain regions.

Attention to syntactic versus semantic properties of sentences, supposedly involving selective attention also recruits distinct brain areas. So, Rogalsky and Hickok 2009, 2009 found specific activation of the Anterior Temporal Lobe. This is the region they found that got activated when participants attention was specifically called towards semantic aspects of the word. So, there has been various kinds of manipulation in sentence processing by using pitch as a as a factor.

Sometimes by using semantics as a factor and deliberately drawing attention to a particular to that particular aspect in the sentence and then trying to see if it has a it has a neural signature and that is what they have actually found the typical certain specific areas in the brain were found to be activated.

But now it is one thing to find out co activation, it is one thing to find out that during language processing certain brain areas responsible for attention and so on, get activated. It is entirely different thing to say that those sentence processing aspects will not work without attentional mechanism. So, however, such findings does not say if attention is necessary or not for processing syntax and semantics.

So, the crucial factor is here. Of course, we see co activation of various brain regions that take us to the domain of specific types of attention and so on, selective attention, spatial attention and so on. It is not still very clear whether it is necessary whether it whether it causes it is there is a correlation, but we do not know about the causation.

Merely says that when subjects attend to one aspect of the some stimuli, the other aspect also receives some processing.

So, attention manipulation affect basically. So, this is the lesson that we finally have. Attention manipulation affect some aspects of sentence processing both ERP and fMRI evidence suggest that selective attention could modulate parsing, it could modulate, but whether it can cause or whether it is absolutely necessary or not that we still do not know.

In terms of neuropsychology, for example, there are some interesting findings again. Ah In patients with cortical damage, we talked about brain neuro degeneration and how various kinds of language disorders actually generate out of that problem and for example, Alzheimer's and Parkinson's and so on. So, that these are the population that we are talking about.

So, in patients with cortical damage, with limited resource for attentional mechanism have also been found to have sentence processing difficulty. In terms of neuropsychology, we see that patients with cortical damage also have difficulty with sentence processing. So, sentence processing problems sometimes are they do co-occur with neuronal degeneration.

So, for example, in case of Parkinsonism, this disease affects the basal ganglia and the frontal striatal thalamic loop, which is important for executive functioning such as working memory and attention. So, basically what we are looking at here is that Parkinsonism as a disease has certain neurodegeneration happening in particular areas which are responsible for memory, working memory, attention and so on.

And, these people have also been found to have problems with word and sentence processing. So, such patients often fail to do what tracking performance in sentence processing.

Even in simple sentence processing task they find it very difficult if given alongside any other task. So, in simple task word tracking is difficult, in a dual task it is again very very difficult. And, they even fail to notice phonetic and semantic errors in sentences. So, all these point to the fact that such patients lose the automatic aspect of sentence processing.

Remember, we talked about automatic as automaticity in sentence processing, that certain aspects like phonetic identification that happens at 100 that is 100 milliseconds within the within the onset of the stimulus. Similarly, word category identification happens within a very very short time. ELAN shows your 100 to 200 milliseconds. So, these things are missing in case of the Parkinson's patients.

So, what happens basically is that those areas because of the neurodegeneration in those areas, they even lose out the automatic aspect because within before 200 millisecond you cannot have a voluntary reaction. So, this is they are understood to be automatic, but in

this case they lose even that because they have lost phonetic and semantic errors in sentences, word tracking performance is also affected.

If we look at SLI, we have talked about SLI before specific language impairment which is typically found in some children without any other disorder. So, they have no other neuronal disorder, any other cognitive disorder, but some specific language related issues they have. So, these children typically show severe problem with grammar, semantics and phonetics.

A recent study, 2009 again, examined age and IQ matched SLI and control normal control children on a visual sustained attention task, the performance of the children with SLI was poorer than the control group. What this means is that there were 2 groups of children, one group suffer from SLI, the other group does not; other group is normal children and they were given a task that is dependent on selective attention sustained selective attention.

So, attentional deployment was the task. There was no language related task. However, we already know that SLI patients SLI children have a severe linguistic disorder. Now, there is no reason why a person suffering from just a simple linguistic disorder could also do badly in terms of attentional tasks.

So, even they even showed deficits in auditory and visual stroop task. They are dependent on attentional mechanism, deployment of attention and executive control and so on, but that also gets to be seems to seems to be affected. So, which shows that in the background there is some kind of a mechanism that do play out in terms of connecting linguistic abilities with attentional abilities.

In case of speech, that is production of language joint attention between children and their caregiver is found to be very very important for language acquisition. This is something we have already seen, when we talked about language acquisition. So, attention takes does bring in lot of interesting outputs there as well.

One important thing is that in case of children, the attentional mechanism is supposed to be in place by the time the child is 3 years of age. So, that mechanism is kind of almost fully developed by the time they reach 3 years. This is also the age when children speak in sentences. So, because of this correlation in terms of temporality, there have been many studies to look at whether that is actually that there is a module modulating effect as well.

So, Tomlin study, which is a landmark study again, demonstrated that selection of sentential subjects and crucial reference are modulated by attentional selection of objects in the visual field. So, there were objects in the visual field and student and the subjects had to speak about them.

So, participants used certain objects as subjects of sentences that is first noun phrase, if their attention was drawn towards that object with the help of a cue. This is a Posner's cuing paradigm. So, there were objects in the in the visual field. The subject was the participants were looking they were made to look at those and those are the objects they used as subject in the sentence. So, that this is how they showed a connection between this the attention and the sentence generation.

Eye tracking evidence shows that, in another study, if participants were asked to name individually presented objects the they inspect that object for 200 milliseconds before speaking. Thus engaging selective attention, individual objects when you have to name objects. So, before the name they look at they pay selective attention to those objects that they have to name for they spend 200 milliseconds looking at it before they speak.

In another study, children and adults were found to pay selective attention first to the event and then to the human agent. So, they were displays of various events, various normally occurring scenario and they were asked to describe the scene, right. So, presented with pictures and asked to describe what is happening.

So, what they did was the first attention was deployed at this at the event, event aspect of the picture. So, what is somebody is playing, so, that part of the picture they focused first and then they looked at the agent who is carrying out that particular activity. So, because speaking about something requires one person to map the events on the subject predicate structure.

We need to create a subject predicate structure, but for that we know what goes where, right? A sentence structure while creating a sentence we have to formulate that particular structural aspect of it. So, we must know what is happening there. So, that is why probably the subjects were found to be used looking at the event aspect first and then the agent and then formulating the sentence.

In terms of reading, also there are some interesting research findings and what we see is that part of it we have already talked about before. So, we will just go over this in a brief manner. So, reading basically is an acquired ability. It is not something that was given to us reading is a recent activity in terms of humans.

So, even though it is development is recent, human brain has already specialized some already has some specialized networks and a complicated chain of attention allocation system associated with reading. So, we are not only have a chain of attentional allocation system, but we also have some specialized networks in the brain that are devoted to reading.

So, visual word form area is one such area which we have discussed in the last lecture, which basically looks at looks at identifying visual the word form and so on. So, this leads to visual word recognition. So, while reading there are various stages of reading, so, first you have to recognize the word and so on.

So, visual word form area facilitates the top down contextual knowledge and it is interaction with the bottom up features. So, what you are on the both sides of the attentional mechanism. So, on the one hand the stimulus that is given to you the features that are given to you to read and then the attentional allocation and the interaction is what visual word from area looks at.

So, in case of sentence reading, reading a sentence is basically a complex process that involves both linguistic and visual process, right. So, since this process involves eye movement in case of sighted people, it involves eye movement. So, naturally it involves visual attention that is something we have already seen.

So, attention shift is also mandatory. So, we shift attention from one word to another and that is how we read. So, most of the research in this domain basically we have looked at in later looked at sentence reading from 2 perspectives: whether it is a serial processing or whether it is a parallel processing.

There are 2 models we will not get into go into the details for brevity of time, but these are the 2 important models that have been given for towards understanding how the eye movement control actually happens. So, E-Z model talks about serial shift of attention

from one word to another. So, when we read a particular given sentence, we read word after one word after another. So, we move our attention there is a shift that happens.

But, the SWIFT model talks about that proposes attention as gradient, where one can process several words together. Basically, when you are looking at one word, you are not only focusing on the foveal aspect of it, but also on the para-foveal. So, there is a particular word in the focal focus, but then we can also see the other areas surrounding it.

So, we do not really read one word at a time and that is in fact, there are many such games that float around in the internet, you can read you can read a paragraph even when there are lots of errors because we do not really go by one word after another. We get the meaning even if there are errors, the letters are you know sometimes reversed, letters are orientations are reversed and so on and so forth.

So, the models differ in terms of how basically the linguistic features guide eye movement. So, this is how the this is the basic difference between these 2 models. Linguistic how linguistic features in the given stimulus can have different modulations on the eye movement, as it is as it is employed in processing.

Yet another interesting area within language attention and language processing is that of cultural variation. This is again a very new area of research. New in the sense of experimental research, but the study actually goes back long time. We remember we talked about the linguistic relativity hypothesis and so on.

So, recently there has been a lot of work using the same hypothesis, but using experimental paradigms. Looking at attentional language in terms of spatial understanding, how the attention allocation to objects in space may or may not differ depending on the language one speaks, and obviously, the culture that it connects to.

So, in case of space, attention allocation locates objects. So, when we are looking about talking about objects in space, there are 2 things that happen. First and foremost, attention locates object in space and then language describes it's position, right. So, language talks about it visual attention or any other kinds of attention we will locate the object and then language will give it a description.

So, we have already seen that languages differ a lot, in terms of the kind of frame of reference that we use. We have seen that there is a relative frame of reference, there is intriguing frame of reference and there is absolutive frame of reference. Absolutely frame of reference is very interesting from research point of view.

Because it needs a very different kind of computation at in real time come very very which has to be dynamic, which has to be one has to always remember one's location and the angle one has moved, in terms of the fixed location from where the location is derived in that particular language.

So, frame of reference is different from one language to another as a result of which the allocation spatial allocation also is different. But, the important question here is whether cultural differences can be seen in processing as well. So, fine there are differences in linguistic terms, but does it mean that when it comes to processing, attention allocation will also be different.

There have been some interesting studies ah, but it is an emerging area again with respect to experimental work. One interesting study by Coventry 2010 show how language comprehension depends upon the affordances. We have talked about affordances before and functionality of objects. So, what one object can do? So, trees are climbable, you know. So, umbrellas are used for stopping the rain or from for you know making us to get us from rain getting drenched and so on.

So, the functionality and the affordances of an object, that particular understanding, does have an impact on how the sentences of how we process sentences. So, functionality of objects when listening to spatial language is something that Coventry looked at. This is called this is the famous umbrella experiment the task was to match a picture with a given description. So, there are various pictures and there are various descriptions.

The finding was speakers match existential knowledge to judge the suitability of the description. So, which picture actually so, even if for example, this picture in this picture you cannot say that he covered himself with an umbrella.

So, there were various task, various sentences given – the man is under the umbrella; the umbrella is over the man and he is so on and so forth. So, depending on the world knowledge of the people of the of those sentence situations, the matching happened.

Similarly, yet another very interesting area of attention and culture and there are a lot of data is coming in from the domain of bilingualism. Bilingual bilingualism research is beginning to look at how language processing strategies might differ across culture even at a very base basic core cognitive mechanism like attention.

So, there are some studies that have looked at it, where they look at if culture has a unique role in core cognitive component like attention. So, bilingualism research for example, this is this has been a very important and influential research which has been replicated by many others as well. This study looked at Arab and British participants.

Now, Arab and British cultures are very very different on the one hand British culture respects individuality. So, societies are individualistic, analytic and so on; whereas, Arabs are a collectivist culture something like this oriental occidental difference. In India also Indian culture is a collectivist culture whereas, in the Western culture, American culture, British culture and so on their individualistic culture.

Given this kind of a background, the study predicted that the Arabs would deploy more dispersed attention processing, while the British might give selective attention to individual objects.

So, what they did was, they searched for objects presented focally or in the background. So, they had the there were various pictures given and the subjects were supposed to find out an object in the in that picture.

Sometimes the manipulation was pictures were presented focally, in the foreground, sometimes in the background. And, they were expecting that the British people will find the objects presented in the foreground easily compared to the Arabic speaking people. Arab Arabs will be better in finding out the object in the background because of the dispersed attentional mechanism.

And the result shows result is in tune with the prediction. Arabic nationals were found to be slower in finding objects presented focally. So, this is connected to the differences in cultural aspect of the attentional mechanism, because collectivist cultures will find the objects in the background, but not so much in the. So, they were slower. Not that they were not able to find out they did find out, but they were slower and that is what is important here.

There have been many other similar studies as well, specifically Nisbett and his group has done many studies in this domain, where they have shown that easterners use more contextual processing than westerners and seeming like Americans use more attention to foreground than background and so on.

So, there has been some interesting studies in terms of how Eastern and Western cultural variation actually plays out in terms of attentional allocation; whether it is linguistic task or a non linguistic task. Many more such studies are coming out, but the results are not yet conclusive.

So, to summarize language processing in general and sentence processing in particular do reflect deployment of attentional network to a great extent. Of course, there are many many different strands of research and, but the fundamental aspect is that they do employ attentional mechanism.

This connection is visible through visual attention modulation as well as brain imaging studies. However, the results are still not conclusive, in terms of the degree to which attention might affect automaticity aspect of the of sentence processing. This is very crucial and we still do not ah. When there is a deliberate processing, of course, attentional mechanism is deployed and there is a lot of dynamic relationship.

But, the automatic aspect of language processing, as we have already discussed in the beginning of this lecture, how much that depends on how much attentional mechanism actually can affect that automaticity is yet to be found out. So, this is where the research as of now stands.

This is some references.

Thank you.