Advanced Cognitive Processes
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Lecture – 19
Reading – I

Hello and welcome to the course introduction to Advanced Cognitive Processes. I am Ark Verma from IIT Kanpur and we have been talking about language in the last week or so. In the last lecture, I talked to you about production of language. I tried to explain what are the various processes in production of language and it basically began from you know you conceive of an idea of what to speak about and you go through various stages which will describe very well by Levelt model of speech production.

And we kind of saw that you know starting from a conceived idea to actually moving your muscles is actually a fairly complex processes there are quite a few very sophisticated and very fascinating you know details that you really have to take care of before you are actually you know even uttering a single word. So, that was about production of language. Today I am moving towards slightly different territory.

I am going to spend a couple of lectures now talking a little bit about reading again it is not really a course on language. So, I am not really I am going to go in much detail of this, but the idea is actually to make you familiar with a little bit about aspects of reading and we are going to you know look at how reading is accomplished what kind of a cognitive processes reading involves and say for example, how does the visual processes, how does the visual perceptual mechanism interface with reading because reading is not only a visual perceptual skill, but it also a cognitive skill.

So, there has to be some interaction between perception and language here.

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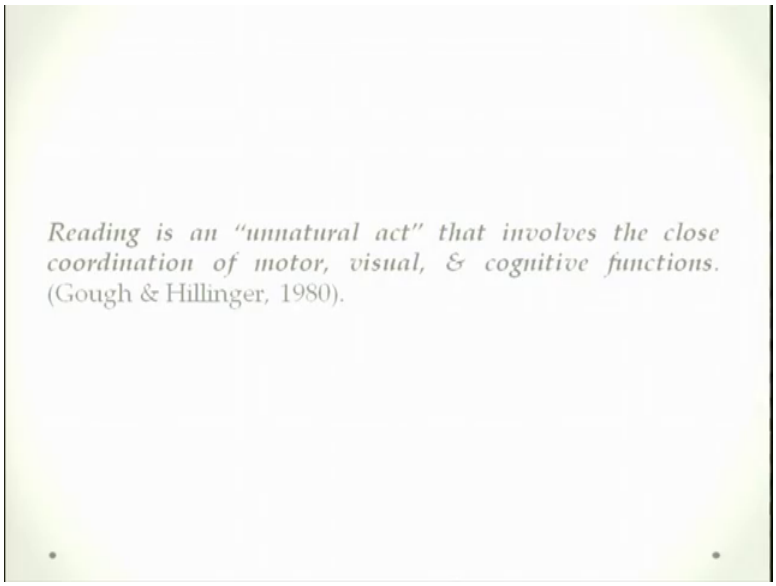

So, let us begin by asking this question about what reading is. Now, if you remember I have been you know constantly reminding you of the fact that when we talk of language we are generally talking about spoken language, when you are talking about production of speech that is the more natural form of language that people have been used to since you know eternity, since so long millions and thousands of years ago.

But, the idea is that you know let us say past a few thousand years ago scripts started evolving people started making symbols abstract symbols on walls and those symbols started denoting stuff and this is something which kind of developed and it came to the point that now you have really very ni[ce] you know very sophisticated scripts you have symbol systems that can you know elaborate and that can kind of depict or denote any system or any you know aspect of spoken language that you would want to talk about.

So, on so, I mean it is it is become so interesting in such a way that reading is almost now considered as a very natural you know extension of interacting in using language. However, reading is not something that the brain was attuned to do ever since language evolved reading and Gough and Hillinger basically in nineteen eighties remarked this that reading is an unnatural act you know it is not something that the system is made to do it is something that the system kind of picks up you need explicit training for reading.

If reading were a natural act you know people would automatically do it say for example, you know a spoken language you know you do not really need a lot of explicit

instruction for people to acquire spoken language, but reading is something that people need explicit instruction you know. People need to spend time learning how to read learning how to connect these symbols learning how to you know go from the visual symbol to the sound to the meaning.

So, in that sense reading is certainly an unnatural act that involves a very close coordination of at least three processes. It involves coordination of motor processes, visual process and cognitive process. Why is motor because motor and visual are slightly linked when you are talking of reading because you have to move your eyes and then do the visual analysis of the symbols to get to meaning and meaning making obviously, is a more linguistic or language processing based or function.

So, this is I mean these are the aspects of reading which we will try and you know discover in the course of the next two lectures this one and the next one and we will try and discover why a reading is such a special process.

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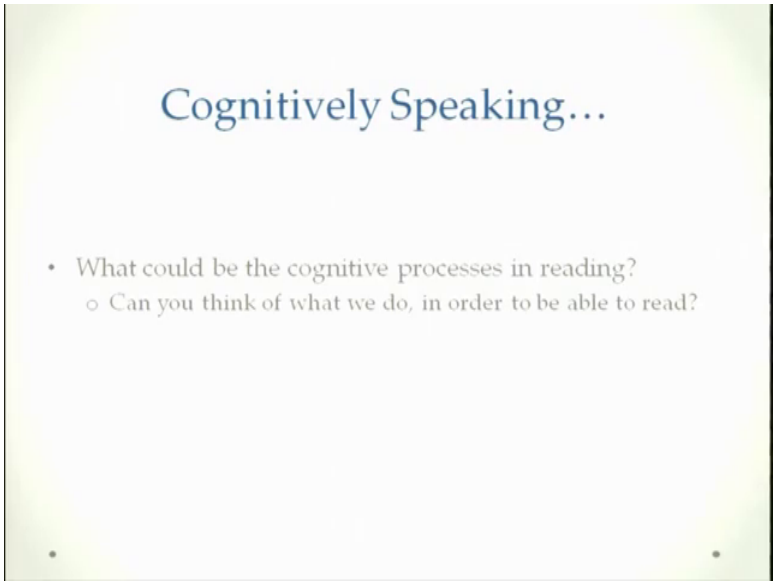

So, let us begin. Now, if I ask you know can you think of what are the different cognitive processes that people must be using by you know performing the reading and I have already given you some clue about that I am I have already mentioned things like visual analysis.

So, one of the most basic things that somebody would be doing is probably doing the visual analysis you know making sense of what this symbol really means appreciating say for example, if you know look at the scripts in Indian languages the Devanagari script that is used for Hindi for that matter is a fairly complex script you know it has not only the letter that is you know corresponding to [FL] it also has diacritics or [FL] you know on the top sometimes in the beginning sometimes in the end sometimes on the bottom sometimes.

So, the idea is you have to really make sense of what these complex symbols are also what these [FL] are on top of these symbols and that is a fairly you know that is a fairly challenging visual task to achieve.

And, you see it is it is such a interesting task that nowadays if you go for an eye check up or something that the general visual acuity test that they will give you involves reading you know of letters and reading of alphabets from a particular distance. So, this is one and the other thing that the you know that might be very important for reading after you have done the visual analysis is to actually link the visual symbol.

If you remember I was talking about the grounding problem earlier linking this visual symbol per se which does not really stand for anything to a sound based representation which stands for the actual object in the real world remember we were talking about how people make meaning and one of the things about making meaning was that how do you connect this symbol to the real object in the world to the object in the real world.

So, you have to first achieve the visual analysis really get to know what this symbol really is about and then kind of you know go to the sound based representations from this visual thing and the sound based representation is later linked to meaning. So, in that sense if you know if you kind of think over it for a minute or 2 reading is a fairly complex cognitive function which involves many phases. So, we will see we will try and see what are the things that people are doing.

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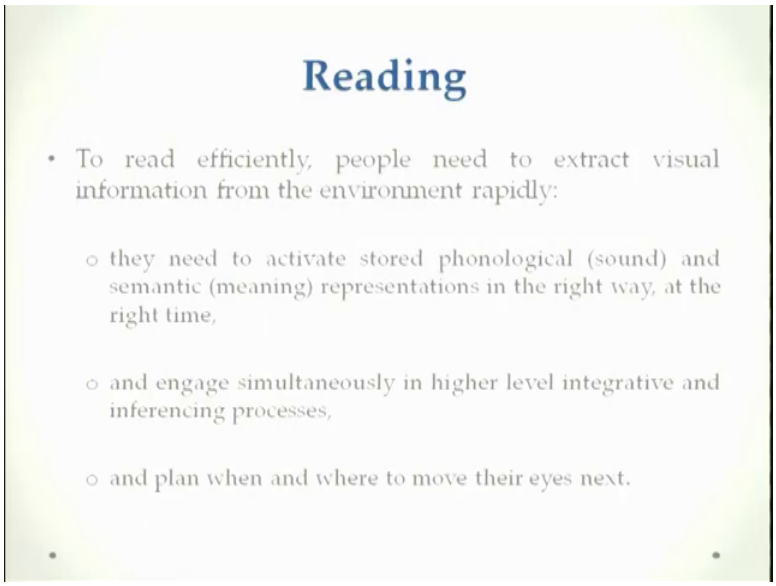

So, reading to read efficiently one of the first things is going to an into a little bit more detail here people need to extract visual information from the environment rather rapidly. You will not see that people spend a lot of time on one word and then they move to the next word and then they move to the next word it is almost very natural it is to people who have gained some degree of literacy it is very natural for them to you know kind of move on from line to line and page to page in a very quick you know in a very little time in a very quick matter of seconds.

So, what they are doing here is they are activating the phonological code and connecting it to the semantic code that is the sound code with the meaning code in the right way and in the right direction for that matter if you are reading a script like Hindi or for example, English you have to kind of go scanning from left to right in a very rapid phase doing the visual analysis going to the sound and then going to the meaning at a speed which is fairly interesting.

And, the idea is you also have to be because comprehension involves fair you know a fair meaning complicated processes. So, while you doing the visual analysis and while you are generating the sound and the meaning there you also have to integrate all of these representations to the you know larger frame say what are you reading about you know.

Suppose, you are reading a thrilling story, so, while you are doing all of this you know basic level analysis processes visual and then phonological and then meaning making you are also kind of thinking in a in a broader sense about what about the plot is you know whether the villain will be caught or not and those kind of things. So, in that sense again you know you would see that reading is a rather complicated process. And, one of the very important things about reading is gaining of this visual information and how do you gain this visual information you move your eyes over the text.

So, part of today's lecture we will actually emphasize on the fact that moving eyes in a particular manner is very important and there is this entire motor system that is kind of dedicated to you know help you plan your eye movements such that you can get maximum information and correct information when you are scanning a piece of text.

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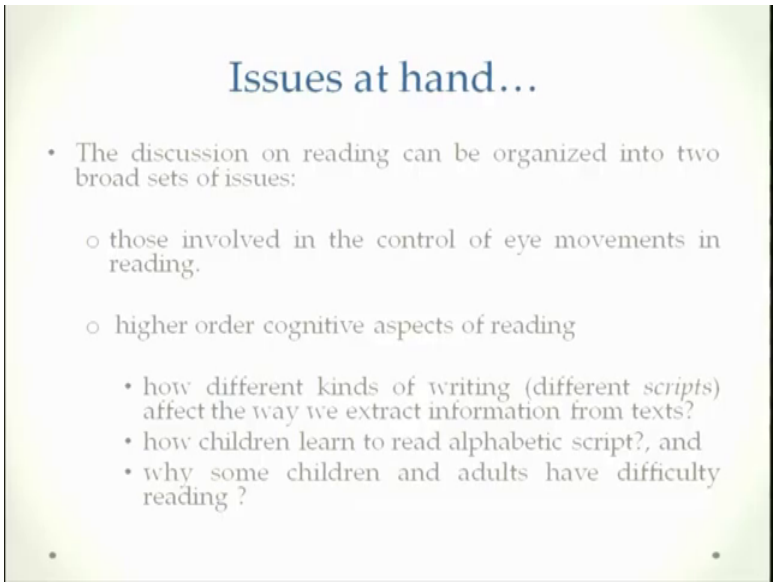

So, given that I have given you this preface this little background there are you know two kinds of issues that mainly come to the fore when you are talking about reading. The first issue and the more basic issue is basically involved in the control of eye movements in reading how do you sca how do you use your eyes to scan the piece of text that is very important and then there are higher order cognitive aspects of reading things like, for example, what are the different kinds of how are the different kinds of script going to really you know influence your eye movements, how will you gain information from these different kinds of scripts.

Suppose, for example, you know scripts like in Hindi and you know fairly simpler scripts like English and then there are even more complex scripts like the Chinese or the kanji and kana scripts in Japanese.

So, what is this aspect of these different scripts that will influence how you are going to uptake information while you are reading? So, those are very important aspects. Also when you are talking about reading being an unnatural act one of the things that people need to pay attention on is how are people acquiring the ability to read. You know, reading is not something that you are born with or not something that you acquire almost naturally without instruction, you need some instruction you need some help in figuring these things out.

So, what are these characteristics that children are using in order to grasp particular scripts. Also when you talk about this one of the things that certainly should come to the fore is there are we know of people who suffer from basic difficulties in reading. So, I mean I am sure you all of you must have heard of dyslexia some point or some place. So, we will in the course of these two lectures talk a little bit about how you know difficulty in reading kind of gets translated to disorders like dyslexia what are the things that might have gone wrong and so on and so forth.

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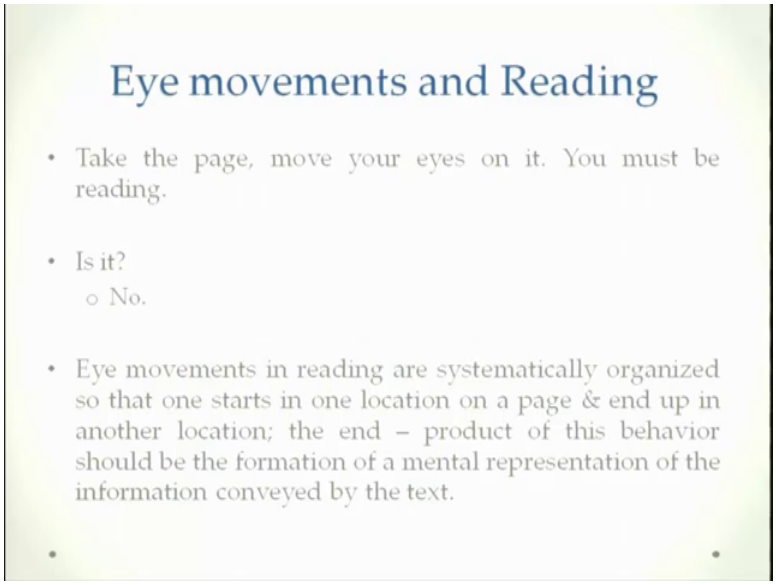

So, let us now come towards you know tackling one of the first issues at hand let us talk a little bit about eye movements and how eye movements might help us in reading. So,

what kind of eye movements comprise readings? If suppose for example, there is a page of text suppose you know there is a newspaper in front of you or there is a screen with alphabets written, if you are just scanning your eyes randomly over there are you reading will you gain information out of it? No. You are not reading per se you have to move your eyes in a particular fashion in order to extract visual information and that is what will comprise reading.

So, eye movements in reading especially are very systematically organized you know. So, people start in one location on a page and then end up at the other location and the end product of this behaviour because you are planning to move you know you probably start from the first word then you go to the second word then you go to the third word and you are kind of moving in this fashion till you actually in a particular order you are not really vertically scanning at least when you are reading Hindi or English you are not vertically scanning stuff or not diagonally or randomly scanning you are kind of moving word by word in a particular direction which is consistent video script.

So, left to right for Hindi and English and right to left for you know Persian, Hebrew or those kind of languages.

The end product of this eye movement behaviour basically should give you a mental representation of whatever the text is conveying to you whatever information the text is kind of intending to convey. So, you have to do that visual analysis go to the meaning and go to the sound part and then go to the meaning part.

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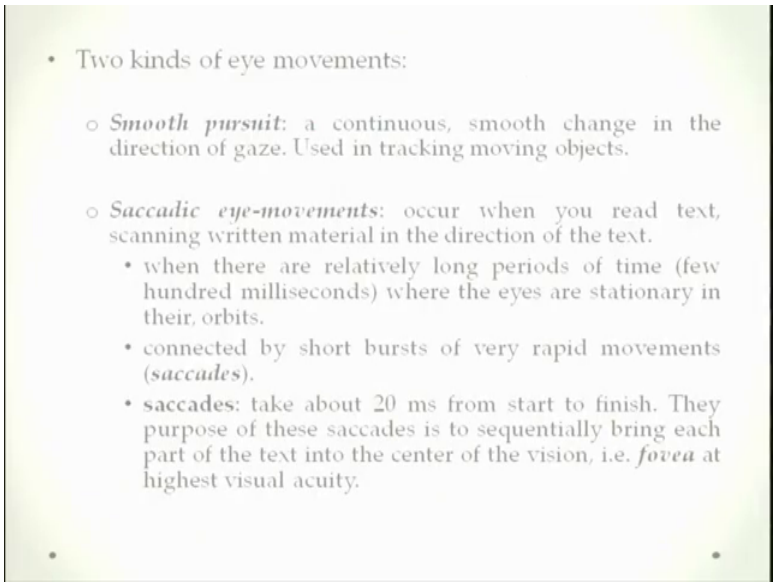

So, this is again one of the things about eye movements are not randomly giving you information about reading it has to be systematic and planned in a particular way so that it gives you more information. Now, because we are talking about eye movements let us talk a little bit about various kinds of eye movements which are talked about with reference to reading one of the most basic very you know a simple kind of eye movement description is called smooth pursuit.

Smooth pursuit is basically if you are tracking a continuous and a smooth change in the direction of gaze. Suppose, you are looking at a screen and on that screen from left to right or right to left a particular object is moving. Suppose, you know a fish is moving from left in directions to the right and your task is just to follow the fish. So, it is very smooth the fish is moving at a particular speed and you are just tracking your eyes your eyes are locked to the fish and you are kind of just very smoothly sailing along with the fish from at particular direction left to right or right to left, that is smooth pursuit.

The other kind of eye movements that are interesting are called saccadic eye movements. Now, when you reading text and you have to scan the written material in the direction of the text what really happens is there are relatively longer periods of time a few hundred milliseconds, two hundred millisecond, three hundred milliseconds where the eyes are kind of stationary in their orbit. So, they are kind of not really moving these things are referred to as fixations I will come to that in a bit of while and these relatively stabler

periods of eye movements are linked and they are connected with short bursts of very rapid eye movement.

So, suppose you are kind of resting at location A, you have to go from location B, your eyes are resting here for let us say 200 – 300 milliseconds and suddenly there will be a rapid eye movement from location A to location B this rapid eye movement is referred to as a saccades s a c c a d e s and the saccade basically takes almost around 20 milliseconds from start to finish. It is it is it is a very rapid eye move[ment] 20 millisecond is 0.05 of a second, ok.

So, they the purpose of these saccades is basically to fetch and sequentially fetch the information from part of the text and to help these visual symbols come at the centre of your fixation. The centre of the fixation or centre of the vision is referred to as the fovea. Fovea is where in your retina the you know there is a maximum acuity. So, the idea is if something is at the fovea it is read best the degree of accuracy is best. So, the idea is constantly eye movements or saccades will try to bring interesting regions of text that are interesting to you in the centre of vision at the fovea.

So, the whole point of moving eyes from word 1 to word 2 to word 3 is to get word 1 at the fovea then get word 2 at the fovea then get word 3 at the fovea and you are doing this using saccades. So, saccades are movements rapid very rapid eye movements between two relatively stabler periods which are referred to as fixations.

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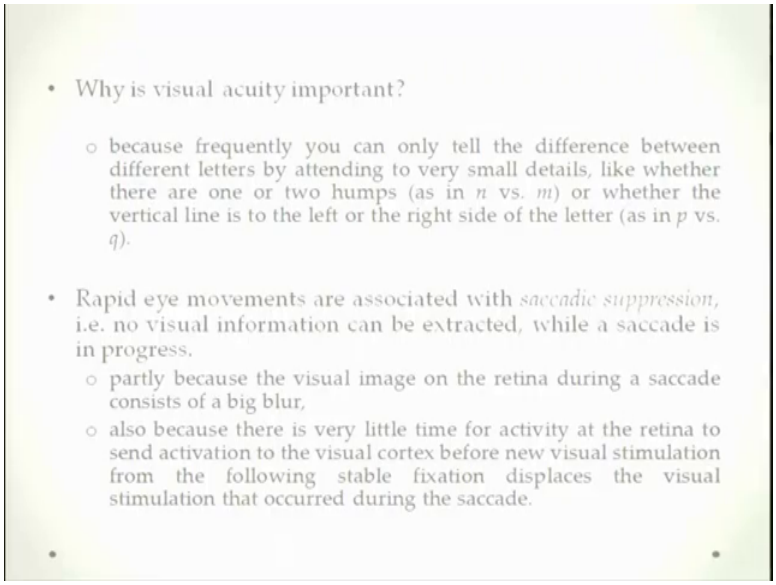

Now, why is visual acuity important? Why is you know centring of these text these words very important? The idea is because very frequently you know there are letters in all there are alphabets in all languages suppose for example, you are talking about n and m and you are talking about h and n or you talking about [FL] and you know [FL] and those kind of things.

There are very minute details that you might be able to miss if you are not really looking at it, ok. So, the whole point of making these eye movements is to bring these alphabets bring these symbols at the centre of the vision wherein you are having maximum accuracy when you are having the max the highest resolution if you might say and that highest resolution helps you gain the best information the best look of these written symbols. So, that is why visual acuity is very important.

Now, these rapid eye movements which I was talking about these saccades are also associated with something called saccadic suppression. Now, I talked about relatively stabler periods and then the fast moment when this fast movement is being executed this 20 milliseconds is the time where no information can virtually be extracted from the text.

So, if you are kind of fixating at A section one of the text and then going to the section B everything in the middle which you traversed will not give you any information why is that happening because there is very little time for the activity at the retinal level to actually reach your brain so that you can infer whatever is happening at that point in time. So, whatever information you are actually gaining is not during the saccade, but before the start of the saccade and after the end of the saccade, ok.

This whole time gap is referred to as saccadic separation because the movement is so swift that there is almost no time for the retinal information to get you know really interpreted in your brain and for you to really decipher what that you know thing was that your eyes passed over.

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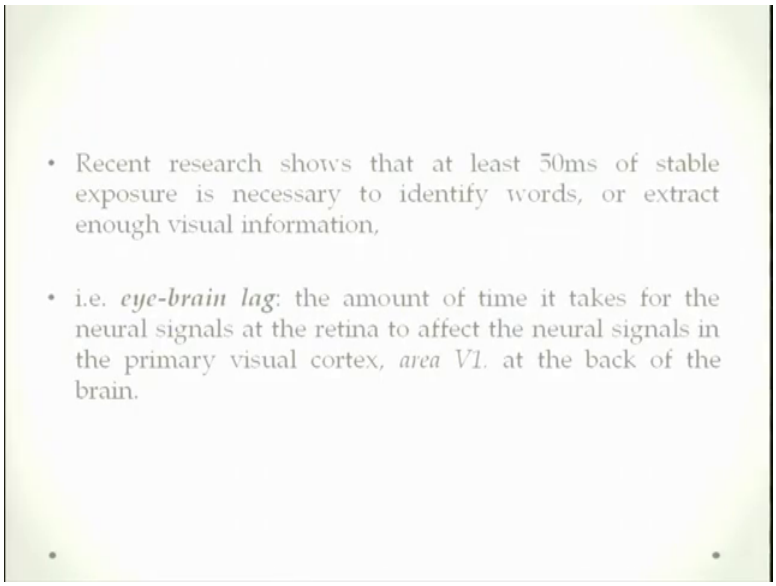

Recent research has shown that at least 50 milliseconds of stable exposure is necessary to be able to identify words or extract enough visual information and as I was saying saccadic separation is just for 20 milliseconds you know your eyes move from location A to location B so quickly that this duration is so little is much you know that you cannot really gain any meaningful information out of it.

So, this 20 milliseconds is referred to as the eye-brain lag and eye-brain lag is the basically the time of the time it really takes for neural signals at the retina to start affecting the neural signals at the primary visual cortex where the interpretation of information is happening.

So, these 50 milliseconds is you know you can say is the eye-brain lag the time that it takes for any visual information from the retinal level to reach the primary visual cortex in the brain for information to be deciphered.

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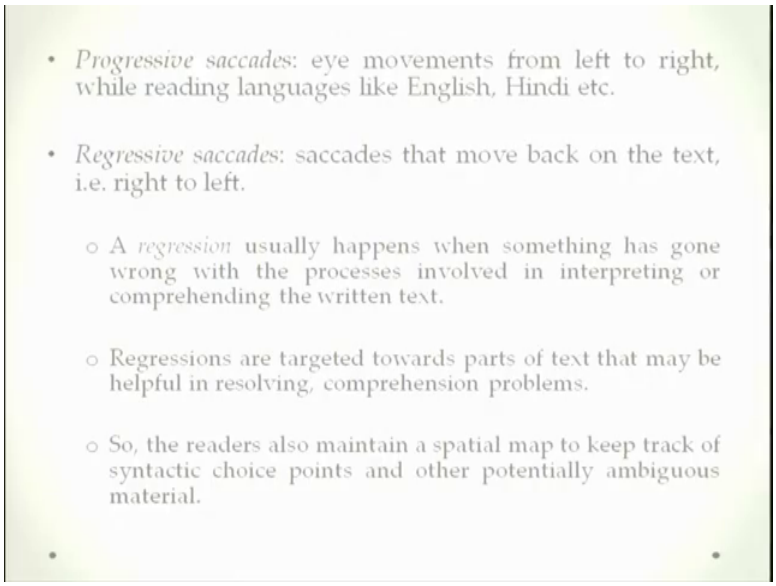

There are also various kinds of saccades that we might talk about. So, if you are moving in the direction of the text let us say from left to right as a text is moving this is called a progressive saccade. Sometimes, however, what might happen is that once you reading from you know word 8 word one to word 2 to word 3 to word 5, 6, 7 sometimes word 5, 6, 7 might not be very clear.

So, you might want to come back to word one and 2 to read it and then make more sense of word 5, 6, 7. These kind of coming back saccades these kind of saccades are referred to as the regressive saccades. So, saccades that move back on the text contrary to the direction of the text are referred to as regressive saccades. So, two kinds of saccades we talked about.

A regression usually happens you know when something has gone wrong with the processing or something you know there is a difficulty in interpreting whatever you are reading. Suppose, for example, you are reading a sentence like this you know Ramesh had two cats; ones one of the cats was named Meera the other cat was named as Shyama and Shyama used to eat stones.

Now, as soon as you were kind of coming to this word stones you would want to kind of you know relook, what have I been talking about, what have I been reading about because stones is not something cats usually eat. So, you will want to come back and scan the previous portions of the text to really check whether you know this is fitting or

not these are the reasons these are the kind of phenomena that encourage people to make regressive saccades and a kind of reinterpret their entire scenario.

Regression is generally a target towards parts of the text that may be helpful in resolving comprehension problems you might want to come back. Ok, am I really talking about cats here, so, you might really want to look at places which will help you resolve this conflict right here also readers you know because you have to have the you have to have the possibility of sometimes moving back or sometimes moving forward generally readers would like to maintain what is called a spatial map to keep track of their syntactic choices and basically you know where the potential ambiguities might arise.

If you remember in the last lecture when I was talking about sentence comprehension, I was talking about the fact that you know particular kinds of words have to be challenged with other words in order to get particular meanings. Now, the idea is reading in eye movements and you know reading with respect to eye movements will need to keep track of where you chunked particular words together.

If you remember the example I was reading yesterday doctor Phil discuss sex with Rush Limbaugh. Now, you would need to know where you have attached this sex with or where you have attached with basically so that different meanings might emerge. So, that is again one of the reasons why regressive movements are there.

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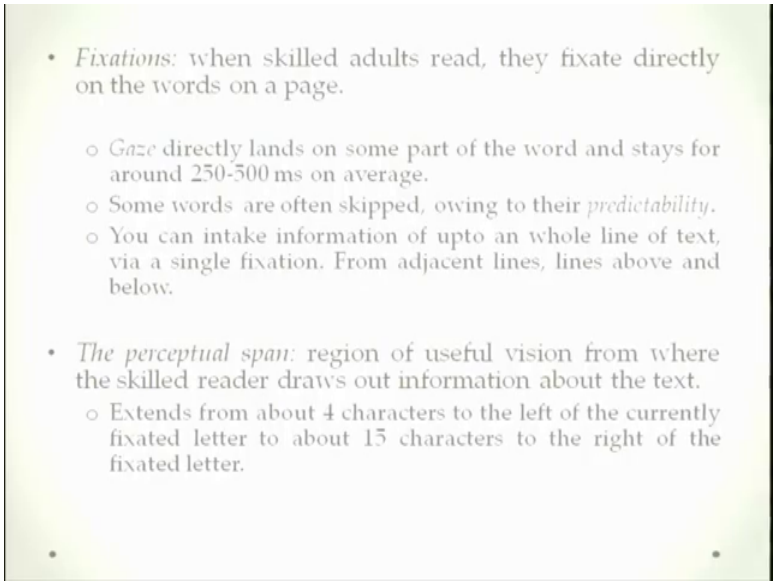

Now, this stabler periods that I was talking about; this stabler periods were referred to as fixations. Now, when skilled adults are reading they fixate directly on the words on the page this ability is something which is said to develop gradually. So, once somebody is acquiring the ability to read when you are talking about children who are just beginning to read they will not probably directly look at the letters and they will not probably their landings will not probably be very clean and consistent.

But, generally when you are talking about these relatively stabler times when the eyes are not moving much these things are adults basically are getting most information from there. These time periods are referred to as fixations now gaze is what where you are looking. So, gaze directly lands on some part of the word and stays there for around 250 to 500 milliseconds on an average. So, that that is the duration wherein you are kind of analysing whatever this word looks like, whatever this word might mean, what is the word next, what is the word you know preceding this those kind of information you know you are gaining here and this duration is around 250 to 500 milliseconds.

Some words are often kind of skipped because suppose you are reading a highly familiar text and you know what is the next word, you would know what it so suppose, you are doing the third or the fourth or the fifth reading of a particular story book that you have read so many times. Suppose, you are reading you know Harry Potter or something like that. A lot of times you will you will know that what is the next dialogue you can already predict so because you want to really read fast and you kind of you know want to go through this very quickly, you will in some sense because these words are predictable you will kind of skip over them. This is one of the things.

So, you can intake information from up to an whole line of text via signal fixation. Suppose, you are fixating on the second word of a five letter line of a five word line sometimes it is possible to from this fixation of the second word of the line to get information from two words this side two words the other side and get the whole information at once I will talk about this in a bit more detail in a minute. You know this intake of information the whole line is basically governed by something called the perceptual span.

Now, let us elaborate what the perceptual span is perceptual span basically is the region of where a useful information you know the region of useful vision from where you can

actually gain most information where you are reading something and the skilled reader basically gains information from this entire useful vision from this entire perceptual span and suppose if a line kind of falls within this perceptual span, obviously, you will be able to gain information about the entire line at once.

Now, this perceptual span be extends from around 4 characters to the left of the currently fixated letters to about 15 characters to the right because you I am talking about the script when you are reading from left to right. So, 4 characters to the left and 15 characters to the right is what your perceptual span would look like and this is the entire region for which you can gain information from just a single fixation.

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Here is just an example of this again some figures I have kind of drawn from the internet. So, you see roadside joggers endure sweat, pain and angry drivers in the name of roadside joggers endures sweat, pain and angry drivers in the name of fitness. So, the idea is your eyes are moving from roadside to joggers to endure to sweat and it is moving in that fashion and if you kind of go to the next a healthy body may seem reward. So, you see seem and you kind of coming back. So, this is what the regression thing is.

And, if you see the at the bottom level you see the fixation is at 4 and. So, fixation or the fovea is there. So, you see the 100 percent acuity is there and then you have less acuity on both the left and the right sides.

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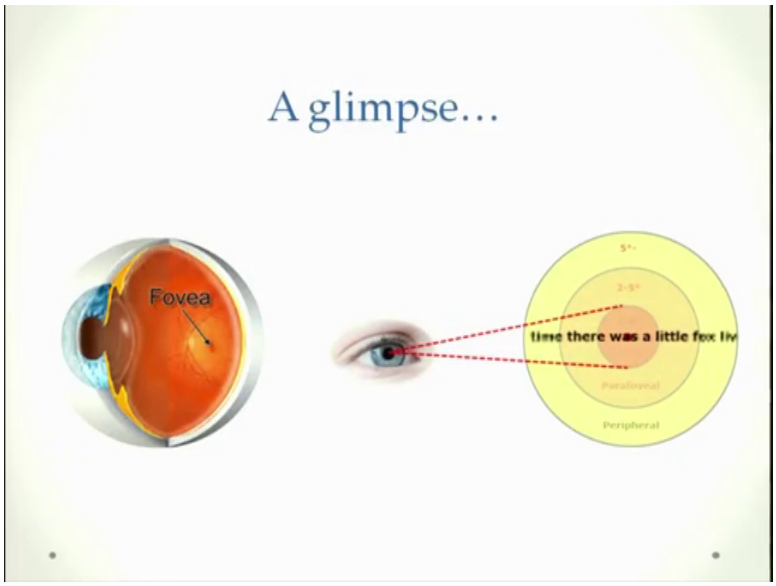

This is basically just the graphical description of how the you know distribution of vision is. So, from 0 to 2 degrees is your fovea where the maximum acuity is there from 2 to 5 degrees is parafoveal and 5 degrees onwards is your peripheral vision.

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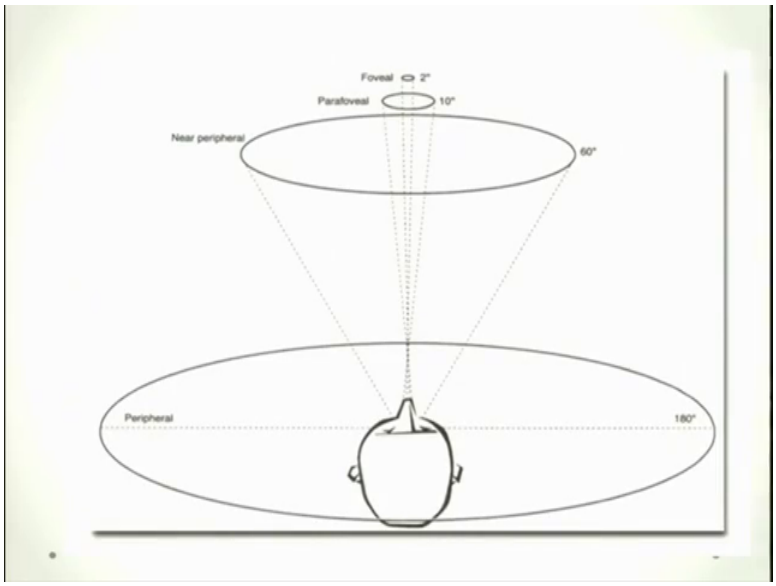

This is again just the same thing. So, foveal region is around 2 degrees, parafoveal is around 10 degrees, peripheral is around 60 degrees. So, these are basically just depictions of showing that how much information meaningful information you can actually gain vision.

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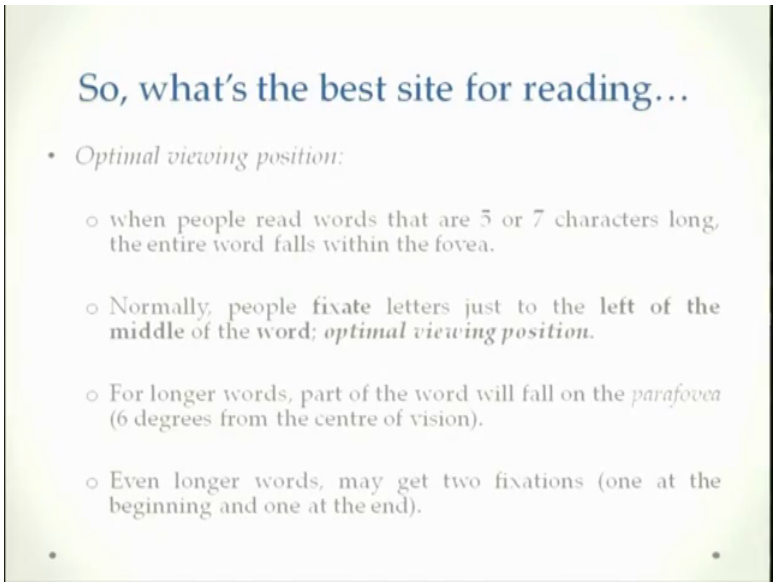

So, given the perceptual span given that you have to move your eyes from one word to the other word to the other word what should be the optimal site for gaining most information the optimal site is referred to as optimal viewing position and a lot of research about this is there in English and some other languages.

So, the idea is when people are and the results I am discussing are from those languages when people read words that are 5 to 7 characters long the entire word will fall within the fovea because the entire span of the word will be under 2 degrees of visual angle. So, the idea is when 5 or 7 letter world you are reading this entire word is falling in the fovea, so, you are getting the most information.

Normally, what happens is that people fixate letters just to the left of the middle. So, suppose it is a 5 letter word. You will basically kind of a fixate just left to the third letter, ok. That is the point where you will able to gain maximum information when you are reading a particular word and all of these things have been experimentally demonstrated and people have kind of come up with these ideas that you know for this is the best site for getting most information. If you are presenting somehow manipulating peoples landing sites at just left to the middle of the word this is where your the reading performance of participants had been found to be maximal.

So, for longer words part of the word will fall in the parafovea. Suppose, you are talking about 8, 9, 10 letter words from 2 degrees onwards and so sometimes what might happen

is that for longer words you might need to have more than one fixation. So, you fixate in the first part and the new kind of fixate in the same word on the second part and you kind of gain information, obviously, such words because you kind of spending almost two fixations here will be harder to read you will spend more time in reading.

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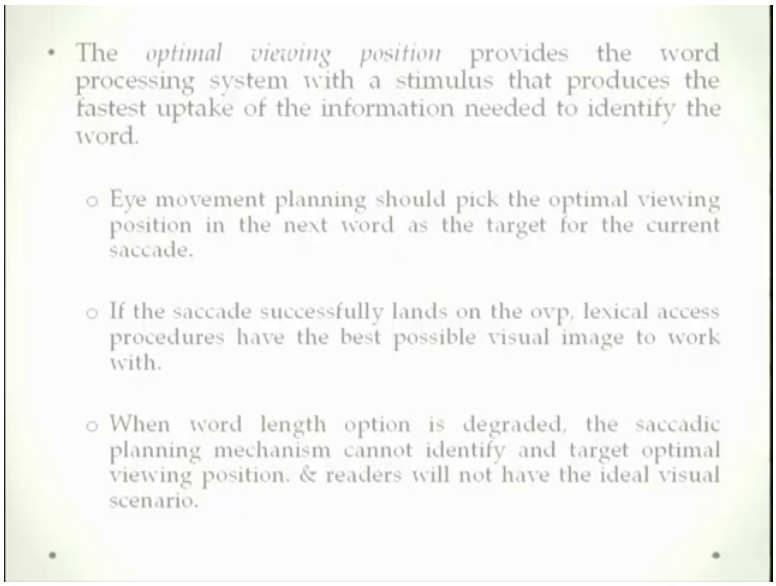

The optimal viewing position basically provides the word processing system with a stimulus that produces the fastest uptake of information needed to identify the word. So, if you are landing on the optimal viewing position that is where the fastest uptake of information is going to happen and that is what will facilitate the fastest reading of these kind of words. Eye movement planning in view of this optimal viewing position should therefore, be able to pick up the optimal viewing position in the next word as the target while it is still at this current word.

So, the idea is a eye movement planning should have to keep an account that now I am at word one this is the optimum viewing position at word one and when I move from here when the next saccade is initiated the landing site should actually be the OVP of the second word. The landings second landing site should be OVP of the third word and this is how this eye movement planning would be optimal and will be maximized to get you maximum and fastest reading performance.

So, if the saccade successfully lands on the optimal viewing position lexical access procedures the way how you are going to end you know activate mental representations

will you know get the best possible visual image to work with remember if the visual image is not really possible sometimes you will have the aid of top down processes, but sometimes if you are not really familiar with the word the top down processes will not be able to kick in. Remember we were talking about the trace model in one of the last lectures and this is pretty much kind of what links to the you know trace model and stuff.

Now, where word length option is degraded when you do not really know how long the word is the saccadic planning mechanism will not really be able to plan and identify the target optimal viewing position and that will lead for you know to the readers have readers having problems and the reading will be slowed down.

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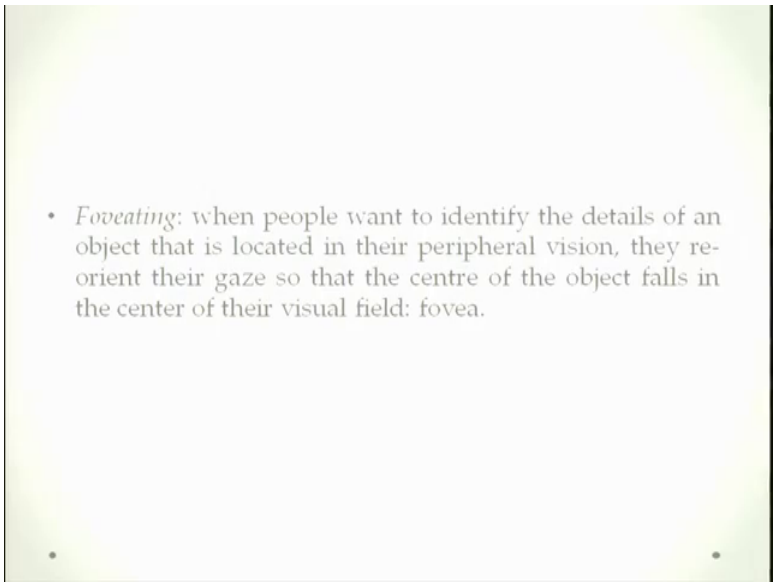

So, this is about eye movement planning fovea let us talk a little bit about foveating. Now, foveating is basically when people want to identify the details of an object that is located in the peripheral vision they reorient their gaze so that the object centre of the object falls in the centre of the visual field that is the fovea again we have been talking about this for now and foveating is basically just the practice of trying to bring whatever the object is at the centre of your visual field that is the fovea to gain the best information out of it.

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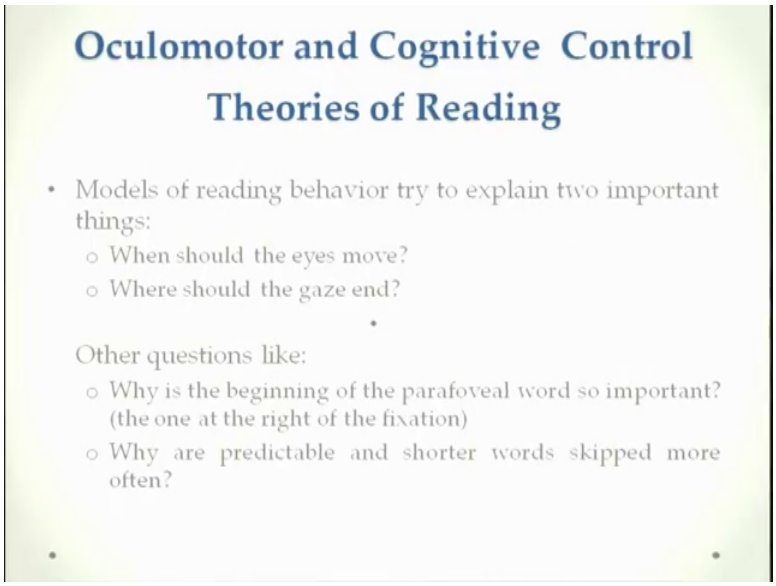

Now, let us kind of move towards theories of reading a little bit and I will not really cover all the theories, but let us just talk about what kind of reading theories exist. Now, models of behaviour of reading tried to explain at least two things first is when should the eyes move what is the time course of movement of eyes and the second is where should the gaze end where do you really stop, and there are, obviously, other questions like you know where is why is the beginning of the parafoveal word.

So, important why do you really want to you know read the second word or say for example, why are predictable and shorter words skipped more often than longer words those kind of processes also those kind of questions are also which people really talk about.

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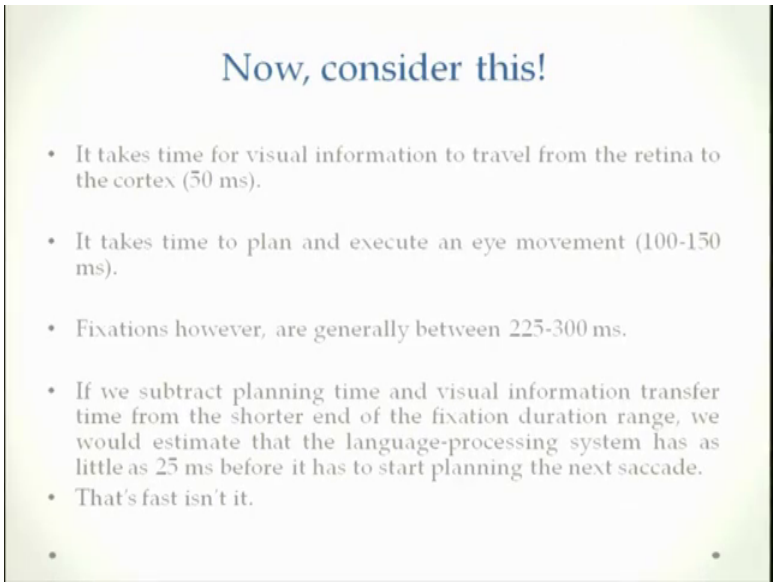

Now, just I will give you a bit of a trivia here it takes time you know for visual information to travel from the retina to the primary visual cortex. If you remember I talked of the eye brain lag and that time is around 50 milliseconds it takes time to plan and execute an eye movement which is around 100 to 150 milliseconds. So, you your somewhere information is going it takes 50 milliseconds you have to plan the next movement which will take around 100 to 150 milliseconds fixation generally are somewhere around 200 25 to 300 milliseconds within this duration you have to do both planning and information uptake.

So, if you do if you just subtract this if you let us say we will take the higher limits if you subtract from 300 that is the maximal time of a fixation if you subtract 150 plus two hun[dred] plus 50 from that you are barely left with around 100 milliseconds to really comprehend a word that is the timescale that is the you know a short time that you are operating to gain most information from the written word and also you have to make meaning out of it and integrate this meaning with the rest of the structure that you are going to read. So, this is how fast reading is actually happening.

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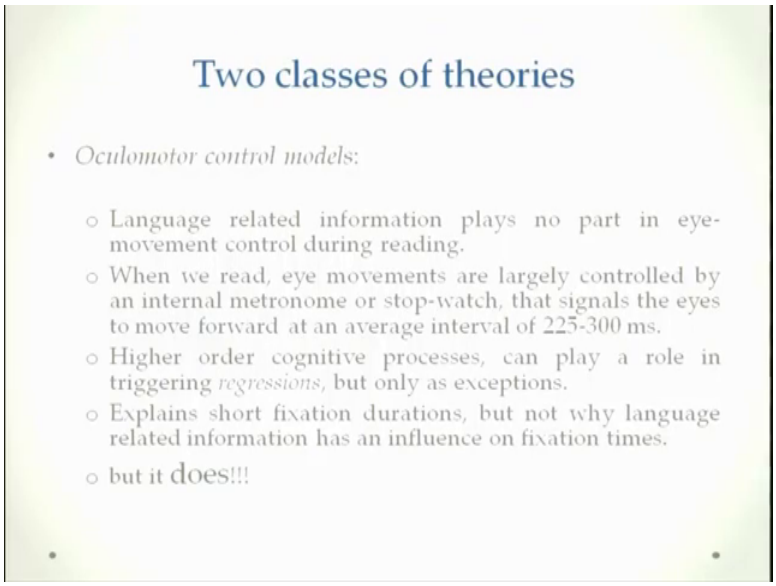

So, two classes of theories exist oculomotor theories and cognitive control theories. Let us talk a little bit about oculomotor theories. Oculomotor theory is basically assumed that language processing is not really partaking in reading processes. Basically, these theories are more concerned with movement of eyes and how eye movements are made how they are planned how they are initiated and how they are terminated, ok.

So, the assumption is like when we read eye movements are largely controlled by an internal stopwatch or a metronome whatever you may call it that moves that signals the eyes to move forward at an average rate of around 225 to 300 milliseconds higher order cognitive processes comprehension etcetera can play a role in triggering regressions not in progressive triggering regressions that also very rarely only as exceptions. Also this is one of the these are these theories kind of try and explain shorter fixations, but they do not really talk about why language related information may not interfere with fixation times.

Now, this here is a little bit counterintuitive you are reading you are doing a language comprehension task, but you are not really sure of how language comprehension is going to influence your eye movement planning. So, this is slightly a problematic with the oculo oculomotor theories and anybody who has done a little bit of research on reading would know that these processes of language do impact eye movement planning and we will talk about that at some point.

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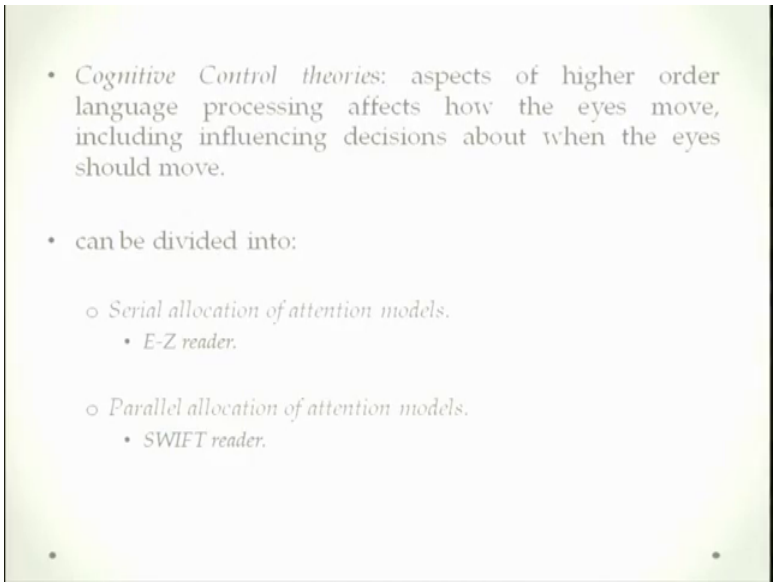

The other class of theories is the cognitive control theories. The cognitive control theories basically believe that aspects of higher order language processing affect how the eyes eye will move across the text. So, how or how difficult or easy it is to gain meaning out of these words will obviously, influence how will I plan my eye movement from word one to word two to word three and so on and so forth. So, two kinds of theories you have cog oculomotor cognitive control and cognitive control theories there are two models I will discuss just one of them.

One of them is the serial allocation of attention model one word then other word then other word it is called the E-Z reader and the other one is the parallel allocation of attention model which is the swift reader. I am not really going into details of the swift model this time again this is not really a lecture on language, but I will kind of just use the E-Z reader to give you a very basic interview very basic introduction into how the reading process might be working.

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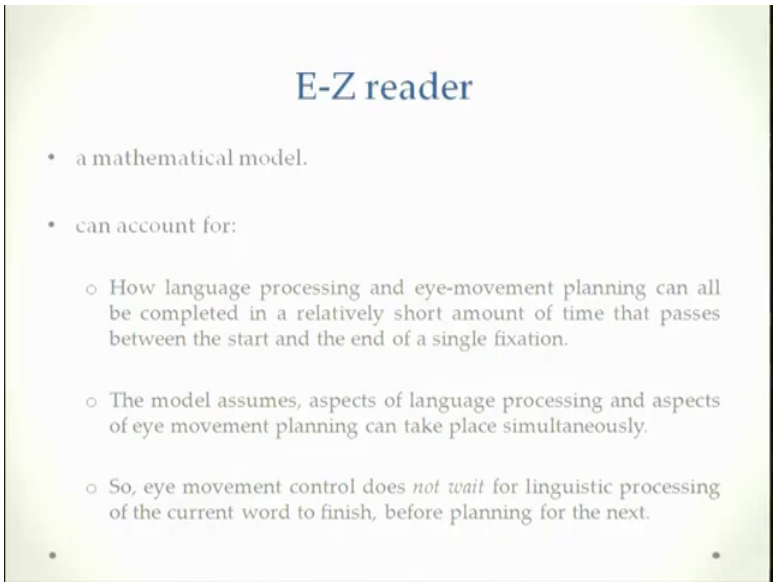

So, E-Z reader is a mathematical model it basically can account for how language processing and eye movement planning can all be completed in a relatively short period of time remember I was giving you this time period of around 100 to 125 milliseconds. The model actually assumes that aspects of language processing and aspects of eye movement planning can take place simultaneously.

Even though they are not kind of I mean that is that is one of the things that you know this model will try to explain also it says that eye movement control does not really wait for the linguistic processing to complete and it kind of just moves on at it is own pace and the linguistic process are trying to catch up all the time.

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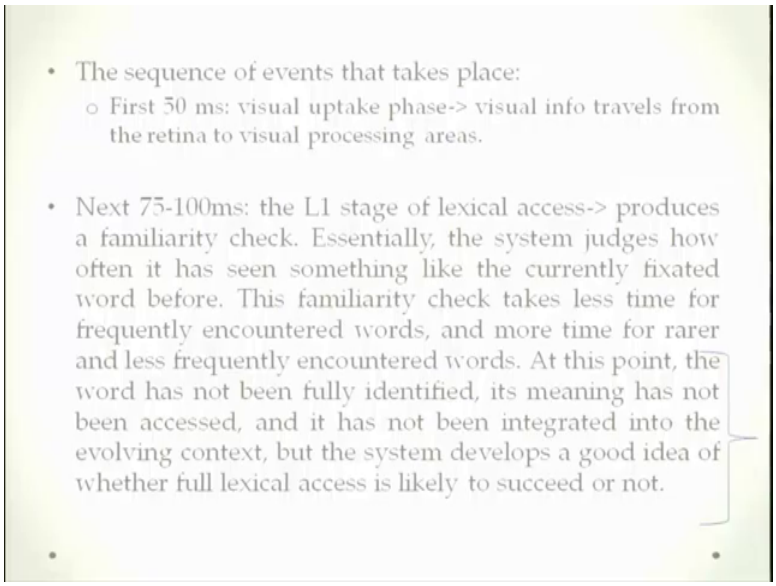

So, the there is a sequence of events that takes place according to the E-Z model is the. First say fifty milliseconds that is the visual uptake phase when you are landing resting at a particular word sight. So, visual information is travelling from the retina level to the brain level the next 75 to 100 milliseconds. Remember, now you are at around 125 to 175 the L1 stage of lexical access is happening what is the L1 stage the L1 stage is just giving you a very rough familiarity check do.

I know this word have I read this word earlier is this word really predictable in this stage basically the system is judging how often it has come across some a word like this one that you are reading and this kind of tells you whether you have to spend more time here or just quickly move to the next one. So, this familiarity check allows you to take less time for frequently encountered word and more time for infrequently encountered words, ok.

For example, if you have read a particular word again and again and you really know the meaning of the word it is not really advisable that you spend a lot of time there. So, if you will quickly move on to the next words. The word has it is way one of the important aspects in L1 stage is at this point the word has not really been fully identified, its meaning has not been accessed and it has also not been integrated with whatever you have been reading earlier, ok. But the system kind of here because of this familiarity check develops a very good idea about what the you know whether lexical access is

going to succeed or not whether I know this word or not whether this is a meaningful word or not and those kind of things.

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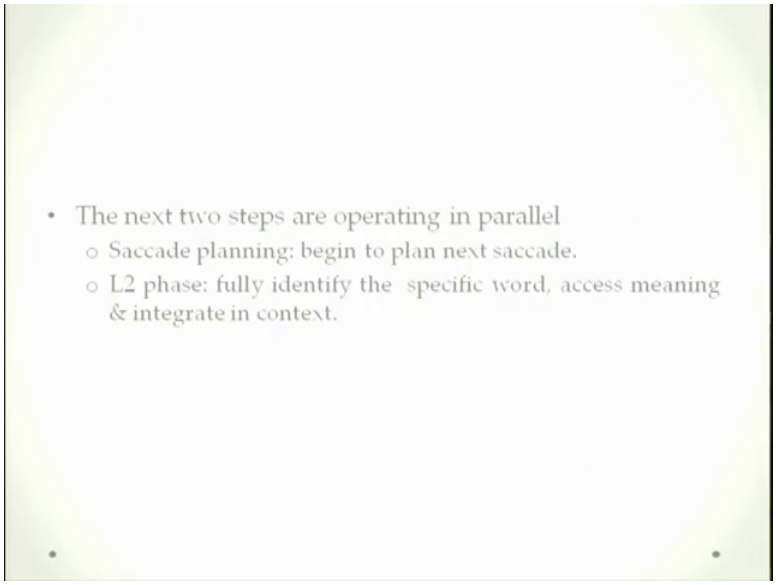

The next two steps are very important and they are basically supposed to be operating in parallel the first step is planning to begin the next saccade. So, while you are still on this word you are resting first 100 – 150 milliseconds are passing you are already beginning to plan where you going to land next that is what we ensure fast reading.

The second is the L2 phase. Now, L2 phase is where the detailed processing of the word is happening detailed meaning making is happening. So, here is where you will fully identify the specific word that you landed on and try and access it is meaning and try and integrate this meaning to whatever you have been reading till now. So, this is what the model is.

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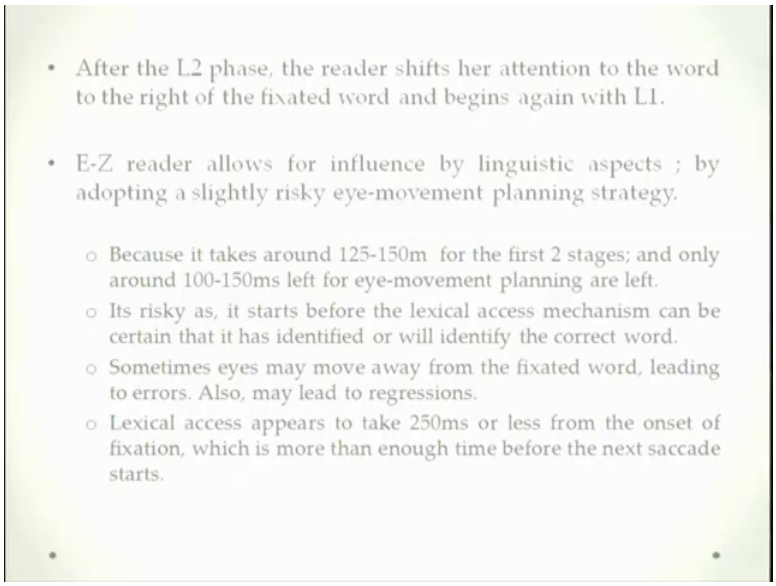

once you have completed the L2 phase the reader quickly shifts their attention to the word on the right of the fixated word remember I am talking about English which is read from left to right or even Hindi which is again left read from left to right and as soon as you have moved on the next word again the visual optic phase and the L1 phase starts and this is what is going on iteratively well while you are reading the particular text.

Now, this is again very simple how the E-Z reader model is saying. The E-Z reader kind of has this inbuilt aspect of allowing influenced by the linguistic aspects. It adopts a slightly risky eye movement planning strategy where it kind of allows these linguistic aspects to come in.

So, it says because it is taking around 125 to 150 milliseconds for the first two stages and only about hundred and 100 to 150 milliseconds for the next stage eye movement. So, that is where this information will come in. It is risky because the eye movement planning eye movement planning. So, quickly is risky because it starts before the lexical access mechanism can be certain that it has identified or will identify the correct word.

Remember, as soon as l one stage is finished the saccade planning already starts and at L1 stage you are not really sure of what the word is you just have a brief familiarity score that ok, I am sure this I am kind of 60 - 70 percent sure that this will be a word and I must have read it somewhere and I am kind of certain that I find it is meaning very quickly, but even before you are 100 percent sure and you have integrated the meaning

the eye movement planning has already initiated. So, sometimes it might happen that your eyes may have moved away from the fixated words leading to errors because you kind of assume that this is that word.

So, that is sometimes what will happen is that when you come across while you reading a particular text, a highly frequent word, but there is just a little bit of a change it is a very similar word to a highly frequent word, but the word is not exactly that. So, you kind of assume that this is that word and you move to the next you realize at the next or the next word that, ok, I probably misread that one you come back and you correct it. So, this is a kind of a strategy that might lead to some errors happening.

Also lexical access if you remember we were talking about the Marslen Wilson task in the last lecture this lexical access needs around 250 milliseconds or less from the onset of fixation which again is you know more than enough time before the next saccade know you know has to start. So, actually the processing of the word starts around you know after 100 – 150 milliseconds you spend on this word and starting from here you are already starting to process the parafoveal word that is pretty much what I am trying to say.

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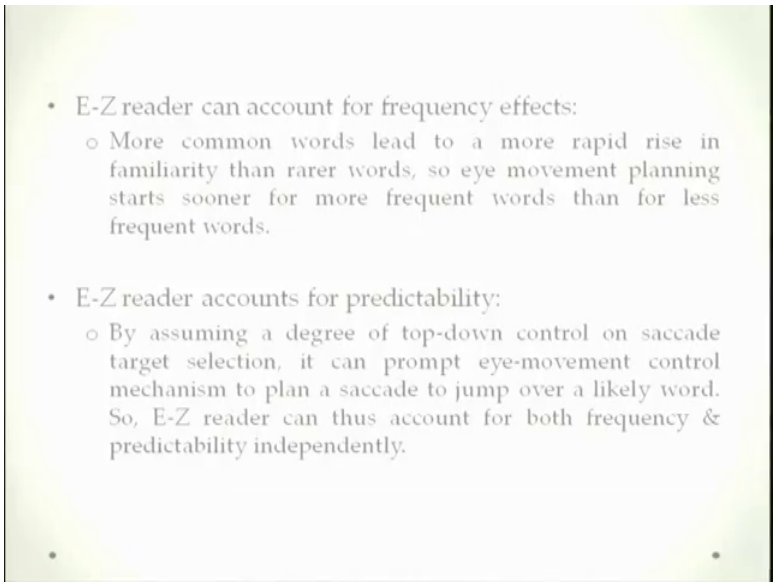

Now, E-Z reader can obviously, account for different kinds of effects that have been observed in reading one of them is the frequency effects the idea is that you know more common words that you encounter more frequently lead to a rapid rise in familiarity than

rarer words less frequent words and so eye movement planning starts sooner for the frequent for the more frequent words then for less frequent words. So, this is probably something that can be explained or that can be used to explain why people read more frequent words much more fast as compared to less frequent words that is one.

The second is E-Z reader because it is talking about the L1 stage and parallel saccade planning and then the L2 stage can account for predictability being a very important factor. So, because by assuming in degree of a little bit of a top down control you know the frequency and familiarity analyses by using this degree of top down control on saccade target selection this can really prompt eye movement control, ok. Eye movement control mechanism to plan a saccade to jump over a likely word because you kind of are at this word, but the next word you all almost sure that this is what the next word you can already skip it go to the next word.

So, more predictable words are already processed while you are on a fixated word and in that sense this will help us explain a little bit about what predictability you know plays a role how predictability plays a role in reading.

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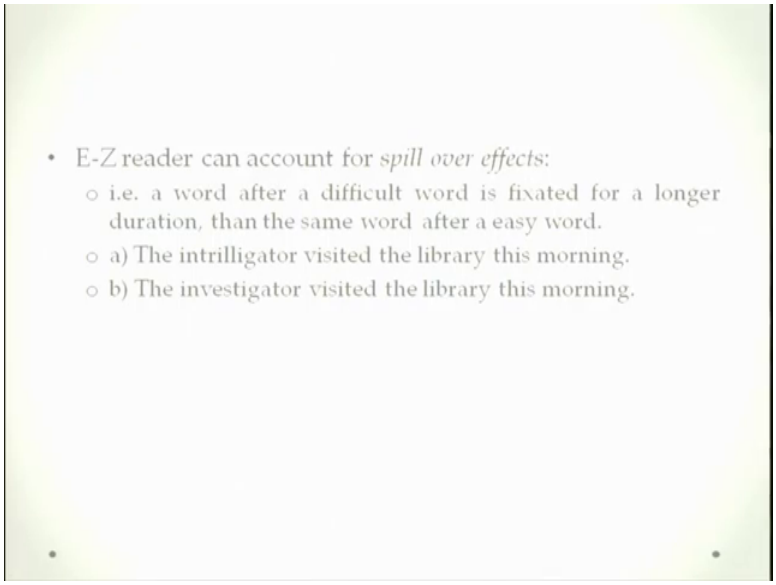

Also E-Z reader can account for spill over effects. So, if a word if there is a word after a difficult word that is supposed to be fixated for a longer duration than the same word after a easy word. There are two examples here the intrilligator visited the library this morning, the investigators visited the library this morning.

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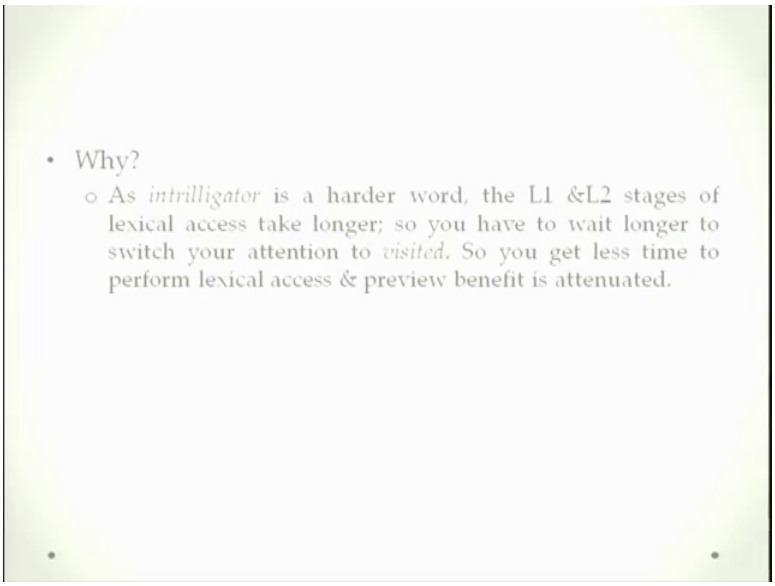

Now, because the intrilli[gator] interrogator is a more complex word it is a harder word the L1 and L1 stages of lexical access will take a bit longer. So, you have to wait a bit longer to switch your attention to the word visited and so that is why you will get kind of some a little bit less time you will get a little bit less time to perform lexical axis and the preview benefit for the parafoveal reading is kind of attenuated, it is lessened. Suppose, if you read the second sentence the investigator is a highly familiar word.

So, while you are on investigator as soon as 100 and 150 milliseconds has past, you already kind of go to you know you have started processing visited and because you know again visited is a faster word you will kind of you know get that parafoveal preview benefit. The parafoveal preview benefit it is simply the amount of you know head start that you get in processing the word which is next to the one which you have fixated or the word that is in your parafovea.

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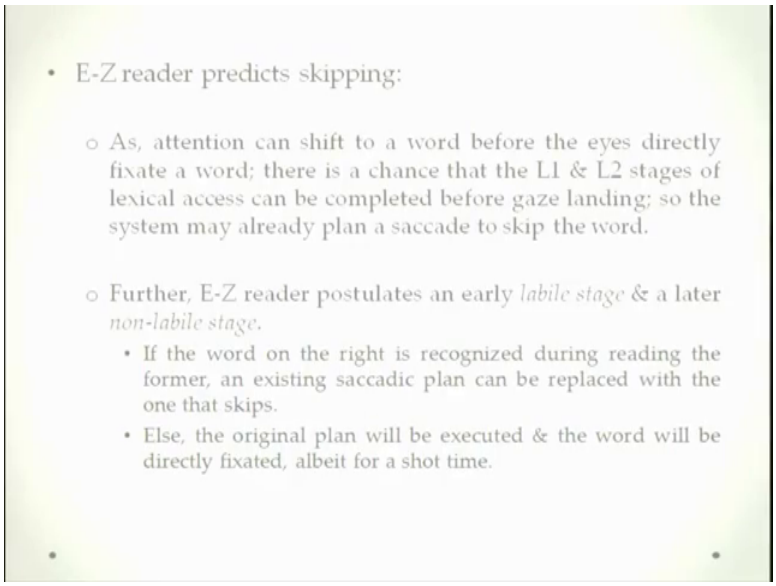

So, E-Z reader also predicts skipping as attention can shift to a word before the eyes directly fixate a word. There is a chance that L1 and L2 stages of the lexical access can be completed even before gaze landing happens. So, just what I was explaining. So, the system may have already planned saccade to skip this word because you have already read it. You are on investigator you know visited is a highly frequent word you have already kind of read it and you move to the next word.

Further E-Z reader kind of postulates a labile stage and a later non labile stage. So, the first stage is if the word on the right is recognized correctly during the reading an existing saccadic plan can be replaced with the one that skips. So, you kind of initially thought I will go and read this word, but while you are on this word and you have already parafoveally processed it you might have a change possible. So, you might just decide to skip it on the go.

Else, the original plan will be executed and the word will be directly fixated suppose you have not been able to figure out what this word is. So, you land on that word and kind of you know process it in all it is detail.

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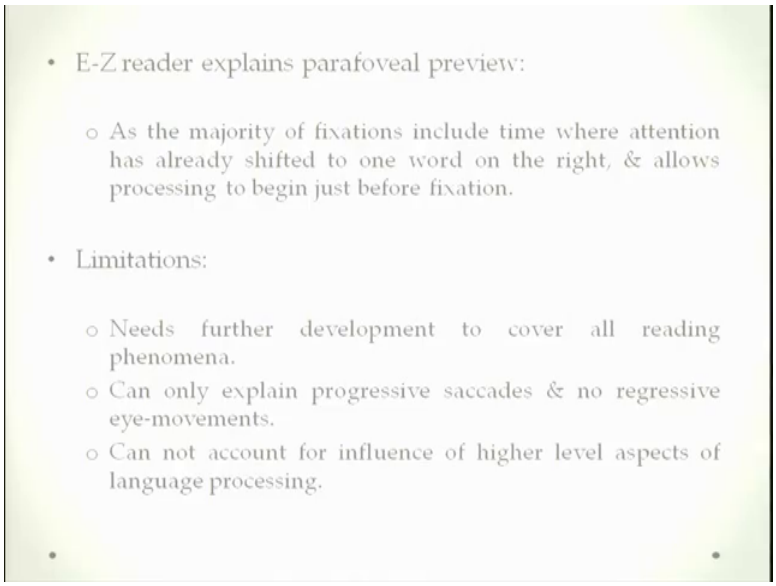

Also, E-Z reader can explain parafoveal preview. So, for example, as the majority of fixations include time where attention has already shifted to the other word on the right allows basically processing to begin just before fixation. So, even before you have landed on this word on right you have already started processing it because your L2 stage of the current word and your saccadic planning have already began. Obviously, it seems like the E-Z reader kind of have has everything in control, but again it is just one of the models there are other models of reading out there I am already skipping the swift model of reading.

So, it is a good model. It is a model that kind of explains a lot of things and I have just used this model to describe to you what are the different intricate processes that are involved in reading sentences or reading words; So, there are obviously, some limitations to this as well it needs further development to cover all the reading phenomena there are. So, many other things that happen in reading I have not really gone into a lot of detail about those also this is one of the models that can explain both progressive saccades and no regressive eye movements because you are already processing everything in the left to right direction you do not really need to come back, ok.

However, it cannot really explain for the influence of higher level aspects. So, there are many other kind of effects that happen with language processing which this model cannot really account for again it is a rather simple word reading model.

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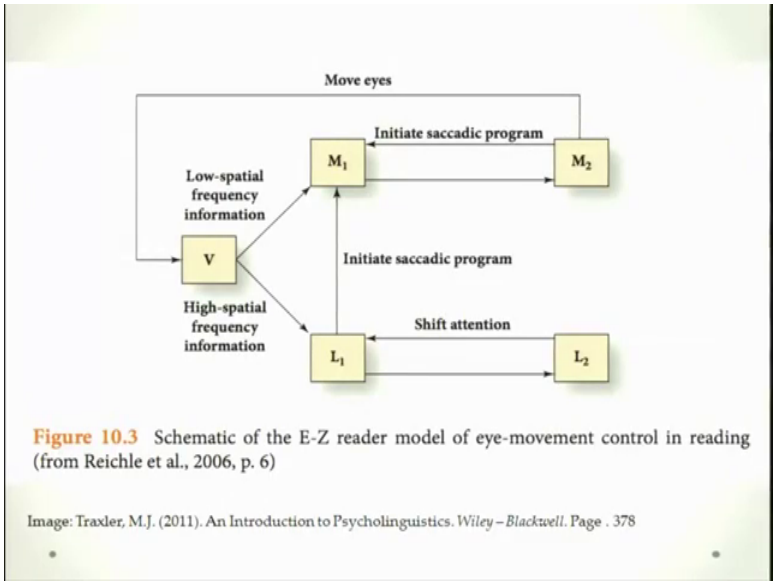

Figure 10.3 Schematic of the E-Z reader model of eye-movement control in reading (from Reichle et al., 2006, p. 6)

Image: Traxler, M.J. (2011). An Introduction to Psycholinguistics. *Wiley – Blackwell*. Page . 378

So, this is probably you know all from me about reading this here is the E-Z reader model you can actually have a look at it.

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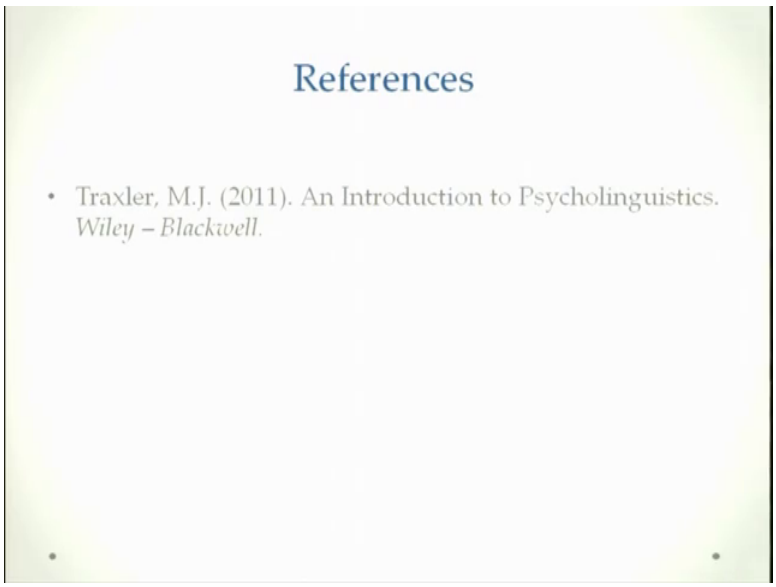

Again, this is something I have borrowed from Traxler's book on psycholinguistics and this is all from me today and we will talk to you about something else in the next lecture.

Thank you.