Lecture - 26
Reading - 1

Hello and welcome to the course, introduction in the psychology of language. I am Dr. Ark Verma from IIT Kanpur. And we are now starting the sixth week of the course. In this week we will be talking a little bit about reading and we will be covering various aspects related to the skill of reading, whatever the mental processes are, what are the mental processes involved in reading. Also, we will talk a little bit about difficulties in reading or say for example, component components of reading like, script and you know how do you move your eyes, to get maximum information, all of those kind of things. The topics

that I mentioned, will be spread over the next five lectures, in today's lecture I will start, basically with asking some very basic questions about, reading and I will also start, talking a little bit about one of the most important issues about reading that is movement of your eyes. So, without wasting out of time, let us try and see what reading is about.

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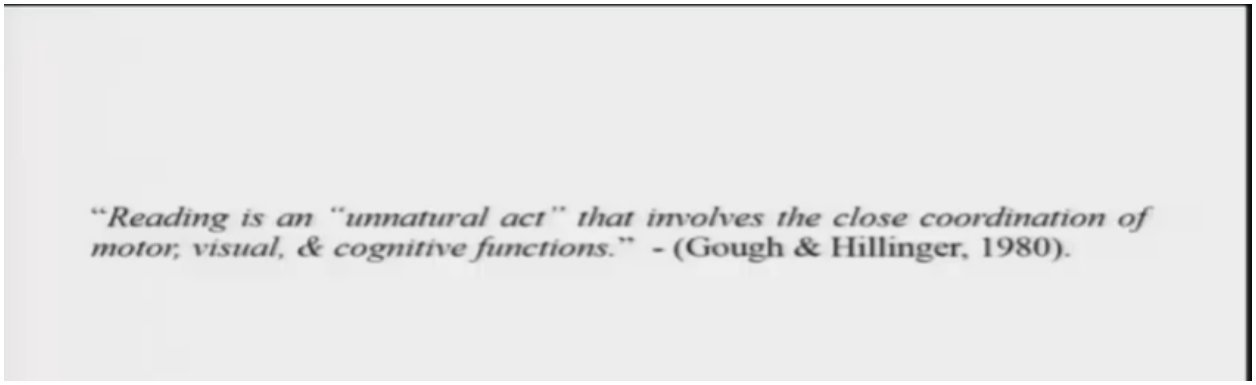

And there is this definition, there is this comment on reading by, Gauguin, 'Gough and Hillinger' that Traxler mentions and I am kind of putting up, putting this up here for you to read and reflect. And this is how it goes, it says, reading is an 'unnatural act' that involves close coordination of motor visual and cognitive functions. So let us try and you know discuss, a little bit about this particular definition and what does it really say, it's, it's not really a definition it's more like a comment, on what a reading should be. Now, the first thing that you would notice is that they're calling me reading, an unnatural act. Now, you might wonder why so and a simple answer to that would be that we are not designed to read. Okay? As organisms or at least, maybe now, but in the initial period, we are not really designed to you know, read in a sense that you know, we create symbols and then we decipher those symbols, to get information back from them. So, that kind of process is not really something that you know, we were prepared for biologically, evolutionarily or in any which way or in a societal way or you know, so to speak. So, in that sense, if you see reading is something that is, sort of completely a man-made skill, it is something that, we develop, we develop the scripts and then we developed our abilities, to interact with the script to gain, information out of it. So, that is something that is a very important and in some sense is, something where that fascinates us about, this capability of reading is because, if you remember in the last chapter is, talking about the visual word form area and the phonological word form area. So, apparently it seems that, something that we started you knows, you know thousands of years ago, so to speak. Now, the brain is kind of you know involved in, in that skill, to such an extent that, there are dedicated areas of the brain that might be handling you know, this kind of thing, so there is a visual word form area that helps you, decipher whatever script is written at some place and you know get some information out of it. So, in that sense it may be therefore said that reading is an unnatural act, in a sense that we are not naturally, you know wired to read, it is something that we have developed better, as a species you know, a few thousands of years ago and we are kind of continuing on that, you know, say for example, generations after we're reading started and our generations that have to come later, we kind of introduced them to script in some sense of the word and that ability to read, now is considered as an integral part of, whatever cognitive mental you know, functions that we have. So, that is, that is one part. And then the other part that is important in this continent, in this comment is that reading involves the close coordination of both

or three kinds of functions, motor functions, visual functions and cognitive functions. So, cognitive is still, kind of an umbrella term I will come to that. But, what is motor? And what is visual about this? Basically, they are one and the same thing in a sense that you have to move your eyes, in a coordinated systematic fashion, in order to you know gain maximum information, out from the script. So for example, if you're reading this you know, you're reading this word by word or say for example, you're reading just one word and then skip few and then read the third word and the seventh word or so on. Now, you're basically still, if somebody were to record your eye movements, for you know a fixed period of time value, reading a text maybe one page, two page, whatever. What can be discovered, very easily is that there is a pattern to how your eye is move, there's a pattern to how you move your eyes, over the text and gain information, from the script. So that is something which is you know very, very important, also visual functions you know, say for example, scripts are not really you know just random shapes ,they have with them, a lot of information compressed into the screen, into their symbols. Say for example, we were talking about words and you know, we were wondering that, how much information that the word has, all of that you know needs to be deciphered. It's say for example, there are so many different scripts and there are so many different say for example, symbols in the screen, English in that census is a slightly symbol that it has 26 alphabets and so on. But, say for example, take a script like Hindi, which has you know, there's so many alphabets and they have in addition to it, it has some Dykeretakes and it has half alphabets and has, you know basically, you know those small signs that come on the top and the bottom and you know also many different kinds of signs and they're used in quite, a few different permutations. So, in essence were say for example, Chinese or Japanese, which are even more, you know complicated scripts in, in some sense and the idea is that, say for example, for those kind of scripts, there is a whole lot of information in just one symbol, in Hindi in English for that matter you know, the letters or the alphabets or say for example, the actual as if you're talking about Hindi, kind of you know have, some information. But, they still have to be in some sense, combined with other syllables or other extras or other alphabets, to create you know a major percept to create a major word and so on. But, there are scripts that we know of that; basically one symbol is already a word or sometimes in entire sentence in itself. So, in that sense the visual analysis part is also very, very important and the thing is you have to coordinate the motor and the visual parts of it, because you have to move your eyes, in such a way that you can maximize the information uptake, from the script. So that is basically, only going to be possible, if the motor part or if the movement part of the eyes is happening, in consonants, with how you're visually analyzing a given script. So, you have you know, you have to be coordinating these two processes and you know, some things because we kind of learn to read, we are from the literate sections of the society, we don't really take, thing that this is so very complicated. But, the fact is that, this is something that we take some time to learn, you know children take some time to learn and children take some time to coordinate these two things. So in that sense, it's a very sophisticated, you know function that is known, you know by the name of freedom. And then, there is this third aspect that, common talks about is cognitive functions. What are the cognitive functions that I might be talking about? I mean, to basically you know just, very name of you, we can talk about say for example, you can talk about, meaning making ,we can talk about say for example ,going from the graphemes that is the script, to the sound that is beautiful to phoneme conversion and from the phoneme conversion to you go to the actual word ,you create meaning and the meaning kind of leads you to you know ,so many different areas, you have to overall understand, the symbol and the word that you're reading and you have to also integrate that symbol or the word, into the larger sentential context or in the context of, what eventually you're reading, what does it mean, how is it written all of those kind of things, you know what are the processes that, help

you to go from grapheme to phone into meaning. So, all of that basically is, is again is a set of mental functions or mental processes that you need to coordinate in, in a very you know you'll need to perform them in a very systematic manner, in a very coordinated sense, in order to be able to successfully read, at least one script so to speak. But, we know that people are kind of you know, bilinguals and bilinguals in terms of reading as well, so there are people, say for example, who would be able to read Hindi and English and sometimes a Hindi words in written in English scrape out, the English words and in Hindi script. So, these are some of the very you know, basic questions that we probably need to ask ourselves. And we'll touch upon some of those questions in this week, in the different lectures that are going to be you know given. So, again just so you know, leave you with this, I'll just repeat this again and I and you could kind of you know reflect on what we've talked about right away. So, reading is an unnatural act that involves the close coordination of motor, visual and cognitive functions. So, motor is movement with the eye is, visual is how much information and how you are getting information from the symbols and cognitive functions basically, refer to you know meaning making integration ,with their context and all of the other set of functions that we have, actually talked about in the past as well. So, with this preface, with this kind of you know, background what reading might be about, let us also talk about, say for example, what are the cognitive processes in reading it?

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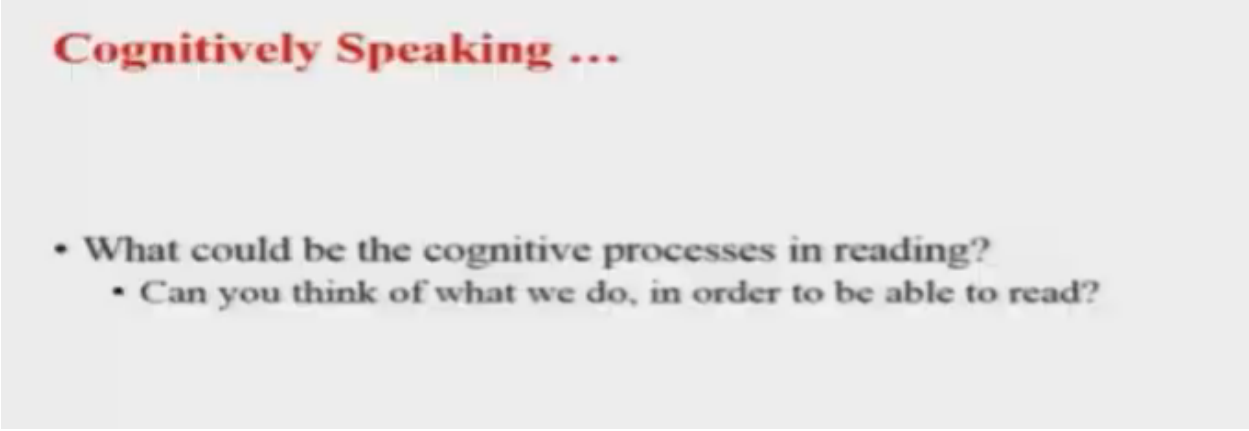

What is it that the brain does? What is it that we do, in order to be able to read? You know properly. So, that part is something that we would really need to, you know take care of and let's ask, ourselves this question, say for example, one of the first things, I can think of one you know doing, as a part of reading is this aspect of you know, converting the written symbol, to the sound symbol, say for example, any number of symbols can be written and you have to analyze them, visually you have to see. Okay? Is this a horizontal line is, a slanted line is, a vertical line and in what sequence they are arranged, so that you kind of go from that Griffin. So that aspect is called,' Griffin' that visual symbol that is linguistically, meaningful is referred to as their Griffin's and you have to analyze that, Griffin's for information converted into a phoneme and as, you see they say for example, in Hindi or English for example, it's written from the left to right, in a sort of a linear sense, you have to you know concatenate and join these Griffin's and the resulting phonemes, in order to construct words. So that is also a very, very important process that we do and then we kind of go to the sound, you have to access the sound and then once you have the sound representation, what you go for is called the, 'Lexical Access'. We've talked about lexical access, in some detail and we've kind of if you remember, you know the reason that it, it is not really a

very, very simple process, not a one-step process, there's little, feature level, later level and you know, word level in the, in the trace model that we talked about earlier. And then from that its meaning making its, making its integrating the meaning with the entire sentence and then an entire paragraph and in a broader scheme of things, what did I read when I read this particular chapter. So, there, there are these mental processes that you will need to you know, do successfully and in the right manner in order to be able to read successfully, even one page of text that comes your way. So that is something that, you know we will talk about and let's just, kind of detail that a little bit again so, to read efficiently, what do we need to do? To read efficiently, we first need to activate the stored phonological and semantic representations right away,

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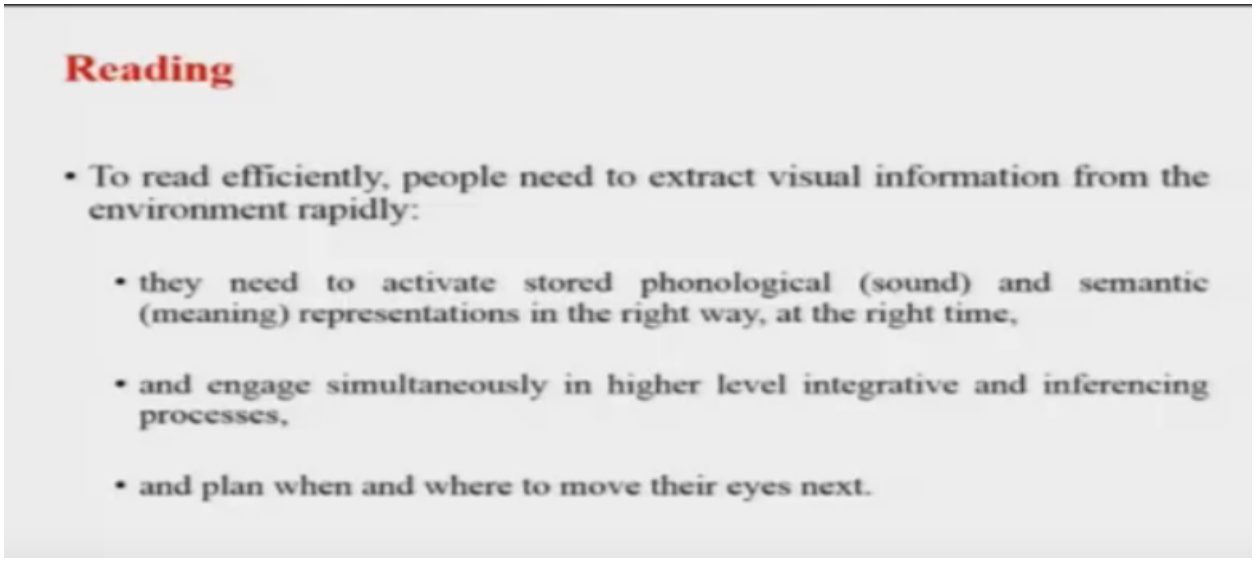

at the same time, you know at the right time, when you're reading. Say for example, you started with on, with a particular location on the page and you're moving from left to right and then, coming to the next line and then again, moving from left to right. All of those activations from the you know, Griffin to, phoneme to the meaning, have to happen simultaneously very quickly and in a way that your speed of reading, so you do not take you know, loads of time to read, one sentence or one word or one you know a letter, you do it in a fairly rapid way and that is also very fascinating that you have to do this, entire you know page of text, moving from one you know set of symbols here, do it from the left to the right and it's kind of do that, at the same time. Also, at the same time, you have to engage in these high-level integrative and inferential processes. Say for example, you know what did the sentence mean, with respect to whatever I have heard till now, you know a lot of times what happens is that suppose you're reading a thriller novel or you're reading you know, some very complicated poetry, you kind of come back, you come on the fourth line, fifth line, maybe the next paragraph and you know one and then that you know string of thought, loosens up so you go back, you read it again and you come back, a lot of time people kind of you know, do this back and forth back and forth in trying to, maintain that you know, string of thought that they are understanding what they are reading and also in a sense that, they are kind of making sense, of water whatever this text means, by itself and also in the larger scheme of things. Say for example, you know there might be a small incident, but in the, say for example, in thriller if you are reading ,you know there, there might be small instances, but they are connected, something to something

that is much you know, happened much earlier. So, in some sense reading also, kind of you know, invokes you to keep those memory, you know traces, active and kind of you know help you, be able to keep these integration and inferential processing, alive and all right, while you're reading texts. Also, something that is very, very important is that, how you move your eyes across the text? How you move your eyes across the page? You know at what speed, at what distances is, it like from one point to, another point or is it in a gradual way, how is it that the eyes really move in, order to facilitate, your visual uptake of the information, from the graphemes. So that is also very, very important, so these are these three, very basic processes, slightly broadly put here. But, you have to do that, in order to successfully read, any amount of text that you need to negotiate. Now, if as a psycho linguist, if as you know as a scientist, you have to kind of try and understand, the sets of processes that goes and into reading, people have n tracks are also a kind of divides into two kinds of processes one.

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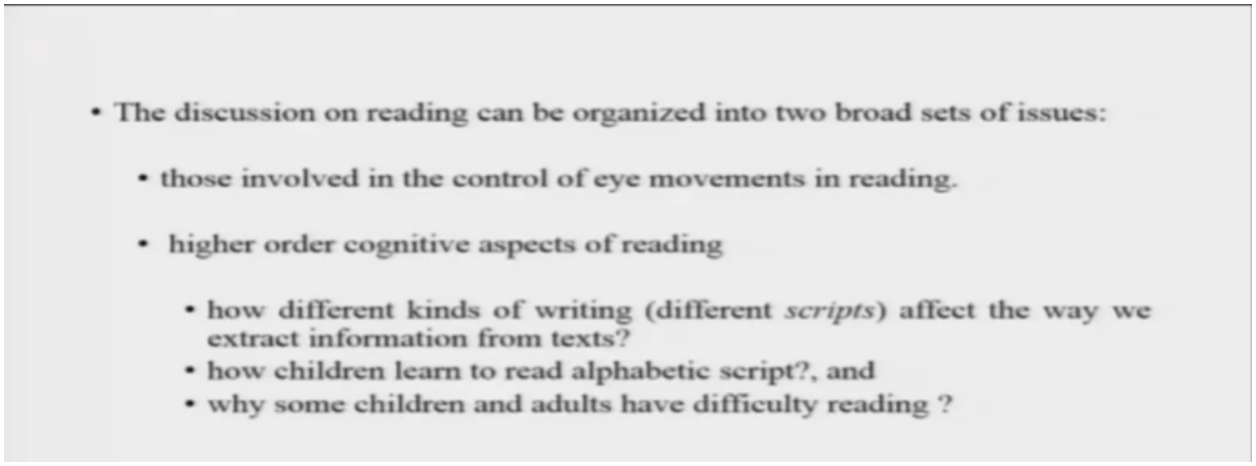

We're basically involved movement of eyes and the control of you know eyes, while you're reading. And the second is basically about, the higher cognitive processing, the meaning making an integration and all of those and the grammatical judgments and all of those kind of things. And there are many related questions that you could ask. Say for example, as I was giving you an example, of Hindi and English, I could give you an example of, Hindi, English, Chinese and so many other languages that, the scripts are also in, in some sense, very different from each other, even in India say for example, there's so many of these Indian languages which, basically you know, as far as, speaking is concerned might sound similar. But, the scripts might be very, very different from each other and you have to kind of, you know, if you have to negotiate reading in two three strips, you have to kind of know which symbol, belongs to what script and what does it sound like and what does it mean like, I can kind of remember, you know say for example, in the Arabic or Persian scripts, sometimes the diacritics or the maatras that we talked about in Hindi are not specified at all, so Hebrew for that matter is a very good example, Hebrew in Hebrew the mantras are not specified, so basically what you actually read is, mostly consonant you know, consonants that are written one after the other and you have to remember the maatras, so an early Hebrew reader kind of still, finds them specified in the script. But, for the most part when adults feed you know vowels and, and the mantras are not really specified and you have to kind of you know, remember them or it should be in your expertise that, you kind of can decipher the Mattress correctly, because that is how you will be able to read the entire text, related questions could be how do people or how do children learn, to read

each specific script. Say for example, how do children reach the alphabetic scripts in English, for that matter. And a related question also is, say for example, as I said that reading is an unnatural act, we're not really wired, for reading we do not really, reading is not really, also an innate skill that comes with it that, comes with birth, we need to acquire reading, people need to instruct us how to read and into what scripts you read and so on. And that kind of brings us, to this knowledge of that not everybody, not all the children that you know, start to read or begin instruction in reading, can read eventually at the same level, so there is that thing as well that not everybody, masters the skill of reading equally well, you know there are some people who are very, very good readers and there are some people who are sort of average readers and there some people or poor readers, you know, that there are people who suffer ,with the deficiencies in their reading abilities. And say for example, there are specific cases, which are you know, which can be classified into particularly disorders, like dyslexia. But, then there are other people also, who are not very, very good at reading, but they might not really be dyslexic, you know to begin with. So, there are some of these questions, which you know we need to ask, ourselves and we probably talk about them in some detail, in this chapter.

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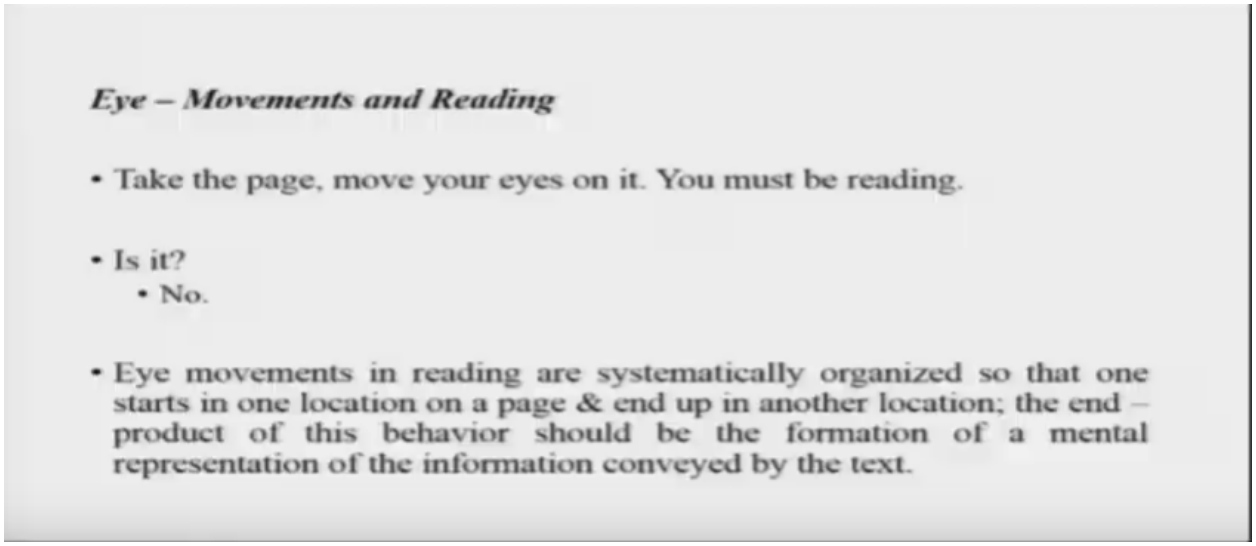

So, we can kind of you know now move into the first topic in the chapter, which is eye movements in reading. So, let's talk a little bit about, what kind of eye movements I require, suppose you're kind of taking a man you know page, news paper or on a paper that you have in your hand and you're kind of you know, just randomly moving rice all throughout the page is that, will that amount to reading, I mean you might still, you know your eyes might say fall on, on a location wherever it is and you might pick up that, word. But, if you can get kind of randomly moving your eyes, across the page you're not really reading; that basically you know tells us that yes, I movements especially when you're reading, and not really just scanning a particular scene, tend to be very, very systematically organized and this is somatically, a systematic organization basically is, is in such a way that you start always, on one particular location on the page, I usually say for example, in scripts like Hindi, English, on from the left side and from the left side you kind of move gradually, in a very systematic fashion, from left to Right On one line and then come down and then, again start at the leftmost and then move from left to right and then change line, again start from the left box and move to the right words. Okay? So, this is basically, how you know, you

extract information from the script and you get to read, whatever is written on that text. When you talk about eye movement, so let us kind of spend, a few minutes on talking about different kinds of eye movements that are there. And in eye moments there are multiple kinds of eye moments that people have identified, some of which might be relevant to reading, some of which might be relevant to you know barely looking in the, in out into the world, you know, scanning the scene and so on.

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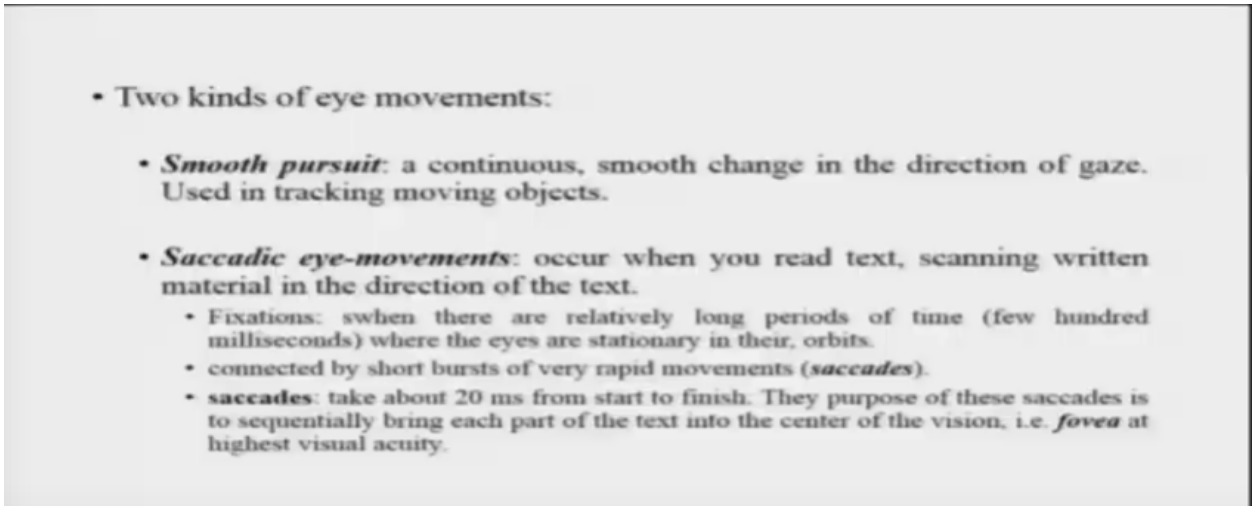

So, well the first kind of eye movements: at one could talk about is smooth pursuit. smooth pursuit kind a the easiest way, to understand how smooth pursuit, eye movements really are, is like suppose if there is an object that is moving in the visual field and I'm kind of tracking this, object with my eyes. You know a lot of times people are kind of you know, standing somewhere and their vehicle is going by it, if you try and track those vehicles from, the left part of your visual field, to the right Part of the visual field and outside into the periphery, this smooth movement and that really happens, a continuous smooth change in this direction of gaze, gazes where you're looking at, it's called you know, ‘Smooth Pursuit’. It’s mostly used in tracking moving objects. Okay? So that is smooth pursuit, other kind of eye movements that, one could talk about, are the saccadic eye movements. Saccadic eye movements basically occur when you're trying to read text. And you basically, then you scan in the direction of the text, suppose if you are reading Hindi or English, it's usually from left to right, if you're reading uruthu or Arabic then it will be from right to left. So, basically the eye movement is kind of now, tied to what script you are negotiating? What script you reading? And kind of will follow the pattern of the script, in order to maximize or optimize, your information uptake, from the script. Okay? So, saccadic eye movements or say for example, have quite a few things, there are times within this where they're relatively long periods of time, where the eyes are stationary, in their orbits, they're not really moving a lot around there. And these are basically connected by a very short burst of rapid moments, so there's, there's this place, where your eyes are you know, stationary for a bite and then they move to the next point and then move to the next point and they move to the next, these movements the short bursts of movements are referred to as, Saccades. Okay? So, saccades are rapid eye movements, from point A to point B, in the visual field and they are sort of very, very fast, yeah they usually take around, 20 milliseconds to reach from you know, one point two actually, it's it takes around 200 seconds it might be a typo here, 200 milliseconds from start to finish. And the purpose of these Saccades, basically you know, why do you need to move your eyes, you can keep your

eyes stationary and you know get the maximum information out of it. So, that could be a question that somebody would ask. And the answer to that question is that what the cards are trying to achieve is, they're trying to achieve maximum visual equity. So, I will talk about this very shortly, but when you're looking out, into the visual field, when you're looking out into the world or looking out onto a page of text, the information that you can uptake, from there is not uniform across the entire region suppose, if this is a page, you'll not be able to get information uniformly from this section, this section, this section or from the top or from the bottom at once. Usually what happens is that, the information is you know is best, is in its highest resolution, if I might borrow that metaphor is, it in its highest resolution, at the place where the information can be directly projected, onto the fovea. So, fovea is a short is a small you know, portion of the eye, at the back of the eye and the rate and I'll show you, some of those figures very quickly, so basically what we are trying to do is, all the eyes are trying to do is, to get the information at the fovea. So that you can get maximum information and then, move to the next location, you know get that information onto the fovea, take information in there. So, the entire purpose of these eye movements or the saccadic eye movements is, basically, to sequentially bring each part of the text you know, one word, second word, third word, fourth word, onto the fovea. So that you can add based and you know, in the best way possible, to take up this information and analyze it and you know, make it available for conversion of griffin to funny. Okay? Now, in that sense, you might ask. Okay?

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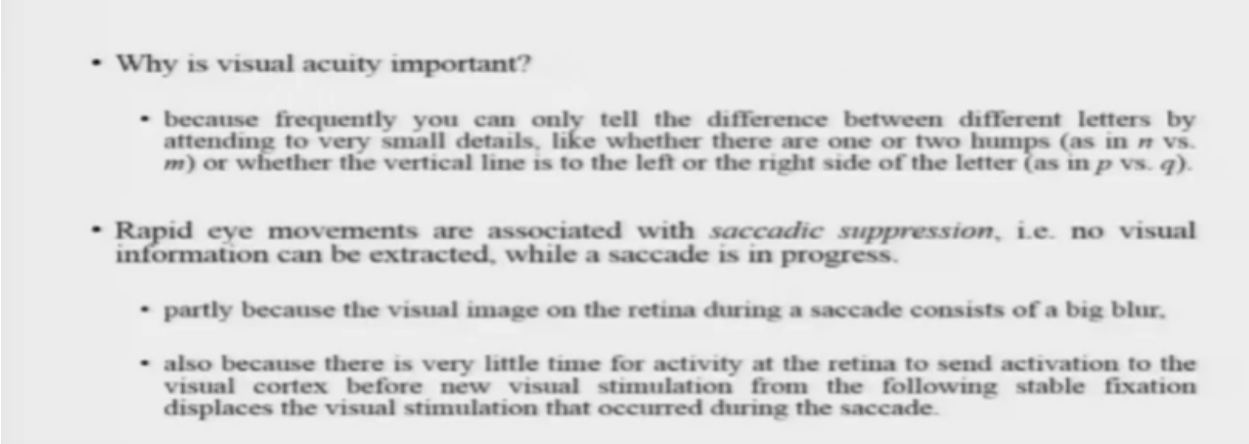

Why is this kind of visual acuity important? Why do we need that high degree of resolution that, we have to kind of move our eyes in a sort of a tiring manner so to speak and to get all of this information, on the fovea? Now, basically visual equity is important, in a sense, if you kind of think, a little bit and if you look at the kind of scripts that we navigate to it or that we negotiate with sorry, the scripts have very peculiar, minor differences. Say for example, you know, you might all be aware of the difference between, only differences that, you know it's almost sort of a reversal thing and the P and Q and end and M and there's, so many of these you know alphabets, which can be confused, with each other and if they are written as a, as it takes in a shorter font altogether. Now, then obviously you know, you need to be very, very careful, you need the highest visual acuity, to get that information correctly. Because that is the building block, of whatever you're going to read. So, in that sense that is very important, in any scripts like Hindi for that matter, it becomes even more important. Because, scripts like Hindi have almost a nonlinear arrangement of Akshara and matra's, all around him. So, you have Akshara you have half

Akshara's and you have matra's on top, on the bottom, on the left, on the right, if sometimes marked on to the Akshara itself. So, there are so many of these matra's and in that sense, you would not want to mistake, one a Akshara or another or you would not want to miss a much. Say for example, it's a very simple thing; say you can so there's this word called, 'UNK in Hindi' and the only thing is anchors and their small bin to, a small dot on the top of it. So, the thing is you have to in their sense, be very careful of even that dot. Because, otherwise the word will not make any sense, so in that sense, you need the highest equity information possible or highest resolution possible, highest visual equity and that is possible to get and that is only possible, if the information is falling directly onto the fovea, when you're looking at it and that is basically, what the eye movements are trying to do all the time. Now, one of the things that also so we talked about, smooth pursuit, we also talked about saccadic eye movements, what other things is basically when these circuits are happening ,when there is a you know rapid saccadic eye movements take place, there is another phenomena that kind of intervenes this is ,which is called, 'Saccadic Suppression'. And saccadic separation is basically, when you're moving from point A to point B, on the visual field, all the information in the middle is you know, it basically looks like a big blur, it's not really something that you also have information for, say for example, if you were reading first word of sentence and the third word and you immediately move from the first, to the third or you've skipped the second so to speak, you will have less information of the second word, mostly the second word could be just, a preposition or grammatical thing or determine or a and the kind of thing and it does not really matter, if you skip, it because you're still making decent sense, out of the entire thing, but suppose you kind of miss, an important, word then you kind of you know are messing over the entire reading thing, it's not going, alright. So, in the middle when you move from point A to point B that part is called, 'Saccadic Separation', no information can be, actually extracted during the cicadas in motion, why is this happening, why do you not you know, get more information, while you're moving this saccadic, partly because the visual image that falls on the retina, during this a cat is mostly a blur. It's, it's not detailed and it's so fast that you don't really register a lot from there, also there is a very little time for activity, at the retina to send activation to the visual cortex. So, you also have to understand, how reading is happening and part of it is, when you for waiting at some place, the retina is receiving some impressions, from the script and those impressions need to me strange to the visual cortex, at the back of the window occipital cortex, which kind of you know, makes meaning out of the symbols so it says. Okay? This is the symbol, this symbol actually means this, that part takes a little bit of a time and while you're in the saccade, while you're moving from point A to point B, jumping from here to there, this you know, time period is also very small and you really cannot kind of you know, process information so fast that you will be able to, take information, file moving you know the ice itself. So that part is, is there, so that's why Saccadic suppression happens.

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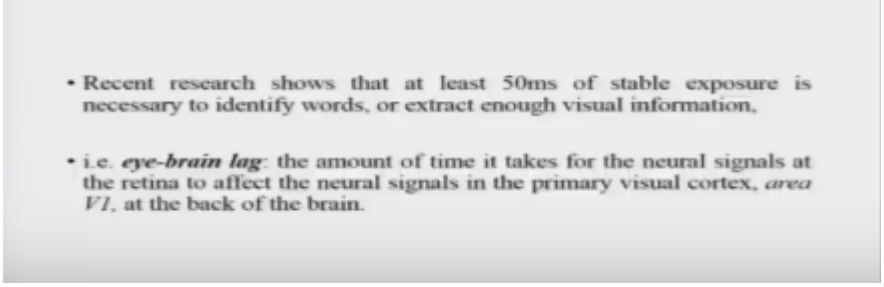

And research basically shows that, in order to really get some information, from the script, you basically need at least 50 milliseconds of exposure, during the saccade moving, from point A to point B, there is not you know that kind of time available and that's why you will not be able to actually process, any information between that. And this, loss of information basically, it is also a technical term for that, which is called, 'Eye Brain Lag'. Okay? The eye brain lag is, basically the amount of time, it takes for the neural signals from the retina, to affect the neural signals in the primary visual cortex area. So, that time, you know say for example, how much time it took. So, this 50 milliseconds time is the eye brain lag, which it kind of which the eye takes, to move information from the retina, to the primary visual, cortex in order, to you know for you to convert the grapheme to phoneme and make more sense out of it.

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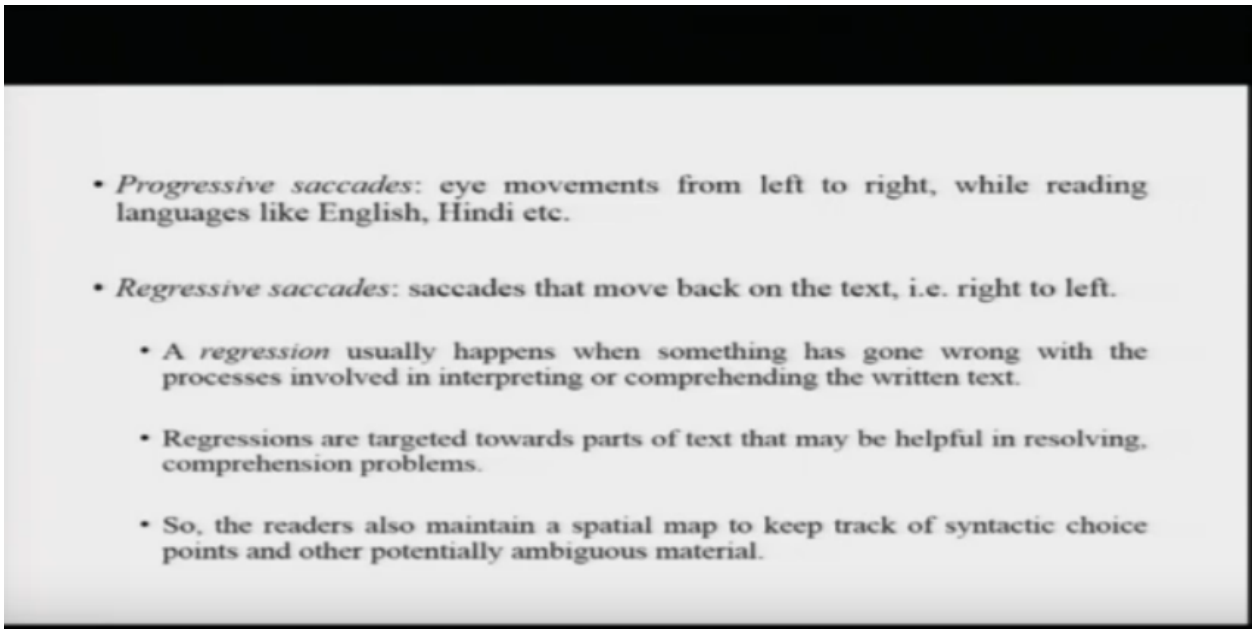

Now we can come to other kinds of saccadic, eye movements, when eye movements are in the direction of the shift, left to Right they are referred to as progressive circuits, if the, the circuits tend to move back, suppose you're reading this particular sentence, Right in here. You go from this were to this were to this were to suddenly come back, this coming back, is called a,' Regressive Circuit', moving from one point or I'll show you read, this one-god information then you move to this one, god information you move to this one. So, these were progressive circuits well when you have to come back, sometimes you read, the sentence at the end you don't really understand something when you come back, this coming back is called,' Regress Saccades'. Or regression in eye tracking papers, regression basically usually, happens when say for example, something has gone wrong with the process, involved in interpreting whatever the symbols, are whatever the words are or comprehending the text. And these revelations are basically then, where do you come back to. So, these are targeted towards parts of the text, that may be helpful, in resolving comprehension problems, suppose there's a sentient RAM came, very hungry from RAM came home, while he was very hungry. And then he put jam on his socks and ate it.
So, something like that so, when you kind of he put jam on his socks, they'll kind of try and you know, go back to it and say make sense of what it what is it actually, you know whether I have misread something or the sentences. So, some kind of cell you all say well they're all very simple actual sentences, sometimes

you don't you know understand, it and you want to come back and check what has really happened. So, the read is basically, also in that sense you know how can they come back to the exact, same area where there is some problem, you know so, the regressions are targeted, toward parts of the text, where they and that may be helpful, in solving any kind of comprehension problems or ambiguities. Now how can reduce exactly, come back to that same point, is because we just do maintain a sort of a spatial map, to keep track of syntactic choices, to keep track of you know semantic, ambiguities and so on. Okay? So, we've done this chapter; on Sandra crossing you see that so, many different syntactic choices need to be made. And if you're doing it sort of unconsciously, semi consciously, you need to come back atcha, is this was this a verb, was this a noun how was this there where do I attach the sentence structure, you'll need to come back, you'll need to do a lot of this you know for words, the card and progressions in order to kind of you know, do this in error-free sort of a manner, in this duration, your eyes are resting at some point of time, suppose say for example you move from, point A to point B you spend some time, here before you move there the point the time that you spend here. The time that say for example, you know you're fixating directly, at is basically called fixations. Okay?

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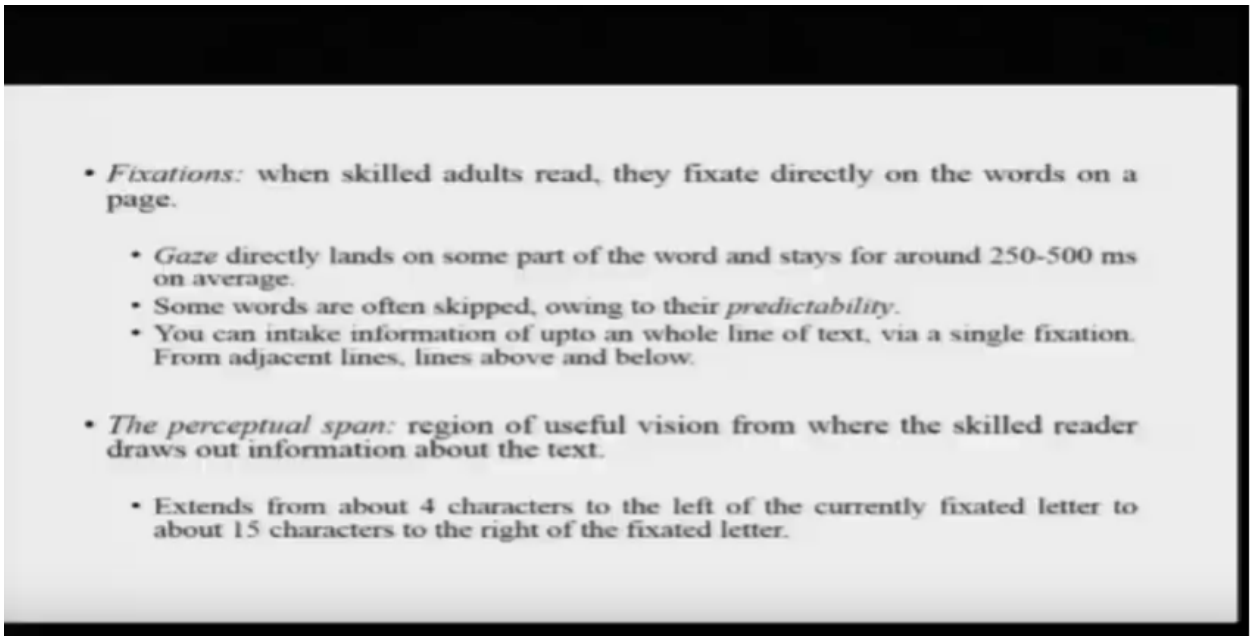

So, these, these durations basically, are sort of you know close to around 200 to 250 milliseconds? And sometimes the eyes can directly land; towards they say for example, you started with reading, at particular location on the page. So, you were you kind of started with, there and you spend it, on - twenty-two hundred - and fifty milliseconds there. And then moved to a different place and then if you stayed there. So, all of these basically are called,' Fixations'. And fixations basically, allow you to uptake a lot of information from, the text that you're fixating or the text that you're gazing directly at, looking at, eventually. So that is, there's also something important.

Now, another thing that I could talk to you about is the perceptual span: So, when your eyes are fixating at a particular place, how much information can you get, say for example, if I'm looking at the second word of the sentence, can I kind of get the whole sentence in my view or I am just getting information from that, word that I am fixating from, so that can be answered in a sense, by this concept of perceptual span.

And the perceptual span is basically, the region the region or the area of useful vision, you know the area that you can are gaining information from, while your resting your eyes, at that particular place. And that kind of can, differ from you know, from the skilled lead reader or to the novice reader. But, usually is around from say for example, four layer characters to form to the left till around, fifteen characters to the Right. And this will be basically for Hindi or English. So, if you're fixating at point at a point here ,four letters to the left and fifteen letters to the right is what your perceptual span would be and equity will also not be the same in that entire nineteen letters or twenty letters, basically the equity will be highest at the center, where you're actually fixating less that, will fall on the fovea and will tend to reduce, as you move on either side, of the fixation point.

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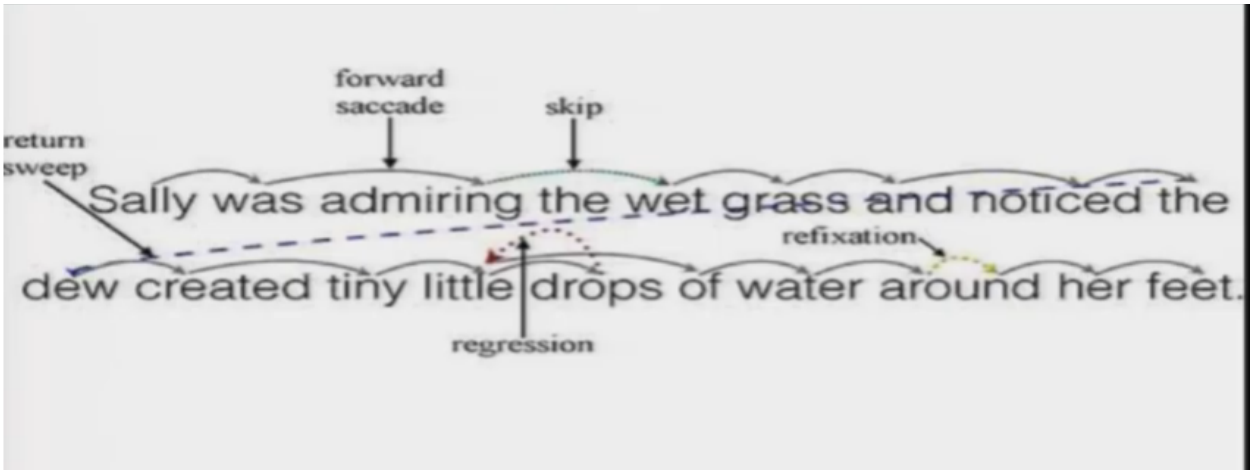

Let us look at, some of the figures that will help us, you know understand some of the things I was talking about, see can see a forwards addresses and the sentence is Sally, Sally was admiring the red dress and notice that you, created tiny little drops of water around her feet, so you can see say for example, the person started reading from Sally and moved to was and it's yeah! you know move to admiring and then skipped, the move to wait and so you can see that this is basically, what the thing is and if in the second line you can see from drops, from drops of water, there is a from drops to little, there is a regression that has happened, so somebody is kind of looked back. Okay? What did I read now, I probably was missed, I probably missed it, what did understand it clearly. So, you can see Saccades, you can see skips and you can see your regressions here. And they will see a little bit of reification sort of here, where in say for example, if you fixate it at this point and then, because the word was longer the word, around is almost six letters to it, so you kind of free fixate at the same letter. And you also see the return sweep, from the end of the sentence, to the beginning of this sentence. So, these are some of the eye movements that you can see.

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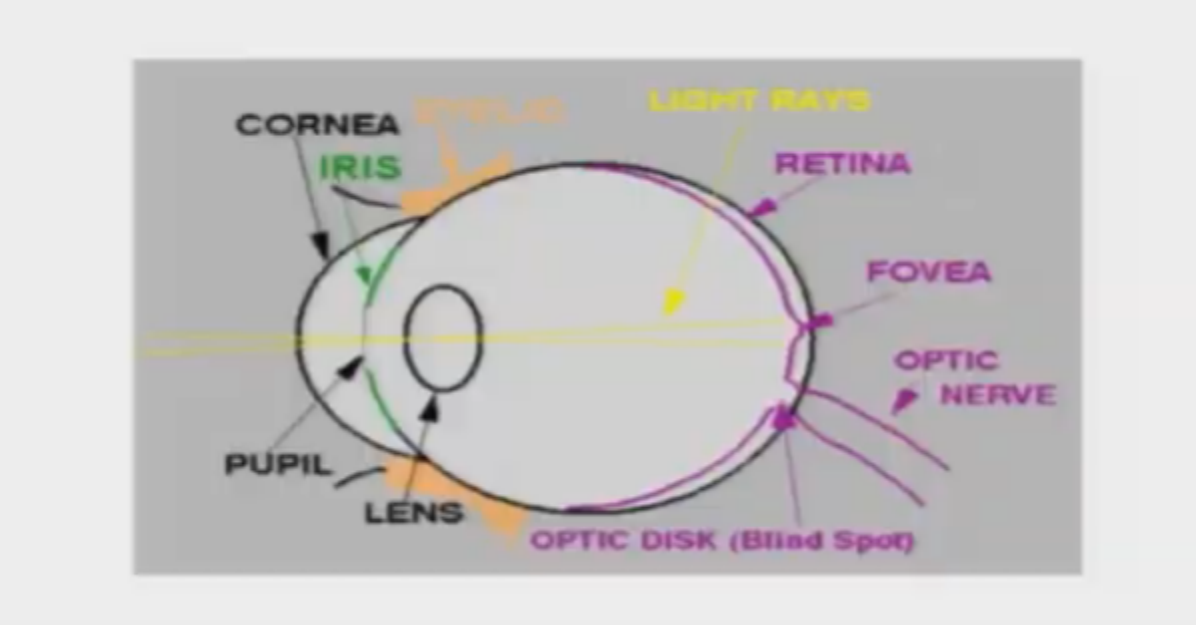

Here, in this figure you can see the fovea and in pink on the right. A fovea is a little kind of bulging area there, which has the highest density of, you know rods and cones and kind of that's why, it provides you the maximum resolution, if you really need to know, a little bit more about this, I think I've recorded this, in the course basic cognitive processes and then, you can kind of go and read a little bit, about where I've talked about perception.

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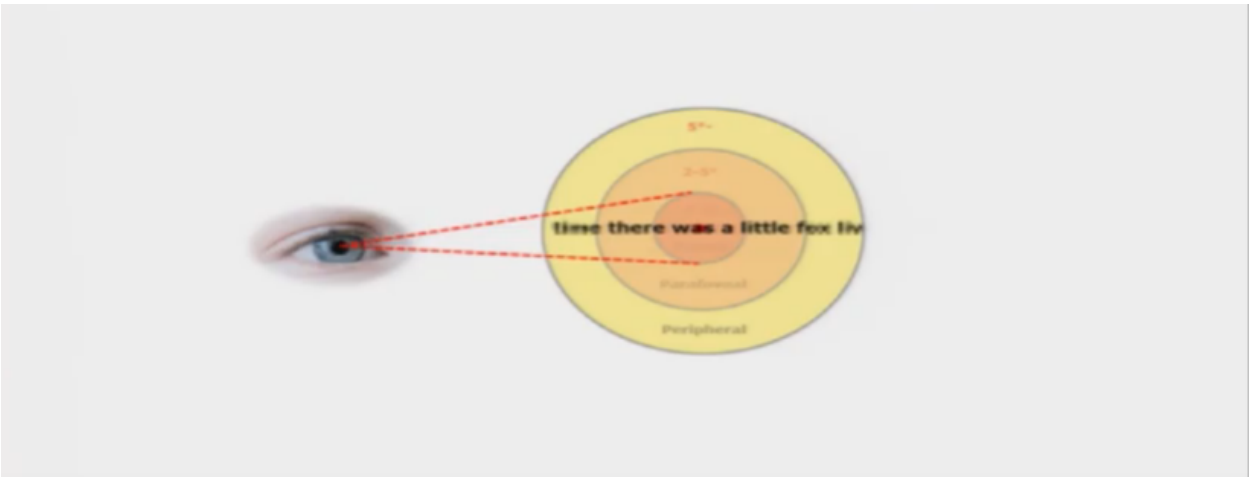

Now, this is basically how the range, the spatial area is organized, you can see from, you know, one to two degrees is the fovea and from two to five degrees is the Para fovea region around the Para around the fovea region. And then, five degrees and onwards, there is something that is called, ‘Peripheral Vision’. And you will see the, visual acuity is very different. So, from one to two degrees there is the highest visual acuity, from two to five degrees it is a little less and from five degrees onward it is very, very less.

So, you might need to move your eyes, again within the that spatial area, to get information this is exactly how it looks.

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So, the fixation part you see, there's 100% equity at the number four, yeah. And then, if you move towards the left and towards the right, you see the equity is kind of dropping off .Okay? So, around the fixation we've got four or five letters are seen, with the you know highest visual equity. So, if that even if, if a single word is long, you might not really be getting in full information, on the end of the beginning of the word. So, this is basically something very, very important that you need to keep in mind.

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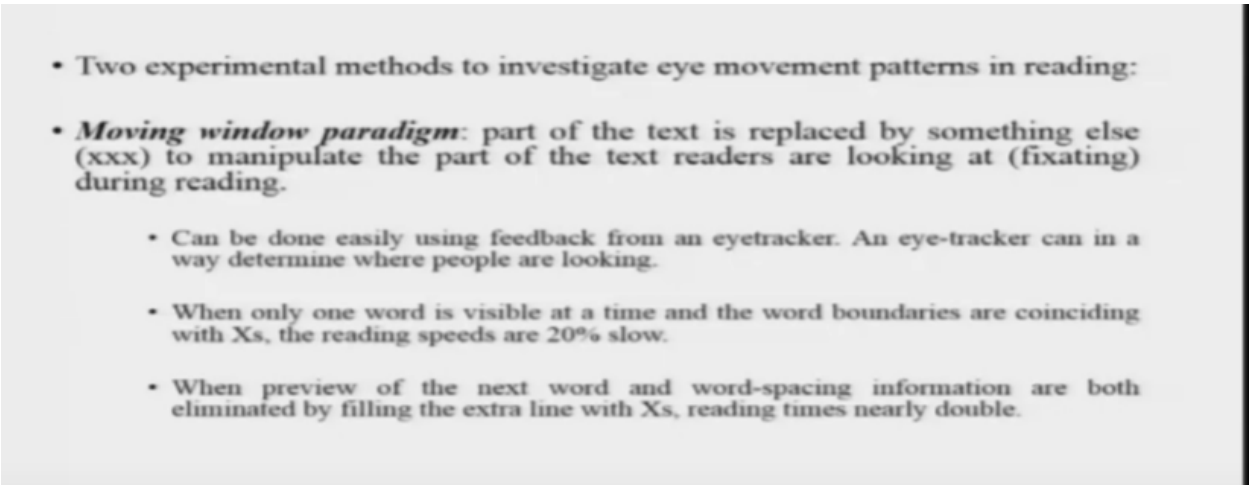

Now, we talked a little bit about, different kinds of eye movements that are involved in reading, we can also talk a little bit about, say for example, what are the experimental paradigms that have been used, to investigate the role of eye movements in reading. So, there are these two particular paradigms that I would like to mention, which are very, very popular in, reading research. So, to speak which kind of uses eye tracking methodology, one is the moving window paradigm. Moving window paradigm is basically, where in a part of the text is placed and replaced by something else, say for example, xxx to manipulate the part of the text that the readers are actually looking at, at any point in time. So, basically you want to be sure that the reader is picking up information, from only the part of the text that you want him to read

and nothing, I say for example, if you want to really see, how a person is processing a particular word and there's so many words here, in there so many words here, you could not really be sure of what the person is reading, so what you do is, you kind of keep this word in tag but convert all of this into X and all of this into X, as soon as the reader is read it, around 250 milliseconds and the root reader needs to move to the next, this one becomes exposed and this becomes excess, in this becomes excess and then another this one becomes exposed ,in this becomes excess, in this becomes excess. Let me give you an example, so this is a change, change. So, if you if you kind of saw this, give me three steps. Okay?
So, everything else is basically just XS and on each of these slides, I exactly know that you're processing that word. And whatever your fixations and patterns Saccades, my Saccades there, I can be sure that those are in response to that particular word and depending on whether that word is, a high frequency or low frequency word or a complicated word to read or an easy word to read, I will know is that pattern kind of corresponds to your eye movements pattern. So that is there basically and that's basically the important point here. And this can be done, easily using feedback from an eye tracker, an eye tracker is basically a device that, kind of is a very simple device, it basically is a sort of a camera and there's an infrared light source and the light source kind of you know, projects array of light to your eyes and it reflects back, on whatever you reading and then there's this camera is tracking that light source and basically in, in that sense it is mapping, how your eyes are moving on you know, the visual field or on the line of text that you're reading. Okay? And then, so because in this paradigm you're only reading one word at a time, what happens is, when only one word is visible at a time, the word boundaries and are coinciding X's, the reading speeds become almost 20% slower than, how somebody would naturally read and that is intuitive and that can be expected. Now, when the preview of the next word and words facing information are both, eliminated by these extra lines, in excess, reading times almost double. So you kind of become slower by almost fifty to sixty percent.

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So, this is basically again a demonstration of the moving window paradigm.

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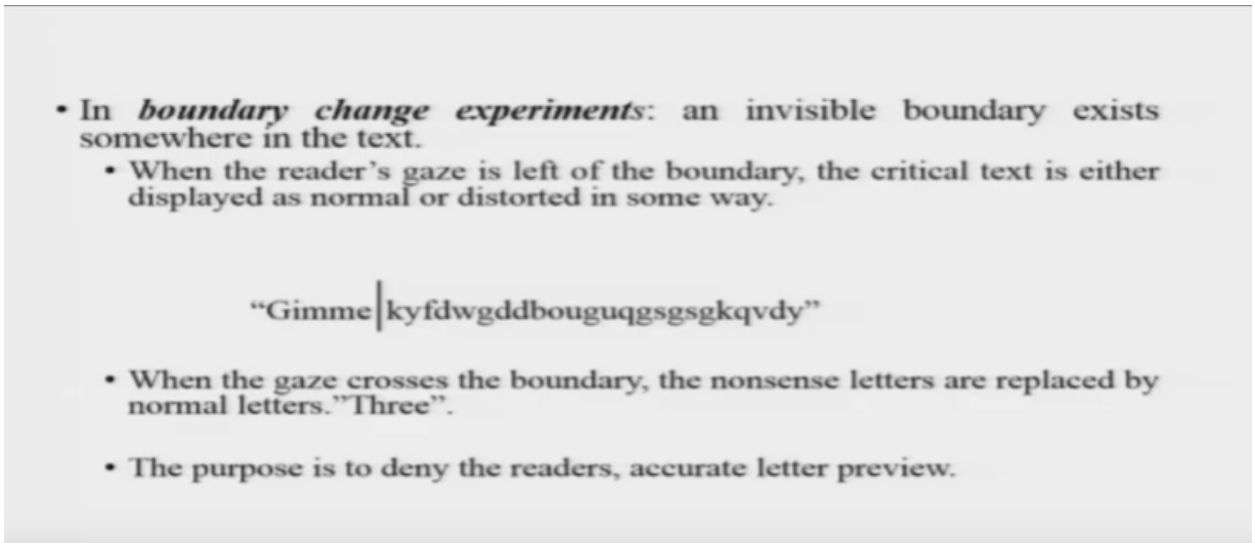

The other paradigm that you can also talk about is, the boundary change experiment, where in say for example, you don't really keep everything as XS. But, you kind of have invisible boundaries ,as soon as the gate and when the gaze is, he just gazes to the left of this boundary, the critical text is either displayed as normal or it's distorted in some way and as soon as you, change the boundary the nonsense letters are replaced by normal. Let's say for example, give me and then there's a boundary in here just random letters, as soon as these boundaries cross, this becomes three; this becomes random eaters, this freedom generated. So, this is the boundary change experiment and basically, the idea behind this boundary change paradigm is, to deny the readers any kind of preview, of the next information and move further, we will talk a little bit about, how preview might be helpful? Preview is way that because, when you reading this particular word and you're fixating on this particular word, are the words here, other words here, also sort of giving you some information are you kind of getting any preview information before fixating those words. So that basically is called, 'Preview'. And usually is referred to by the term of Para foveal Preview. So, foveal is what you are actually getting information, out of and then there's this degrees, two to five that area, very and also some information can be easily, you know gotten to read and that information also interacts with your speed of reading and so on. So, that Para foveal preview is denied in the boundary change paradigm.

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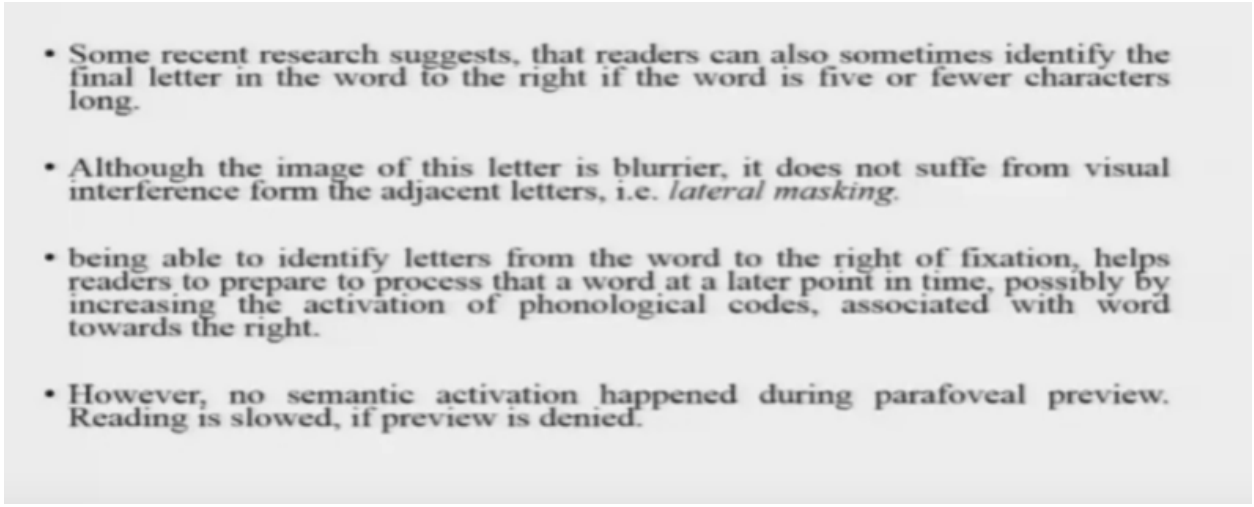

Now, there is some research suggests, that readers can also sometimes identify the final letter, in the verge to the right that is not what you're foveating, if the word is five or fewer characters long. So, for example, the end is smaller and if that area is falling in the Para fovea, you can actually read tell us, what the last letter of the next word is, which you're not really fixating. Okay? So, although obviously the image of this letter is much bloodier, it's not in your you know it's not in your foveal vision, it does not really suffer from visual interference, from the adjacent letters and you know this is basically called, 'Lateral Masking'. So, you kind still getting, some information out of it. Now, being able to identify letters, from the word to the right of fixation, helps sometimes Lee, readers to better predict and you know to and also say for example, you've processed that a little bit earlier, when you reach that you can be fast about it. Say for example, the word that you have had no preview of you'll spend some time, hundred 200 milliseconds whatever, in getting information and while you're getting information from there, suppose there is a mechanism that is also getting you information from the next letter, when you reach this one, you can be faster about it. Or say for example, if you realize that. Okay? This is just a preposition on an article a and that kind of thing and you decide to skip it and move to the next one. And you're still getting another Para fovea information. So, Para fovea information in that sense is something very, very crucial, in order to ensure the speed of your reading, also in order to ensure the correctness and the you know, accuracy of your reading. So, however I mean, so it visually it can be, it can be, a lot of help even though the information's resolution is not very high, the activity obviously, as we discussed is a slightly lower. Also, however finally we can say that, you know no semantic activation really happens, so you are not probably getting out of meaning, out of what is there, but you see can get the visual information out of there. So, in that sense that is, that is something, which is slightly important and one would need to know that.

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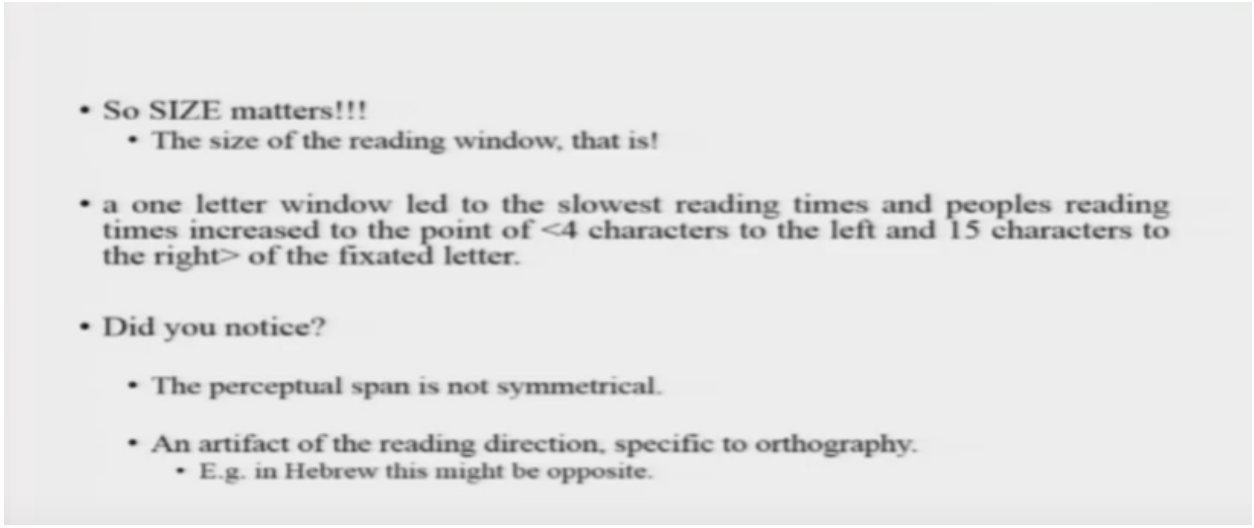

So, also other things is say that the size of this reading window that we talked about ,4 letters for the left and 15 letters to the Right is also something that matters. So, the size of the reading window, kind of matters in order to determining your speed of reading that entire text. Now, so that's basically, what we said, four letters to the left and 15 characters letters to the right is basically, your reading window time. If you notice that 4 to the left and 15 this is not a really a symmetrical window, basically this is an artifact of reading direction. So, if your reading from left to Right this is 4 to the left 15 to the right, if you are reading from right to left as in Hebrew, maybe 4 to the Right and 15 to the left. Okay? This is, this is again something that you, develop in response to the script that you're learning to read, okay. So, again something that is you were picking up, you're picking of the scale and the system is organizing itself, according to the script that you learn in to negotiate. Another important aspect that we can talk a little bit about is, this concept of

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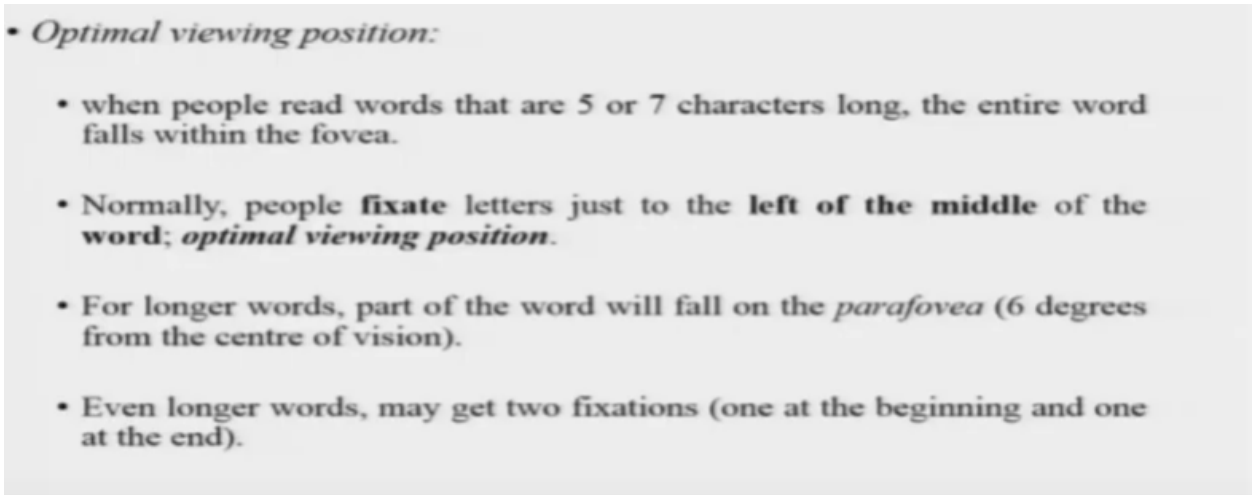

optimal viewing position: Now, optimal viewing position is an interesting concept, which basically, kind of dictates or informs us, of the best site to land your eyes on. Or say for example, from the best place in the world where you can get the maximum information. So, the optimal position, where if you like eyes land, you can get the maximum information out of the word and consequently can guarantee in a maximum speed of reading. So, when people read words that are around five to seven characters, long the entire word you know, falls within the fovea and what people normally would do is, they fixate letters, just left to the middle of safe area for a five letter word just left to the third letter is, what you would fixate, at and the entire letter will be within the fovea and that is the best or the optimal position, to read that word. So, if you again reach to the next word, you'll probably reach the just left to the third and the less left with her, in all other five or seven letters, words and it kind of ensures that, you're reading at a very good, fast pace not really making so many errors. But, if words, if words are slightly longer, more than seven letters or you know, eight or nine or ten letters most part of the word ,then will fall into the Para fovea and basically that will reduce, your accuracy of reading and also kind of reduce, your speed of reading. So, in that sense what happens is that usually people would kind of make two fixations, on within the same word, so one in the beginning and one at the end and those two fixations, will both be spent at the same were to, gain information about the word, in the most error-free manner. That kind of you know, obviously a slows on your speed, but obviously you really need to do this, in order to get the most accurate information. Now, this optimal viewing position and people have kind of you know, done a lot of experiments and figured this out for a, lot of scripts.

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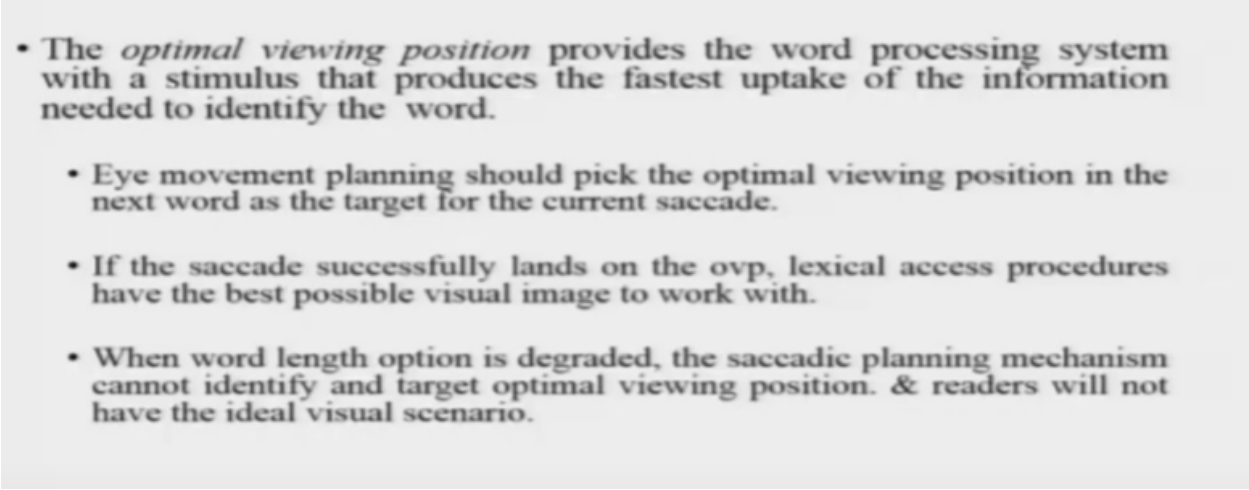

So, this optimal viewing position basically, what it does for the system is that it provides the word processing system, with a stimulus that produces the fastest uptake of information. So, the whole point of this optimal viewing position is that you know exactly where my eye should launch, in order to get the fastest uptake, of visual information, from here. Okay? And in that sense, basically Eye moment planning also kind of follows this, Eye moment planning basically, should pick up this optimal viewing position, in the next word, as the target for the currents Saccades. So, while you're reading, well you rendered at the optimal position and this world, you are at the same time, calculating the optimal position for the next word and the next word and the next word. Okay? So, one word at a time, you're kind of moving and while if you are doing ,being able to do this calculation correctly and in a fast way, you can eventually be

able to read, all of this, in a very quick way and also without making too many errors. So, if the Saccade successfully lands, on the optimal viewing position for the next word itself, lexical access procedures, have the best possible visual image to work with and you know that eventually the entire process kind of gets, fast and, and it gets you know, error free when say for example, the word length option is degraded, it's not really very clear, it's a longer word or something like that, the saccadic planning mechanism, may not be able to identify the target words, optimal viewing position and then, that that's why the readers will not really have ,the ideal visual scenario, their reading will slow down, maybe they might commit a few errors, in order to read this entire thing successfully. So, basically you know, so this is, this is all that's very important.

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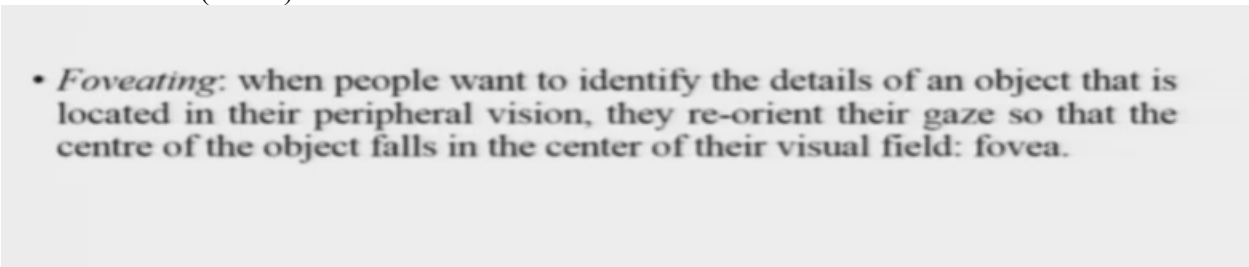

And then, there's this thing of you know, there's this last thing that I wanted to talk to you about is, foveating: So, those whole point of moving your eyes, across is basically to try and get the best visual image possible to work with, for the lexical process, lexical access mechanisms. So, when people want to identify, the details of an object that is, located in the peripheral vision, they reorient their gaze, they're not really moving ahead, viewing their gaze. So that the center of the object falls within the fovea. And within the via, so within the fovea and that is where you'll get the best image, highest amount of information from that and this entire you know, business of moving rise systematically through the entire page is, basically part of what is called, 'Foveating'. So, that was all from me in today's lecture.

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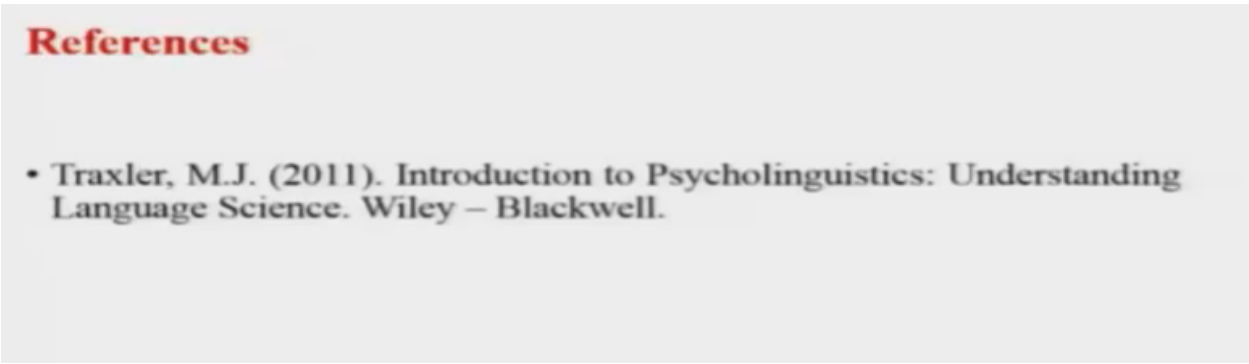

We talked a little bit about kind of eye movements also, what reading basically involves. Let's move into the next lecture, really I talked to you about, particular models of reading. Thank you.