Advanced Cognitive Processes
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Lecture-20
Reading-II

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. We have talked about aspects of reading in the last lecture and I will just try and take that discussion a little bit further by involving some of the cognitive processes that are there in reading what are the aspects of scripts that, you need to keep in mind.

And a little bit about difficulties in reading which is again covered under section referring to dyslexia. So, let us begin rather quickly.

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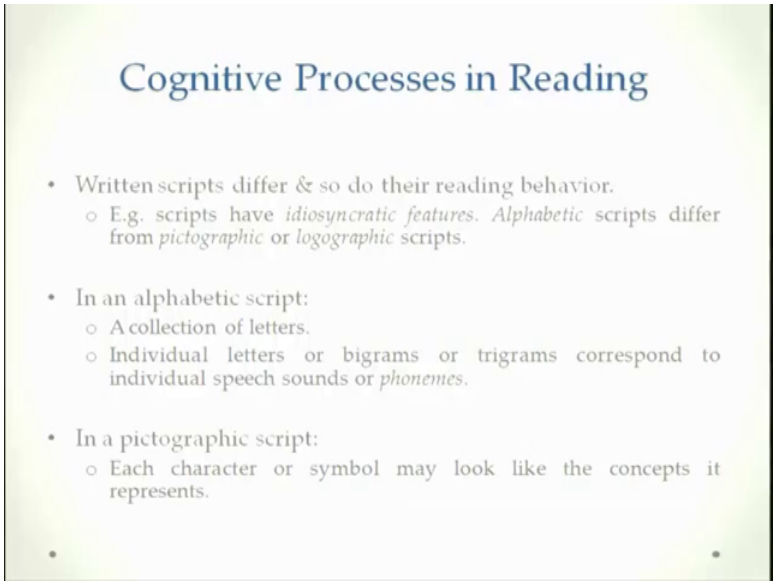

So, what kind of cognitive processes might be intervening reading you know reading scripts differ. So, script of Hindi or script of English is very different from the script of Hebrew or Prussian or for that matter Chinese or Japanese.

So, different scripts have basically things called idiosyncratic features and these idiosyncratic features are those unique aspects that each scripts has. And the reader of each of these scripts have to be well versed with have to be familiarized with these

idiosyncratic features in order to master reading using that particular script ok. Say for example, alphabetic scripts are slightly different pictographic scripts are different and logographic scriptsare different.

So, in alphabetic scripts we typically English is an alphabetic script there is a collection of letters each letters or groups of letters or bigrams or trigrams basically stand for or correspond to individual speech sounds or phonemes. And basically each because each letter is a phoneme you combine letters as you combine sounds and you create words out of that a pictographic script is one.

Suppose for example,; that means, is wherein each character or symbol may look like the concepts that it is trying to convey. So, for example, each letter if you are say for example, in a particular script if you want to depict how you know you want to talk about a tree it is quite probable that your description that your symbol for tree looks or resembles the tree in some form ok.

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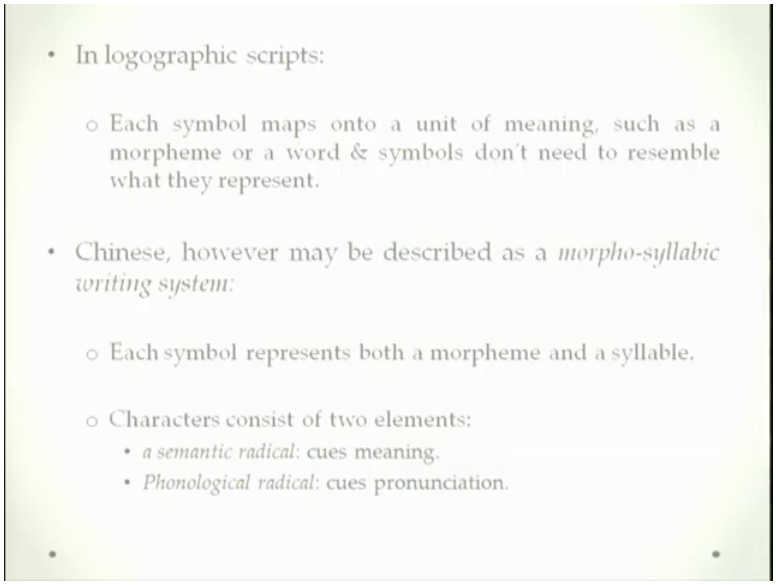

So, that is one and there are logographic scripts in logographic scripts what happens is that each symbol will map onto a unit of meaning such as morpheme or a word and symbols do not really need to resemble what they are representing unlike the pictographic scripts. So, these are the three broad varieties of scripts that you can talk about. Now I have very you know interesting example in Chinese; Chinese have has been described by people as morpho syllabic writing system.

What does a morpho syllabic writing system? It is nothing really to be afraid of or very complicated here each symbol letter each symbol will represent both a morpheme a part of the word and a syllable a part of the phonological word. So, characters consists of two elements one is a semantic radical which will tell you something about the meaning of what it is representing and phonological radical that will tell you about how this has to be pronounced.

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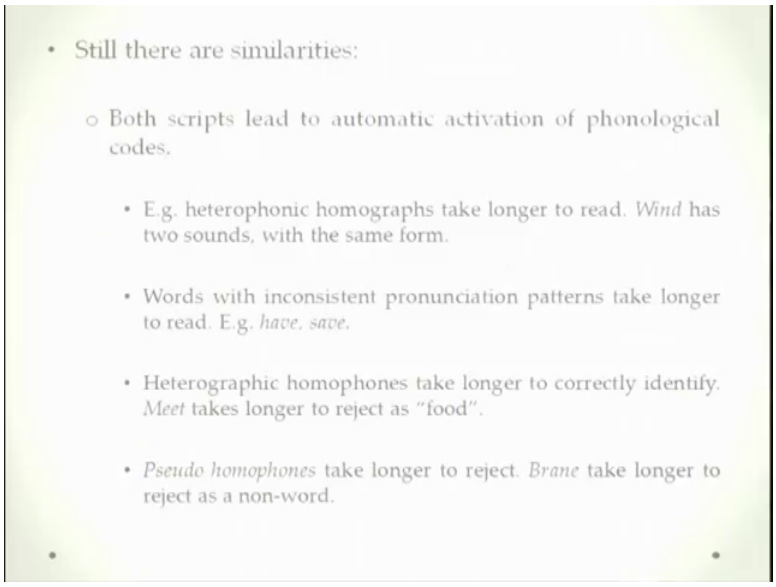

So, in that sense because there are morphemic and syllabic aspects Chinese is referred to as morpho syllabic scripts; however, there are some similarities with the morphogical with the Chinese scripts with other scripts for example, both kind of scripts will lead to automatic activation of phonological codes. So, there is the phonological radical it will automatically help you generate a pronunciation for whatever you are reading.

So, heterophonic homographs you know things that sound different, but written in the same way. So, suppose for example wind has two sounds with the same form. So, wind basically can be read as wind or it can be read as wind. So, it is homographic features the same set of words has to sound associated to the wind and wind.

So, these kinds of things will take longer to read in both alphabetical scripts and scripts like Chinese. Also words with inconsistent pronunciations would take bit longer. So, suppose h a v e is have, but s a v e is not save its save. So, there is inconsistency in

pronunciation coming which; obviously, will slow the reader down while reading aloud other thing are heterographic homophones.

So, things that are written differently, but are sounding exactly the same meet takes longer to reject as food because m e e t stands for meeting somebody, but it also sounds like m e a t which is food. So, if you kind of ask somebody you present this word meat and ask them the food or not it might take them a little bit longer to reject meat as a food item

Also another script pseudo homophones are difficult to reject they take a long time to reject for example, the word b r a n e which basically resembles the sounds of brain b r a i n we will take a little bit longer to reject. All of these kind of effects are very similarly happening across Chinese scripts like English as well.

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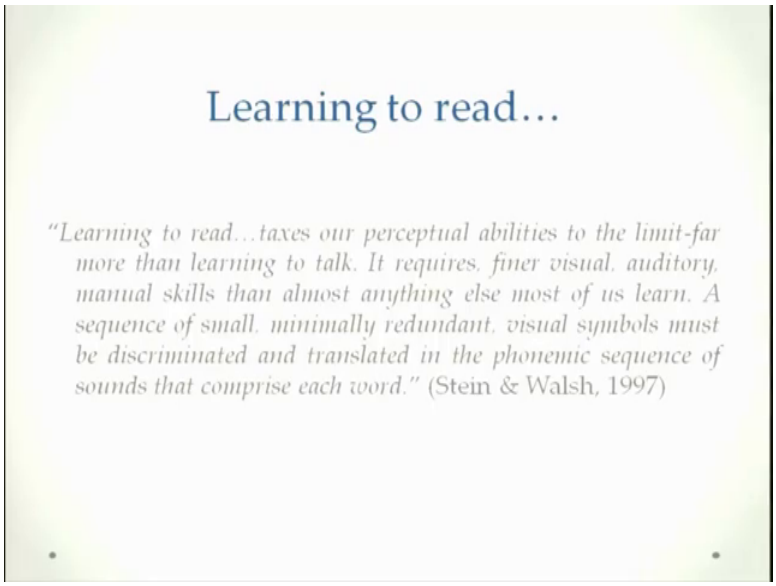

So, this is again some similarity between the two kind of scripts because we are just trying to talk about sounds and everything let us talk a little bit about building block of reading.

So learning to read again I am just borrowing a quote from Stein and Walsh from (Refer Time: 05:30) book learning to read taxes our perceptual abilities to the limit far more than learning to talk. Because again if you remember the way I began this discussion on reading is that reading is fairly unnatural it requires finer visual auditory manual skills

than anything that almost anything that we learn, it is probably one of the most complicated task that we have to you know we have to learn to master. Also a sequence of small minimally redundant visual symbols must be discriminated from each other and then translated in the phonemic sequence of sounds that comprise each word.

So, I mean this should help you kind of appreciate how difficult it is you know these are very small symbols you know a b c d e f or [FL] and [FL] and those kind of things these have to be converted into sounds you are just looking at the visual. The visual has to be connected to the sound and the sound has to be connected to the meaning all of this has to be done at a fairly rapid pace you know rather dynamic fashion.

So, in that sense reading is difficult. So, what do you really need to do in order to learn to read at least two things.

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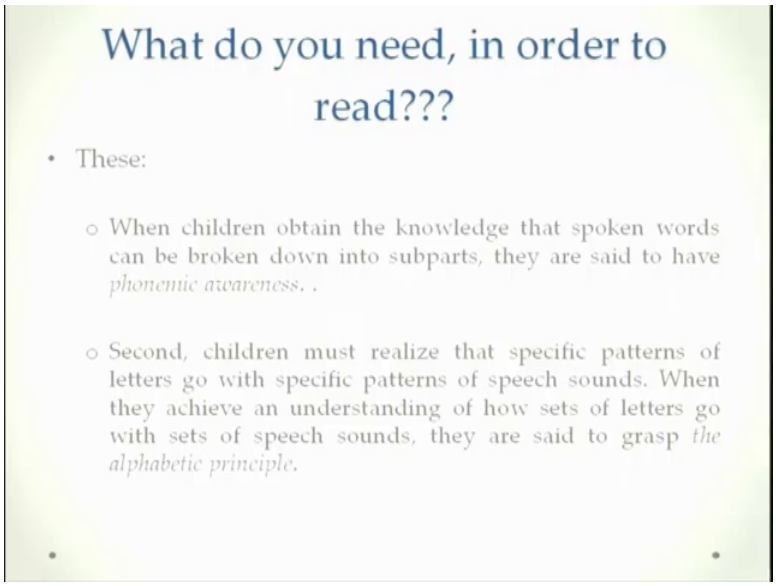

When children are obtaining the knowledge that spoken words can be broken down into subparts they are said to have phonemic awareness. So, something that the child has to learn to master is this aspect of phonemic awareness whatever I am saying can be broken down into sounds and sounds has to have to be represented by you know the basic symbols.

So, this phonemic awareness that you can break things down into sounds is very important. The other thing is that the children must realize that specific patterns of letters go with specific patterns of speech sounds.

So, you have to be able to put together letters together to create sounds and that is also important effect. So, when they achieve this understanding of how you know sets of letters go together to create specific sounds they are said to have grasp what is called a alphabetic principle.

So, one of the two basic abilities that you need to master in order to learn to read is the phonemic awareness the fact that you know spoken words can be broken down into subparts smaller sounds a and the second is that the subparts can be created by a you know putting together particular kinds of specific letters is the alphabetic principle.

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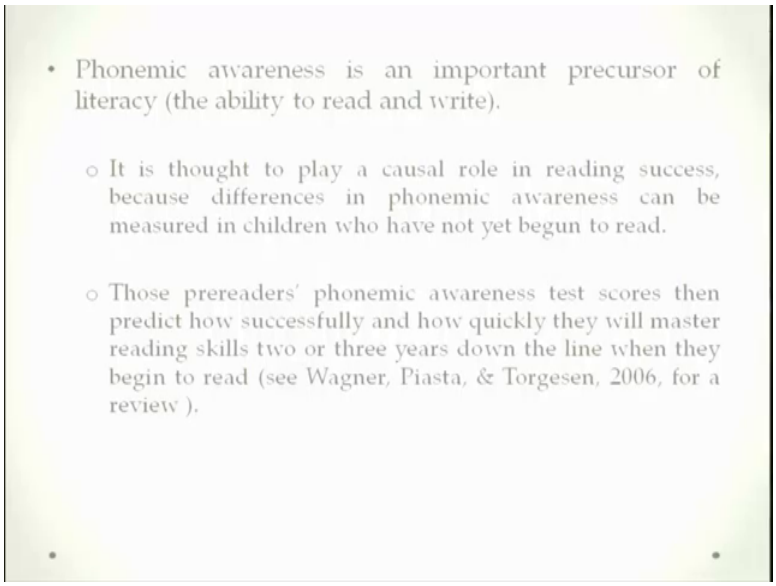

These two things are very important phonemic awareness is supposed to be one of the most important precursors of literacy you know. Unless the child masters this principle of phonemic awareness it is very difficult rather impossible for the child to master reading it is thought to play a causal role in reading success because difference in phonemic awareness have been measured in children and they have basically been correlated with the final ability to read.

So, children who have been found to be very good with phonemic awareness have been found to acquire reading more seamlessly in better way at earlier. Children who have been found to be deficit in phonemic awareness have been basically you know linked with difficulties in acquiring reading.

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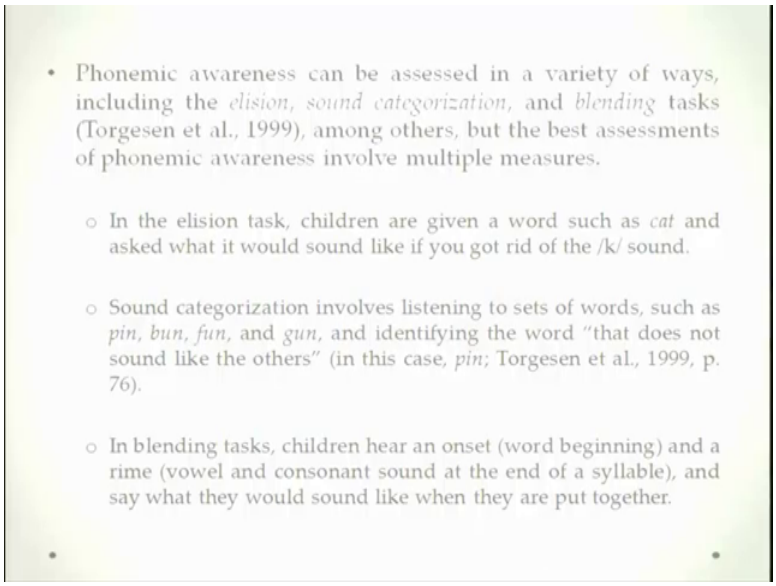

Phonemic awareness and there is a way to measure them phonemic awareness can be assessed in a variety of ways. For example, the elision task in which you give the child a particular sound suppose I asked the child to give cat mat bat hat and then I ask the child to say remove the ka sound and tell me how it sounds.

So, the child should be able to tell me at remove the ba sound then how does this sound the child should be able to tell me at. So, this the elision task different kind of task is sound categorization wherein basically it involves you know listening to sets of words and identifying the word that does not fit suppose I am saying a pin bun fun gun.

So, the child should be able to tell that pin is different from bun fun and gun. Again the idea is that you teaching the child to appreciate how sounds are created, how sounds can be broken down and changed manipulated etcetera. In the blending task again a very similar task to just make an awareness children hear an onset and a rime the beginning of the syllable and the end of the syllable.

And they basically try and see how you know what they will sound like if you would combining two different syllable cap and pat. How do you know if you take the beginning of one end end of one it probably can be made as pat. So, the child needs to be able to break these things down and play with these a little bit so, that the child acquires you know phonemic awareness and masters the basic principle of reading.

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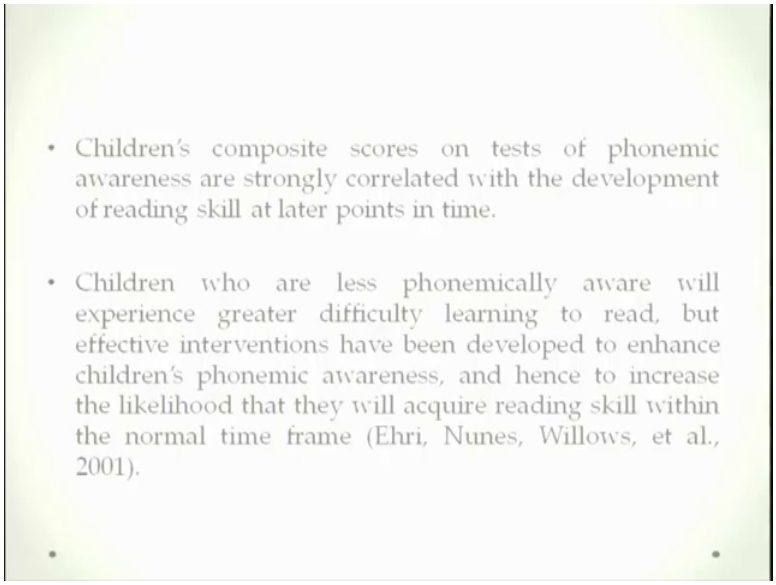

Now, children's composite scores on tests of phonemic awareness using task like I just described; here have been found to be strongly correlated with the development of reading skills at a later point in time.

Also it has been seen that children who are less phonemically aware will experience greater difficult in learning to read and for this reason people have come up with various methods various interventions to develop and enhance the children's phonemic awareness. And hence to increase the likelihood that they will turn into better readers highly skilled readers as time passes by. So, this is little bit about phonemic awareness.

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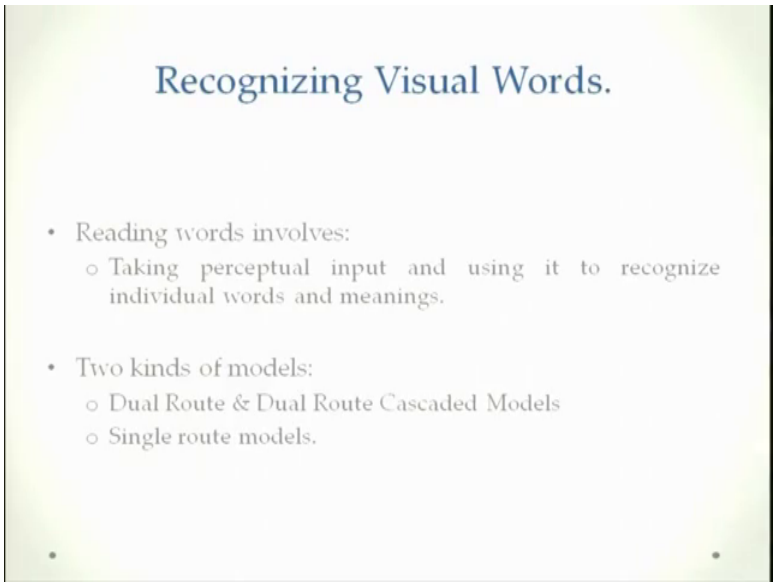

Let us now move to recognizing visual words; in the last lecture I was talking to you about reading using eye movements I was mostly talking little bit about how do you read longer sentences I am just in this lectures spending some time on reading individual words. So, individual word reading basically involves taking a perceptual input and using it to recognise a word and meaning.

There are two kinds of models dual route models and single route models.

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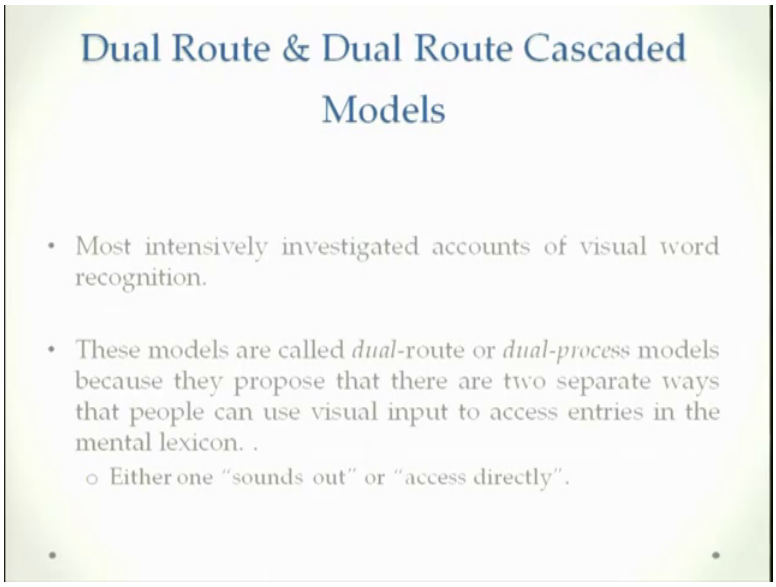

The dual route models basically I have been one of the most investigated accounts of visual world recognition. And these models are called dual route or dual process models because they propose that at least there are two ways of wherein reading can occur. The first way is the direct access way and the second way is the sounding out way.

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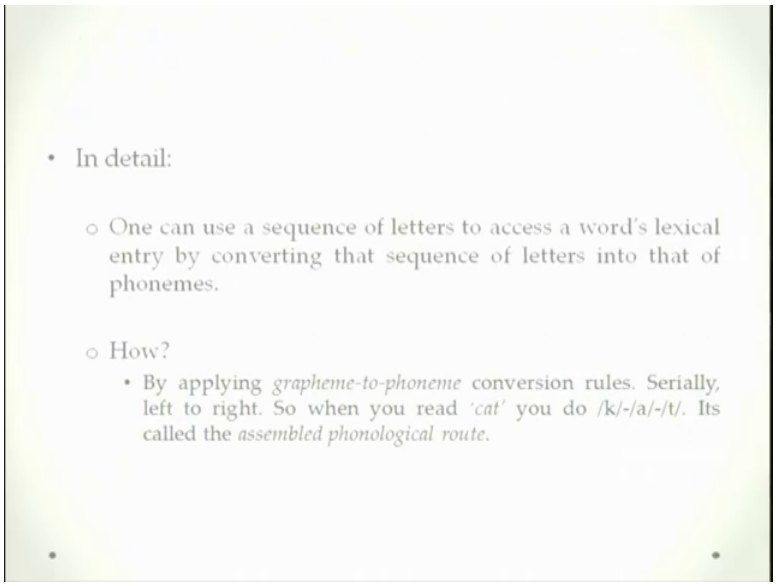

I will just describe this in a little bit more. So, idea is if you are actually looking at you know bunch of letters put together as a word; there are two ways that you can read it. The first is that you can use this in sequence of letters; so, access a words lexical entry by converting that sequence of letters into that of phonemes.

Suppose you are reading b a t bat you have to come up with the sound of what b stands for and what a stands for and what t stands for link all of this together you have sounded this out now you know that b a t means bat; so, it is bat.

So, this is one of the ways of doing this conversion that I was talking about is referred to as grapheme to phoneme conversion; grapheme is the visual symbol phoneme is the auditory symbol. So, you have to convert the visual symbol into the auditory symbol in order to understand the meaning of the word that is the g-p-c conversion and when you are reading using the g-p-c conversion route you are basically using what it is referred to as the assembled phonology route.

So, assembled phonology route is basically when you sounding out each letter sequence in the word and then constructing a sound based representation.

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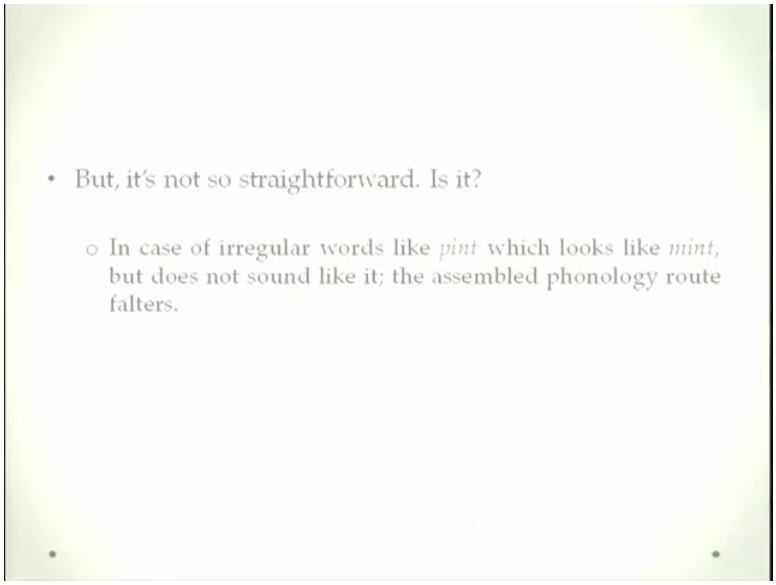

However it is not really straightforward you know suppose for example, you are reading irregular word like pint you know p i n t its very probable that you know somebody has not read this word earlier might make a mistake and read this as pint. Because you know you have you probably will have more familiarity with the word mint because mint is something that you kind of you know come across more often.

So, if you come across mint and then you are kind of a reading this word pint you not really being able to you will not really be successful in coming to the correct pronunciation if you are using the assembled phonology route. So, how do you do it because the assembled phonology route is leading it to problems. Suppose and it will lead you to problems in words like bouquet for example, b o u q u e t bouquet basically you know you say it as bouquet, but if you go with the phonology route you probably say as bouquet or something like that ok.

So, it is fairly evident that the assembled phonology route might lead you to certain mistakes. So, what is the solution?

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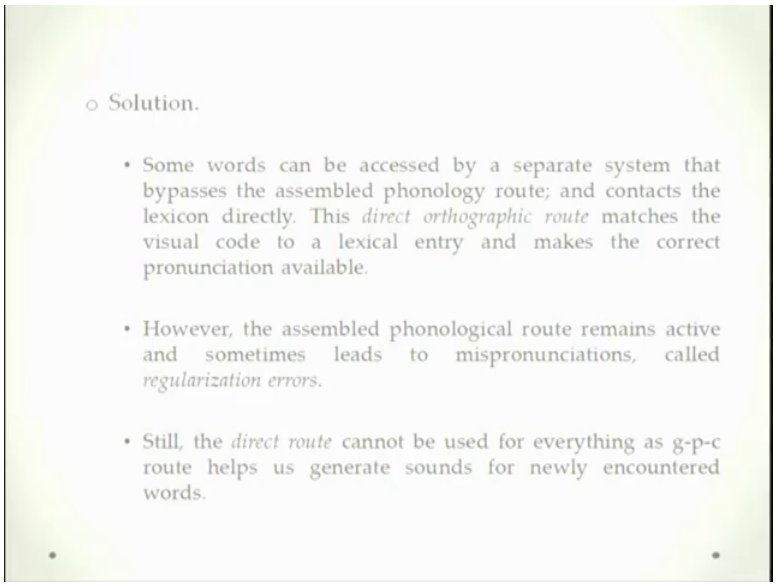

There is a solution and the solution is that some words needs to be accessed, some words which are irregular which are not really following the grapheme to phoneme conversion consistency.

They might be accessed directly; you know you have to memorize them you have to remember that there is an exception rule being applied here. And this exceptional rule the invocation of this exceptional rule is referred to as the direct orthographic route. So, the direct orthographic route matches the visual code to a lexical entry that is in your brain and it that this matching will make the correct pronunciation available to you. You are not going by sounding e sequence of the letters what you are doing is you are reading this you know that you know this you check whether you know this word already and you come up with a direct pronunciation already.

So, also its does not really mean that you know the symbol for the assembled phonology route becomes inactive the assembled phonology route also becomes is active and sometimes it would lead you to mispronunciations which are referred to as regularization errors. Suppose if I start saying I start reading p i n t s pint this is a regularization error I should remember that you know if this basically p i n t as stands for pint and that we will be the access to direct route, but sometimes I will make this mistake and I will read p i n t as pint that is where I am committing the regularization error.

Still the direct route cannot be used for everything as g-p-c route generally helps us generate sounds for newly encountered words. You know direct route is accessible only for the points that you know this word if you have not seen this word earlier. If you are not aware of this word reads like then you will anyways end up using the grapheme to phoneme conversion the assembled phonology route and that is why the route is also very important.

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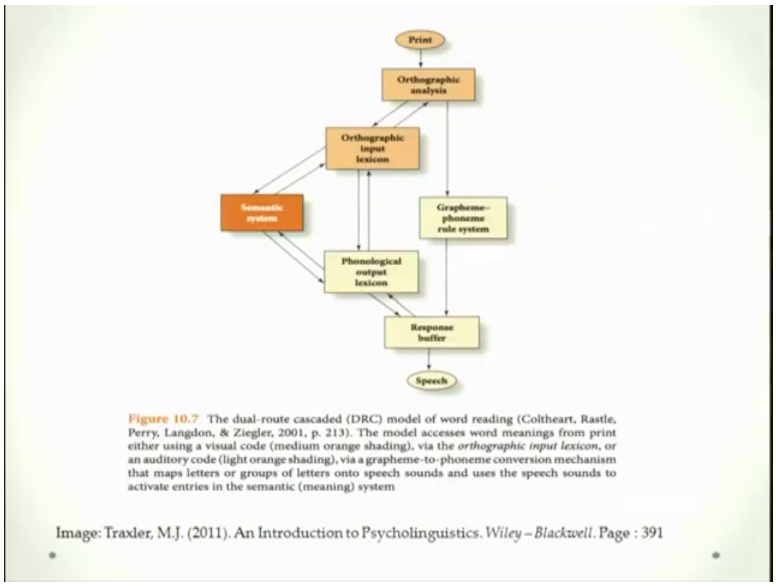

Figure 10.7 The dual-route cascaded (DRC) model of word reading (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001, p. 213). The model accesses word meanings from print either using a visual code (medium orange shading), via the *orthographic input lexicon*, or an auditory code (light orange shading), via a grapheme-to-phoneme conversion mechanism that maps letters or groups of letters onto speech sounds and uses the speech sounds to activate entries in the semantic (meaning) system

Image: Traxler, M.J. (2011). An Introduction to Psycholinguistics. *Wiley – Blackwell*. Page : 391

This is how the direct dual route cascaded model looks like; you will see that there is a direct connection from orthographic analysis to a response buffer which is the grapheme phoneme rule system. And then there is the orthographic input lexicon and the phonological input lexicon again you will see how these things are connected.

More important is; however, I have described already how this model really works. If you really noticed the g-p-c route if you look back at this figure the g-p-c route postulates serial activation code for letters.

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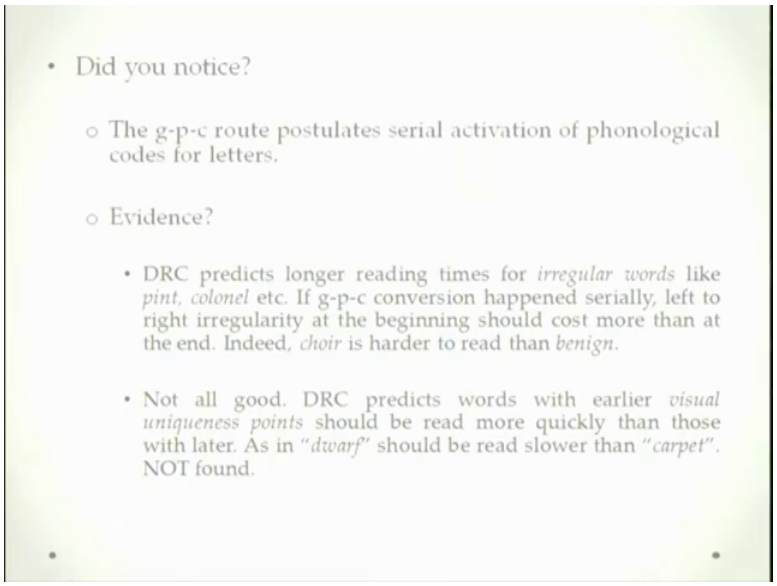

So, g-p-c route basically is going to tell you that you know you activate first letter first second letter and third letter this is the serial allocation that that needs to happen. So, is there any evidence of these are we doing it in parallel or are we doing it in serial. So, there is some evidence for this.

So, dual route model basically predicts that they will be larger reading time for irregular words like pint and colonel etcetera and suppose if g-p-c conversion was happening serially left to right irregularity in a left to right fashion; irregularity at the beginning of the word will should cost more or will cost more than irregularity at the end.

And if you really look at the experimental results that are available you will find that if there is irregularity at the beginning of the word, you generally take more time in reading that word it kind of can act as an evidence of saying that this dual route this assembled phonology thing is happening serially and it is happening from left to right depending on the direction of text that you are reading that is there.

But if it does not really apply across the board for some cases DRC predicts that you know words with earlier visual uniqueness points. Suppose for example, the words like dwarf should be read slower than words like carpet, but this has not really been found dwarf is also read as fast as carpet and then this kind of thing you know it is in a bit of a problem again I will just enumerating some evidence related to what reading experiments have shown and again this is something that is ongoing.

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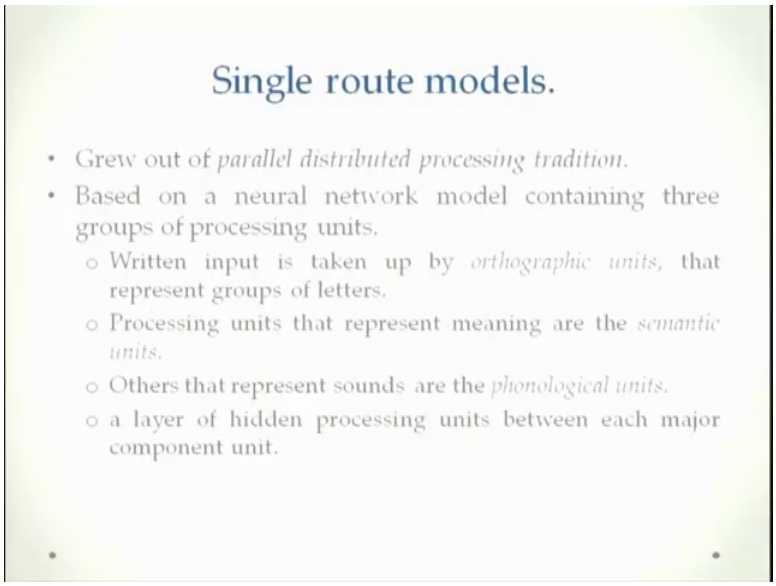

So, a lot of evidence are kind of sometimes contradicted. So, we talked about how reading would happen, we talked about this model of reading and this was the dual route model. Let us look at one of the single route models the single route models again it kind of borrows from the parallel distributed processing tradition Mcclelland and Rumelhart.

And what do you say is reading really happens in just one process, what they have his they have a neural network based model has a particular components, do the orthographic processing where in the visual analysis is done, it has components that represent meaning which is the semantic units and then it has components which have the phonological. So, they had orthography components meaning related semantic components and phonology related sound based components.

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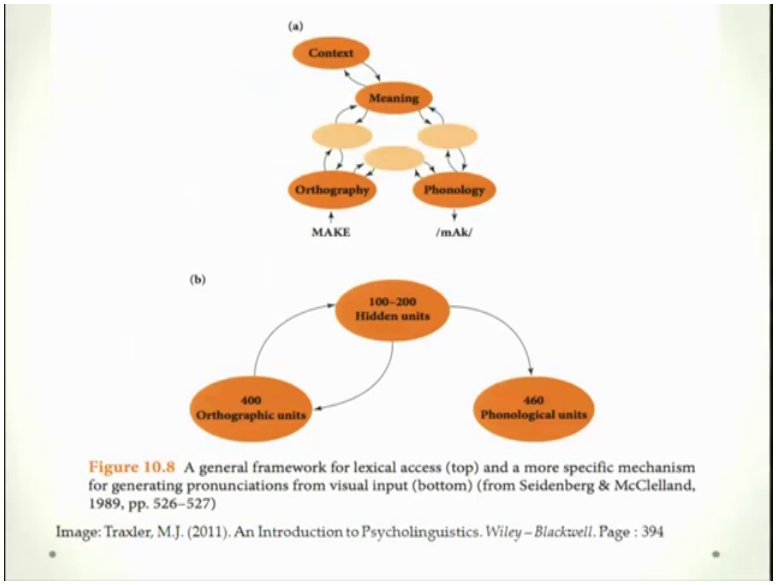

Figure 10.8 A general framework for lexical access (top) and a more specific mechanism for generating pronunciations from visual input (bottom) (from Seidenberg & McClelland, 1989, pp. 526–527)

Image: Traxler, M.J. (2011). An Introduction to Psycholinguistics. *Wiley – Blackwell*. Page : 394

And therein there is a hidden of layer of hidden units and this you know contribution between this between hidden units is basically what achieves this process of reading.

So, if you can look at that figure a here the context is also playing a role meaning is there orthography phonology are also interacting.

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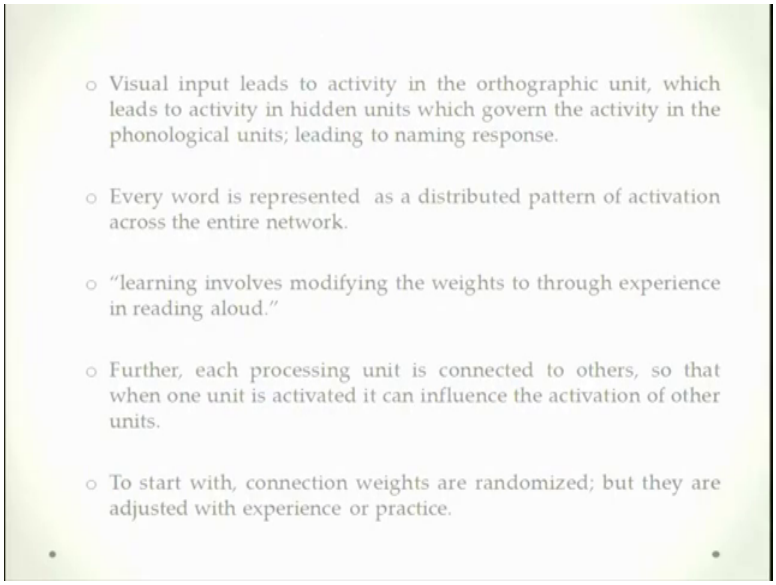

So, what happens in this model is when there is a visual input visual input will leads to activity starting in the orthographic units which will leads to further activity in the hidden units. Hidden units is where the processing is actually happening and hidden units

is basically where the you know they will convert the visual input into phonological thing.

Every word is represented as a pattern of activation across the entire network how many phonological units are activated, how many orthographic units are activated, how many hidden units need to be employed here all of this every word will have an index which will basically give you the number of units activated across the unit. Learning to read basically in this kind of model will involve modifying the weights through experience.

So, how many words have to be basically read through the direct assembly direct route how many words will have to be read through the assembled phonology route; practice will basically tell this module practice will basically help this model associate those kind of weights. One processing unit is connected to others; so, that one processing unit is activated it will be able to influence the activation of other units as well.

So suppose there is some activation you are seeing orthographic unit because it is connected to hidden units and they are connected to phonological units there is already some activation there. Because it is connected to meanings semantics based units those activations will also go there and the entire network will get activated to start with once the event you start training this network on reading the connection weights will need to be randomized they just some random things and some inputs starts and the system starts reading.

But with practice as number of trials pass the system tries to zero in on the correct pronunciations.

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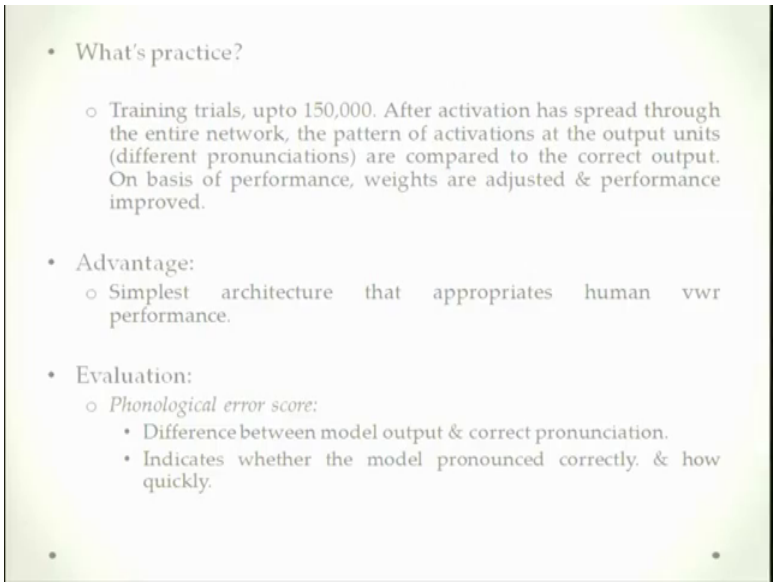

So, training you know up to 150 1015, 1000 20000 trials paining are there after activation has spread through the entire network the pattern of activation basically comes out as the output units and the whatever the pattern of activation is there in the output units is compared to what the correct output could be.

And this comparison keeps on going on and the idea is that eventually the network should learn to basically give output the correct pattern of activation in the output units as the correct output is there. So, the idea is the network gradually with practice with trials learns to let us figure out the correct pronunciation of each of these words. Now it seems like a little bit complex, but it is really not it is one of the very simple architecture of reading that kind of appropriates human visual world recognition performance as well.

There are ways to look at this model that is one of the things called phonological errors score. And the phonological error score is basically just the difference of pronunciation between the correct pronunciation and whatever the pronunciation the model is giving you.

So, because you compare the correct output with the given output of the system you can kind of come up with a particular score. And the idea is with practice this phonological error score should be reducing and the correct output and the output that your system gives should kind of you know be congruent to each other should match each other.

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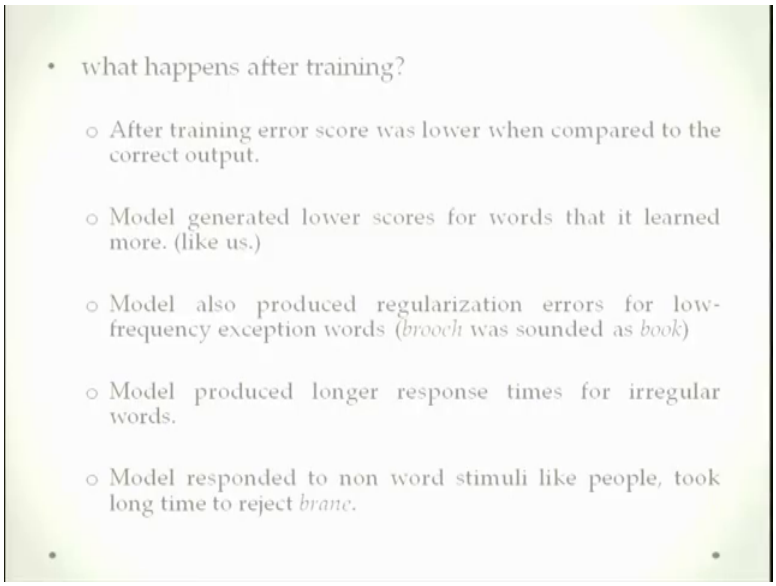

What happens after training? After training is happened after you have kind of train the model on 150000, 250000 trails what will happen then?

After training a particular errors score just I was saying phonological error etcetera would basically become lower as compared to the correct output. The idea is the in the machine is the system is trying to appropriate what the correct performance is the model will generate lower scores for words that it had learnt. Again I am talking about after training has happened the model also start using regularization errors for low frequency was just as humans would do.

So, if humans are basically reading words like brook as book you know the model will also start doing that you know because it is trying to match the actual performance. Also it was seen that this model produced longer response times for irregular words because it is difficult to read them using the assembled pronounciate.

Model started responding to non word stimuli like people and it kind of started taking more time to reject words like brane as invalid word.

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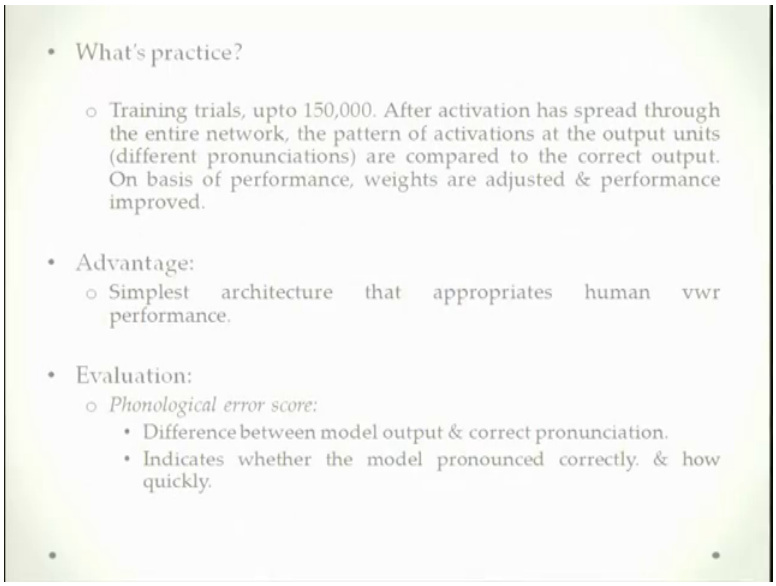

So, after training has happened these are some of the effects that the model kind of shows before during training we already saw that you training this thing on 150, 250000 trials the model is trying to compare the output that it has come up with the correct output and is trying to figure out whatever the rules are needed, whatever changes are needed, whatever weight adjustments are needed to match the correct output in that learning happens and in that the model learns to read words you know.

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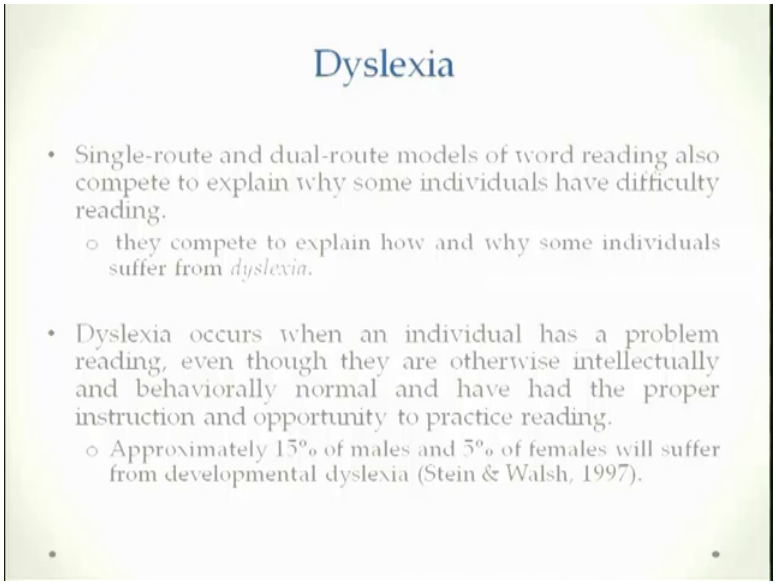

So, to speak; so, we talked about two models of three word reading we talked about the DRC model, dual route model and we talked about the DRC or the dual route model and we talked about the single route model. Now both of these models also tried to explain how difficulty in reading comes up.

So both of these models have tried to come up with explanations and explain how some people will suffer from a difficulty to read referred to as dyslexia. Now you must have all heard about dyslexia at various places its being one of the topics of discussion lately. So, dyslexia basically it occurs when a person has a problem in reading when somebody cannot really read properly.

Even though they are otherwise intectually intellectually and behaviourally completely normal their IQ scores are good their visual analysis is good everything else is completely fine just that they are lacking this ability to read. So, its not really a major disorder you really. So, to speak it is not really debilitating disorder you might know of various people who done very well in the lives and have suffered from dyslexia earlier.

So, the idea is just about making this connection between the visual symbols and the sound symbol and finally, leading to meaning. So, approximately 15 percent of males and 5 percent of females anyways have suffered or will suffer from development dyslexia again this is data from 1997 from Stein and Walsh.

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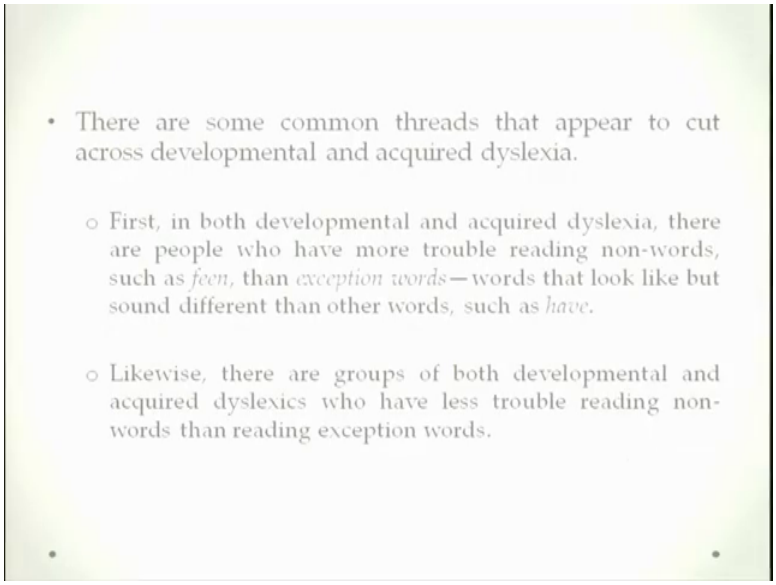

And there are common threads there are common patterns of difficulties that developed dyslexia and acquired dyslexia have. Now I will just differentiate between developed dyslexia and acquired dyslexia developed dyslexia is something that already happens while the person is maturing you know during growing up here the child probably is not able to grasp the concepts of phonemic awareness. Or some you know reasons are there and because of it the child is not able to master reading that is developed dyslexia.

Acquired dyslexia is; suppose say for an example some injury has happened something has happened and that is lead to the difficulty in reading that could be referred to as acquired dyslexia. So, there have been different kinds of patterns that have been common across the kinds of dyslexia that are observed. One of the very important patterns is that there are people who have more trouble reading non words like if I write f e e n feen than exception words.

Suppose the words like have and say when those kind of things. So, there are people who have difficulty reading non words also there are groups of both developmental and acquired dyslexics who have been less trouble reading non words, but more you know than reading exception words. So, two kinds of people are there one who have more trouble reading non words, less trouble reading exception words and there are people who have more trouble reading exception words and less trouble reading non words.

So, this is sort of double dissociation that you will see for double dissociation it is basically you can refer to you know the earlier lectures that I have given in the last course.

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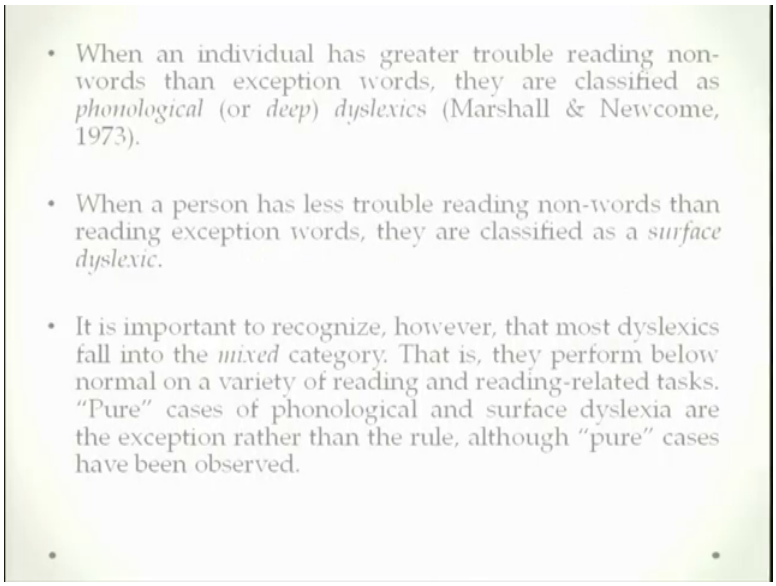

But double dissociation typically tells you that there are two different processes at work in these scales. So, when an individual has greater trouble reading non words and than exception words they are classifies as phonologic or deep dyslexics.

If they cannot read non words then they are probably having deep dyslexia or phonological dyslexia; the meaning is basically that they are not being able to use the phonological assembly route. When a person has trouble less trouble reading non words and they have more trouble reading exceptional words then they are referred to as surface dyslexics; the idea is that in surface dyslexics the meaning and the word connection is lost.

So, they can come up with a assembled phonology route they can come up with pronunciations etcetera or what has been lost with these people is the connection between the meaning and the sound part ok. So, the general problem is that they are not being able to connect meaning with the word form that they have activated.

It is very important to recognise; however, that most dyslexics will generally form into a mixed category, there will be some aspects of deep dyslexia some aspects of phonological dyslexia ok. So, they perform below normal on a variety of reading and reading related tasks and it is very rare that you will come across a pure phonological dyslexic or a pure surface dyslexic.

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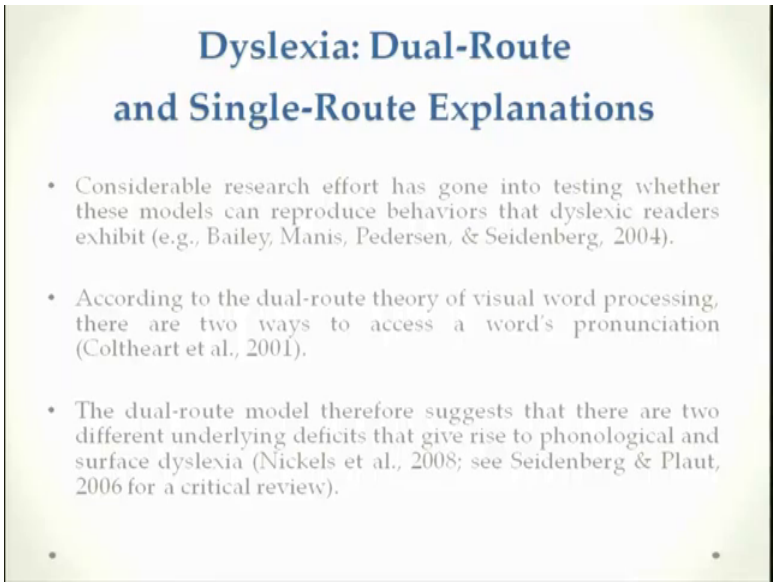

So, both kind of models as I was saying basically have tried to explain how dyslexia happens. So, considerable research effort have really gone into testing whether these models can reproduce behaviour by dyslexic readers show.

Because if these models can really reproduce those behaviours you can try and mend these models and in the process try and help the people who have dyslexia as well; So, according to the dual route of theory of visual word processing there are two ways to you know come to a word pronunciation.

As I have already said assembled phonology route and the direct access route. So, the dual route model basically suggests that there are two different underlying this deficits that give rise to phonological dyslexia and surface dyslexia.

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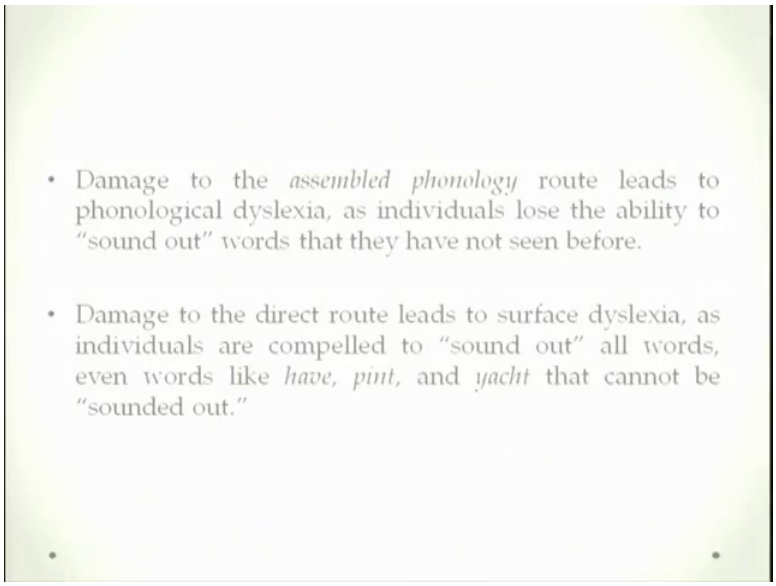

Let us look at that damaged to the assembled phonology route will lead to phonological dyslexia. Because the problem here is just coming up with the pronunciations because this assembled phonology route is damaged phonological dyslexia will happen, but these people can read exception words because the direct route is intact here ok.

So, these people will basically not be able to sound out words that are not accessible by their direct route that is one kind of dyslexia. And on the other hand if there is damage to the direct route this would lead to the surface dyslexia because the link between the word form and the meaning is lost. These people will be compelled to sound out all the words they will use the assembled phonology route more often and they will lead to regularization errors like reading p i n t as pint and not as pint.

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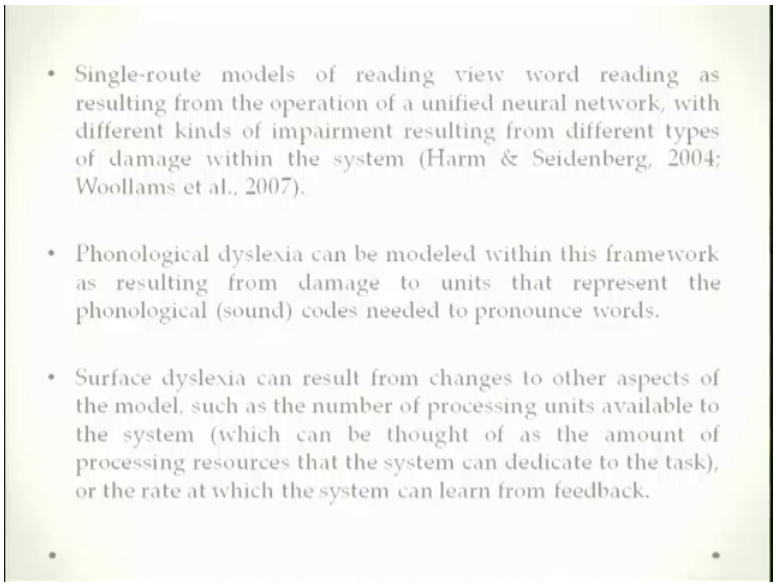

So, these are the two deficits which are leading to two kinds of dyslexia according to the dual route model of reading. Single route models of reading view word reading as resulting from the operation of a unified neural network.

So, if you remember the parallel model which I was talking about the single route model has everything linked to each other. So, it is you know it is not possible that just one of them is lost or something like that just the DRC was saying ok. So, with under this kind of explanatory mechanism different kinds of impairment result from different types of damage within the same system ok.

So, phonological dyslexia here can be model within the framework as a result of damage to the unit that are representing the phonological codes. So, the phonological units will be damaged surface dyslexia can result from changes to other aspects of the model suppose some of the hidden units are damaged or the connection between the hidden units and the meaning units are lost. So, again it is the same system different aspects of system might be damaged to lead to different kind of patterns of dyslexia.

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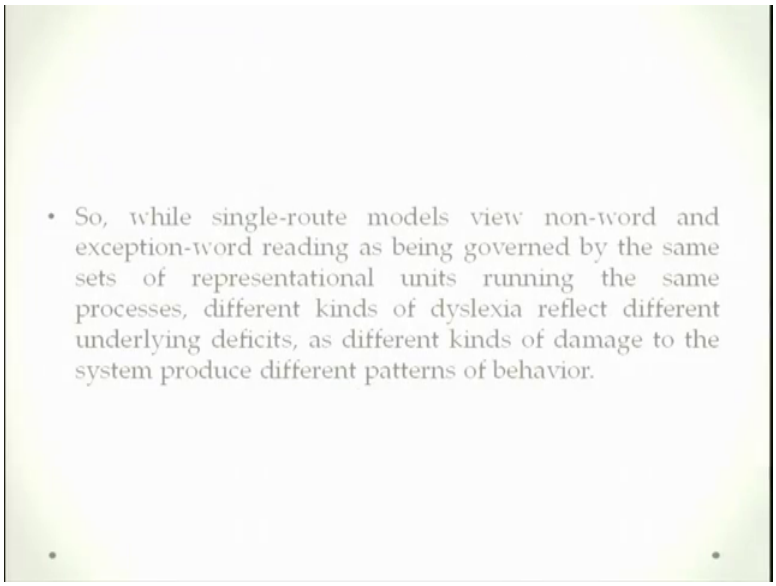

So, while single route models view non word and exception word reading as being governed by the same sets of representational units, running the same processes different kinds of dyslexia might reflect different underlying deficits as different kinds of damage to the system will lead to different patterns of behaviour. I am not saying there are two different systems I am saying they different patterns of dyslexia are arising because different aspects of this same unified systems are damaged.

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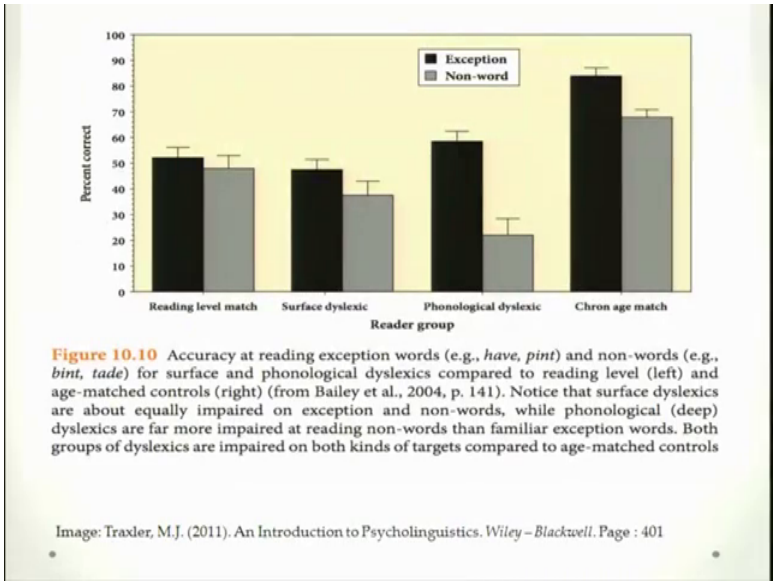

Here I will just show you just the reading performance of reading at exception words for both surface dyslexics and phonological dyslexics. You can see that there is the second left and there is a phonological dyslexit dyslexic and then at the end extreme right there is a chronological age match.

So, we will just try to see how this reading performance can be explained by the two models.

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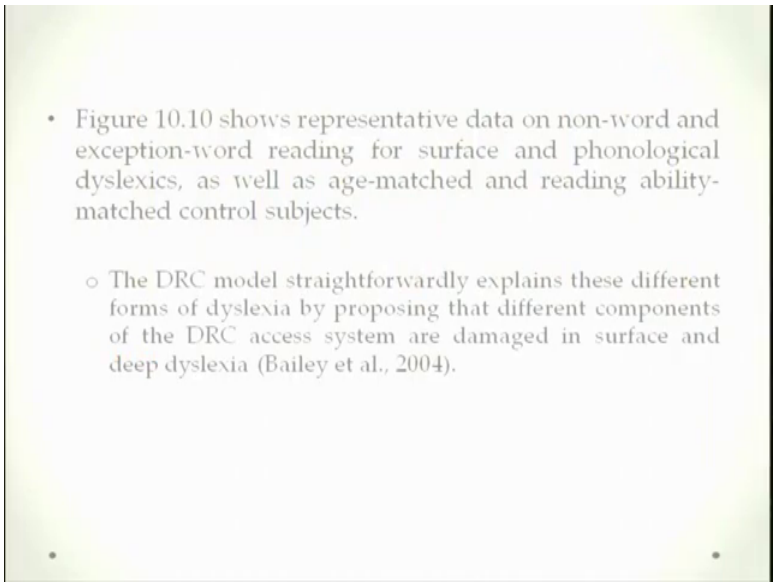

Now, this figure basically as I was just mentioning shows representative data on non word reading and exception word reading for both surface dyslexics and phonologic dyslexics.

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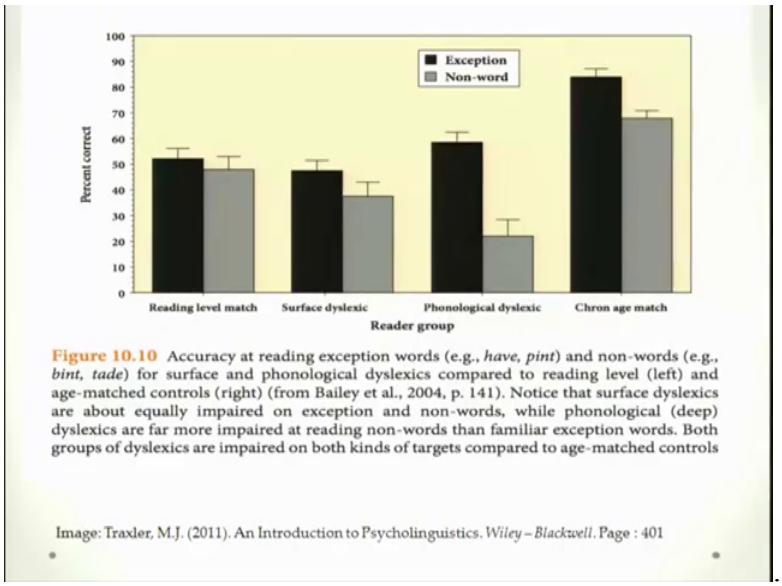

Figure 10.10 Accuracy at reading exception words (e.g., *have, pint*) and non-words (e.g., *bint, tade*) for surface and phonological dyslexics compared to reading level (left) and age-matched controls (right) (from Bailey et al., 2004, p. 141). Notice that surface dyslexics are about equally impaired on exception and non-words, while phonological (deep) dyslexics are far more impaired at reading non-words than familiar exception words. Both groups of dyslexics are impaired on both kinds of targets compared to age-matched controls

Image: Traxler, M.J. (2011). An Introduction to Psycholinguistics. *Wiley – Blackwell*. Page : 401

You can see here that surface dyslexics are more correct at reading exception words phonological dyslexics are also slightly more correct in reading exception words, but there is a great mismatch between exception word and non word reading in phonological dyslexics and surface and exception word and non word reading between surface dyslexics.

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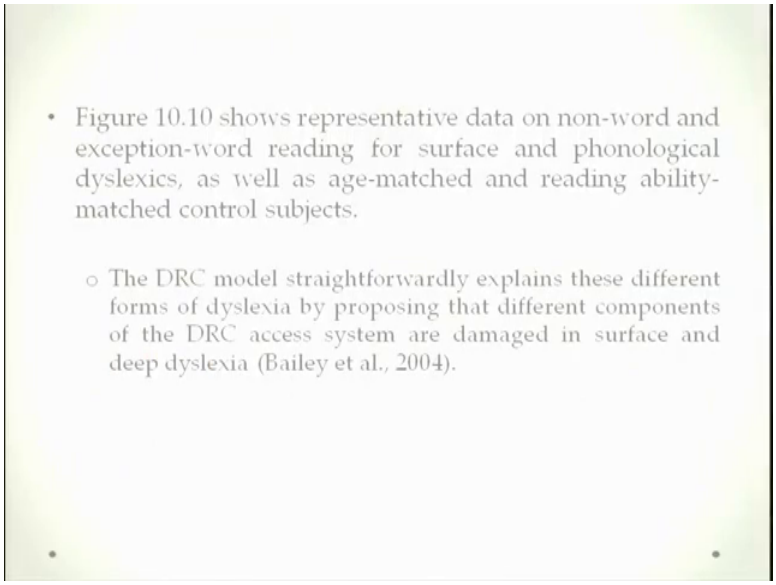

So, DRC model can explain these findings very straight forwardly by proposing that different concepts of the DRC different routes of the DRC system are damaged in surface and phonological dyslexia.

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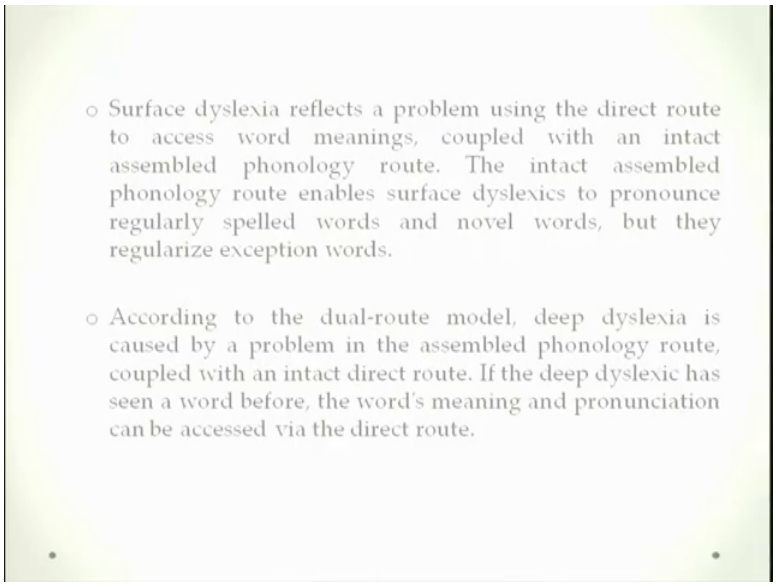

Surface dyslexia basically reflex again I am just kind of revising whatever I have said surface dyslexia represents problem using the direct route to access word meanings compiled with an intact phonological route. So, phonological route is fine just the link between word meaning and word form is lost.

The intact assembled phonology route will enable the surface dyslexics to pronounce regularly spelled words and novel words, but they will not be able to pronounce correctly the exception words. According to dual route model deep dyslexia is caused by a problem in the assembled phonology route which is coupled with an indirect with an intact direct access route.

So, here the direct access route is fine the assembled phonology route is a problem. So, exception words these people will be able to read better, but phonological words I mean the regular words will probably have a problem in reading.

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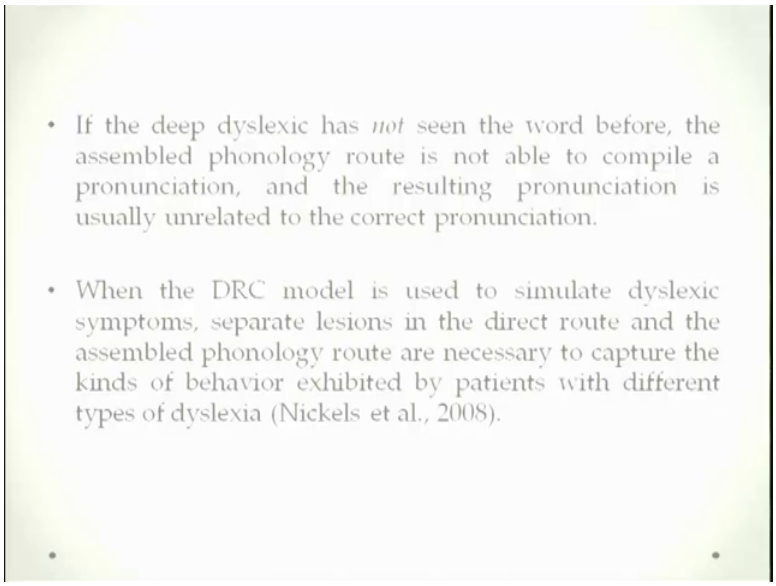

If the deep dyslexic that is the phonologic dyslexic has not seen a word before the assembled phonology route will not be able to compile a pronunciation and the resulting pronunciation will sometimes become unrelated to the actual pronunciation because that assembled phonology route is not working.

While the DRC model has been used to simulate the dyslexic symptoms separate lesions have you know separate damages have in the direct route and the assembled phonology route are necessary to mimic the behaviour of surface dyslexic or phonologic and deep dyslexic.

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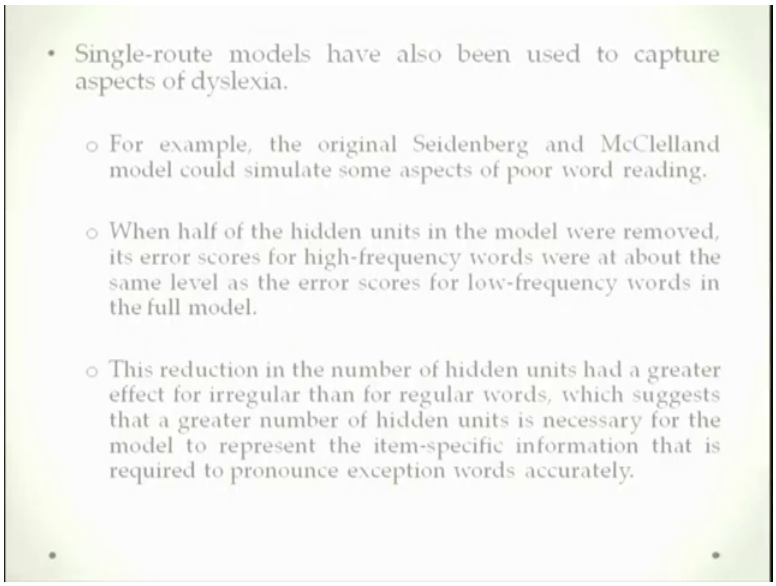

In single route models people have also tried to capture how dyslexic perform and what has been found is for example, in the original Seidenberg and McClelland model.

It could simulate some aspects of poor word reading and it basically was when half of the hidden units in the models were removed the error scores were high frequency words are about the same level as error scores for error score for low frequency words. So, the idea is the number of units are damaged and that is leading to problems in reading.

This reduction in the number of hidden units had a greater effect for irregular rather than regular words which suggests that a greater number of hidden units is necessary for the model to represent item specific information you know more resources are needed for item specific reading to happen.

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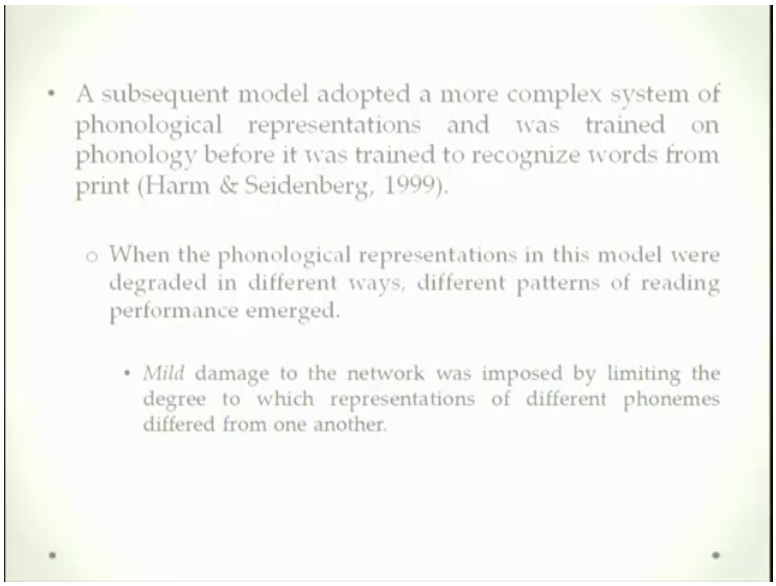

Also a subsequent model, a different model has been adopted to you know explain more complex system of phonological representations. And then it was trained on phonology before it you know it was kind of trained to read using for phonology to recognize words.

And when these phonological representations in this model were degraded in different ways then different patterns of reading difficulty emerge. So, if these phonological units suffered mild damage then the basically the network you know was limited by it could not read the representations from different phonemes differed from each others; different kinds of sounds being represented by same letters.

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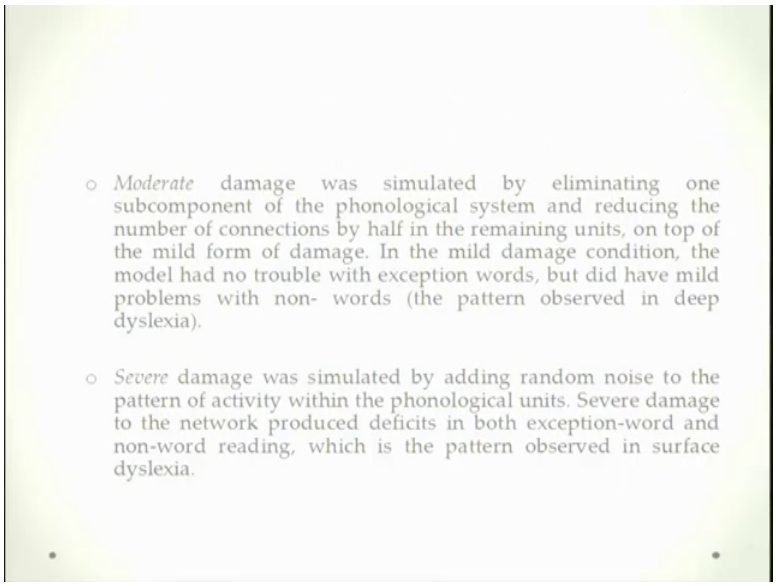

When the damage was moderate from mild to little bit more moderate this was directly simulated by eliminating just one component of the phonological system and reducing the number of connections in half in the remaining units on top of the mild damage; this kind of damage you know in this mild damage condition model had no trouble reading exception words, but it could not read the phonological words.

It had major it had mild problem with the reading from the phonological route. When a severe damage was there and most of these phonological units were damaged then basically what happened was that a severe damage to this network was produced deficits in both exceptional word reading and reading normal words using the assembled phonological route.

So, this is one of the ways in which people have tried to mimic reading of words using these single route computational models.

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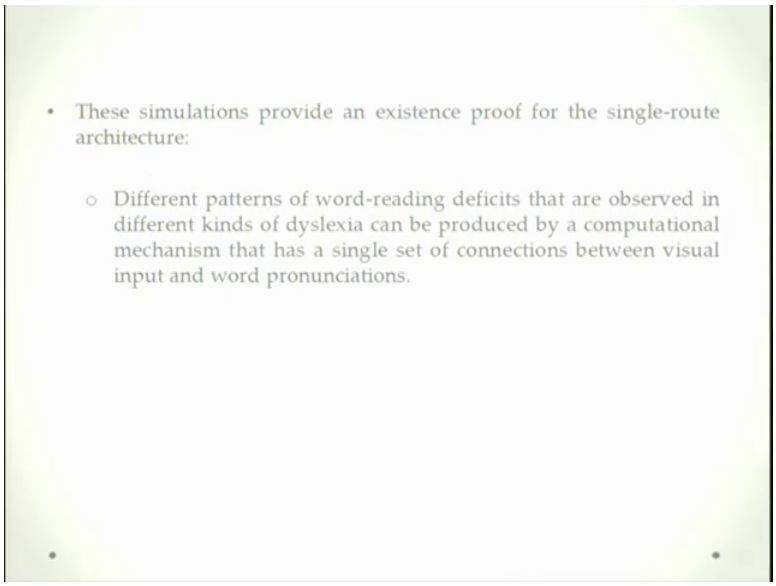

These simulations basically have kind of you know pointed towards the possible proof for existence of single route architecture. So, the idea is that these models try and point out and say that it is just that you know it could be a unified system the extent of damage to that unified system will lead to different extents of patterns of surface dyslexia and you know dyslexia appearing.

So, again this is something which is going on I do not think really think that this debate is settled, but the idea is that different patterns of word reading deficits that are observed in different kinds of dyslexia might be produced by computational mechanism that has a single set of connections between the visual input. So, I think this is all from me about reading and dyslexia and word reading I will talk to you about something else in the different lecture.

Thank you.