The Psychology of Language
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Lecture No. – 16
Reading and Writing - I

Hello friends, welcome back to this lecture number 16 on this MOOC's course on the psychology of language. Up till now we have covered a lot of ground on understanding what is language, what are its various factors, what is its nature, and other participants of the human language system. Today, what we are going to do is we are going to look at two interesting facts in the human language.

One is the writing system and the other is the reading system. Now, as you would have imagined, reading and writing is something which is not inherent or not evolutionary in nature for humans because our great great grandfathers never used to write nor they used to read. So, we will look at how the reading and writing systems developed in human language and what is the psychology behind those reading and writing systems.

Now, before we jump into understanding the psychology behind reading and writing, how this is done, what are the forms of it, how does the brain interpret and handle reading and writing, let us take a little bit of a journey back to where this course started, so that we have a context in which the present lecture is based. So, at the very beginning of the course we started out by explaining what is language for that matter, and what is communication.

And to understand the difference between language and communication we focused on the basic form of communication which is the animal communication system. We looked at what a typical animal communication system would be like, what are its characteristics and why would animals communicate at all. We also looked at some various basic forms of animal communication system and the models of animal communication system.

For example, the call of the Vervet monkeys or the waggle dance of the honeybee, and we looked into detail of what these things are. Now, once we had an idea of what a basic communication system is like, we started focusing on to the more complex human language

system which has its own rules, structure, the idea of how it is communicated, and what does it mean.

So, we looked into the structure and the principles of the human language system, or the human communication or language system next. Once we have looked and did a comparison of the basic communication system in animals and the much developed human language system, we went a little bit further and looked at the evolution of language, how did language evolve.

And there we looked at evidences which have been left to us through generations of research which basically provide or which basically tells us how did language evolved. We looked at the idea of a language specific gene, we looked at the idea of how there are social learning theories of languages, and we also looked at some others fossil evidences of how language would have evolved.

And lastly, we recounted or we sort of found out what are the evidence that language basically comes out of evolution. So, we were looking at those evidences which point towards this fact. We looked at the proto language, the use of pidgin and the use of the human eye and all these structures and evidences which would explain how language would have evolved through eons and eons of usage.

So, how did the basic language system comes about and how does the modern language system comes what. Now, once we had this idea of the history of language and a little bit about what is the difference between the human and the animal communication system, we focused ourselves on to looking at how research is done into language. And so, we looked at the scientific method of doing research in language.

We looked at how any language study is designed in terms of how to decide the independent variables, the dependent variables, the kind of design that we should use in doing language, whether it is between subject or within subject design. We also looked at how does the scientific method actually proceeds from theory to observation and back to theory, and how does induction and deduction play a role into this whole research cycle.

Further to it, we looked at behavioral techniques of doing scientific research in language in terms of measuring latencies or reaction times and accuracies which indicate some idea of how languages are built around or some interesting facts about languages. And, lastly, we focused ourselves into the idea of how language is handled by the brain. So, little bit about how this kind of a study of language-brain relations studies are done.

And, so, we looked at those areas of the brain which are dedicated to understanding language. For example, Wernicke and the Broca area and how these two areas, the Wernicke and Broca areas they interact with each other and how they form a common system for the human language system. We also looked at some other brain areas which are involved in language production, perception and so on and so forth.

We looked at some modern techniques like the EEG, the MRI, fMRI, and other near infrared imaging, how these techniques actually help us in conducting brain related studies on language. Now, once we had a good idea of how to do studies on language, scientific studies on language are there, and what is the history of the animal and human language system, the next part was to focus on the first aspect of language which is speech.

Now, speech is a very basic form of language. So we started out by looking at how this speech is perceived, how do we hear speech, the sound that we hear and how do we make meaning out of sound when people utter it. So, we started by looking at the auditory perception, how does the auditory perception start. We looked at factors of how the wave is transmitting information and what it is composed of, what are basic frequencies, what are overtones, and what are the basic features of any auditory perception system.

We looked at the idea of the human ear which is responsible for all the auditory perception which goes on. Next, we took a classic speech sound and we broke down that speech sound in terms of spectrograph and looked at various characteristics of the speech sound, for example, what are formants, what are sonorants, what are fricatives, and those kinds of things which are special characteristics are the speech sound.

Next, we focused ourselves on to the development of the speech perceptions, how does speech perception develops in children right from the idea of motherese to baby talk and so on and so forth. And, lastly, we looked at some theories of speech perception, basing

ourselves into the auditory framework of speech perception to the motor theory and the direct realism theory. In short, we covered up how speech is processed and how speech is heard.

Now, once we are clear of how speech is heard other interesting obvious question was how speech is produced, and so we dwelled into the idea of how speech is produced in humans. So, we started doing complete analysis of what the vocal tract looked like and how the production of speech happens from the vocal tracks. So, all those factors, the anatomy of the vocal tract and how does it produce speech sounds.

Then, we looked at the areas of the brain which are dedicated to hearing these speech sounds and making meaning out of it, primarily, again, the Wernicke and the Broca area and the connection between them which makes us perceive the speech. The next thing that we were interested in is looking at the models of speech perception, the feedforward and feedback model and some of the models of speech perception. For example, the DIVA model which is a computational model, the dual stream model, and so on and so forth.

And, lastly, we looked at how the development of speech production happens in smaller children, or how smaller children understand the idea of producing speech. We focused a little bit on how babbling helps in speech production, and then we looked at theories of social aspects of babbling. We also looked at speech disorders which gave us some idea of how speech is produced in smaller children and how smaller children learn to produce speech.

Now, once we were able to handle speech sounds, the primary ingredient of any speech sound are words. If we look at how the human language, at least the English language is structured, it starts off with the phoneme which is a basic speech sound, and add these phonemes together to form something called the morphemes which is the simplest word or the simplest unit of speech which has some kind of a meaning.

And one good example of morphine is the word ending or the tense markers and so on and so forth. These morphemes combine together to form something called words which are the central point or which are the central unit which is used by humans for exchanging ideas. So, words are those units which have a symbol and which have a pronunciation. So, the next question that we were looking for is what are words basically. So, we looked at the anatomy of a word, what does word really mean?

We looked at the kind of words which is available, for example, the content and the function words, the idea that words have a pronunciation as well as a symbol, and those kind of things. Then we looked at how we learn words. So, how does word learning basically takes place in humans. We looked at the speed at which word learning happens and we pointed out some curves, for example, the idea that by six years of birth the children starts learning very fast and there is a drop after that.

So, the children do not learn words but then there is a sprout of learning and this is called on the curve learning. And, so, we looked at how this these things happen. We also looked at how mapping and neighborhood words and other factors help in learning of words. The next interesting thing was once a child has learned a word, how does he retrieve it back, how do humans retrieve words back and that was what we were focusing on.

So, we looked at how word learning happens, both through the phonological form and using of the mental lexicon, and how these two processes combined together to help us learn word. We looked at cortical organisations of how words are stored into the mental lexicon. And the last thing that we looked at is how words are retrieved. So, we looked at where they are stored, that was a third section, how they are stored and where they are stored in the mental lexicon, how the mental lexicon is made, and the last is how the word retrieval happens.

And we looked at several models of word retrieval, for example, the spoken word recognition model, the word production model, the feedforward feedback model, and the Dell interactive model which gave us an idea of how stored words are retrieved from the mental lexicon. The next thing was that words in itself have no meaning or they are not part of a conversation. So, single words never make conversation.

And, so, these words are arranged into sentences which make conversation. So, the next step was understanding what are sentences. So, we looked at the structure of any sentence, how does a sentence is structure, and what each words and how words are in a sentence and what they mean and how they mean. Then, we looked at how the process of comprehending a sentence actually takes place.

We looked at how sentences are produced, the various factors which help us in producing sentences. And, lastly, we looked at learning the syntactic structure. So, how do children learn the syntactic structures of sentences. Syntactic structure means the rules through which sentences a formed and what is a legal sentence and what is not legal sentences. So, how do children learn these factors?

Obviously, once we have sentences with us we are able to communicate and so this communication that happens between people is called a discourse. Now, this discourse is of two forms; one is called narrative and the other is called conversation. In a conversation many people talk at the same time and they exchange ideas. In narratives, one person speaks and the other person actually looks at it.

So we started looking at what is conversation and what are the basic factors on conversation, what principles, nature of a conversation, and so on and so forth. Then, we moved into narratives and how does narratives work. So, conversation and narratives, two forms of discourse, how do they work. We then moved on to something called anaphora and inferences.

So, anaphora is basically replacement of a certain, for example, using pronouns, idea of anaphora. And, lastly, we looked at how does discourse ability develop in children. So, how do children learn to do the disclosure of talk and that makes us come to the idea of how reading and writing happens. Now, as I have mentioned before, this reading and writing is something which was not built in in the human system.

And, so, in evolutionary cycle reading and writing was not there. It is only true past 5000 years or so that this reading and writing systems actually developed. Then, there are no dedicated systems in the brain to read and write, to help us in reading and writing. So, first, we looked at the, in today's section, look at the writing systems and then we looked at the reading systems.

So, how do we develop this idea of reading or how do we develop the skill of reading? Certain brain areas are trained or they are rehearsed into reading and writing, and that is one reason why there are so many people who are dyslexic. They are not able to either read or

write and they struggle with reading and writing. The reason being that there is no dedicated area and there is no training system for the brain to read and write.

And, so, what happens is perceptual systems or perceptual networks in the brain are retained for writing and comprehending writing, and similarly, these are the same areas which are also trained for reading. So, basically, then, what really happens is, this learning is really hard. As you can find in smaller children when they go to school they have a lot of problem in learning to read and write, the reason being that most systems, most forms of writings are different, right?

And, so, if most forms of writing are different, then it is very difficult to understand how does this ability generally develops. But we as humans have this idea of developing writing system or we can develop this writing system very well. So, let us look at how did the writing systems in the world actually start about. The full fledged writing system actually evolved from the calendars and tally sheets which merchants and people doing businesses and commercial transactions in the world, they developed this idea of writing.

Now, in the beginning, the humans were hunters and gatherers and they had no reason for reading and writing. But as the agrarian society developed and these hunter gatherers they started living in close circles, they had to develop an idea of how to keep on counting what they have. And, so, from these calendars and tally sheets and this meaning of accounting or developing a system to account for things, the whole writing system evolved.

Now, civilizations in the Middle East they keep written record some 5000 years ago. So, they believe that Middle East writing system started some 5000 years ago, but historians debate that Chinese came up with the idea of writing far ahead of the Middle Eastern people. If you look at how the society has developed in the past, in the recent past you would have seen that reading and writing was something which was dedicated to only a few chosen people in the society, which were the priests and the bureaucrats.

And, so, these reading and writing system also did not popularise. Only with the industrial revolution that happened in the world, in the last may be 10 decades this reading and writing actually reached the masses. Before that it was some specific groups of people that were

looking at reading and writing. So, basically, all writings in this world can be grouped into three basic forms, that is what I have here.

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So, main writing systems in the world can be grouped into three forms. This is the system, this is the unit of the symbol, and this is an example. So, the first form of writing system is in terms of making symbols. For example, this is one symbol. This is a Chinese symbol for men and this is the Chinese symbol for women. So, the first form of writing system was the logographic system which came from simple structures or simple symbols that people made.

And these symbols actually represented words and morphemes. And an example of this systems are Chinese which is the most proponent user or the most progressive user of this system. So, what then does the logogram actually means? A logogram basically is a written system that represents a word or a morpheme. So, basically a logogram is a system and these pictures that you have, so it is believed that earlier or ancestors also they used these kinds of symbols to write because there was no writing systems developed.

So, these systems are carried out by Chinese and if you look at the Chinese writing system they use these symbols. So, these symbols basically are called logograms. And what is this logogram or this logographic style of writing? The logogram mostly represents a word or a morpheme. Sometimes it represents a word or sometimes it represents a part of a word or a part of sounds together to mean a morpheme, not a complete word, sometimes it is partial word also and a good example is Chinese.

The other form of writing system which has developed in the world is called the syllabary form of writing system, and what is the syllabary form for writing system, here sentence or certain syllables are used. So, these logographs are combined together to form certain syllables and these syllables actually develop the whole writing system. And, so, in terms of the syllabary system, the unit of symbol is the syllable and a good example is the Japanese.

What the Japanese found out is that when they use Chinese, Chinese was a difficult thing to understand, there were so many words and so many pictograms to learn. So, what the Japanese did was they reinvented this Chinese diagram and Chinese logographic symbols and they chose some 40 out of these number of Chinese symbols to make a list of syllables which have some meaning in Japanese.

And, so, that is why Japanese is a modification of the Chinese, and so they use a syllabary system which is another writing system. And the third form of writing system is called the alphabet in which the phoneme is used, the speech sound is used, the unit of symbol is the basic speech sound and simply examples are Greek or the Korean. So, first form of the writing system is the logographic in which the pictures or the symbols are used.

In the second form, the symbols actually mean the word or the morphemes. So, the symbols actually mean the word or the morpheme. So, it is a higher level understanding or it is a higher level unit of language. In the syllabary form of writing system, it is the syllables. So, it is again more higher than the alphabet system. In the syllabary system the basic unit is the syllable.

So, we start with the syllable and that syllables combined together to form the word and the writing system. An example is the Japanese. In the alphabet form, the basic system is the speech sound. And, so, these speech sounds they combined together to find the morphemes and they form these morpheme from the syllables and then the words and so on and so forth. And so, it is a more dedicated system or a more extensive system, the alphabet, and the basic unit sound is the phoneme and examples of these are the Greek and Korean.

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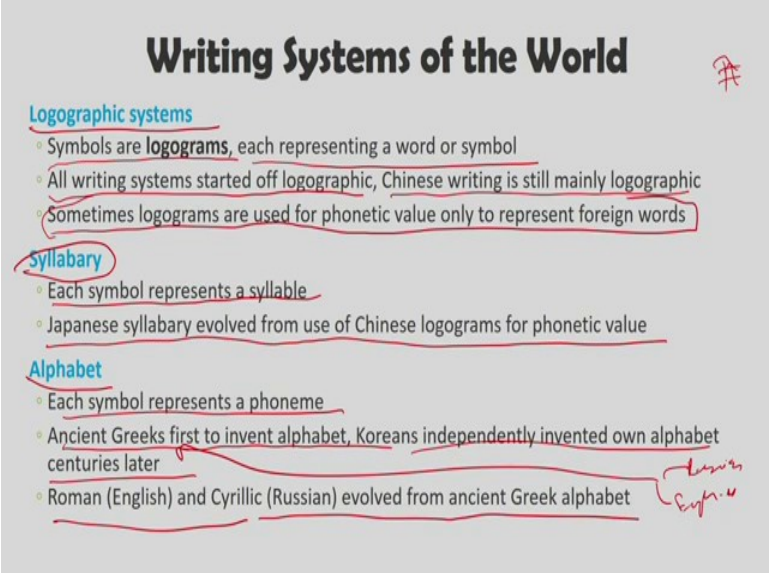

Let us look at some of the writing systems of the world. We have the logographic system. In the logographic system, here the symbols are logograms, each representing a word or a symbol. In the logograph as I said, the words are represented as a word or a symbol. Now the early Middle Eastern and Central American scripts were logographic. The Chinese still use these kinds of logographic scripts.

Logographic scripts they require us to understand thousands of logograms one for each morpheme in a language, and so it is very difficult understanding Chinese or learning Chinese or writing Chinese, it is just difficult. Also the problem came up where Chinese systems borrowed word from other systems or Chinese writing system borrowed word from other languages.

So, foreign names and loan words, they posed a particular kind of problem for logographic systems and the general solution was to use logograms for their pronunciation value only. And so, later on, these logograms are not used for meaning a word or meaning a morpheme, they generally were, in a later development, the logographs or symbols were used for the phonetic value only or the pronunciation value only.

All writing systems started off logographically. As you know that most writing systems started with these kind of symbols. If you look at the ancient Asian civilization, the Mediterranean system, the Egyptian system, any other system for that matter, the Vedic scriptures, all of them mostly they have this kind of a symbols which represent things, the sun, the moon, most examples like that.

And, so, they are logographic. So, most writing system starts with logography and Chinese writing system is still logographic in nature. Now, sometimes logograms are used for phonetic values only to represent foreign words. There are times the modern usage of logograph is in terms of the usage, not in terms of words and morphemes or word endings, it is in terms of only the phonetic value or in terms of the speech value, the pronunciation value.

So, the practice of using logographs, Chinese is borrowed by the Japanese and they made this logographic system, they produce logographic system into a logical conclusion. At first educated Japanese simply wrote Chinese where they wanted to compose a text. But this situation was similar to the medieval European scholars who wrote Latin even though it was not their mother tongue.

Now, in the beginning, there seems to have been a psychological connection between the script and the language and it was in the later generations that show how the foreign script could be used to make their own language. Now, what the Japanese did was they began using Chinese characters to represent Japanese words. So, what they did was they borrowed the Chinese characters and they started making Japanese words from the Chinese words.

But, then, what happens is many words and morphemes in Japanese were not exactly matching or did not have equivalent logographic characters in the Chinese. So, what the Japanese then did was they agreed on a set of 50 symbols that could stand for all possible symbols of the language. Thus, in Japan, the Chinese logographic system they evolved into a native syllabary system which is the writing system which represents each syllable with a different symbol.

And, so, that is what the syllabary system is. The best example is Japanese. So, what they did was they found out that most Chinese logographs were not equivalent to the Japanese words, and so, what they did was they borrowed some 50 different logographs which could stand for all possible syllables of the particular language in Japanese and this is called the syllabary system.

Now, these symbols or characters are simplified to the point that they bear little resemblance to the original logogram. So, they simplified these 50 logographs that they borrowed from

the Chinese, the Japanese borrowed from the Chinese and they made sure that the combination of these would mean all the syllables in Japanese, and so, they made this so easy or the simplified it so easy that the original resemblance to the Chinese character was not there anymore.

So, in a syllabary each symbol represents a syllable and Japanese syllabary evolved from use of Chinese logographs for its phonetic value. In Japan in fact there are two versions of writing system; one is the favoured angular style which is called the katakana which is an angular style of writing, and then you have the old form of writing the Japanese system which the Buddhist monk would have preferred and this is called the hiragana style.

Nowadays both of them are combined together, hira gana and kata kana are combined together to write the Japanese system. Now another form of writing system is called the alphabet. Here, each symbol represents a phoneme. Now, as you saw in the logographic system, the logograph or the symbol would mean a word or a word ending. In the syllabary system each symbol would mean a syllable.

But in alphabet each symbol that we have actually means a phoneme. Now, ancient Greeks were first to invent alphabet. Koreans independently invented own alphabet centuries later. Initially it was the ancient Greeks who invented the alphabet, and the Koreans they took these alphabet and they simplified this thing together. So, alphabet is a writing system that represents each phoneme with a different symbol.

Now, the Roman alphabet which the English people use and Cyrillic alphabet which the Russians use are descendant of the Greek alphabet. So, both the Russian language and the English alphabet are coming from the same Greek thing. So, Roman English and Cyrillic Russian evolved from ancient Greek language.

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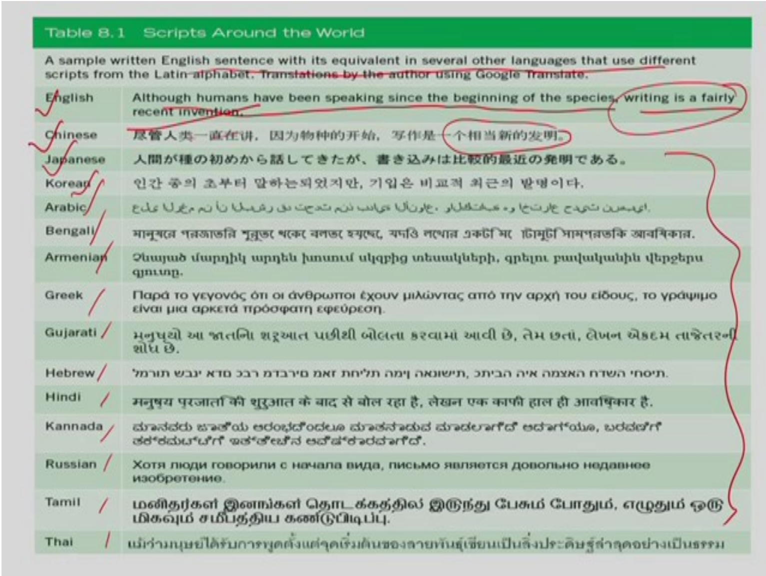

Now, let us have a quick look at some writing systems. Here is a sample of written English and is equivalent to several other languages, you have a sentence. Although humans have been speaking since the beginning of the species, writing is a fairly recent invention and you can see this in Chinese. So, there are certain logograms here. The Japanese, this is the Korean form, the Arabic, the Bengali, the Armenian, Greek, Gujarati, Hebrew, Hindi, Kannada, Russian, Tamil, and Thai.

And so, as you can see that these languages have their own symbol for representing each word in either a word or a syllable or a phoneme and that is how they work. In English you would see that the writing system use the phonological interpretations whereas the Chinese system, each these words, each of these symbols actually represent either a morpheme or a word in its form.

And similar to that, there are other writing systems they have their own descriptors, or they have their own method of encoding this.

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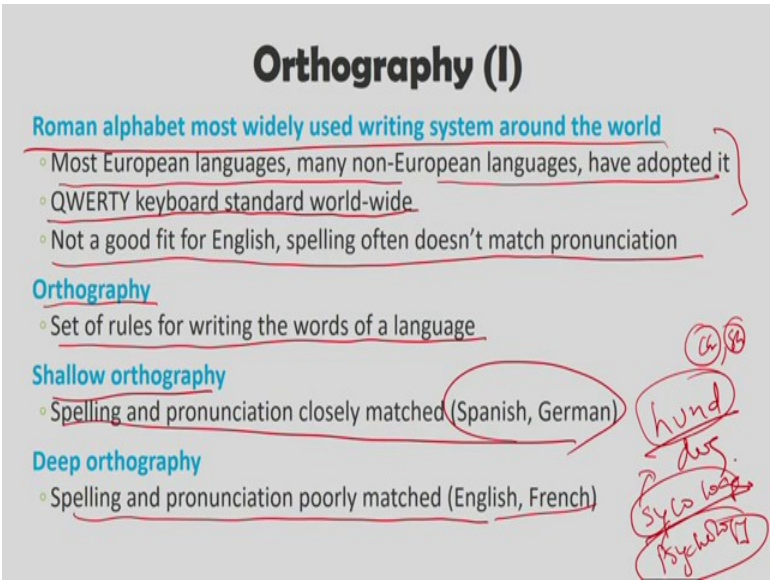

Now another interesting thing to look at in terms of writing system is something called orthography. So, what is orthography then? Orthography is a set of rules which are for writing a word of a language. So, those rules which you use for writing the words of a language is actually called orthography. Now, the Roman alphabet is the mostly widely used writing systems around the world. Roman alphabet to write English is not actually a good fit. English borrows the Roman alphabet for writing English.

So, what happens is the Roman alphabet is actually not a good fit for writing English. The reason being that the Roman alphabet which is basically the Latin it has only two dozen of phonemes, whereas when you look at English, English has 40 different phonemes. And, so, here comes the problem. The problem is that for accommodating 40 phonemes out of only 12 phonemes in the initial Latin, what we have to do is we have to come up with something called combined phonemes or complex phonemes.

So, these kind of combined phonemes, for example, the cha sound, the ch sound, are the sh sound which are phonemes in English they use two phonemes from the ancient Latin. Now, spoken English has undergone a number of major shifts over the last few centuries, but spelling has remained virtually unchanged, with the result that there is often a confusion or a mismatch between the spoken and the written forms in English.

So, Roman alphabet is mostly widely used in writings systems in the world. Most non-European languages have adopted this form of writing system. So, how did this Roman alphabet actually became the most prominent form of writing system. Now, initially, people

were not using the Roman alphabet but with the development of computers and net connected devices, we have to use a keyboard which is called the QWERT keyboard.

And so, the QWERT keyboard, they are standard worldwide, and so they pushed the QWERT form of writing system around the world, or more people started using this form of writing. Even if you want to type German or Russian, you would have to use the QWERT keyboard. And, from there, you have to make some keystrokes. These keystrokes will be reinterpret by the computer to the original language.

For example, writing French or writing the Spanish, the idea is that the keyboard will always be in the QWERT format and so you have to use the QWERT format. And, so, the use of the QWERT keyboard actually made a push to the use of the Roman alphabet. It is not actually good for English spelling, does not match the pronunciation, and so as I said, the, the idea is that English is not a good match for Latin, the reason being that Latin has only a limited number of phonemes. English has more than that, and that is one reason.

The way of spelling is pronounced, there is a difference between the spelling of a word and the actual word in itself. So, that is basically what is called orthography. So, orthography is a set of rules for writing the words of a language. English orthography is complex but Spanish are easy. Now, the situation in which spelling and pronunciation are closely matched are called shallow orthography and the situation in which the pronunciations are poorly matched is called deep orthography.

So, we have two kinds of orthography basically. The languages in which what you spell and what you write, for example, in Hindi, what you spell is what you write, and so Hindi has a shallow orthography. But there are languages, for example, English, or you have more complex systems in the world, Chinese, in which what you speak and what the spellings are, it is very difficult to make a correlation between them.

And, so, those are said to have deep orthography. So, shallow orthography spelling and pronunciation closely match, for example, Spanish and German. If you write hund, if I say the word hund, what you are going to write is hund and this is how the spelling of hund which is dog in German, and similarly in Spanish. But look at spellings and pronunciation poorly match in English.

For example, I wish to write, let us say psychology, so the pronunciation will be sycology. This should be how it should be written, but we all know the spelling of psychology is this and that is why it has a deep orthography, because technically it should start with S, but it is starting with P. The idea that certain words are silence, certain letters are silent, all these makes English word with deep orthography.

Now, we can think of shallow and deep autograph as the two ends of a continuum. Korean is the best form of language which has shallow orthography. So, what Koreans actually did was they intentionally invented alphabet which is called Hangul. This Hangul language you precisely write what you speak and so it is the easiest form of language system to learn.

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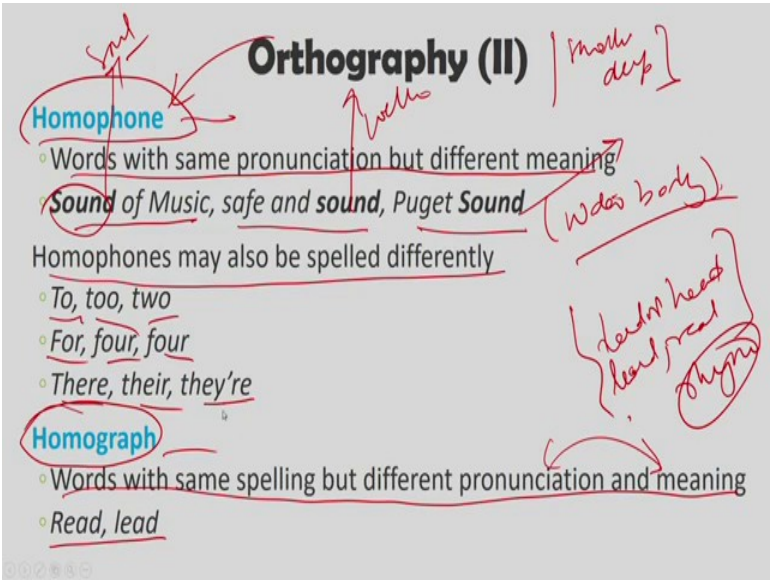

So, how does deep and shallow orthography words they differ with each other. One way shallow and deep orthography differ is how they treat something called the homophones. So, what are homophones? These are words with the same pronunciation but different meanings, so how the homophones are dealt? We will tell you a little bit about how the shallow and deep orthography they differ. So, what are homophones?

These are words with the same pronunciation but different meaning. Look at the word sound. Now, if you look at sound of music, here the way the sound is expressed, the meaning of sound; safe and sound, and the meaning of sound here; and Puget sound, the meaning of sound here are three different things. Here sound of music is the sound that we are actually

talking about, safe and sound means wellness in terms of it, and Puget sound is the running water sound, Puget sound means a body of water, a water body.

And, so, three different things. This is about wellness and this is about sound in actual meaning. So, the same word sound when used with three different contexts would mean three different things. And this is what is called the homophone. So, the same sound is meaning different and how we deal with this homophone is telling us a lot about how the deep and shallow orthography could be different.

Also, homophones may also be spelled differently. Look at to, too, and two. Now homophones, if I just say to, I am giving it to you, or he is too sweet to do something, or it is give me two. In all the cases I am speaking to, but the spelling of to is varying. Similarly, with for, four, and four, and there, their, and they are. And, if you look into it, the words are spelled the same but they are written differently.

And that is why English has a difficult or deep orthography. So, basically, in speech, we have to rely on the context to define the meaning the sound was intended. And this is likewise the case when the orthography is shallow, it is the word sound, but many homophones in English are spelled differently. For example, we have to, too, two and for four, four.

Now multiple spellings of a homophone pose no particular problem when reading them, but they do when writing them. So, basically, that is the kind of difficulty that we have. Now more troublesome for readers are something called homograph. So, one way of differentiating shallow and deep orthography is the homophone. Another way of differentiating between shallow and deep orthography is the treatment of something called the homograph.

So, what are homographs? These are words that are spelled the same but they are pronounced differently. So, words which same spelled but different pronunciation and have different meaning, these are called homographs. For example, read and lead, they are spelled similarly but they are pronounced differently and they have meaning, or example heed. So, if you look lead and read, heed or head, they are rhyming words.

But, then, they are spelled similarly, they are spelled the same but pronounced differently. At the deep end of orthography is the Chinese language. It is often thought at least in the ways the west that each Chinese logogram is an arbitrary symbol, but if that was true few people would have learned 5000 plus characteristics of Chinese. So, there are a couple of hundred basic characters which are common in Chinese which make a simplest way of, which makes us the idea of simple form of learning Chinese.

So, the differentiation between shallow and deep orthography could be done in terms of homophones and the idea of homographs.

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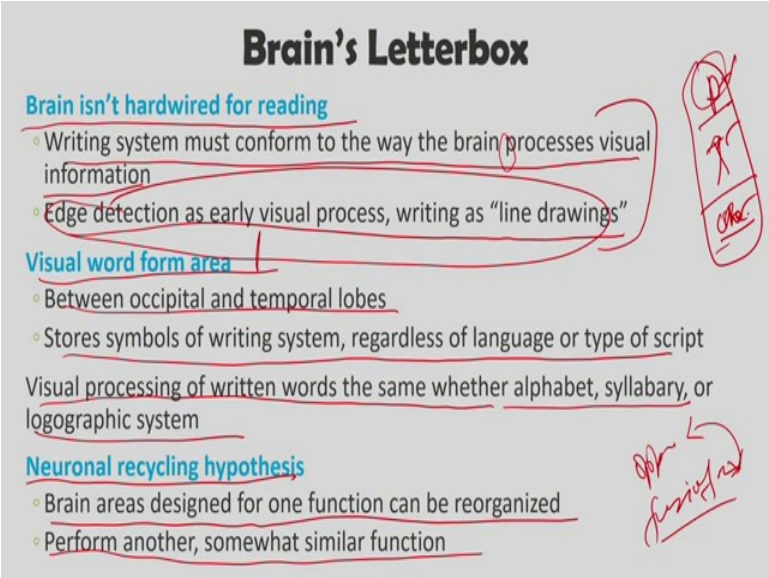

So, basically, then, whether a language has a deep or a shallow autograph has more to do with historical and social factors. So, basically, the idea that whether it is a shallow orthography or deep orthography has to do with societal factors or the fact that where the language is coming from and that is how it is. Now, how does the brain then understand letters, brain as a letterbox. Now, brain as I said was not hardwired for reading at all.

Writing systems represent language at the word, syllable, or phoneme levels, but they are alike in terms of symbol that they use. So, most writing systems, this writing systems may be based at the level of the word or this writing system may be based at the level of syllable or phoneme. As we saw it could be a logographic system or it could be a syllabary system or it could be an alphabet system, but they have to be alike.

How they are alike, because they use the same symbols for writing. So, all writing systems consist of characters that are composed of lines and curves in contrasting orientations. So, even if I write p which is an alphabet, or if I write this which is a logograph or any other form, this is a syllable. So, if you if you look into it, all of these are symbols, and so the use of symbols is what is common in most languages in the world.

And what are these symbols, these are characters that are composed of lines and curves in a particular orientation. So, letters are line drawings. Basically most letters that is used in languages in writing systems are line rhymes. And this is true whether the language is written with a stylus or a clay tablet or a pen or other writing instruments and so on and so forth.

Now, as the brain is not hardwired for reading, writing systems must conform to the way the brain processes visual information. And so, if you read a written statement, or if you read something which is written, the brain has to understand how to process this symbol, and for that we have to depend upon how the perceptual system of the brain actually works. Now the primary visual cortex is in the occipital lobe at the back of the head.

And early process in visual perception is the edge detection and it is one of the brain's first step in distinguishing various objects in the visual array. Now, this is why line drawings are often easier to interpret than photographs. They highlight the edges of an object so that the brain does not have to. Thus, the brain first interprets any letter as visual and not a linguistic object.

So, whatever you write, the first thing that the brain actually does is understand the form in which it is written. The reason is that the brain first interprets any letter which is written. And how does it read it? It interprets this letter in terms of its symbols, in terms of what is written out of it, in terms of its edges and curves and so on and so forth, and later on, in the process of processing only the linguistic form is adequate.

Now, brain also needs a place to store this information about the writing system is learned and this is at the boundary. So, where does the brain store the writing system, where the comparison of the written material which you have in front of it is done? It is in the

boundary between the inferior temporal lobe and the occipital lobe and this region is called the fusiform gyrus.

So, basically, the writing system must conform to the way the brain processes visual information. Edge detection is early visual process and writing as line drawing. So, as I said, most writing systems have a symbol whether it is at the word level, it is at the syllable level or it is the phone level or phoneme level, they have to have a symbol. So, we have to understand how the brain interprets the symbol and that will give us how writing systems or reading systems actually develop.

And so, one way of understanding this is edge detection which is the primary form of brain understanding the language. Now, visual word form area, so between occipital in the temporal lobe you have this area which is called the fusiform gyrus. This is where the storage of symbols or the writing system are done regardless of the type of script which is being used.

Now, visual processing of written words are the same whether the alphabet is syllabary or logographic in information. So, basically, what it means is that the visual word form area is the area which stores all the symbol whether it is coming from a logographic written system or it is coming from any other system for that matter. So, how does the brain then understand this writing, because initially the brain was that developed area for processing visual images forms.

So, how did this develop? How did the brain master this idea of storing the symbols and interpreting meaning out of the symbol and reading that symbol? So, that happens through something called a neuronal recycling hypothesis. What does it really mean? It is not clear why human beings were doing with the visual word form area for hundreds and thousands of years.

Now, perhaps our hunter gatherer ancestors use this portion of the brain for reading animal tracks and distinguishing edible from an inedible plant. Now, the recruitment of special brain areas for the use of visual word form area is generally called the neuronal recycling hypothesis, which is a proposal that the brain areas designed for one function can be recognized to perform another function which is similar in function.

So, brain areas designed for one function can be reorganised, and so, this is how the occipital lobe or the fusiform area, these areas are recruited by the brain for understanding the symbols, which is written in text form and perceiving the symbolism later on extracting meaning of this symbol and generating conversation out of it. So, perform another somewhat similar function, so this is called neuronal recycling hypothesis.

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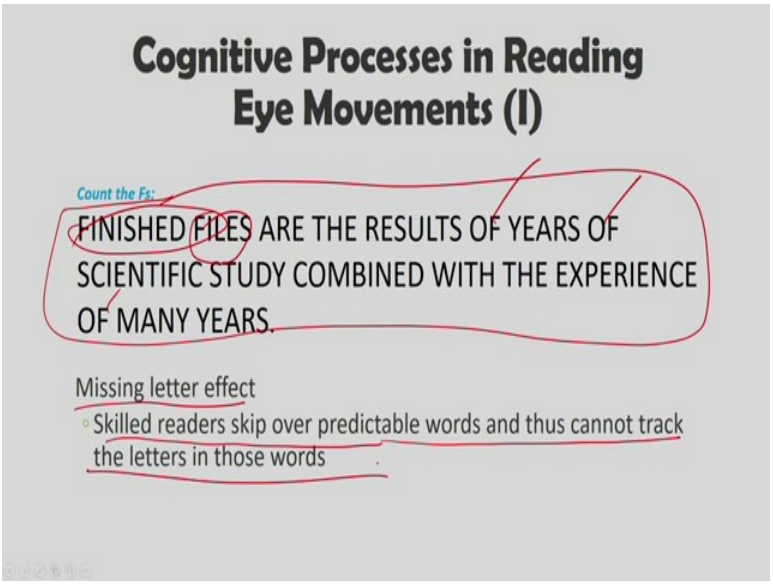

And this is how the brain actually understands writing systems or understands written material and reads it. So, another interesting thing that I promise is we look at how reading happens. We generally believe that when we read, we read in a very smooth manner, and most reading they happen through something called eye movement. So, most reading happens through eye movement. There are two kinds of movement; one is called the saccade the other is called the fixation.

Fixations is when your eye focuses on certain letters and saccade is the jump that the eye does. Basically speaking, as the eyes move along a line of text, a series of saccades and fixations happen. A saccade is a rapid movement of eye from one fixation point to another while fixation is a period of time when the eye means stationary. The average duration of fixation is about 200 milliseconds but it can vary depending on a number of other factors. The brain processes visual input during fixation and ignores it during saccades.

It is believed that skilled readers the targets of saccade is a point just left to the center of the next fixated word. Now beginning readers they tend to fixate all words at the same time,

whereas skilled readers they do not do that, they only fixate on certain words. And if you do not believe me, if I give you this task, you will find out that this is what actually happens. In the beginning or beginning readers actually fixate on all words, but as you progress, you start not fixing on the functional word, but only fixing on the content word.

Now, if I give you this task to count the Fs which are there in this sentence, FINISHED FILES ARE THE RESULT OF YEARS OF SCIENTIFIC STUDY COMBINED WITH THE EXPERIENCE OF MANY YEARS, and if I ask you to count the number of Fs, it is very much possible that you will count the number of Fs, then the count that you have will be less. And, this is because since you are a skilled reader, your eyes are not fixating on the function words, for example, OF, OF, these kinds of words you are not fixing.

And so you will have the number of Fs but you will only have the number of Fs for these kind of words which are called the content word. And this effect is called the missing letter effect. Now skilled readers skip over predictable words and thus cannot track the letters in those words.

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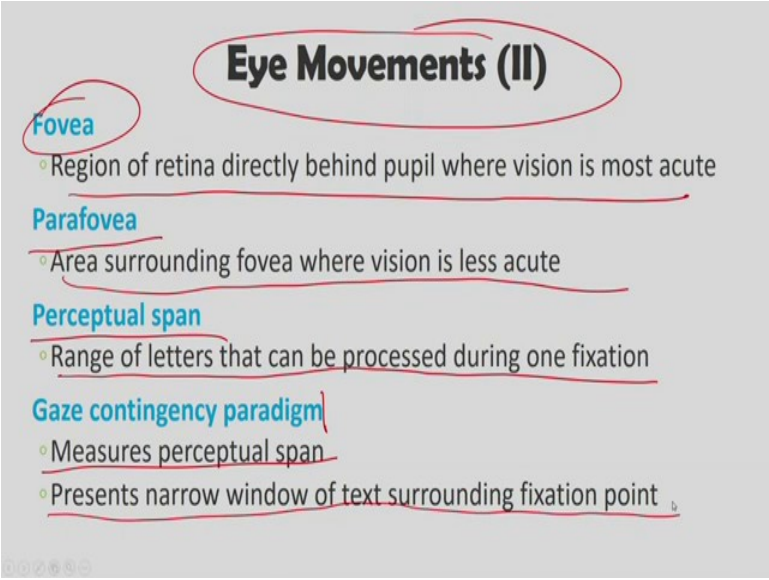

Now, the amount of information that can be taken in during one fixation is limited by the structure of the retina at the back of the eye. Now, fovea is the region which is directly behind the pupil where the vision is most acute. The area surrounding the fovea where the vision is less accurate is called the parafovea and it clearly discerns on the letters that fall in the fovea and the range of the letters that can be processed during fixation is known as the perceptual span.

So, most reading happens in terms of the eye movement. Now, the movement is generally concerned on a region of the retina which is called a fovea which is the region of the retina directly behind the pupil where most vision is accurate. So, there is a region in the eye on the retina where most focusing happens and this is called the fovea. Now, there is another region which is called the parafovea. And so, what is this?

This is the area surrounding the fovea where the vision is less accurate and so reading happens in terms of this fovea, parafovea kind of structure where each sentences or each symbols become the center of perception. Now, perceptual span is the range of letters that can be processed during one fixation. Now, in skilled readers the perception scan is generally lopsided.

If you are a good skilled reader, your perception span will be lopsided, extending extremely 15 characters to the right of the fixation point and about four characters to the left of it. Perception span can decrease as the reading materials becomes more and more complex, and likewise, beginning readers or readers with dyslexia have lower perceptual spans. Now, the perceptual span is measured by something called the gaze contingency paradigm which measures the perceptual span.

What happens is you present a narrow window of text surrounding the fixation point. Based on this narrow window of text surrounding the fixation point, how many words are you able to process will give you your gaze span.

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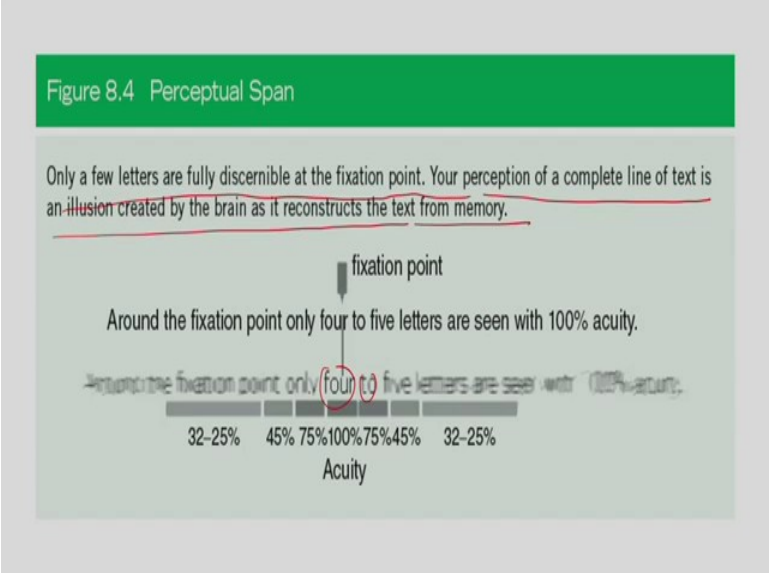

This is how the perception span happens. Only few letters are fully discernible at the fixation point. Your perception of a complete line of text is an illusion created by the brain and it reconstructs text from memory. Now, this is the fixation point, four. This is what happens. So, you 15 letters to this side and 4 letters to this site. The gaze contingency paradigm, what does it mean? The display window is determined by feedback from eye tracking this device.

How much time the display has to be presented is determined by the eye tracking device and changes with saccades to the new fixation point while the rest of the letters in the text replaced by x. Now, since the peripheral image is blurred participants in these experiments generally do not notice the rest of the text as they are masked and the only portion that they are currently looking is displayed.

By varying the width of the display window the participant's perceptual span can be measured. So, span is how much can you read, and so, this is a good example of perceptual scan.

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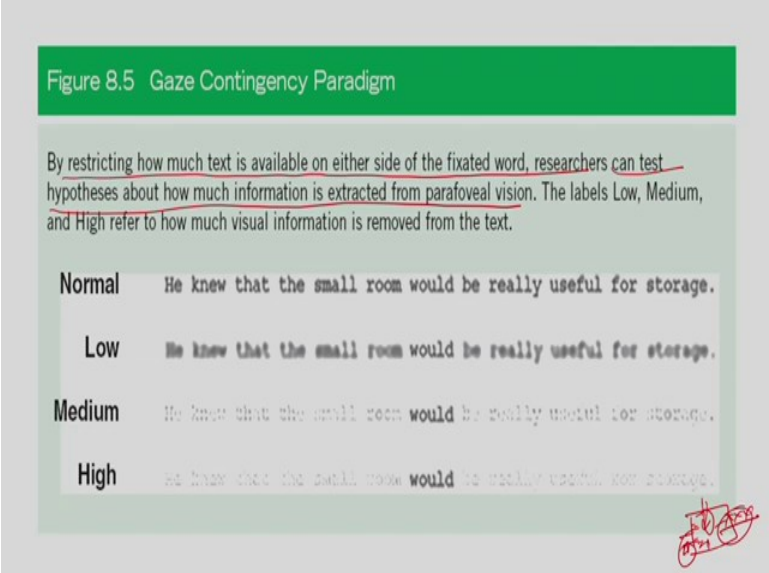

This is the gaze contingency paradigm. By restricting how much text is available on either side of the fixated window, researchers can test hypotheses about how much information is extracted from the peripheral vision. Now, fovea is the region where most perception happens, but the region surrounding this fovea is called the parafoveal region and there are texts here.

Now, it is believed that 15 characters to the right and 4 characters to the left is what skilled readers would process, but then this pan can be tested by using a paradigm like this.

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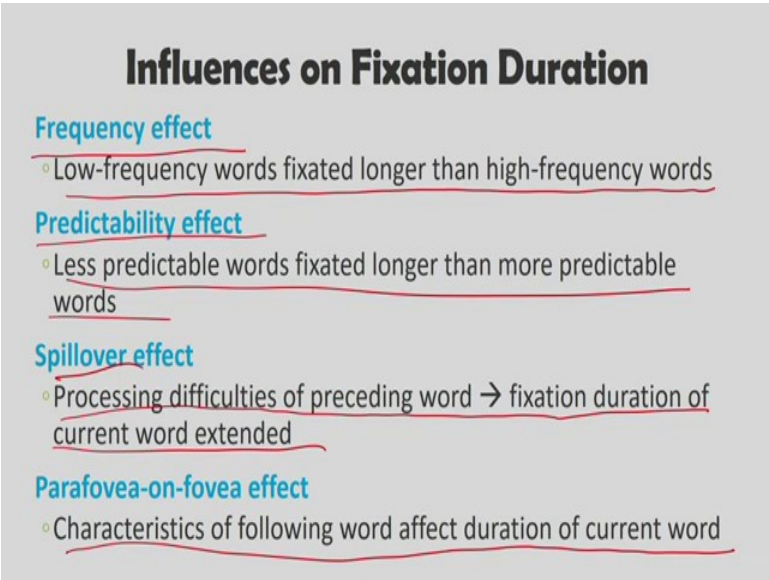

Now, fixation duration is influenced by a number of factors. For example, frequency effect, low frequency words fixate longer than high frequency words. So, how much you fixate, how much time do you fixate on a word it depends upon something called whether the word

is a low frequency word or a high frequency word. Similarly, you have something called predictability effect. Less predictable words are fixated longer than more predictable words.

The more you know what the more predictable word is, the lower the fixation of that word will be, and the higher the less predictable word is, the higher fixation you will have for that one. The higher predictable word is the lower fixation you are going to have for that particular word. There is also something called the spillover effect, which is what? The spillover effect is the processing difficulty of proceeding word, fixation duration of the current word is extended.

Now, if the word that you are presently processing it was followed before or it had a word which was difficult to process, what would happen is a spillover effect. So, the processing time of the next word, even if it is an easy word, will be longer. The reason is that the last word that you are processing, it was difficult or it had difficult processing, and so the time would add up on to the current word and this is called the spillover effect.

And, we also have something called a parafovea and fovea effect. The characteristics of the following word affects duration of the current word. This is a case in which characteristics of the following word affect the fixation duration of the current word. Because the following word is in the parafovea while the current word is in the fovea, this is known as parafovea-on-fovea effect, most specifically when the word is in the parafovea which, remember, cannot be seen clearly.

You can remember that but it cannot be seen, is high frequency or predictability, it can shorten the fixation duration of the current word. So, this is basically what is called the parafovea-on-fovea effects.

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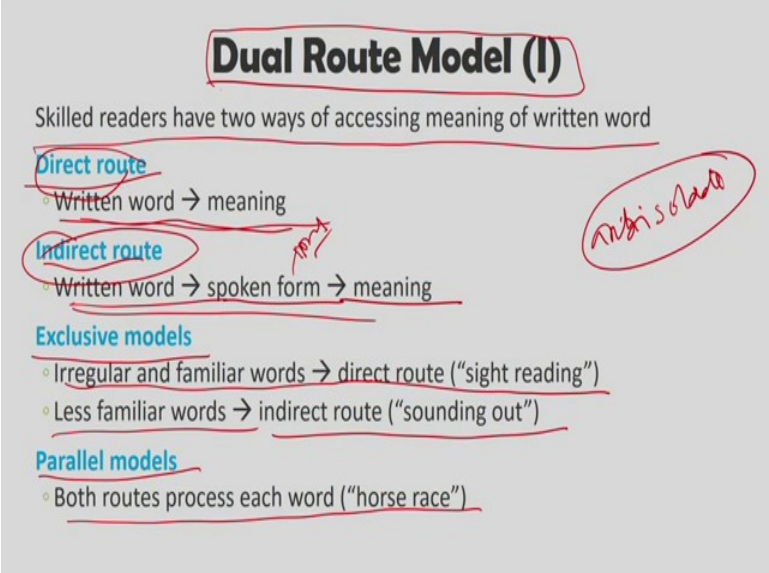

Now, what are the models of reading? One model of reading is called the dual route model of reading. And, so, what does this model believe? Now, there are several models which have been proposed of how we go from written word form to retrieving the word's meaning from memory. The model differ in detail in the mechanism of the predictions they make. And they agree that there are two routes for processing written words.

If you look at word processing and we looked at word processing in the first lecture, we looked that there is something called the dual route model of word fixation or word processing and this dual is meaning versus pronunciation. Now, the dual route model makes the proposal that readers can either first access a word's meaning and then his pronunciation or else first access the word's pronunciation and then its meaning.

This is called the dual form model. Now, skilled readers have two ways of accessing meaning of written word. Direct route, written word, meaning; indirect route, written word, spoken form, and then meaning. Spoken form is called the pronunciation. So, there are two, one is a direct route and the other is the indirect route. Now, dual model can be thought of as different strategies for reading.

When we read words that are very familiar such as the word is or the word of or when you encounter irregular words, when we encounter irregular words such as yacht and colonel, we use the direct to the pressing, because you are the words are easy to learn. Now, only after a word's meaning is accessed, then the pronunciation of these words are accessible. So, those

words which we are familiar of, the word's meaning is first accessed, and then the pronunciation accessed.

On the other hand, when we encounter a word we do not know such as the pseudoword antisoculate, artisoculate is a pseudoword that is created and it may seem like a word. So, the word is antisoculated, this is any word you can create. You can sound it out because you know the orthographic rules in English. So, in this kind of things we use the indirect route. We first pronounce the word and from the pronunciation we try to get the meaning.

So, part of the word soculate means something, so antisoculate or anti is meaning against soculate meaning chocolate, so anti something that kind of a way we generate meaning, and that is called the indirect route. In the direct route the written word gives meaning and in indirect route the written words goes to the spoken form and then the meaning is generated out of it.

The exclusive model, irregular and familiar words, direct route, side reading; less familiar words, indirect route, sounding out is true. There are parallel models also, both route processes each word, for example, the horse race kind of a thing.

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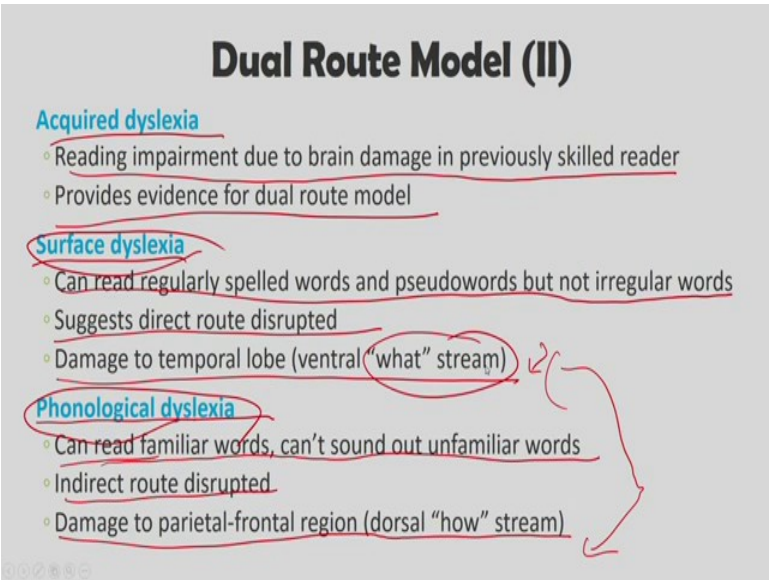

Now, evidences that the dual route model they reflect the actual **(()) (55:21)** process first came from the clinical data on dyslexia. Now, a condition called acquired dyslexia gives evidences that dual route model actually works. And, so, what is acquired dyslexia, what

does it say? Reading impairment due to brain damage in previously skilled readers provide evidences for the dual route model.

Now, a condition called acquired dyslexia involves impairment in reading ability due to brain damage of a person who has previously been a skilled reader. Depending on the exact location of the brain lesion different abilities are lost. Patient with something called surface dyslexia have a condition in which the ability to read regularly spelled words and pseudowords are spared while the ability to read irregularly spelled words is actually lost.

Now, according to the dual route model, the indirect route is intact but the direct route has been disrupted by lesion. The opposite pattern also happens in some form of dyslexia. Patients with something called the phonological dyslexia exhibit a condition in which reading is relatively spared but the exception is that the ability of the sound of unfamiliar word is actually lost.

So, basically, dyslexia gives us an idea of how the dual route model actually works. Now, patients with surface dyslexia tend to have lesions in the left temporal lobe where word meanings are believed to be stored, while those with the phonological dyslexia tend to suffer from damage in the left parietal and the frontal regions which are believed to play a role in recognising and perusing spoken word form.

So, basically then, looking at clinical data from dyslexia or the kind of deficits, either you have surface dyslexia or you have the phonological dyslexia, this basically says how the dual route model or whether the dual route model is true or not. So, surface dyslexia can read regularly spelled words and pseudowords, but not the irregular words. They suggest direct routes are disrupted and damages to the temporal lobe, the ventral word system is disrupted.

In phonological dyslexia, so we have looked in what and where system in previous phonological reading of how the words are spelled anda they are store, so if you refer, you will get some idea of what I am talking about. Now, phonological dyslexia can read familiar words, cannot sound not unfamiliar words. Here, the indirect route is disrupted and what happens is the damage to the parietal-frontal region, the how stream is there.

And, so we looked at in word processing that the dual stream model has something called the what and the how system. If the how system is impaired, we have phonological dyslexia, and if we have the what system disrupted, we have something called the surface dyslexia.

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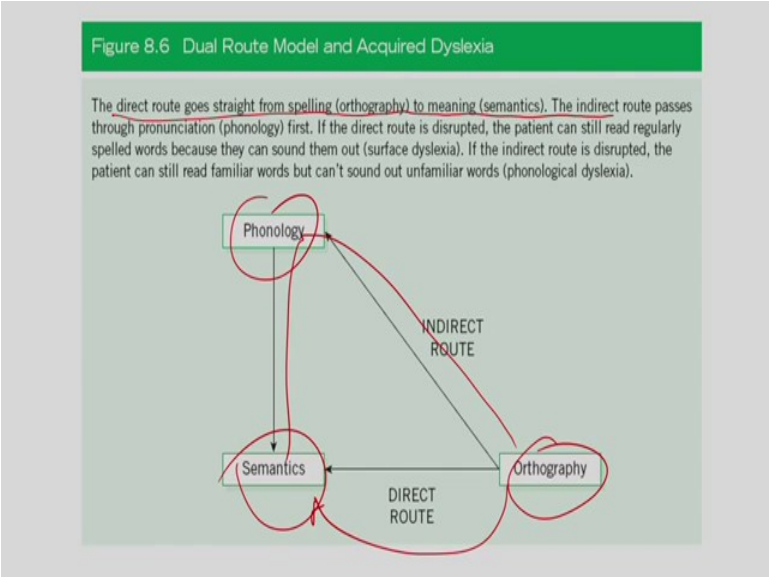

And this is the how the direct route goes from spelling, orthography, to meaning semantics. This is the phonology, this is the semantics, and this is the orthography. The direct route is from orthography to semantics, and indirect route is from phonology to semantics. And this is how word processing actually happens.

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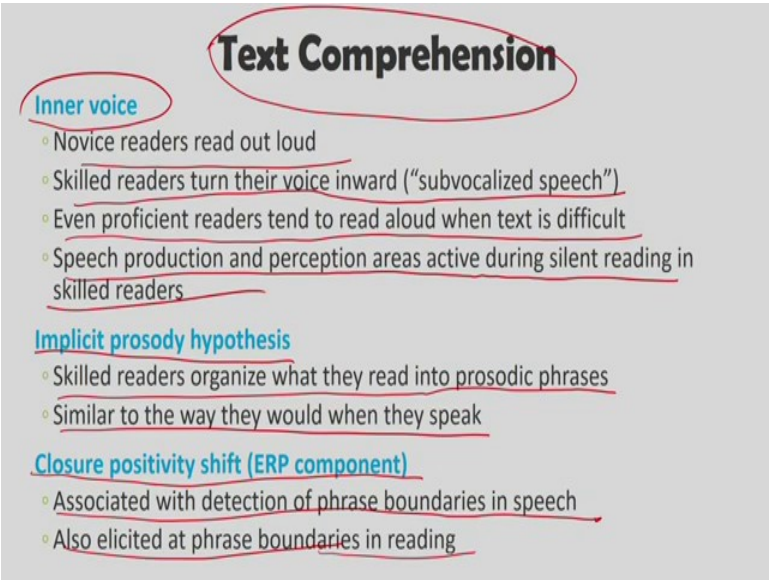

So, one important way in which reading models differ has to do with the question of whether the two routes that we are talking about they work exclusively with one another or in parallel. Now, according to some accounts, each word is processed through either a direct or an

indirect route depending on its characteristics. Specifically, irregular words and highly familiar words go through something called the direct route which is assumed to be more efficient while less familiar words which are assumed to be regular go through something called the indirect route.

Now, the last section that we are going to cover today is called text comprehension. So, how do we comprehend text? When you read a passage you hear your own voice speaking. So, we have something called inner voice. When we read loudly we produce some inner voice. Sometimes when we are reading we do not produce the inner voice. So, this inner voice that we talk about or the sounding of words while reading is basically an important aspect of understanding text comprehension.

We internalize the process of reading aloud as we become more and more proficient speakers. So, what is this inner voice. This inner voice reads out loud. Now, skilled leaders turn their voice inward, they have subvocal speech. So, novice readers who are learning, small children who are just learning, they read the text to the pronunciation loudly and then they understand.

But efficient readers they pronounce the word but they do it in a subvocal form. Now, proficient readers tend to read aloud even when the text is difficult. So, speech production and perception areas active during silent reading in the skilled readers. So, some evidence to support the idea that people rely more on phonological process as the difficulty of the text increases.

Novice readers who find all texts as difficult read out loud but proficient readers tend to read out loud when the text is hard to understand. Neuroimaging data suggests that integrating speech with written text is an important aspect of becoming a skilled reader. Activity in the left inferior frontal lobe which is active during speech perception and production is also active during silent reading, but only for skilled leaders.

Now, there is evidence that this inner voice they involved in more than just the pronunciation of individual words but extends to the prosodic features of speech. So, this inner voice is not only in terms of what but they also extend to prosody of the speech. So, implicit prosody

hypothesis; skill readers organise what they read into prosodic phases similar to the way they would learn to speak.

Now, implicit prosody hypothesis what it means is, it is the proposal that skilled readers organise the material they read into prosodic phases. So, they do not go word by word or phrase by phrase, they read in terms of prosodic features similar to the way they would when they actually speak. So, they read in a manner which is similar to how they speak and this is the implicit prosodic hypothesis.

Now, speech utterances tend to be organised around prosodic features lasting two to three seconds, and this is believed to be associated with short-term memory limitations. ERP component known as the closure positivity shift is associated with the detection of phrase boundaries in speech and is believed to reflect the process of memory storage and redirection of attention.

So, closure positivity shift or ERP component is associated with detection of phrase boundaries in speech, and they also elicit the phrase boundaries in actually reading. So, reading and comprehension text is a dynamic process which is built on cycles of memory retrieval and memory storage. Now, as each word is read, its meaning and all related concepts are retrieved from memory.

This information is somehow integrated with the current context and with previous information to construct a situational model of the text, which then must be stored in long-term memory. So, this is how it happens, memory retrieval versus memory storage system works, and this creates a situational model which led us to understand the text. Rather than waiting until the end of the text, the reader builds up a situation and model in increment fashion.

So, this process happens in an increment fashion, presumably phrase by phrase. Now, if you are interrupted halfway through your story, you can still tell what you have read up to that point and this says that the reading happens in a phrase-by-phrase manner in a situational updating model. Now, it appears that processing written discourse is much more like processing spoken narrative. So, this should put an end to today's lecture.

What we tried to do in today's lecture is we looked at how written text is processed. We looked at the various characteristics of written language, we looked at three different forms of written language and the processing of these written language. Further to date, we also looked at how reading happens, what are the various ways in which reading happens, the dual model feature of reading and we also looked at how text is comprehended.

When we meet next we will look into some development features of this text perception and reading skills in children, and will surmise of what we have done in terms of reading and writing abilities in human language. And focusing on to these reading and writing abilities will highlight how these reading and writing abilities actually help us in developing the language or in terms of understanding and comprehending and exchanging ideas through human language system.

But, till we do that in the next lecture, it is thank you and goodbye from here.