INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

NPTEL

NATIONAL PROGRAMME ON TECHNOLOGY ENHANCED LEARNING

COURSE TITLE
INTRODUCTION TO THE PSYCHOLOGY OF LANGUAGE

LECTURE-31
NEURAL BASIS OF WORD MEANING

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Hello and welcome to the course, Introduction to the Psychology of Language, I'm Ark Verma from IIT Kanpur. And we are now in the seventh week of this course,
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we have talked about various aspects of language, use production, comprehension, sentence processing and all of that by now.

This week I have kind of taken a part wherein I will sort of you know help you revise all what we have learnt, and in that revision we'll also try and add some more information as to each of these processes that we have learned already about wherein the brain they might be occurring, this is going to be an account of say for example if you are talking about language production, what are the areas of the brain involved in language production, but I will have to already revise some of what you already know, so a lot of this week, a lot of this chapter will actually come us a revision of what's you've already done, but what we'll be adding to that is basically this

knowledge of which areas of the brain are basically helping us accomplished those mental tasks.

So with that background let us try and move further and also just one last thing to add, is it also I'll be talking to you about say for example I will show which specific areas, we'll not really, we don't really have so many figures but I'll try and give you an idea of basic sense of how the brain is organized and so on.

So let us move with this without you know wasting our time,
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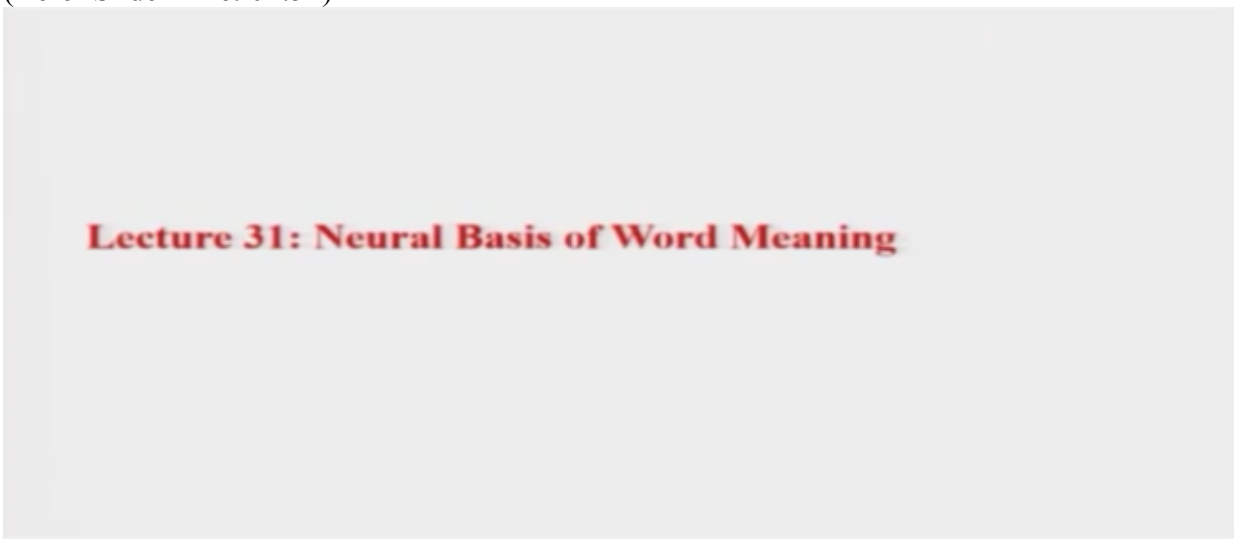

today we are going to talk about the neural basis of word meaning, if you remember on the chapter on word processing and towards the end of the chapter we did talked about the fact that how word meanings might be organized, let us kind of look at that a little bit more and a little bit you know, we'd do a little bit of revision, and then we see which areas of the brain helping us to that job.

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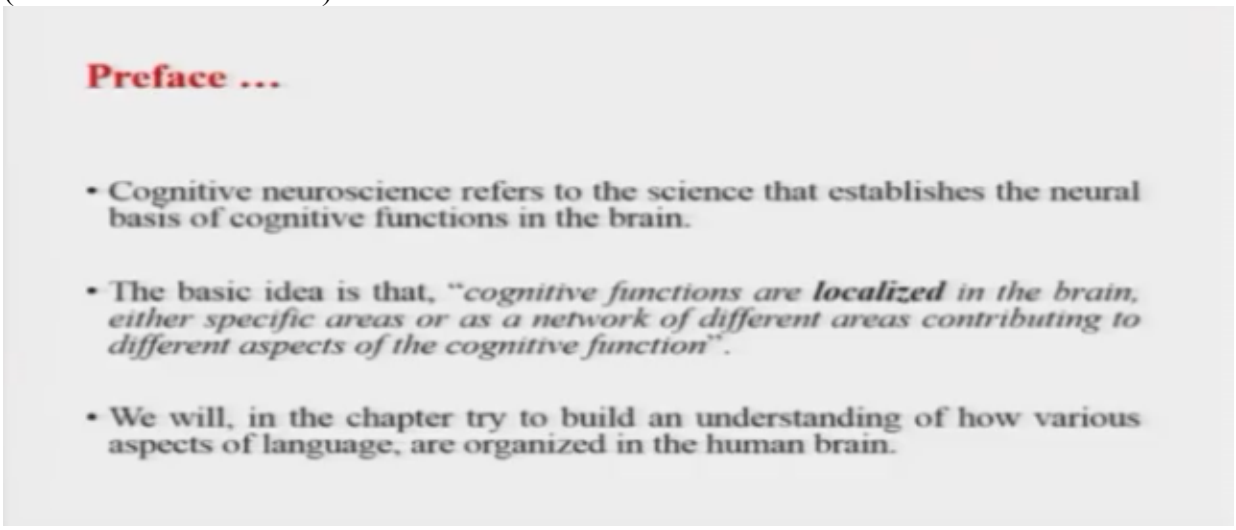

Now preface basically so cognitive neuroscience part of what I'm going to do today is comes under what is broadly called cognitive neuroscience, cognitive neuroscience basically or very loosely you know refers to the science that establishes the neural basis of cognitive functions, suppose you know we've talked about, so we have talked about so many cognitive functions in this course and some of the others, the idea is that what each of the mental function or you know how each of the mental function is organized in the brain, these are some of the questions that are asked in cognitive neuroscience.

The basic idea is that any of the mental functions that we talked about are either done by say for example in a localized fashion done by specific areas of the brain or you know distributor sense are accomplished by a network of areas in the brain, you know, say for example if you remember the word processing chapter you said that okay, is there information about animate objects stored in this particular part of the brain, or is it stored in a distributed sense, that kind of a thing, or say for example in language production you know is the Broca's area, the only area that is responsible for production of language and if that Broca's area is damaged no production is possible, or if that the Broca's area is a very prominent part of a network of areas that help you produce language, so that kind of question is asked.

So in this chapter basically we will be trying you know to establish that kind of a scenario, as to we'll again revisit some of the mental function with respect to language that we have talked about, and we will see which parts of the brain are involved in doing that.

Now coming to words and the representation of word meanings,
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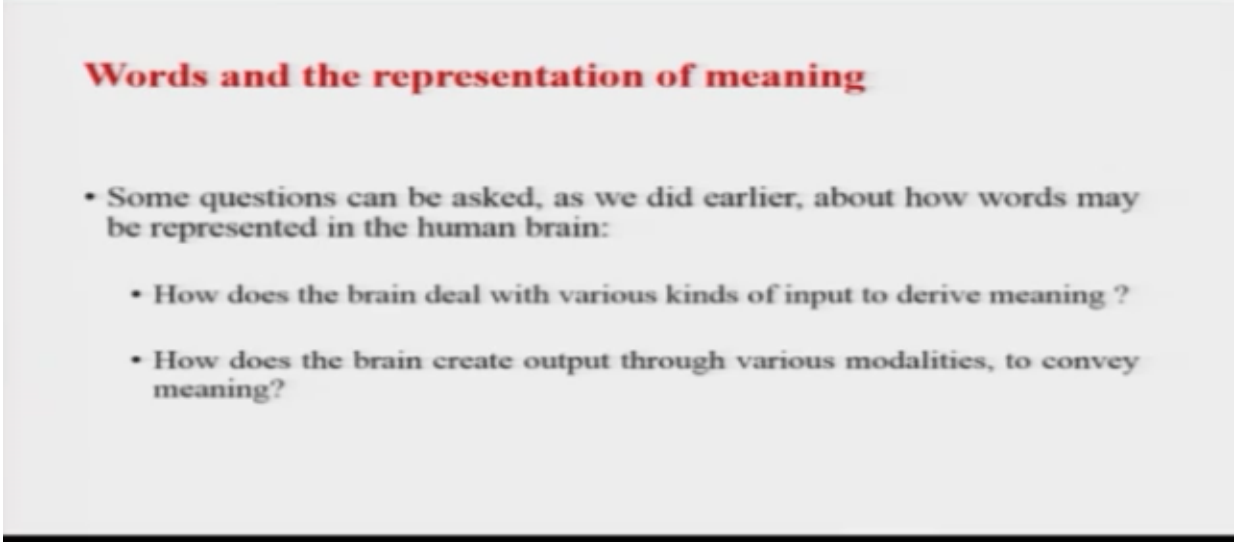

some of the questions that can be asked is in terms of say for example for words there are two modalities that we can talk about, first is the input modality, that is comprehension of words and the second is output modality that is a production of words, so what basically you know can be asked, say for example is how does the brain deal with the various kinds of inputs that come you know to us, and derive meaning, say for example you read a word or you hear a word, both ways the same word might be coming through different routes, eventually the understanding of both words will be common, say for example either I read the word apple, or you say apple and I hear the word apple, the end point is the concept of apple that I should reach.

How is the brain differentiating between these two processes? How is the brain differentiating between the kinds of inputs that are coming in? So we'll talk about that a little bit, and the second question is suppose you have to produce the output, say for example is it the same set of processes that you will take in order to write a word and speak a word as well, so that is also a part of the question that we will look at or we will try and answer.

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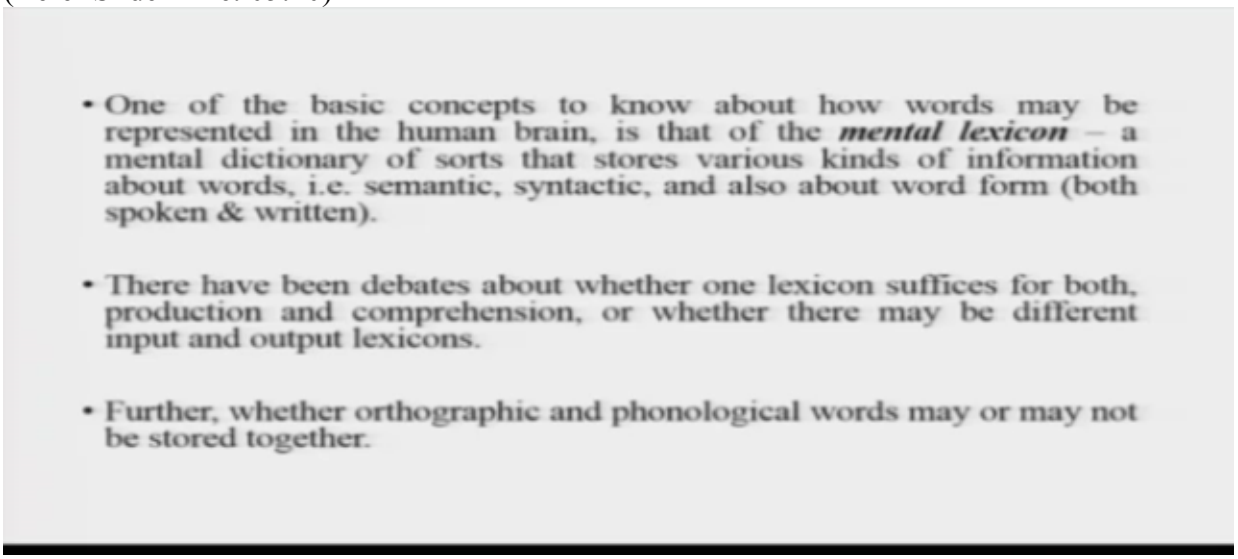

Now what is the basic concepts when you talk about words with respect to specially with respect to you know psycholinguistics, is that words are organized in the brain in a particular fashion? One of the most common concept that you will come across when you read any psycholinguistics is this word called mental lexicon, and the mental lexicon is roughly, it's almost like a mental dictionary and this mental dictionary stores different kinds of information about the word in questions, suppose say for example there is this word apple and you know apple or player or you know mango or say for example you know sleep, sleeping, eat, eating, all those kinds of words, all of these words will be stored in this mental dictionary and the mental dictionary in addition to you know what is the information that this mental dictionary have about these words, so the mental dictionary or the mental lexicon let us call it that, the mental lexicon basically stores information about the semantics that is what the word means, associative and sense base meanings, and also say for example syntactic information, what are the various versions of this word, where are each of these versions appropriately use and what are these you know words associated with, all of that kind of it, so semantic and syntactic information and also information about word form, what is the correct spelling of this word with respect to writing versus what is the correct spelling of this word in terms of sound and some time, and this representations might be related to each other, and the idea is that they are also convertible in to each other, say for example if you have, if you are reading the spelling of the word reading so to speak you can from reading you know, reading that spelling you know deciphering the visual symbol, go to the sound base representation and from there on to the meaning of the word, okay.

So they have been debates about these things, the stuff that I am talking about, they have been debates about these things as to whether there is one lexicon that one unified mental dictionary,

one unified lexical store that's suffices for both production and understanding, production and comprehension or say for example they might be different input and output lexicons, so comprehension is a different side of processes, and production is a different side of processes, so is it possible that say for example the output lexicon or the lexicon that you know or say for example, store that reading and sorry this store that speaking and writing process derive and it's different versus the store that connects to meaning when you are, you know, listening to something or reading something are different, so this debate has been around, other kind of debate that are also been around is whether orthographical or phonological word forms are stored together or they are stored separately, because the form or the representation is different, un-orthographically representation is in form of visual symbols whereas the phonological representation is in form of sounds.

Given the fact that they are inter-convertible is also a very interesting thing and we have to kind of also at some point look at the processes that are involved in converting the written to the sound and the sound to the written form, that is also very interesting question that we can ask.

Now having said that let us try and see where does it all begin, where does you know the processing of a word begin, now irrespective of the fact whether you are listening to a particular word or you are reading a particular word, the first instance of the word you know input will needs to undergo some kind of perceptual analysis, now what is this perceptual analysis? We have talked about that, and just kind of you know repeating all of this information, the perceptual analysis in terms of you know when you are reading is the visual analysis of the orthographic symbol and you have to link those symbols together in order to come to you know some sound base representation and from that sound you may have to again concatenate those sound base representation to form the entire spelling of the word, and then that goes to meaning and so on.

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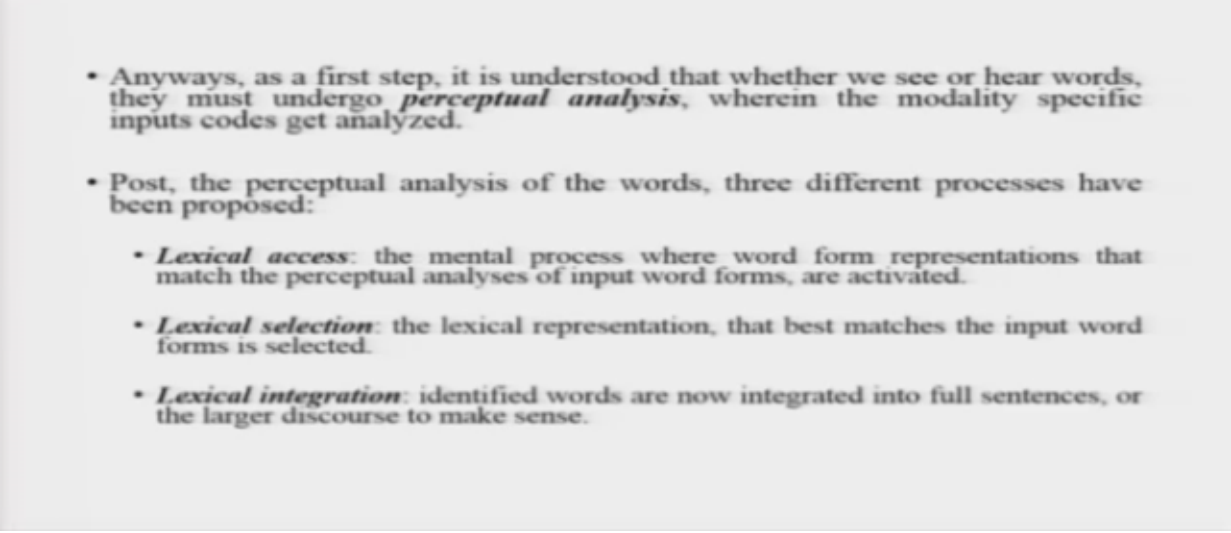

When you're listening to a particular word, you have to say for example if you remember those you know captain, and you know, that example and captain and captive, you have to be sure of what is the word that is being said, if you remember the cohort model, you are listening to something as soon as you listen, arrive at the onset, so many candidates are you know active at

that point, from that point wherein the onset is just started and so many candidates are there to the point that you finally recognize this word is also a very important thing, so initial perceptual analysis is necessary, whether you're listening a word or you're reading a word, now once the perceptual analysis is done and you've reached sort of to the form of the input, okay, this is what the spelling is or this is what the is sound like, then basically what you do is you match this form, the input form to the form that is already stored, you know the knowledge, the mental lexicon wherein you know about these words, you cannot lexically access or you cannot look for a word in your understanding that you have never read, okay, and you can do some other processes there, but the processes that come after you've generated sort of a output of perceptual analysis is a bunch of 2 or 3 processes and that is how, this is how they have been put up.

So the first process that works on the perceptual and output of the perceptual analysis system is the process of lexical access, you use this form and you match it with the form that you already stored in the head and you kind of depending on the match you will activate one or more candidates and that is basically called lexical access, so the mental process where word form representations match or matched with the perceptual analysis of the input and resulting this matching procedure this thing that most matches is activated, that is lexical access.

Now what happens is in lexical access again you might feel that I'm repeating, again what happens is lexical access is that there might be various word forms that you know off that are matching the incoming input to various degrees, on the basis of the various degrees of match multiple candidates often get activated, thereon comes there second process which is the process of lexical selection, so you've kind of you know activated let us say three very close word forms and then you have to kind of you know select which is the one is the most matching ones, so the lexical representation that best matches the input word will then be selected, so that's the lexical selection, so two processes lexical access, lexical selection, what is the third one? The third one is called lexical integration, what is lexical integration? Suppose you've said that okay this is the one that I'm selecting or suppose I'm not very sure of whether bat is the cricket instrument or the bird, or whether the you know bank is the financial institution or you know the side of the river, therein comes the importance of things like lexical integration, so the identified words are now supposed to be integrated with the whole utterance and in terms of the sentence and in terms of the larger context of discourse and that is where the fit is evaluated.

Suppose you want to go with the meaning, financial institution of the word bank, it should fit in with the larger discourse, suppose somebody said you know I planted the tree by the bank, now here even if say for example you know the broadly then most frequent meeting is the financial institution and sort, and that you know through perceptual analysis and lexical selection both are I mean it's the same thing, so which meaning you have to take is going to be dependent on how well that particular meaning gets integrated with the rest of the discourse, that will help you decide, okay. So broadly speaking perceptual analysis, lexical access, lexical selection and lexical integration, this is what kind of decides how you have comprehended a particular word.

Now one of the things there you know with respect to the mental lexicon is and that people may ask is how is this mental lexicon organized, there are so many words a typical person might have a vocabulary for around 40,000 to 50,000 words, and how are these 50,000 words

organized, you know, you might have gone to a pharmacy store and you might have seen that you know people organize that medicine in such a way that whatever medicine you say the person will go in a minute or two pick up the exact medicine from the place that he knew the medicine was, and will come back say acha this is the medicine that you ask for.

With respect to the mental lexicon the question can be asked that we know so many words, we use so many words on the daily basis, how is information organized, there are multiple principles that have been suggested, we'll take a look at some of them today,
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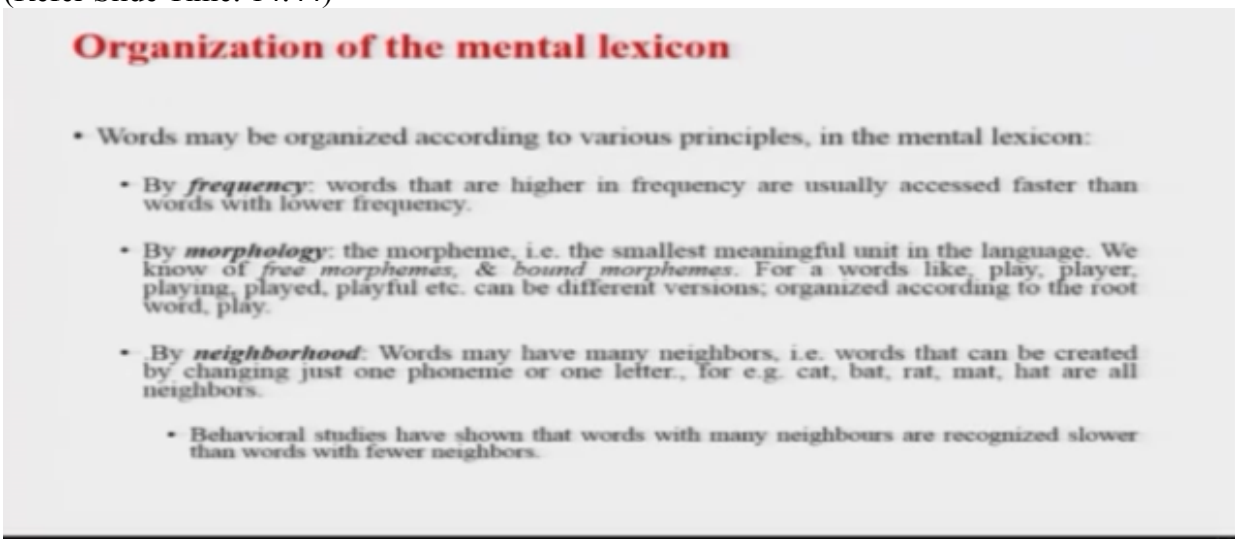

the first principle or the more basic general sort of the principle, is the principle of frequency.

One of the basic organizing principles in the mental lexicon is the frequency principle that says that the words that higher in frequency will be easier to recognize then words with lower frequency, so suppose if there is a threshold or suppose if there is a you know, a bin, a box or anything, the words with highest frequency will be at the top and most easily accessible and hence we show the lowest reaction times, people will be fastest in recognizing these words. This is again one very broad and genetic principle.

The other principle is morphology, now we have talked about morphological organization of words in the Forbes model if you remember the frequency ordered been search model, now in the Forbes model what was there, words were organized according to their route words, so there are many words which have one morphine and there are many words which are more than one morphine, and the words with more than one morphine usually have a route word or on to which the suffix or prefix as added, okay.

So one of the things that this, one of the principles that could be used to organize words in the mental lexicon could be according to route words, okay, so you know of free morphine, bound morphine and so on, suppose there is this word called player, play is the free morphine and play is the route word to which ER is added or ED can be added or ING can be added, a good way to organize the word is that you know create a bin, and the bin is labeled with the word play and all the derivatives of play are in there organized by frequency.

At the top still the word play will be there, because it has the highest route frequency, we've talked about that in the past and every other word basically will be lower than play, all of them will have their different surface frequencies, okay, so that is one way in which also the lexicon can be organized.

The third way that we can talk about is also by virtue of neighborhood, what is neighborhood? If you take a word and you can change one letter or one sound of the word and create another word, do it as many times as possible, so suppose say for example there is this word called cat, I'll try and change a sound and create more words, so cat, bat, rat, mat, hat, all of these are supposed to be neighbors of each other, because just by changing one sound you can create so many of these different words.

Also words may have many neighbors, and words may have fewer neighbors, say for example if you take the word disease for that matter, okay, what sound will you change to create what word, it's very difficult to do that but you can kind of do that exercise later, and you will figure out that they are very few words that can be made after changing an one or two or three sounds in disease, typically we just talked about changing one sound and creating another word, so there could be words like disease wherein you know they have very few neighbors if any, and neighborhood like cat or bat which have so many neighbors, just after genuine how they can create so many words, so this is high neighborhood size, this is low neighborhood size, and one of the proposal is that words with higher neighbors are organized differently than words with lower neighbors.

This is also consisted with the lot of behavioral studies which have shown that words with many neighbors are recognized slower than words with fewer neighbors, you are not talking of the lexical this entire, we are talking about general tasks when we have to recognize a particular word, okay.

So these three are the principles by which how the mental lexicon using which the mental lexicon maybe organized, also the mental lexicon can use a semantic organization, basically I have so many words all three of this, these things that we talked about were properties and characteristics, frequency are characteristics of a word, neighborhood is a characteristics of a word, morphology is also characteristics of a word in terms of how the word is composed.

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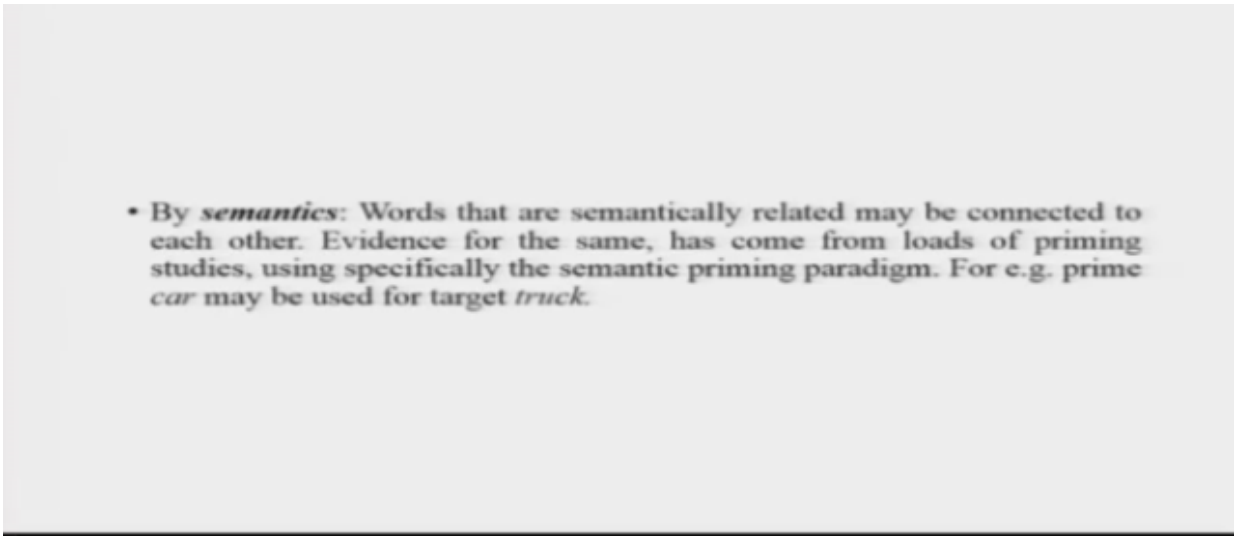

Now there could be other characteristics as well, semantics is one very important category semantics has to do with the meaning, what is the meaning of the word? And can be organized the mental lexicon just wording to meaning, so words in that sense has been proposed, and words that are semantically related maybe connected to each other strongly, so for example cat, bat, rat, cat and rat and let's say dog are probably semantically related to each other because they share so many features they are all animals, mammals and pet animals in some sense, rats mostly you know labs do like to keep rats, so in that sense a semantically very similar as well, and because they are semantically very similar it is the probability that in the mental lexicon they will be closed to each other, also because say for example you know when you've been try and mention rat, you probably also mention cat and we are trying to mention dog, you might also again mention cat, so those kind of things have also been seen, so the proposal is that the mental lexicon might also be organized according to the meaning of these words.

Now there is been a lot of evidence for this kind of organization actually being there, in terms of this evidence mainly comes from a lot of priming studies, so we talked about the priming paradigms, so there is a prime and there is a target, and when you present the prime for a very short duration you know 50 millisecond, 70 milliseconds, the prime comes and goes, then you present the target for let us say 250, 500 milliseconds and you ask the person to recognize the target, you say whether it is a word or non-word or whether it is that specific word, whatever you might want to do, people have observed again I'm trying to revise in the priming paradigm is that depending upon the relationship that this prime had with this target, the target might be facilitated or inhibited, as opposed to is ever no prime behind this particular target, suppose you're presenting targets in isolation versus you present, say for example you present a target word in isolation, you've got 400 milliseconds reaction time, then you present semantically related target and then you get the reaction time of 350 milliseconds, the 50 millisecond difference is called the priming effect, it's called the effect of the prime, so depending upon the kind of relationships, the prime and the target have they might have semantic relationship, orthographic relationship, morphological, phonological, all kinds of relationships are possible, this basically says that you know yeah, you know that the priming effect is there.

Coming back to what I was talking about here is that if the prime and the target are semantically related, it is highly likely that the prime will facilitate the recognition of that target, that can act

as an evidence of the fact saying that maybe the mental lexicon is organized according to the semantics, that's the idea.

Now they have been again as I was saying several models of the mental lexicon, one of them,
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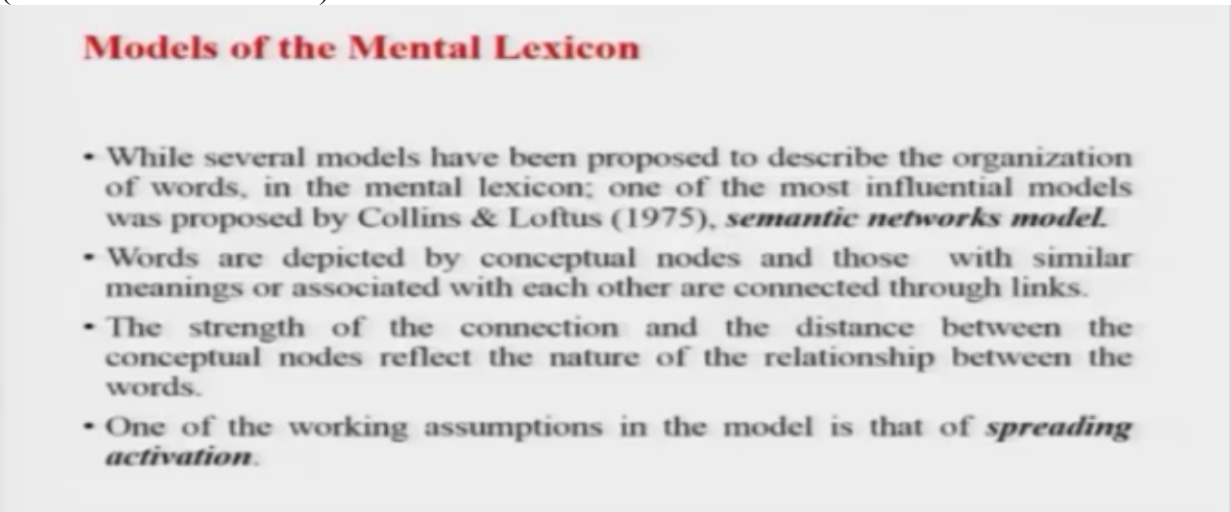

one of the most famous one is that semantic networks model proposed by Collins and Loftus in 1975, I'll show you the network already,
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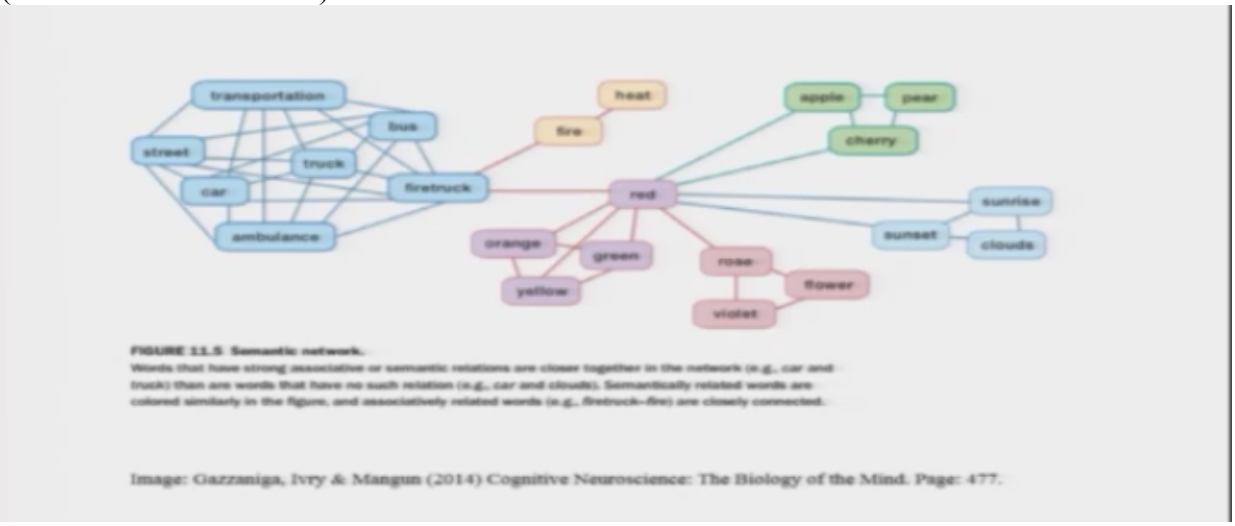

we have talked about the semantic networks model in a lot detail in the chapter on words, here you can see that you know words that are closer in meaning are you know bunched together as a cluster, there also connected to each other by these links so there the words are represented as nodes, the connections between them as links and you can say for example apple pear and cherry, sunset, sunrise and clouds and say fire and you know heat, they are all you know put close together connected very strongly together by the virtue of meaning, say for example yeah in this network words that are closer together you can say car and truck are close together as compared to the words that are not you know related to it, so for example car and clouds is not really very related to each other, so that's not the connection is not there so much.

Also say for example semantically related words are colored in similarly, but say for example the words that are not colored similarly are joined in terms of association, say fire truck is associated with fire, even though the fire truck does not you know it's meaning wise not so strongly related as with, as you know as association wise, whenever you think of fire you might also think of fire truck because the fire truck is used to extinguish fire.

Okay, red and you know fire truck are also related because typically that's the colour in which fire truck is there, semantically there might be not so much relationship, so this is just an example of the semantic networks model, and the semantic networks model is basically something that says okay, the mental lexicon is recognized according to meaning, this is the figure you can see this is exactly how the organization is there, okay.

One of the principles if you remember here is the spreading activation principle, if you activate or recall or queue any of these words, all those words which are connected so closely to a particular word will get the benefit of that activation, suppose you mention red, orange, green and yellow and rose for example and apple and cherry for example, and fire truck for example are all getting activated, okay, things that are closer to red say for example orange, green and yellow because they are all colour, semantically also very much similar will get activated, let us say slightly more strongly as compared to things that are slightly further off, say for example between red and fire truck and truck, okay, so obviously truck might also get some activation because it is connected to fire truck, but by that time the activation would have diminished quite a lot, okay,

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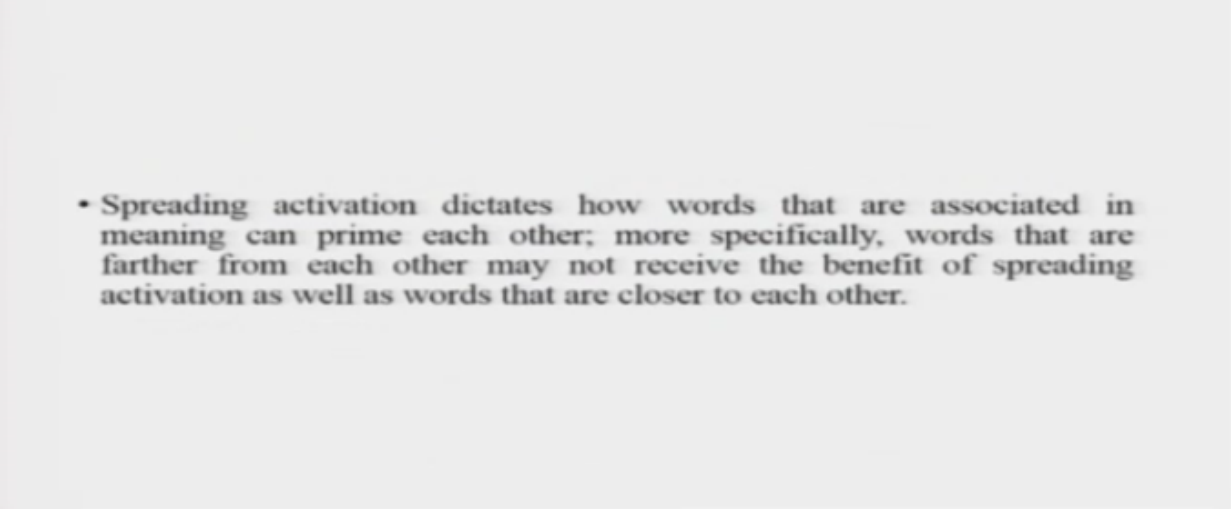

so this is one way in which we had talked about the organization of the mental lexicon.

Other alternatives have also been present, say for example you know we have talked about the HAL and LAC kind of models, how words are link to each other by virtue of association, we have talked about that as well, these questions are you know at the moment also being examined in some detail and there is a lot of research going on in this by a lot of researchers.

Now let us talk about the you know neural substrates of the mental lexicons, so we've kind of revised brushed up our knowledge on the mental lexicon, let us look at the neural substrates, I'm sure we've done this part also a little bit, now it has been observed that people who have

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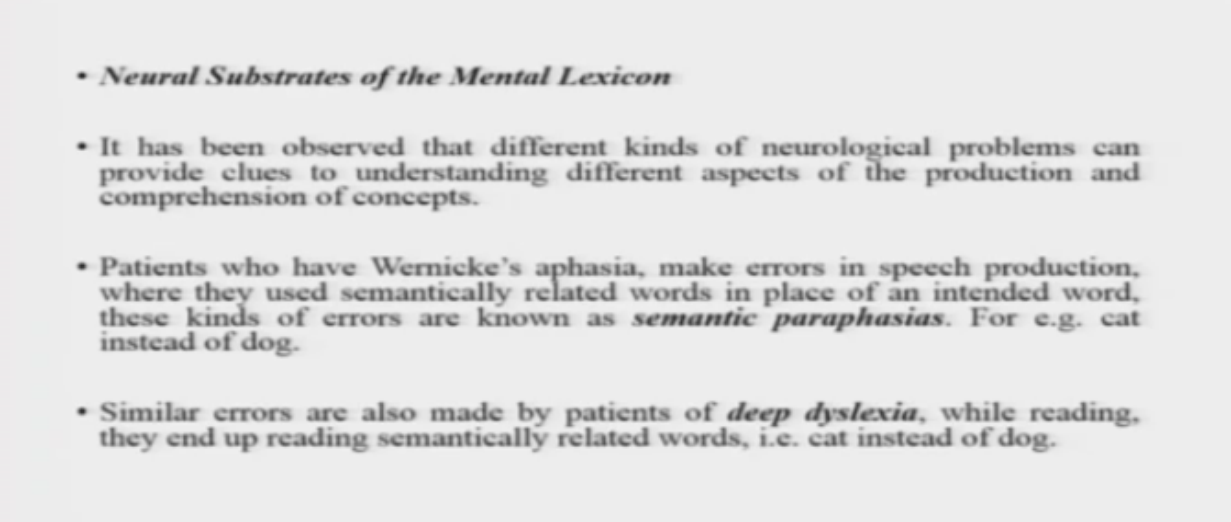

different kinds of neurological problems can provide clues to understanding you know what the different aspects of production and comprehension of concepts could be about, one of the very interesting group of patients, is patients who have you know a particular disorder called semantic paraphasia, the problem with semantic paraphysics is that sometimes if you ask them to illicit a word they will intend to say something but they will probably say you know illicit a word that is close semantic, relative of the intended word, say for example people can you know if they intend to say cat, they might end up saying rat or dog, okay, so this is basically people who have a semantic paraphasias, semantic paraphasia is a symptom in disease called Wernicke's aphasia, we will talk about aphasia probably by the end of this chapter.

Now similar errors also are made by patients who have deep dyslexia, who have semantic troubles in you know taking this reading, so while reading the end of reading semantically related words, cat is written and say for example they have written cat chase the mice, that deep dyslexia might read it as the dog chase a mice because that confusion might be possible.

Now another kind of patients we can talk about is the patients who suffer with progressive semantic dementia, people with progressive semantic dementia shows some conceptual impairments, but some other systems are alright, say for example while this patients will be able to understand and produce this syntactic structure of sentences, they might make you know semantic or meaning related errors, there is also been found that this is basically left you know, this is basically linked with increasing damaged to the left temporal lobes, but we will come to that, okay.

So people with semantic dementia left temporal lobes sort of damage, and superior temporal lobes are preserved, now before we start talking about the brain, let me and before we start using a lot of that jargon, I would like to give you a very brief account of, a very rough account of what the brain looks like and what are these different terminologies about.

Now if you look at the brain, I'm not really very good at drawing this, let us say the brain looks like this,
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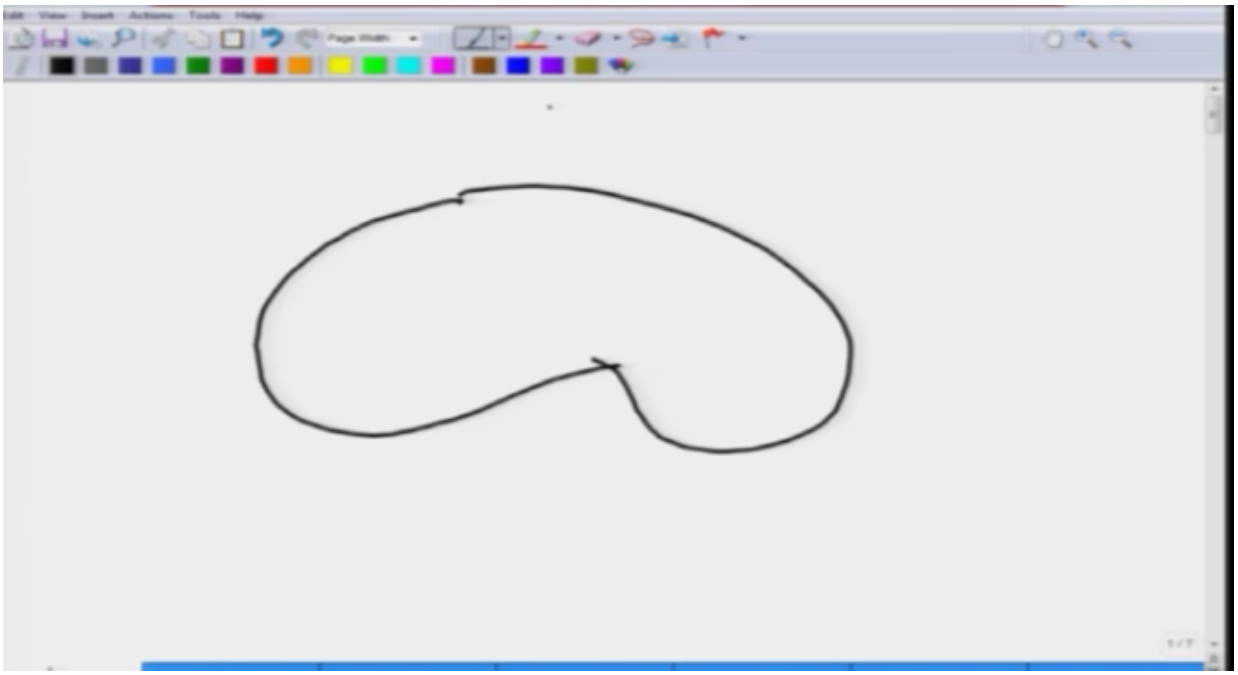

this part is roughly we will it the frontal lobe, so let us say this is the frontal lobe, this part here again slightly roughly this is the occipital lobe so let's call it occipital lobe, then you have this lobe here which is called the temporal lobe and then this part here is basically your parietal lobe,

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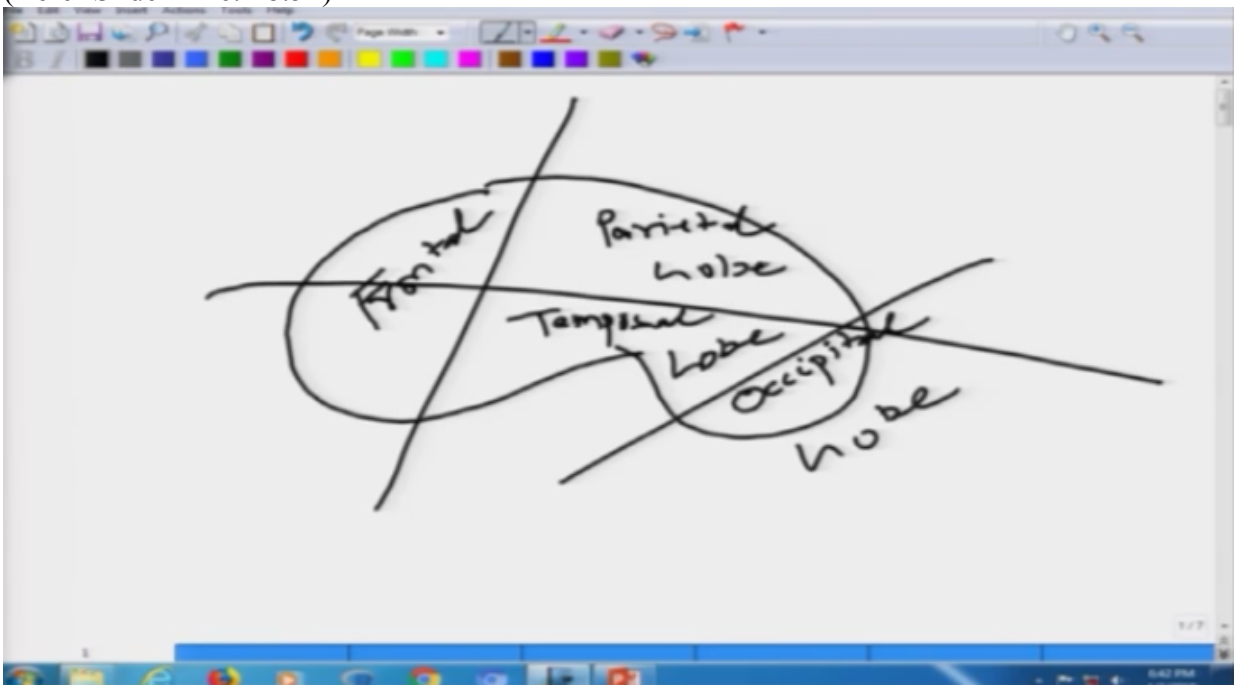

as the brain is, these different lobes very broadly and I have given you a very, very rough description of this, these different lobes are engaged in broadly different kinds of activities, the occipital lobe usually I mean, the occipital lobe receives and processes visual inputs, input basically the eyes will be somewhere here, and whatever the input comes from the eyes is processed here, the temporal lobe here basically has what is called it processes the auditory or

acoustic stimuli, the frontal lobe is mostly involved in say for example you know reasoning, decision making, you know response selection, inhibition say for example maintaining civil behavior, deciding lot of stuff, you know parts of memory also are there, to the frontal lobe kind of does that, the parietal lobe is mostly in you know producing, say for example synthesizing sensory input, integrating sensory input also say for example you know there are different theories, I'm not really going to talk about the entire you know section on what areas of brain does what here, but I'm just giving you a very brief idea, so parietal lobe kind of does have this somatosensory association cortexes, they link you know stimulation together and they also, it also process about you know a spatial locations and those kind of information.

So broadly this is how the brains organization looks like, say for example if I, so you will hear this more and more in this week, so the frontal lobe whenever I say frontal, whenever I say temporal I'm talking about this area, whenever I say occipital I'm talking about this area, so this is occipital, this is temporal, this is the frontal and this is the parietal, so whenever you listen to this, when you say, when you hear frontal lobe this is the area that is in question, whenever you hear occipital lobe this is the area in question, temporal lobe this is the area and parietal lobe this is the area, so again you have to kind of you know kind of catch up with this and remember what these different areas are about, and then one of the things that you will also listen to a lot is, terms related to areas in the brain, so when you are talking about anterior you are talking about say for example things in the front of the brain, okay, now what really, actually in the front, but to any location, so usually you will see anterior temporal lobe, so anterior temporal lobe means let us if this is broadly the temporal lobe, anterior temporal lobe means the area in the front of the temporal lobe, so this is let's say anterior temporal, okay.

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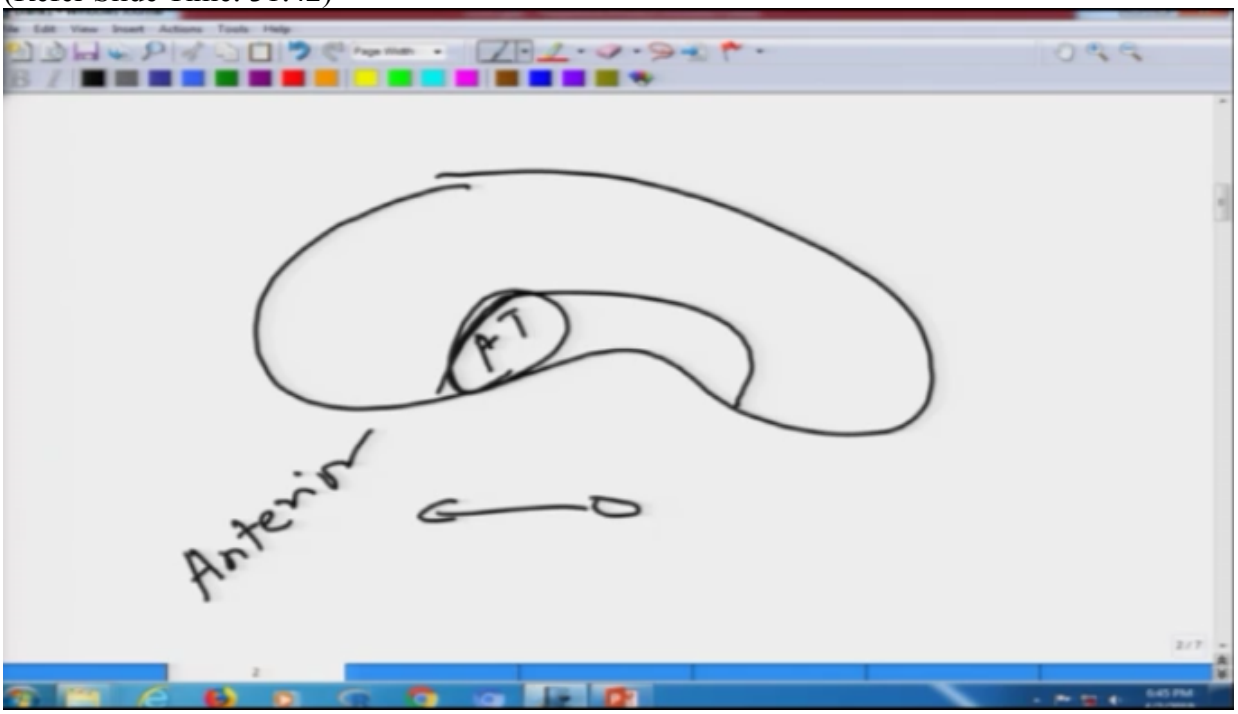

And posterior basically means at the back, so if you are talking about here this is posterior, so anterior means in front of something, posterior means at the back of something, now you will

also hear of inferior and superior if you hear of inferior, you are talking about areas towards the bottom, so inferior temporal lobe is basically this area, is posterior inferior you can hear, say for inferior frontal cortex is this area here, the bottom of the frontal cortex, so you know this is the inferior frontal cortex, also will hear of superior, so superior is that top of something, say for example you can have you know,

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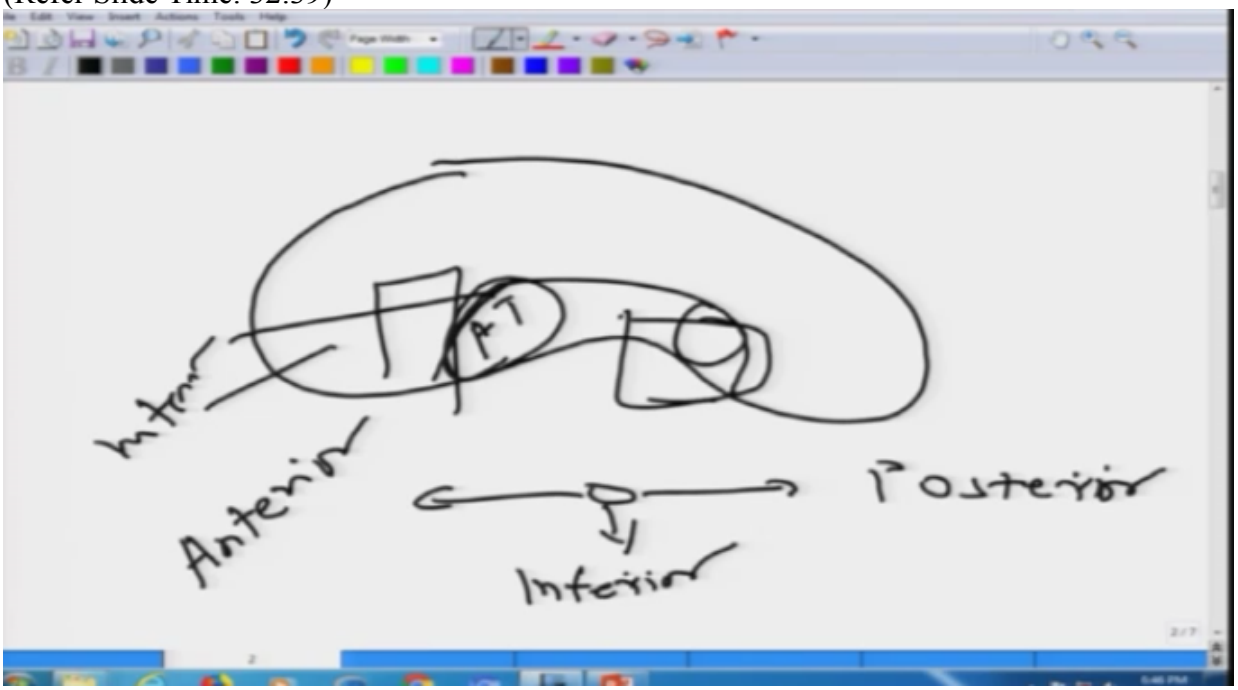

there are also other organization like say for example in the brain there are say for example, there are these different kinds of ridges, so there is this you know, and there are ridges and now I'm kind of slightly just giving you an example, so don't take this as actual, but say for example there are these different kinds of structures in the brain, and these slightly lifted up structure that tissue, basically are called gyro, singular is gyrus, and then there are these ridges in the brain as well, you know folds, these are referred to as sulci or the singular is sulcus,

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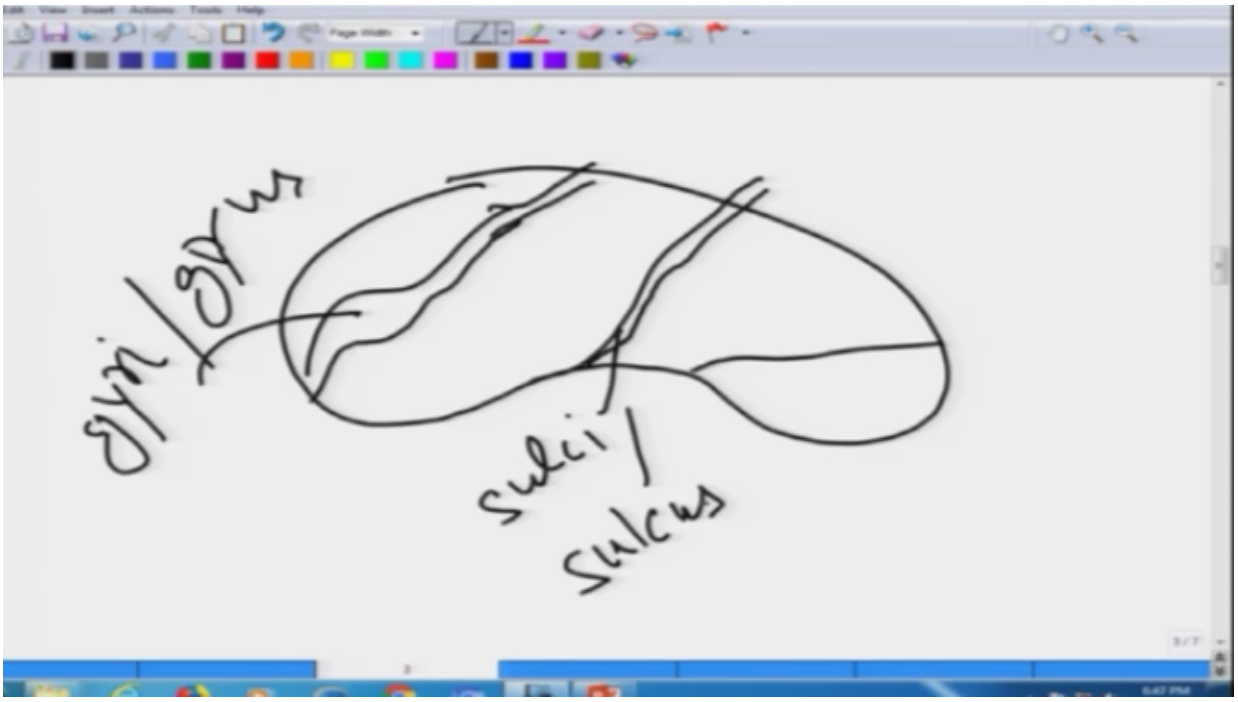

so there is, I'll show you some figures where all of this will be clear as well, so when I am talking about superior temporal gyrus, I'm talking about the gyrus which is somewhere in the temporal area and we are talking about the top of that gyrus, inferior frontal gyrus, if there is a gyrus let us say here, inferior frontal gyrus is the bottom of that gyrus, okay.

So superior frontal and there then we will also hear of middle temporal medial, so there are also multiple views of the brain, there can be a top view which is you know, that they can be a dorsal view, a lateral view, a medial view, say for example you might know that the brain has two hemispheres, if you cut the brain from the middle and you open it as the medial view, there is a surgitel and dorsal and all of that, but I'm not going to confused with all of these, I'm just giving you brief idea of what each of these things mean, and now when you will listen to me using those terms, you have to kind of tell your brain okay, this is what you know this person is referring to, more often they not I will also show you the figures which will be you know a good idea to kind of, good reference point to look at those areas, so that is that.

Let us come back to the stuff here, I hope this was you know useful at least, now what was I saying? I was saying that say for example people who have progressive semantic dementia,
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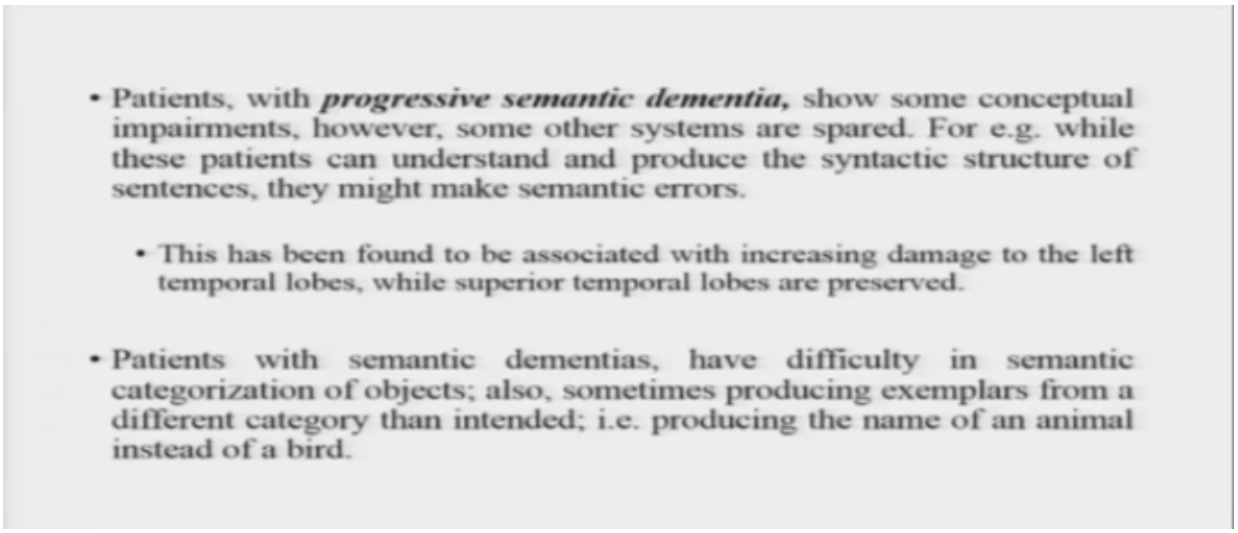

semantic basically will show some conceptual and progressive means dementia with respect to meaning which is progressive, you know which is increasing probably, okay, so while this kind of patients can understand and produce the syntactic structure or sentences they might make semantic errors, they might make meaning related errors, and what has been observed is that

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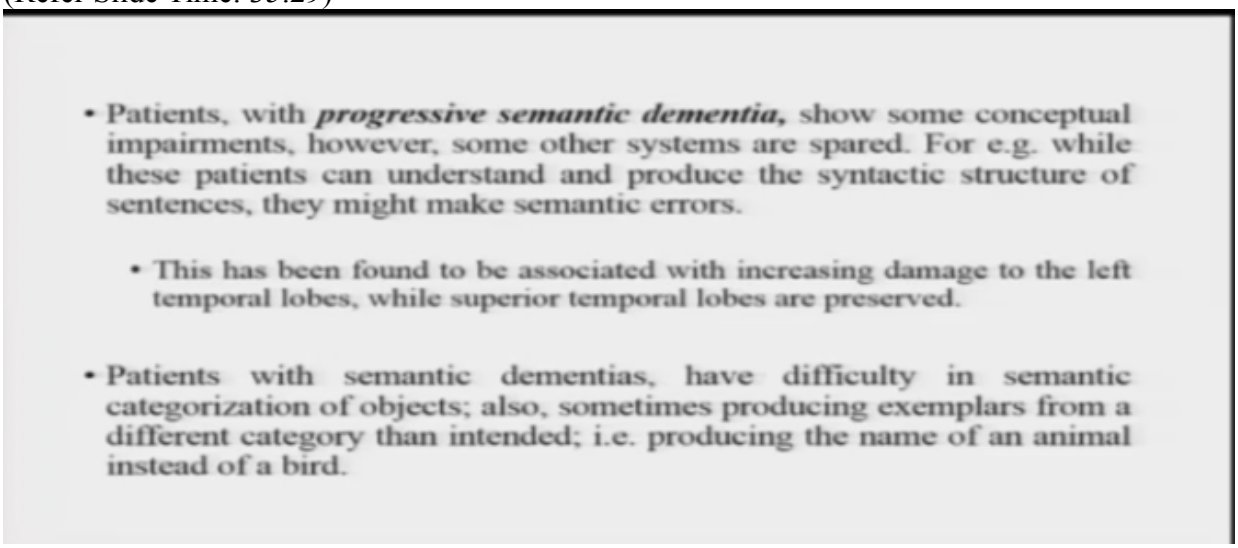

these people are basically you know the damaged to the brain in these people is basically there in the left temporal lobe, so left side and temporal lobes.

While superior temporal lobes the top of this temporal lobes are preserved, okay, patients with semantic deficiency, semantic dementias usually have difficulty in semantic categorization of object so they cannot tell you whether something is animal or a plant so to speak, they also sometimes end up producing example from a different category that end, so you ask them the name of an animal they might you give you an name of a bird, okay, they are not really very good at making these distinctions you know, because of the lesion in the brain.

Evidence from various research, lot of studies basically provides therefore some support for the semantic network idea, because what happens is if you are looking at these patients, if you are looking at the profiles and the symptoms that these patients go through and there is a lot of

assessment, lot of test given to these patients, what is usually been observed is that words that are related in meaning have the potential to be at times be substituted, confuse with each other,
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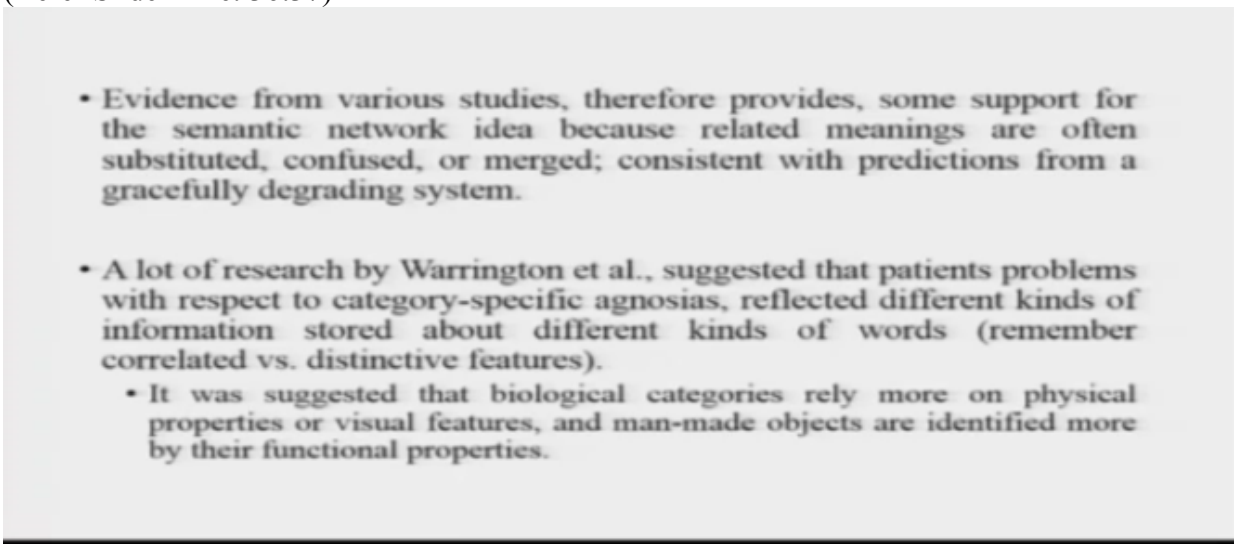

merge with each other and this is in some sense consisting with the prediction of the semantic networks idea, the semantic networks idea was saying that okay, you know, things that are closed to each other will you know get, say for example activation, so if this word is activated and the word, this word is your very close, you might mistake the two, okay, that kind of saying.

A lot of research on this topic Warrington and colleagues had suggested that patient problems with respect to category specific agnosias or semanic you know deficits which are category specific or category specific semantic deficits whatever, reflect different kinds of information about different kinds of words, so it basically tells for different kinds of categories which stored different kinds of information, the exact prediction is that biological categories living things that is identify more on physical features, so if you are talking about biological categories going to talk more about physical features and manmade objects are more recognized by functional features, so that is the idea.

Consequently many correspondences you know across most, a lot of research you know consequently lot of correspondences or links you know associations had been found between the lesion sides and the types of semantic deficits that people experience, we have talked about this in the past, say for example people having impairment for living things, showed lesion including the inferior and the middle temporal cortex so bottom of the temporal cortex and the middle part of it,
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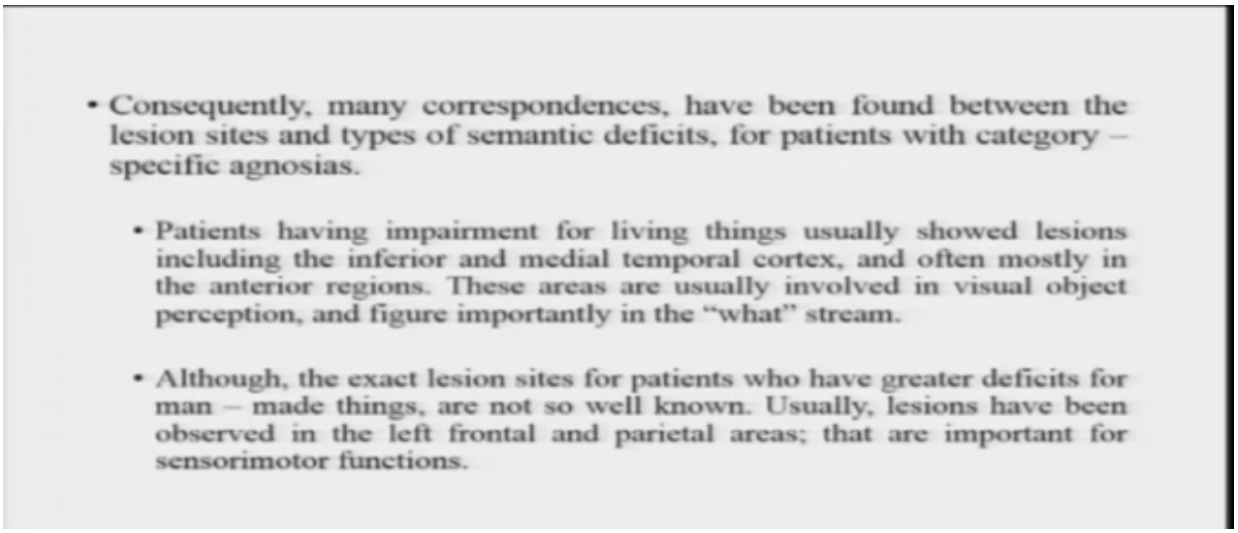

and often mostly in the anterior regions, so inferior and middle in the interior regions, so for example if I have to draw this region for you, if I'm saying this is the temporal cortex, I'm talking about anterior, so in the front and inferior on the bottom, so this is the anterior region of the inferior temporal cortex, so this is the region I'm referring to, this is just an example to show you how this actually works.

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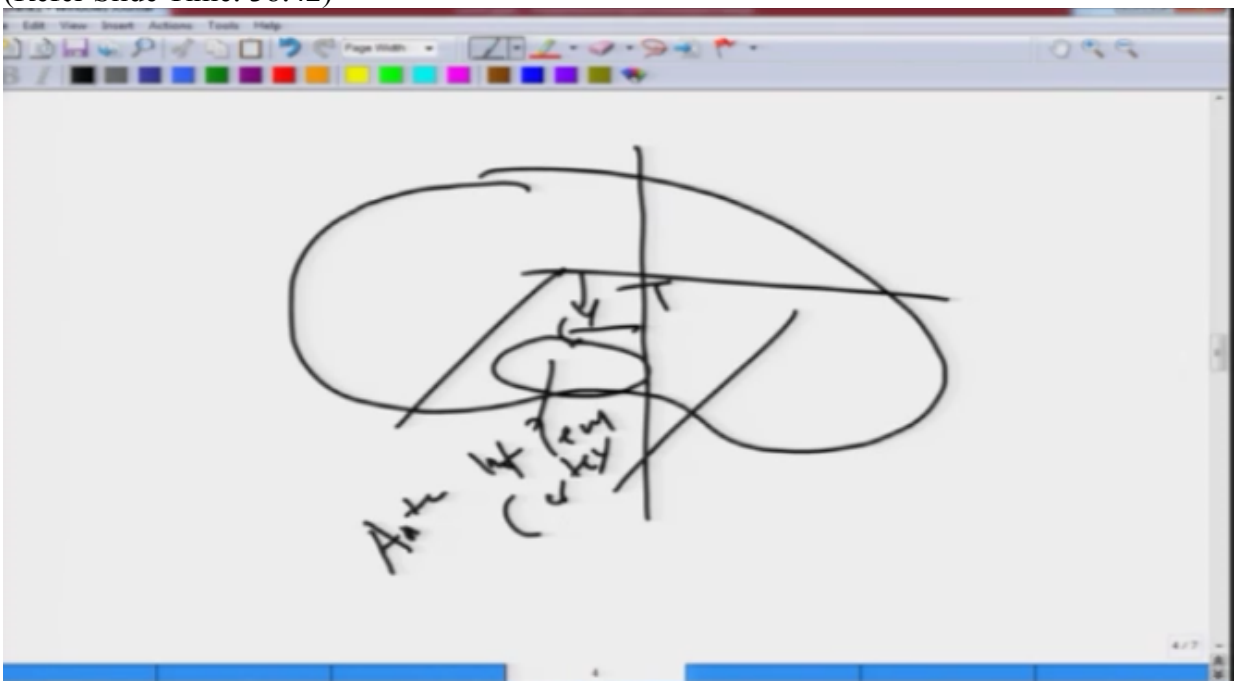

Although exactly so this is basically there, so patients with impairments or living things usually have showed lesion for inferior and middle temporal cortex or mostly in the anterior regions that is the front, these areas have usually and found to be associated with visual object perception, you know, analyzing the features of the object, that's how you proceed with recognize objects, this is basically also the what streams, so some scientists have distinguish between the what stream and how stream, and what stream and where stream, this is also participating in the what stream, okay.

Although exact lesion sides however not really known for people who have deficits for manmade objects, but usually lesions for this people have been found in the left frontal and parietal areas, so left frontal and parietal areas basically for functional features, it seems that the pattern of lesions and their correspondences
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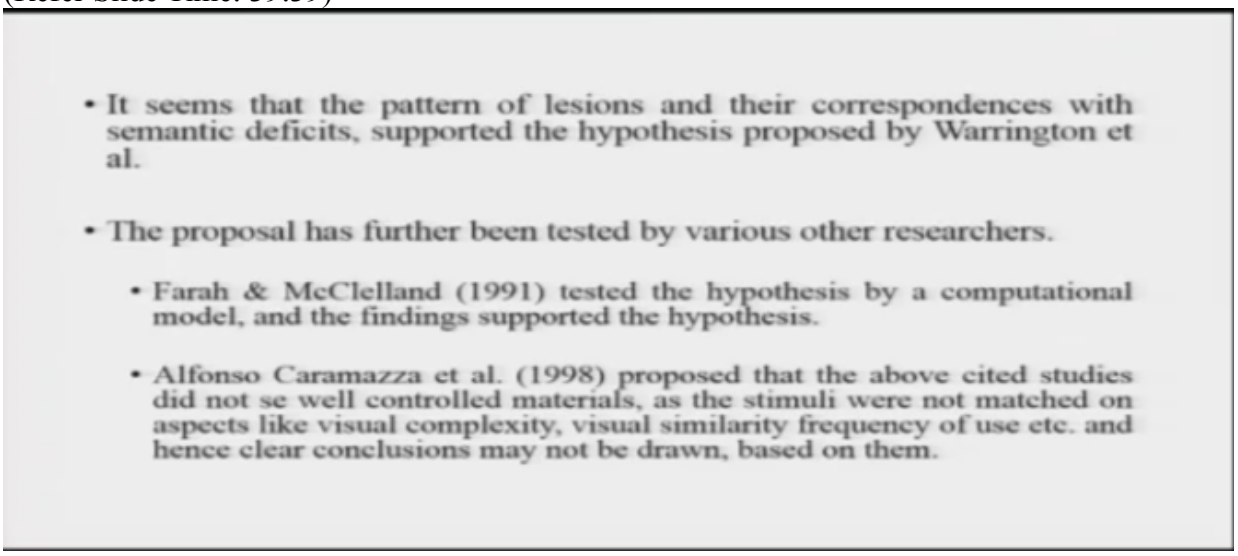

with semantic deficits support the idea that is being put forward by Warrington and colleagues, so that is what they have said, now this proposal have also been put forward and being tested by various researchers, say for example Farah and McClelland they tested this hypothesis by devising a computational model and the computational model kind of showed exactly you know results that were confirming the Warrington and colleagues hypothesis.

Alfonso Caramazza also you know proposed that you know Alfonso Caramazza kind of tried to replicated and you know did not really see that this will happen and he criticize this and he said that a lot of the studies till this point 1998 using these as you know semantic deficits and explaining those symptoms did not really have a lot of controlled materials, now what happens in experiments is that if you have to categorize particular objects you have to categorize them according to very specific protocols, and say for example if you are using multiple stimuli those should be matched on everything all the possible features just the critical experimental feature is the one that has to manipulate it.

So Caramazza said that a lot of stimuli that were being used in this kind of studies were not very well controlled, they were not matched on things like visual complexity, they were not matched on things like visual similarity, frequency of use and so on, and that's why you said that it's probably not correct to draw a very definitive conclusion on the basis of the studies done so far,
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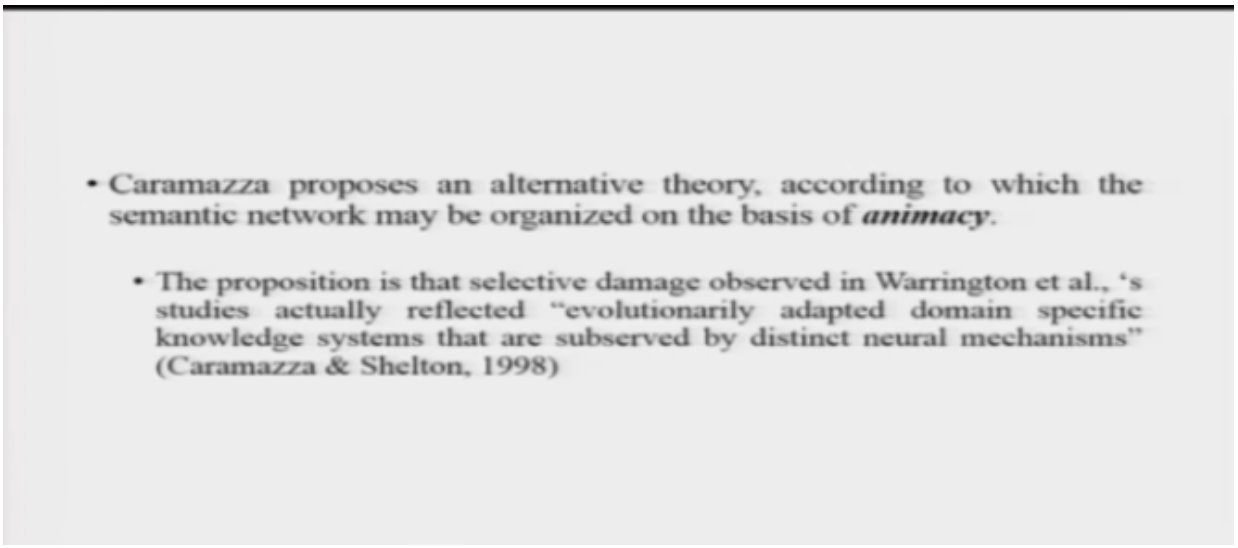

instead he proposed an alternative theory and he said that according to you know he said that basically the deficits that are being observed are probably being observed not really because of the class of the object, but the characteristic of the object, and one of the characteristics that he said was very important was animacy, if something is alive, moves or not, they were animacy.

And the proposition is that selective damage that is basically observed in the Warrington and colleagues patients you know in the studies there are basically reflecting a evolutionary adapted domains specific knowledge systems that are subserved by distinct neural mechanism, so they say by evolution we are wired to look at certain things in a particular way using particular set of brain areas and that is what is being shown in these studies.

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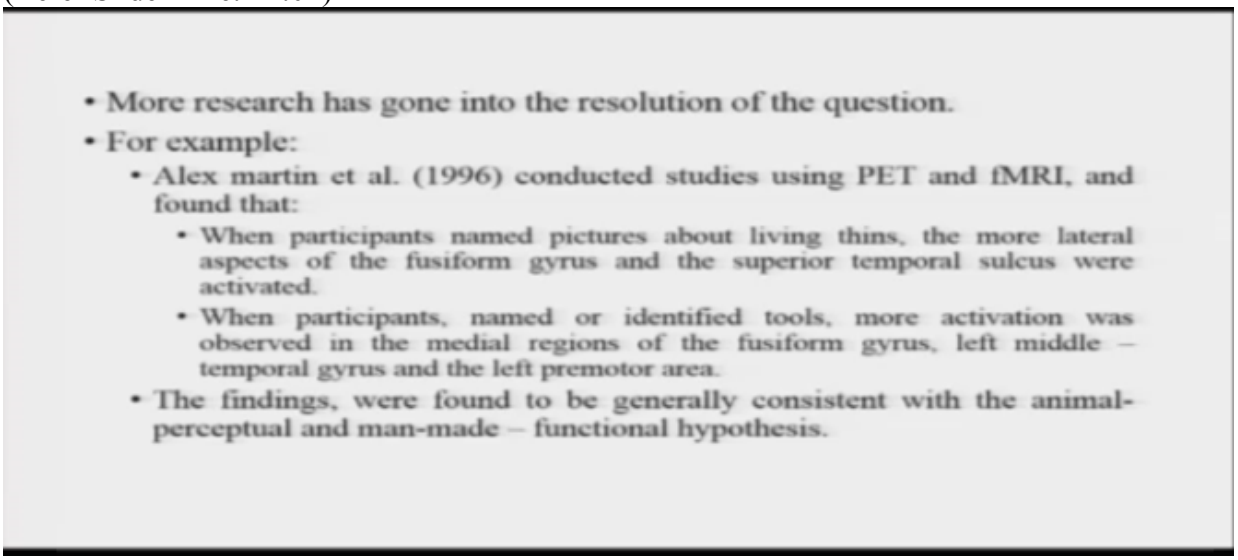

Now here after Caramazza lot of research has gone into you know this kind of you know question as to whether the brain is, the organizing principle for meanings or concepts in the brain is biological categories and manmade categories or say for example you know tools and houses and so on, so a lot of research is going in, some of the researchers done by Alex Martin and colleagues, Alex Martin and colleagues in 1996 they use PET and fMRI and they found that

when participants were asked to named pictures about living things, the more lateral aspects of the fusiform gyrus also area in the brain and near the temporal and occipital lobe, the fusiform gyrus and the superior temporal sulcus, so you know a particular sulci at the top of the temporal area were activated, then participants where naming objects or identifying tools more activation was observed in the medial regions in the fusiform gyrus, the left middle temporal gyrus and the left premotor area, okay, so these were the areas which are showing activation, so these are the different set of areas showing activation for naming tools or other objects, a different set of areas is showing activation when you are naming pictures about living things.

Now these findings again were found to be generally consistent with the animal perceptual versus manmade functional hypothesis, the Warrington said that animals are recognized by perceptual features, manmade objects are recognized by functional features.

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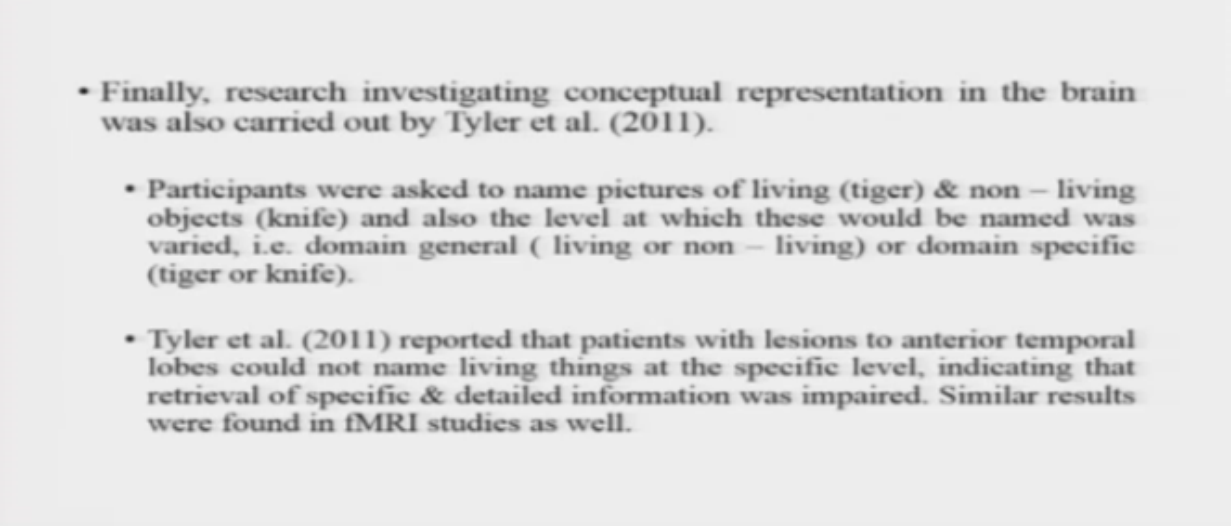

Finally kind of you know the research investigating conceptual representation in the brain was also carried by Tyler and colleagues as recently as 2011, and in their study what happened was they asked participants to name the pictures of living things like tiger, and nonliving objects like knife, and also they also unable at the level and at which this was named, so you can name at a you know slightly broader level as in you know living here and nonliving here, or you can also ask very domain specific name, what is the exact name of this object, you could look at the picture say living, nonliving, you could look at the picture and say the exact name of that object, so they manipulated the level of naming and they manipulated the category of the stimuli that were to be named, and they reported that patients with lesions to the anterior temporal lobes could not name living things at the specific level, indicating the retrieval of specific and detailed information was impaired, not and their deficit was across, I think across both kinds of stimuli, so the conclusion that they made was that retrieval specific and detailed information was impaired when you know, when people are experience in difficulties with respect to naming living things. Similar results are found in the fMRI you know task as well.

Now this is sort of very similar to if you remember we had this discussion in the word processing chapter, we said let's say for example there are correlated features and distinctive features, animals or manmade things does not really matter, as long as you are talking about

distinctive features a particular region the brain will get activated as long as you are talking about correlated features a particular area of the brain is going to be get activated, and again by a particular area I still mean that distribution of particular areas, this is precisely what you can also sort of conclude from this bunch of studies and this is basically what we'll stop at in terms of you know how word meaning is stored in the brain.

I hope a little bit of revision of what you've done earlier and some of the added idea about which areas of brain are accused might have help,
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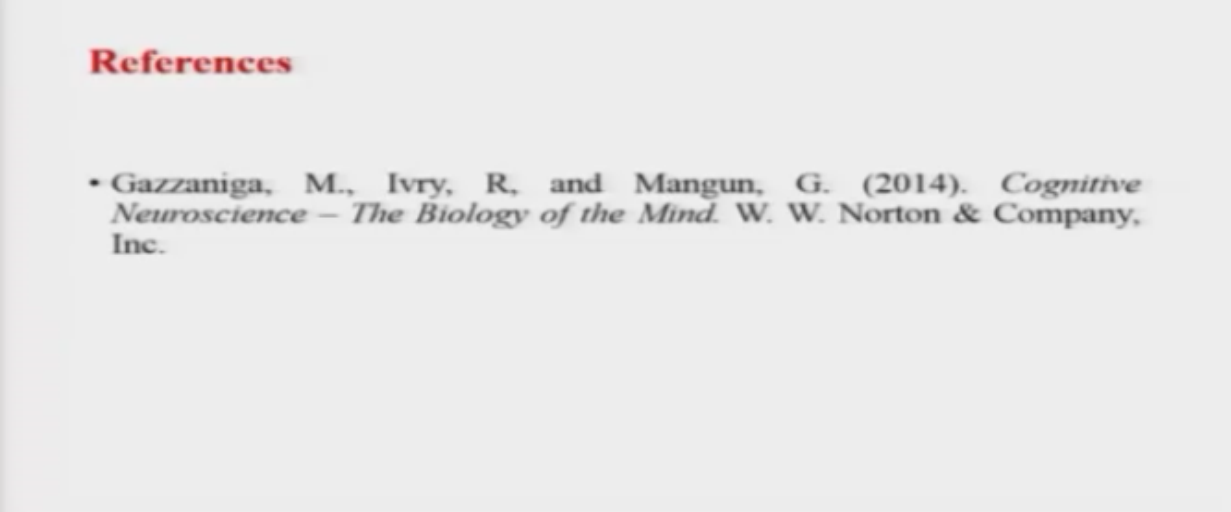

we will talk about different aspect of the language in the next class. Thank you. Okay.

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