Lecture 19

Ambiguity and Representation of Meaning in the Brain

Hello and welcome with the course, introduction to the psychology of language. I am Dr. Ark Verma from IIT Kanpur. And we are in the fourth week of the course, as you know we have been talking about, various aspects of word processing in this week, we have been talking about, aspects of meaning, aspects of lexical access and so on. In today's lecture, I will talk to you about,' Ambiguity and the Representation of Meaning in the Brain'. Now, one of the things that, we sometimes, come across is words that may have more than one meaning and these words, might have more than one meaning, sometimes in a similar context, in something across different contexts .Say for example, mostly however it will happen that,

within one particular context, a, word, will have that specific meaning. So, it is very easy to resolve, however sometimes what happens is that, the context is not really very helpful and the conversation is kind of you know, not giving us any clues, as to what this word particularly means. Let us take an example, let us take the case of the word bank. Now for example, a bank the word has two probable meanings, one is the bank as the you know, money institution the financial institution called the, 'Bank'. And the other could be the Riverside. Now for example, if I tell you that you know, I want to have my lunch by the bank, it could either mean that I want to have my lunch, by the financial institution, somewhere there's a good restaurant around and I'm going to have my lunch there. Or it could mean, suppose if I am living in a city, which has lots of rivers and you know lakes or canal, so those kind of things and if I am telling you, okay, meet me at 4:00 and I'm going to have my lunch there, at you know by the bank. So, then you'll probably make up that. Okay? This guy is going to have lunch, by the riverside. Now, depending upon the context and the scenario, you will be able to interpret, which exact word or which exact meaning, of the word bank is what I am using. However sometimes the to have the potential to get, you know really mixed up and people will have difficulty in figuring out, what exactly is the bank that I am referring to? These kind of scenarios are called, 'Ambiguous Scenarios'. And this leads to a particular phenomena called, 'Lexical Ambiguity'. What is lexical ambiguity? Lexical ambiguity is, the case where the word, for one particular word you don't really definitely know, which is the meaning that is being used, remember the conversation, Humpty was having with Alice and where he said that all the words, you know can, mean, a variety of things, we have to choose which is to be the master of what, which is going to be the primary meaning, the one that I've intended. And that is something that will, kind of be very important for the communication.

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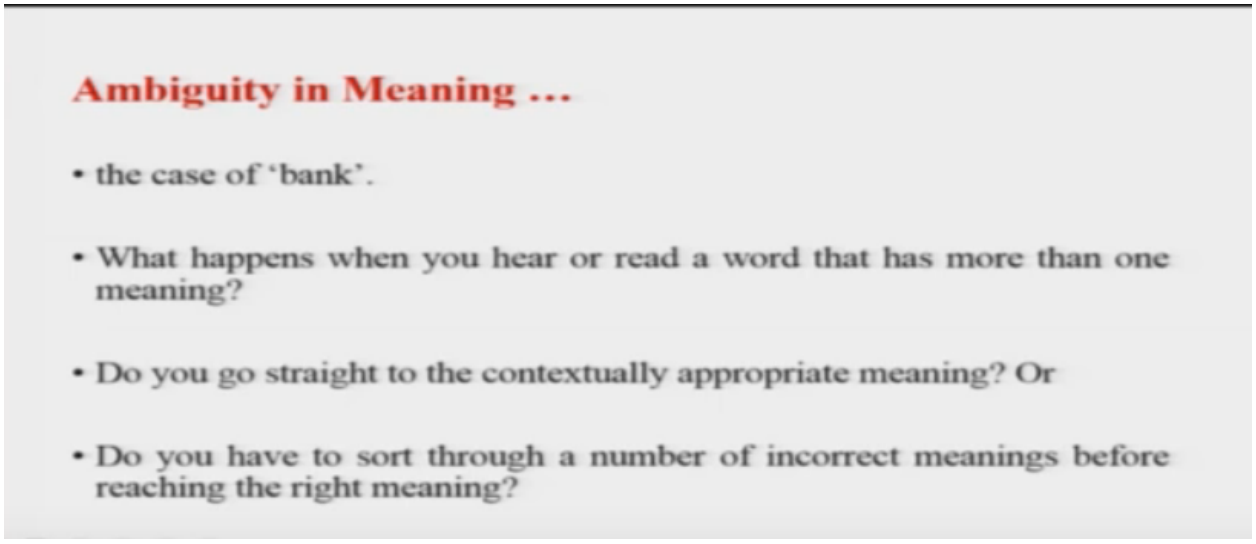

So, in these kinds of scenarios, we could ask a few questions. And questions could be like, say for example, what happens if you are hearing a word or reading a word that has more than one meaning? More specifically do we straight away, go to the contextually appropriate meaning? Okay? This is the meaning and you know there's no doubt, no conflict whatsoever or we have to sort through a number of different possible meanings and from those meanings, we basically select the correct and the most suitable meaning. So, there are two of these scenarios possible, in cases of you know lexical ambiguity.

And the resolution of this conflict basically has been referred to as, lexical ambiguity resolution. So let us see, there are two hypotheses that explain that. Okay? This is something that might happen, according to the exclusive access hypothesis.

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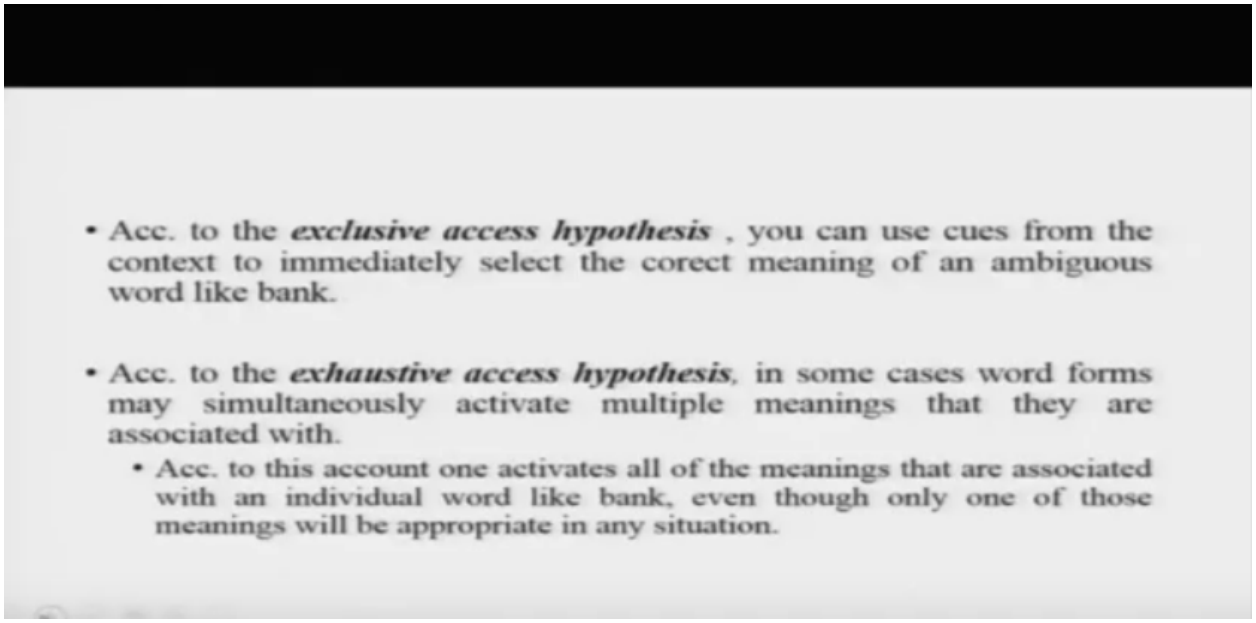

One can use cues from the environment, to immediately select the contextually appropriate meaning of the word and so there is, no room for any kind of conflict or confusion whatsoever. However, the exhaustive access hypothesis says that, in some cases word forms may simultaneously, activate multiple possible meanings and that they are associated with and that could lead to a lot of possible confusion, for the listener, as to which meaning or listener or the reader, as to which meaning is more appropriate in this given context or for this particular utterances. So, there are two of these hypothesis, you have to remember, the exclusive access hypothesis and exhaustive access hypothesis. Moving on, let's discuss one of the experiments that, we're in this was tested. So, these experiments these two hypothesis, competing hypotheses, were first tested, in Chinese experiment in 1979.

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Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other bugs in the corner of the room.

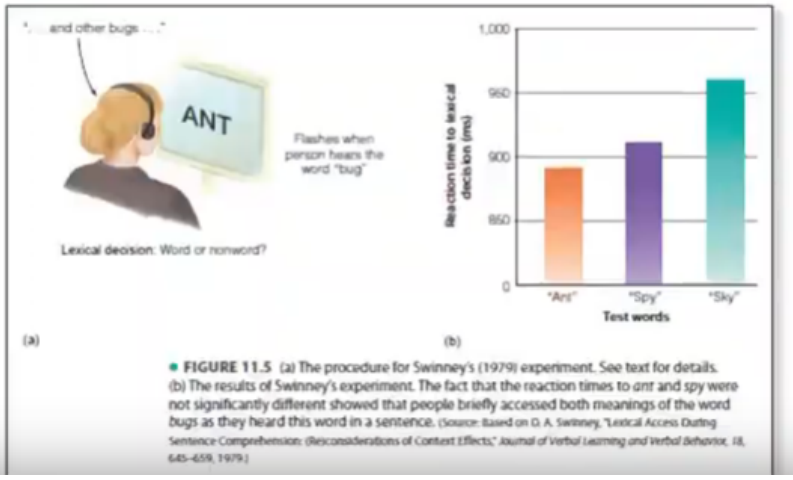

FIGURE 11.5 (a) The procedure for Swinney's (1979) experiment. See text for details. (b) The results of Swinney's experiment. The fact that the reaction times to *ant* and *spy* were not significantly different showed that people briefly accessed both meanings of the word *bugs* as they heard this word in a sentence. (Source: Based on D. A. Swinney, "Lexical Access During Sentence Comprehension: (Re)considerations of Context Effects," *Journal of Verbal Learning and Verbal Behavior, 18*, 645–659, 1979.)

And this was a very interesting setup, you have this word, utterances the participants are hearing in their headphones and on the same time, they are doing a lexical decision tasks, on the computer screen, wherein some target words are appearing. So, let me read out the sentence for you, rumor had it that for years the government building, had been plagued with problems, the man was not surprised, when he found several, spiders, roaches and other bugs, in the corner of the room. Now, the critical word here, in this utterance is the word bugs, bugs can stand for insects, so bug is an insect you know, so the word bugs can stand for many insects of that kind, that were found in the particular you know building. Or because, this is you know a government building, there is a possibility that somebody needs some you know, top-secret information and has put a bug, which is a spy listening device in that particular building. Now, there are two possible meanings of this word bug, one is the spy device and the other is that of insect. And basically, what was being tested in this experiment is, which of the two meanings are you know, activated by the listeners. So, what they did was while the participants were listening this in their headphones, they actually presented words, some which could you know, align with the meaning of bugs that is insects and others which could align with the meaning that is spy device. And the participants basically had to just take word or non word lexical decisions, while they were hearing this and the words will basically come, very closely aligned to the word bugs in the utterance. So for example, they showed that one of the meanings, was the word and you can see the graph here and the other meaning was the word spy and an unrelated thing is sky. you see the spy is and the word aunt is much faster, recognized as compared to the other two words, which probably could tell us that the insect related meaning was heavily activated and was probably dominating, most of the participants and this other meaning, spy device is also activated because, the word spy also receives a little bit of that facilitation. So it means, for us if you look at that both kinds of meanings, the insect meaning and the spy device meaning, have both been activated, in this particular scenario. Now, let us look at the sentence again and see how this could have happened? If you look at the sentence, if you look at this utterance, there is a particular local context to it and there's a particular global context to it. If I'm just reading this sentence, the man was not surprised, when he found several spiders, roaches and other bugs. Because, there is this mention of other insects, the insect meaning of bug, really gets a lot of support and really gets primed up. So there's no, you know surprise that, that is

one, that is receiving the most benefit. However, if you read or pay attention to the entire utterance, starting from rumor had it that for years, the government building had been plagued with problems? Because, we're talking about a government building and you know, you might have seen in so many movies, people you need secret information, out of the government buildings, it also kind of you know, creates a possibility for the more imaginative ones that the spy device meaning, could also be the one that is intended here. Alright. So, you see both meanings are getting activated, irrespective of the context sort of in this particular experiment, this result certainly favors, what is referred to as the exhaustive access hypothesis? So, this is something interesting.

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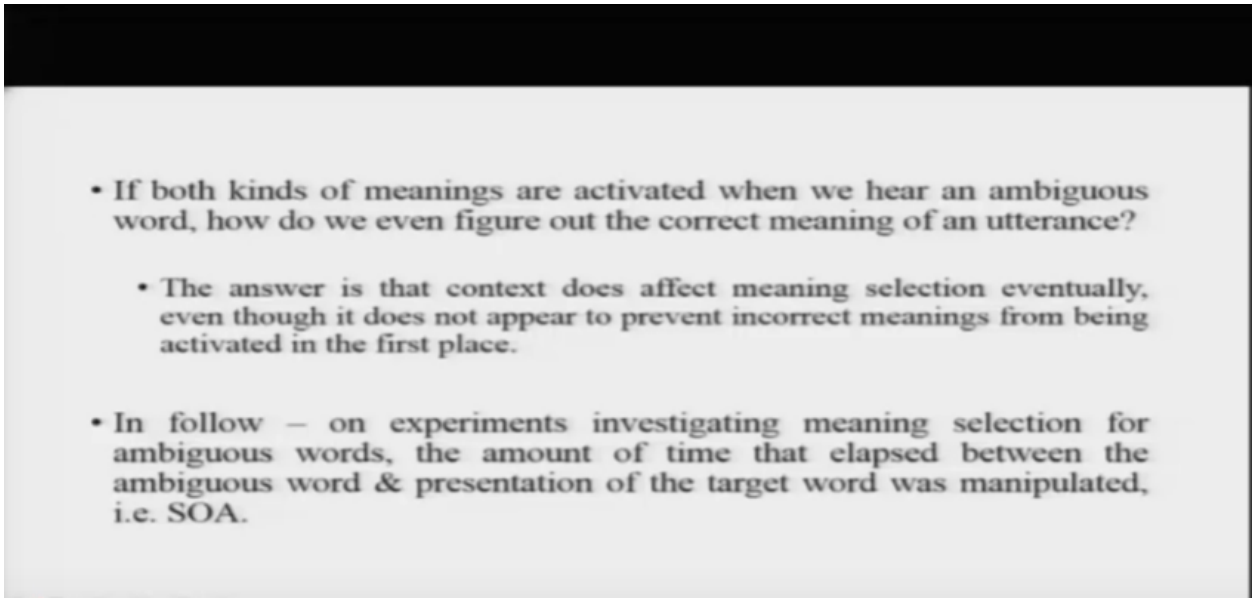

Now, if both kinds of meanings are getting activated, when we hear the ambiguous word, how do we even figure out, which is the correct meaning of the utterance? You know because, suppose this is happening all the time, as a listener. How do you react very quickly in you know, react according to the correct intended meaning, of a particular utterance. Now, the answer is that or that mostly context affects the meaning selection eventually. And even though, it is not really appear to rule out of the activation of competing meanings. But, for the most part, it already gives support, to the meaning that is appropriate to the context. So mostly you will not really be in trouble and you will be able to you know, really deliver as so, Okay. This is the actual meaning that was intended. In follow-up experiments, investigating meaning selection for ambiguous words, it is also we know so that the amount of time that elapses between the, utterance and the presentation of the target word ,now also affects, which of the meanings or whether both or just one of the conduction the appropriate meanings, will be activated.

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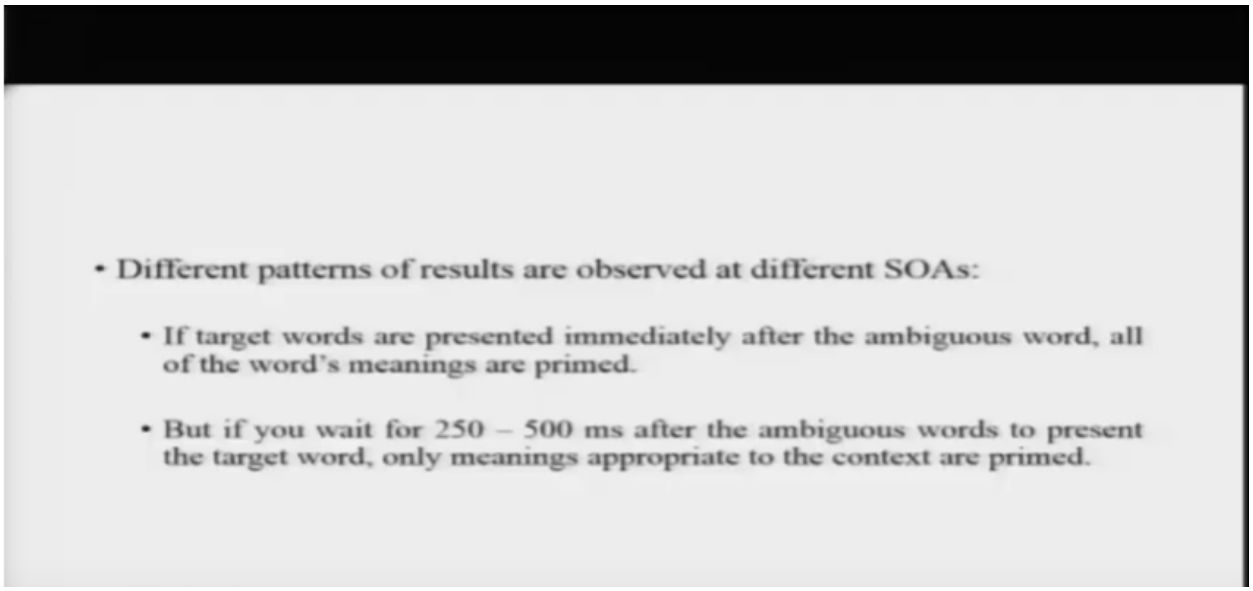

Let's look at that, different pattern of results are observed at different SOAs. And SOAs, basically similar onset, SOAs basically tells us that this was the prime word and this was the target word in time, the target word could be closer to the prime or it could be further off from the prime. And prime is the word bugs, basically you know in the last experiment. Now, if the target words were presented immediately after the ambiguous word, now it was found at, both of the meanings were necessarily activated. But, if you kind of wait for around 250 500, 250 to 500 milliseconds you know, in that time window, after the ambiguous words, you know and you present the target were, what 250 to 5 minutes after that biggest words, usually only the contextually appropriate meaning, showed up. Okay? So, it probably seems that within that time period of you know, 0.25, 2.50 seconds, the system kind of sorts, you know evaluates the other environment and settles down with the correct meaning. So ambiguity in fact, if it is happening is happening for a very, very short period of time. However, it is interesting for psycholinguist to look at, in what scenarios this is getting activated and what are the processes that we are using? What are the cues that we are using? To you know, achieve this lexical ambiguity resolution. Moving on, as I said, the control of context is very important, even before that let us discuss a little bit, as to you know, meaning dominance in case of these ambiguous words.

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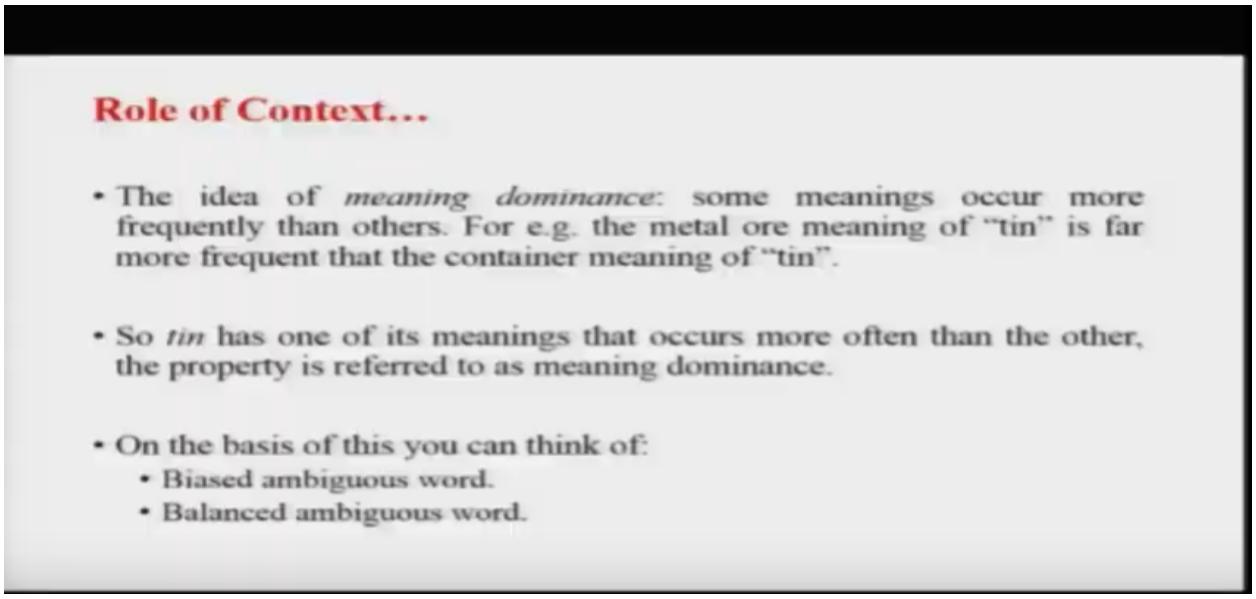

Now, the idea of meaning dominance is that, some meanings for particular words might, be the more dominant meaning. Say for example, if both meanings you know, have to occur with the word, one of these meanings could be occurring 80, 90 was another time and while the other one could be occurring only up to 10 to 15% of the time, the meaning that occurs, more number of times or is used much more commonly is, referred to as the dominant meaning. So, in the case of the word bank that I was discussing, the meaning that refers to the financial, institution etc., is probably the much more dominant meaning, as compared to the meaning with respect to then, the riverside. At least especially in you know, if you're living in the cities and you're not really, your general conversation, does not really involve going around banks etc. Okay? So, this is this concept of meaning dominance. And on the basis of meaning dominance, basically what you can do is? You can divide the ambiguous words, into two varieties. One of them could be biased ambiguous words, wherein there is one meaning which is particularly dominant and balanced ambiguous words, where neither of the meanings are particularly dominant and they're both sort of, have an equal probability of getting activated or getting used at any point in time. So, this is one thing that I would like you to remember.

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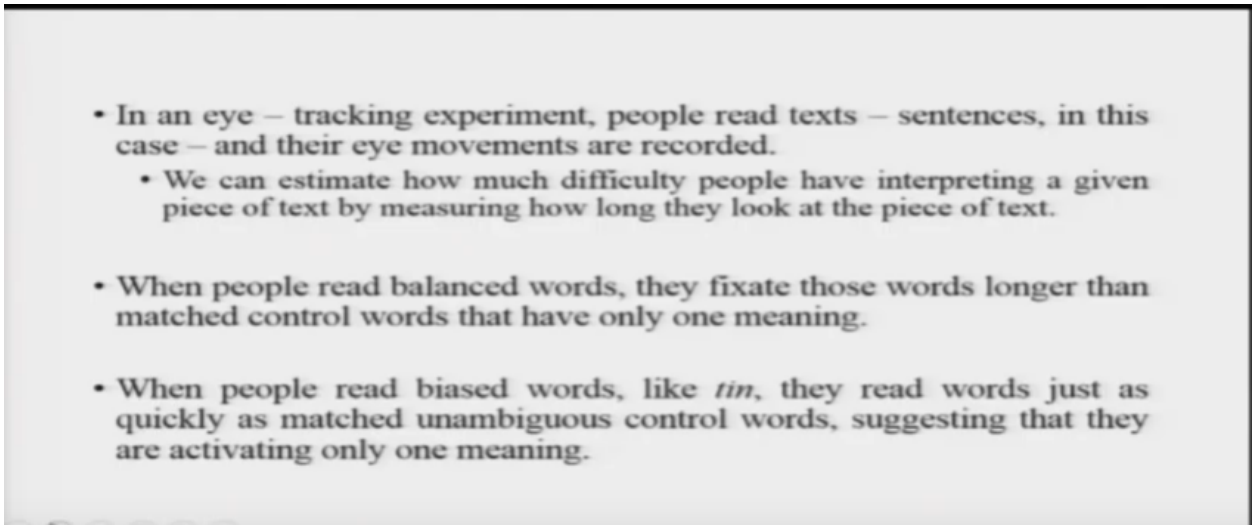

And people kind of did some of the experiments to check this out and how this really works, so in an eye-tracking experiment, what happens were that people read text, the sentences that is and their eye movements, while they were reading those texts were recorded. What did they find? They find that when people were reading balance words, they fixated on those words slightly longer, as compared to when they were rereading biased ambiguous words. What should this tell us this probably tells us that people were spending a little bit more time, deriving meaning out of the balanced ambiguous words, as compared to deriving meaning out of the biased and ministers, because they already have one meaning, which is easy to interpret? Now, this is this but say for example, if context starts interacting with whether a word is balanced or you know, bias that also could lead to an interesting scenario.

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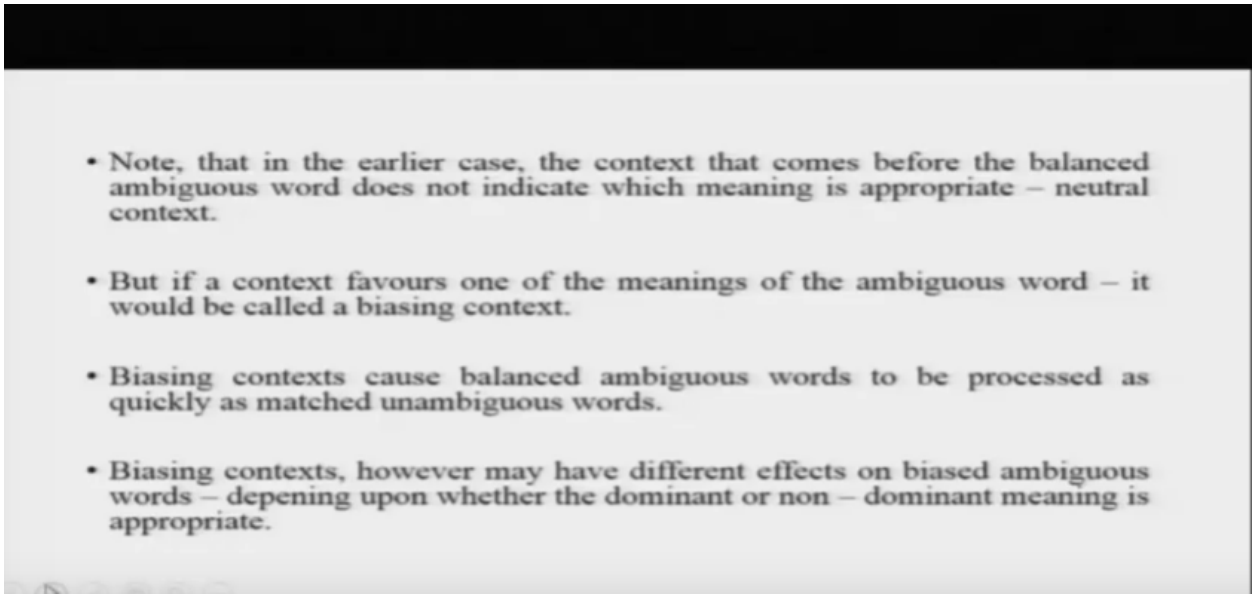

So for example, you could have a neutral context, which kind of does not really help out any of the two meanings or you could have a biasing context, which could help, only one particular meaning of the

ambiguous word, suppose the conversation is going on, about money and you know shares and all those kind of financial instruments. And then, the word man figures up. Okay? Then, obviously you know the context is helping the financial institution meaning of the word. Or say for example, if the you know talk is about a picnic where, somebody is gone you know in the countryside and you know, they just talk of valleys and rivers and you know whatnot, then maybe the context should be ballet, should be favoring the river side meaning of the word bank. So, they depending upon, how the context is, the context can interact with whether a word is balanced ambiguous word or a biased nebulous words. Now, these biasing contexts have been found, to cause balance ambiguous words to be processed, as quickly as the, unambiguous words. So for example, if there is some help from the context, you will be able to read the balance ambiguous words, almost as quickly, as the unambiguous words. Because, both factors are if probably you know, pointing towards the same meaning, it becomes much easier for the, person to resolve the ambiguity here. Biasing context-aware, may have different effects on balanced ambiguous words, depending upon whether they are dominant or non dominant meaning is being supported, suppose in a biasing context, the non dominant meaning is supported then what do you expect, I would say that probably you know, the two effects will interact and probably lead to a very interesting reaction time profile, wherein you could see some costs, of this interaction with context, alright. So or maybe did a non balance meaning, kind of can you know, b-prime in such a way that it dupes the non dominant and dupes the dominant meaning, at least for that particular scenario.

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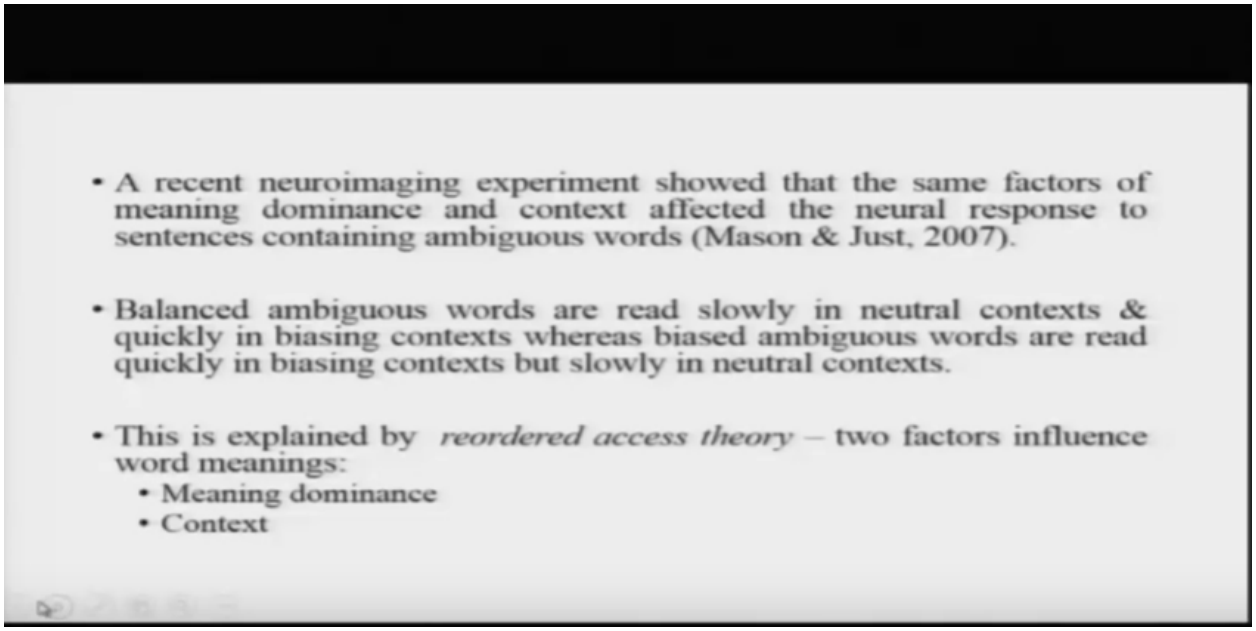

Now, they did this Neuroimaging experiment and showed that some factors of meaning dominance and you know context, differentially affected the neural response to sentences, containing ambiguous words. So, you can see that, there are differential effects, at the level of the brain, with respect to whether the context is biasing or neutral or whether the ambiguous word is biased or balanced. what they define, we find it balanced and because words are read slowly in neutral contexts, quickly in biasing context ,where bias ambiguous words are quicker, whereas bias and bearish words are read quickly, I sing context but slowly, in neutral context. So, this is obviously I think it's intuitively expected, if balanced our biggest

word gets helps from the context, it will aid fastly, if it is not helped by the event that it will get read you know, slowly on the other hand the bias and biggest worst, again rate can also be read quickly in biasing context, when the meaning is supported, Dominance meaning is supported and they will be read slowly, in a neutral context. Okay? So, this is, this is something that, has to be taken into account. On the basis of this very interesting interaction, between the you know the context and whether the ambience word is balanced or biased, they've come up with a new theory, which is basically called a, 'Reordered Access Theory'. And the reordered access theory basically says that, both factors should affect the kind of word, you know meanings that, you will make out of these words and the context and two variables are meaning dominance and context. Okay? So, both of these will interact to actually tell you, which meaning is you know, more activated at this particular scenario. Okay? So, this is about ambiguity resolution, let me move to the next section of today's talk. And we are now going to talk, a little bit about,' Neural Basis of Lexical Access'.

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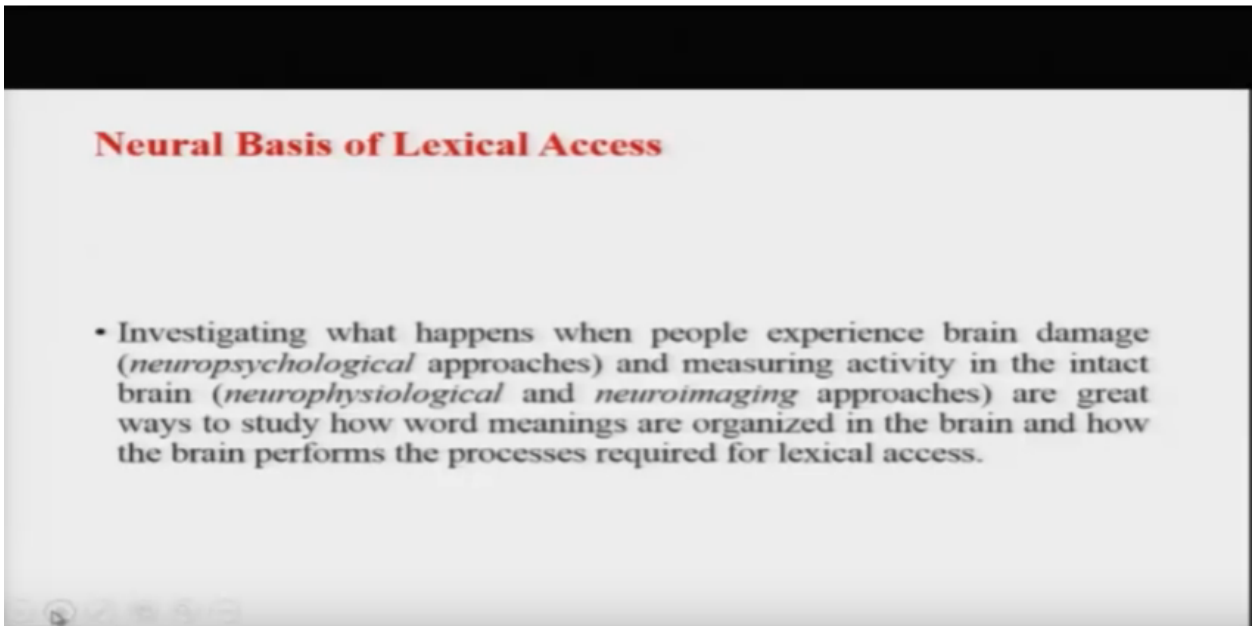

We've talked a little bit about in lexical access; we've talked actually quite a lot about lexical access, which is what? Lexical access is how do you reach the word form, how do you access the word form, in the you know in your semantic system in your memory system. And what we're going to talk about today is, how easy or difficult it could be, to access this word from, nearly at the level of the brain .Okay? Now, this to start this topic, mostly what has been found is when people experience brain damage, neuropsychological studies and when you measure the activity in the intact brain that is, normally cognitive neuroscience, neurophysiology in your Neuroimaging approaches, offer a great way, to study how word meanings are organized in the brain, say for example, for a normal brain you kind of you know, almost are interacting with a sort of opaque system, you don't know what led to this particular output. But, say for example, if you're you know looking at particular patterns, in you know people who have, unfortunate brain damage or some kind of you know, brain injury, lesions and strokes and whatnot that kind of you know sometimes can lead to very interesting patterns and those interesting patterns, could tell

you that. Okay? If this area of the brain is damaged, this is the kind of meaning deficit that is being experienced. So, maybe this area has something to do with that aspect of meaning, this is the deduction that, you know psychologists or neuropsychologist, cognitive neuroscientists, hope to take out of these kinds of studies. So we look at, we look at different kinds of studies here.

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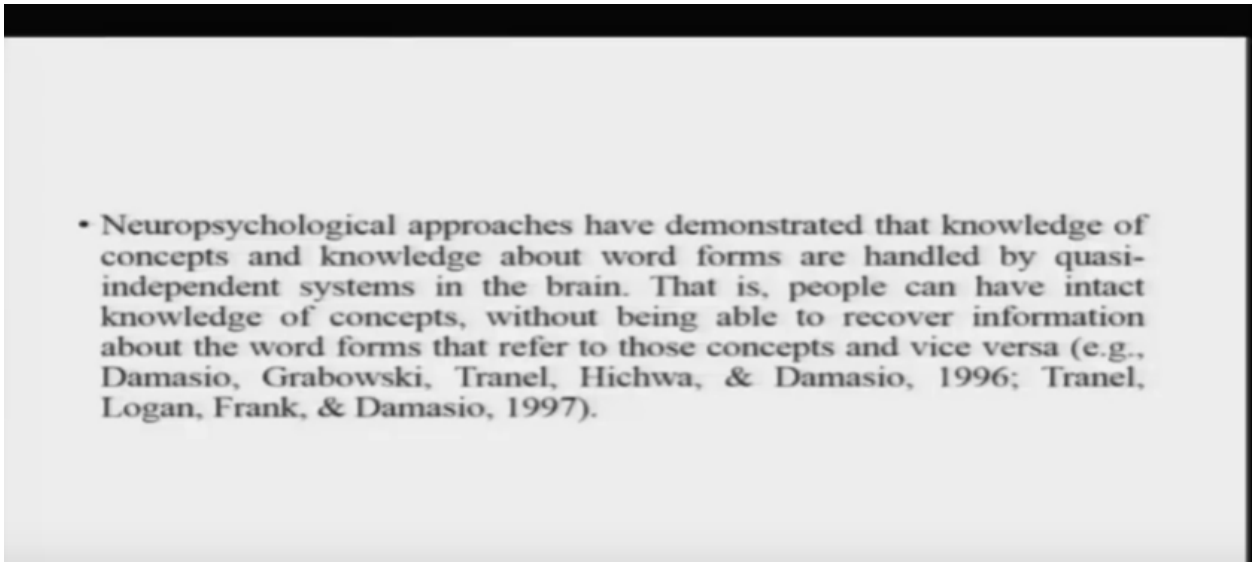

Now, neuropsychological approaches, have demonstrated that knowledge of concepts and the knowledge of word forms are sort of handled by quasi independent systems in the brain. So, you might the semantic part, the knowledge about a particular concept. Say for example, whether this pen is used for writing or something, something, something is separately stored as compared to, the word form pen. Okay? So, this is, this is the distinction that, neuropsychological approaches, have you know showed us. So, just summarizing that, so people can have intact knowledge of concepts, without being able to recover information about the word forms that refer to those concepts and vice versa. So, there could be some people, who cannot really name an object, when you show it to them. But, they can tell you, how the object is used, what are its dimensions shape color uses or whatnot. Okay? There could be other kinds of patients, who will basically be able to name them appropriately, but if you ask them some knowledge about, these objects, they will probably not be able to do that. So, this kind of dissociation exists and this kind of dissociation tells us that, apparently and you know, these two kinds of information are stored separately, in the human brain.

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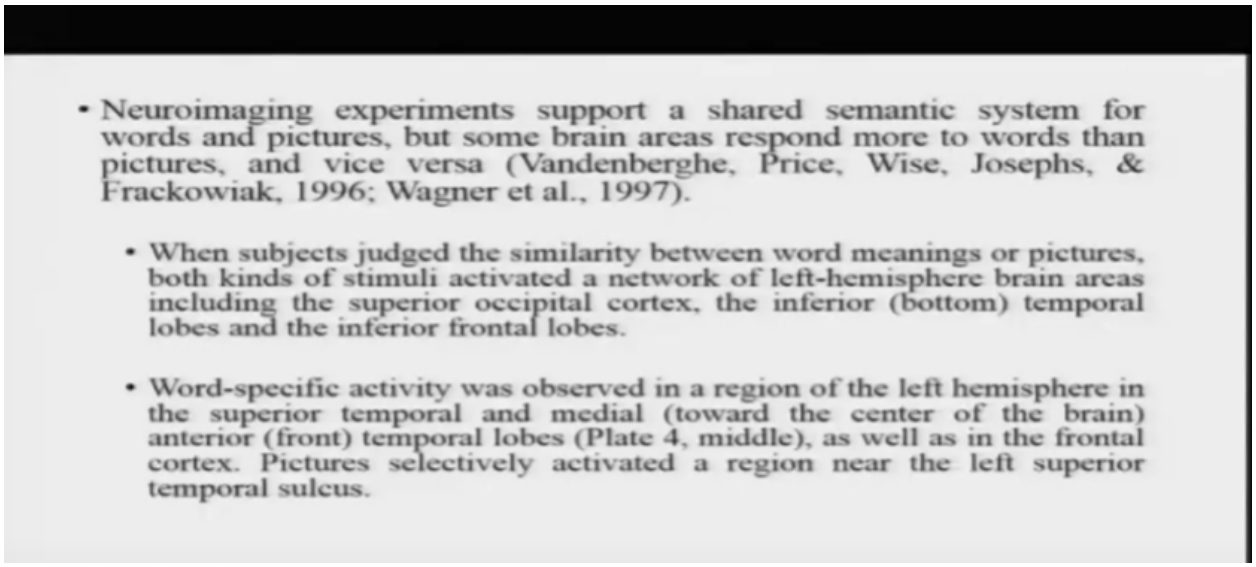

Moving on, Neuroimaging experiments they also kind of support the sort of an interesting idea. And they, support a shared semantic system, for words and pictures, but some brain areas have been shown to respond more to words, than to pictures and vice-versa. So, they say that because accessing words or accessing you know pictures is, sort of very similar, the only true way, the only problem is that the route is slightly different. Obviously you also have to do a little bit of a visual analysis with words, you have to do visual analysis to look at what the picture is and then it directly goes to the conceptual store, with words we'll probably do the visual analysis, reach the sound or phonological representation and then reach to the conceptual so, so there is a little bit of a difference. But, say for example, it has also been shown that some areas of the building respond, more to words, while some other areas of the brain respond more to pictures .So that is, that has been said. And this kind of happens across different kinds of tasks, so for example, when subjects were asked to judge the similarity, between word meanings or different kinds of pictures, both kinds of stimuli were found to activate, a network of left hemisphere brain areas, especially the superior occipital cortex, the inferior temporal lobes and the inferior frontal lobes. So, these are the areas in the brain that were found to be activated. Now, a word specific activity was also however, word specific activity, activity only specific to words, were observed in the region of the left hemisphere, in this near the superior temporal and the medial areas and the anterior temporal lobes, as well as, also in the frontal cortex. Pictures however selectively, activated a region near the left superior temporal sulcus. So, you see there is a sort of a distinction between, where words creating brain activity, versus where pictures are creating great activity.

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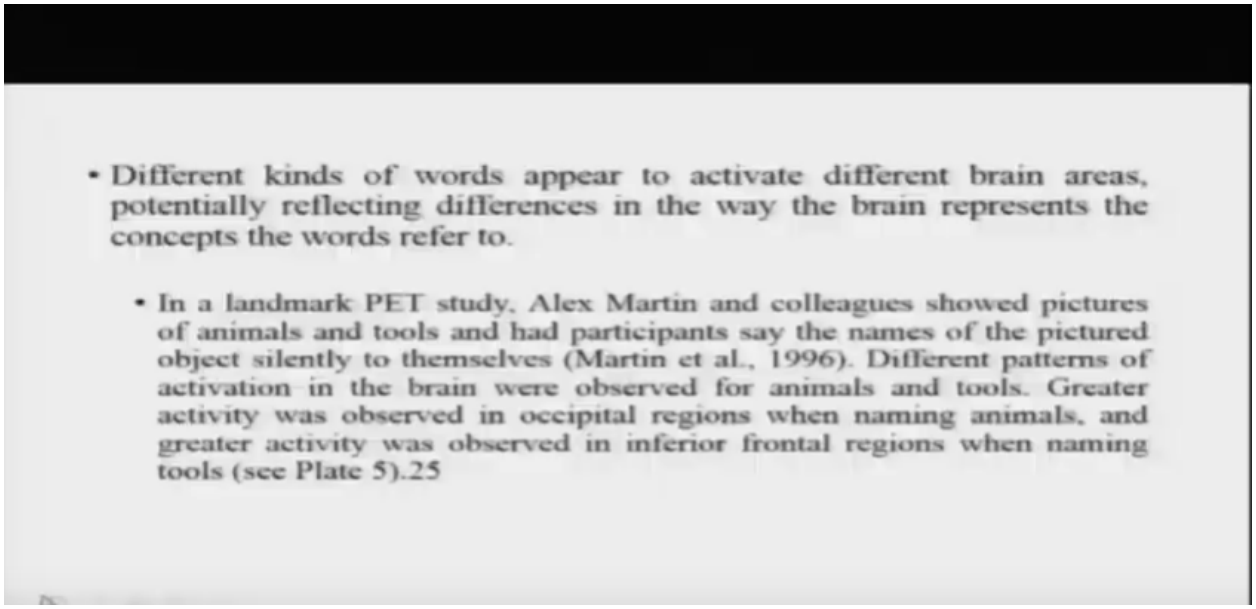

Also different kinds of words, appeared to activate different areas of the brain potentially reflecting differences, in their meaning, you know there and basically are telling is that you know, if the word means these kind of things, these areas will be recruited, if the word means these kind of things, these areas will be recruited. Okay? And every interesting example was Alex Martin study, where in they showed pictures of animals and tools and had parchments say the names of this pictured objects, silently to themselves. So, the task is that a screen a particular picture will come and then another will come, in there we come and you just have to name, the picture silently. So, a picture of a dog came and you in your head said dog and then you said, so for me it's, it's not audible; it's just silently to themselves. Now, what happens is what they find is, different patterns of activation in the brain, were observed for animals and tools and graded activity was observed in the occipital regions, when people were naming animals and graded activity was observed, in inferior frontal regions ,when they were naming tools. Now, why does this differential activity, actually emerge, you have to really look at, what is a particular concept. And a particular concept by nature of itself, we you know activate particular kinds of meanings and sorry, will activate particles of brain areas, as opposed to you know, a specific set of it. Say for example, animals there is a lot of analysis, of visual formats a ect, you know, you probably need to do and that's why the occipital regions, probably get activated more, whereas tools there is a lot of aspect of action related to them. So, the inferior frontal is the you know area and the motor cortex, which probably you know, seems to get primed of whenever you're talking about tools, like you know a hammer axes or those kind of things.

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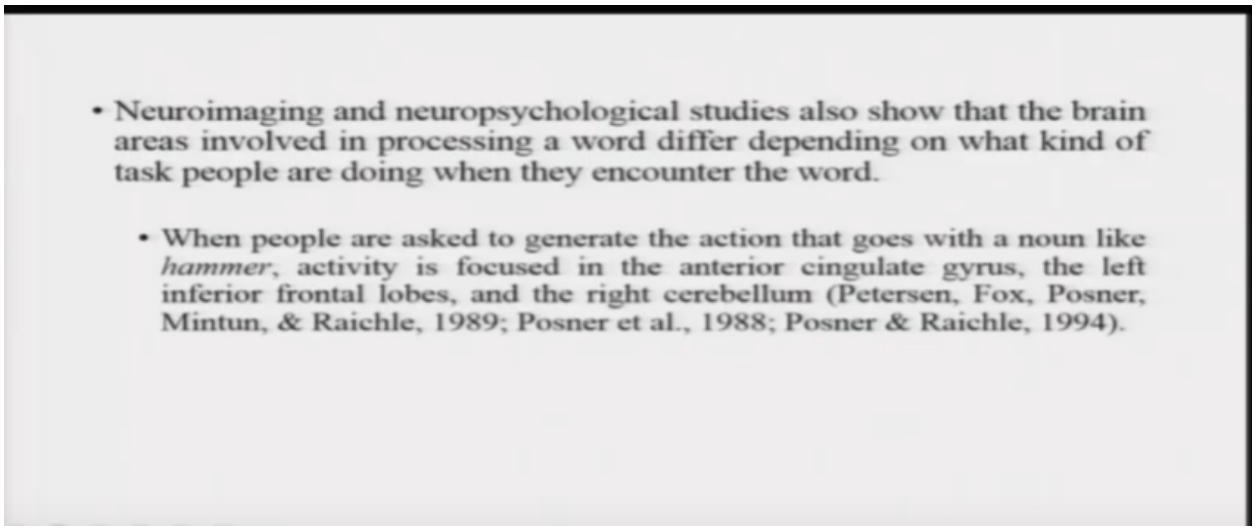

Neuroimaging and neuropsychological approaches, both have shown that brain areas, involved in processing of word, basically depend upon what kind of tasks people are doing, it also not only depends on the kind of concepts, people are talking about. But, also the kind of tasks people are doing with that concept. Say for example, when people were asked to generate, the action that goes on with a noun like a hammer, activity is found to be focused in the anterior cingulated gyrus, the left in here inferior frontal lobes and the right cerebellum. If they were mainly asked to just recognize or do something else, up hopefully you know certain different areas of the brain, would have shown, activation.

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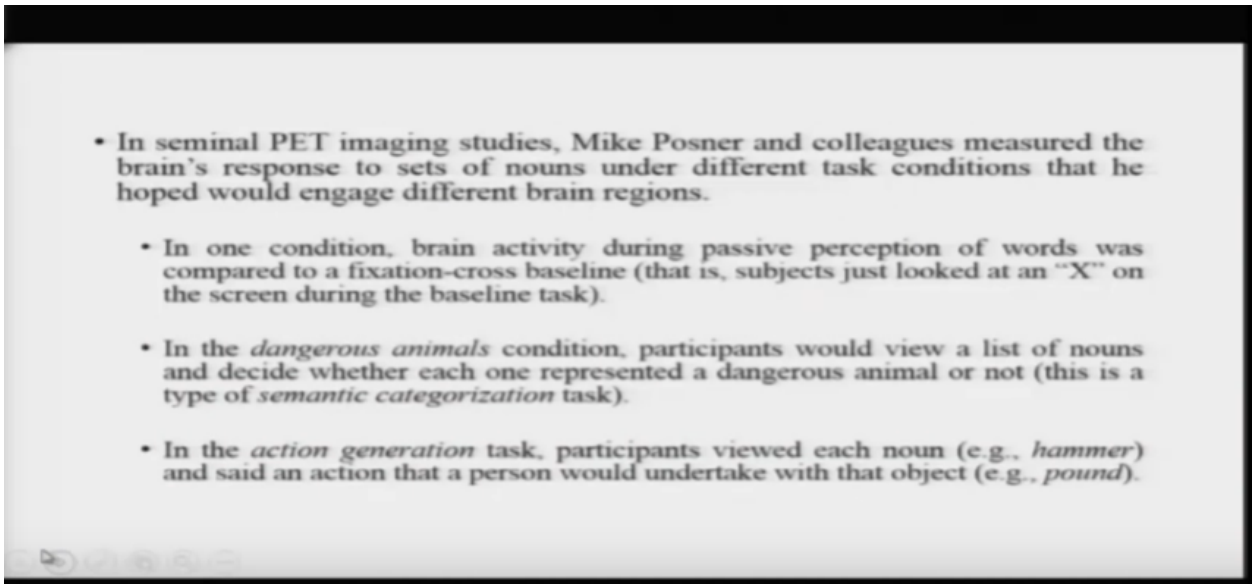

Now, let's take a few examples, in a Seminole PET study. PET is basically positron emission tomography, it's a simple mirror imaging technique, whereas radioactive isotope is injected in the person's, bloodstream and that radioactive isotope reaches the brain and the assumption is that those areas of the brain are recruited for a particular task, blood flows, you know blood flow kind of goes there and that is

where this radioactive, I should have a move and what people can do is, they can track this radioactive isotope that gives you an idea of ,which areas of the brain are recruited for what kind of task. So, coming back in Seminole PET study, mike personal and colleagues they measure brains response, two sets of nouns, under different task conditions. So, it were all the, stimuli were all nouns, but there could be three kinds of tasks that people could be doing and expectation was that the three different kinds of tasks, will recruit the three different kinds of regions in the brain. Let us look at that more closely now, in one of the conditions, brain activity was measured during passive perception of words, as compared to fixation cross baseline. So, in one screen there's s fixation and you're measuring brain activity, on the other screen instead of the fixation the word is written and the person just has to read the word and rate activity is measured, nothing, nothing really actively apartment is doing here, there's another condition in the, dangerous animals condition, parts we would view a list of nouns and decide, whether each one represented a dangerous animal or not. So, I could present you a list of nouns, some animals, some other things and this asks you, whether this particular noun, it represents a dangerous animal or not. This is sort of a semantic categorization task. Okay? And so, this is the second kind of task, the third task was the action generation task, you will be again presented with a you know, a bunch of nouns some of them tools and basically what you will be us, to do is that you know, what kind of a think about an action that you will do with this object, suppose I'm sure a picture of a scissor, you imagine cutting, if I show you a picture of a hammer, you imagine pounding a nail, if I show you a picture of an axe, you imagine cutting, so those kind of things.

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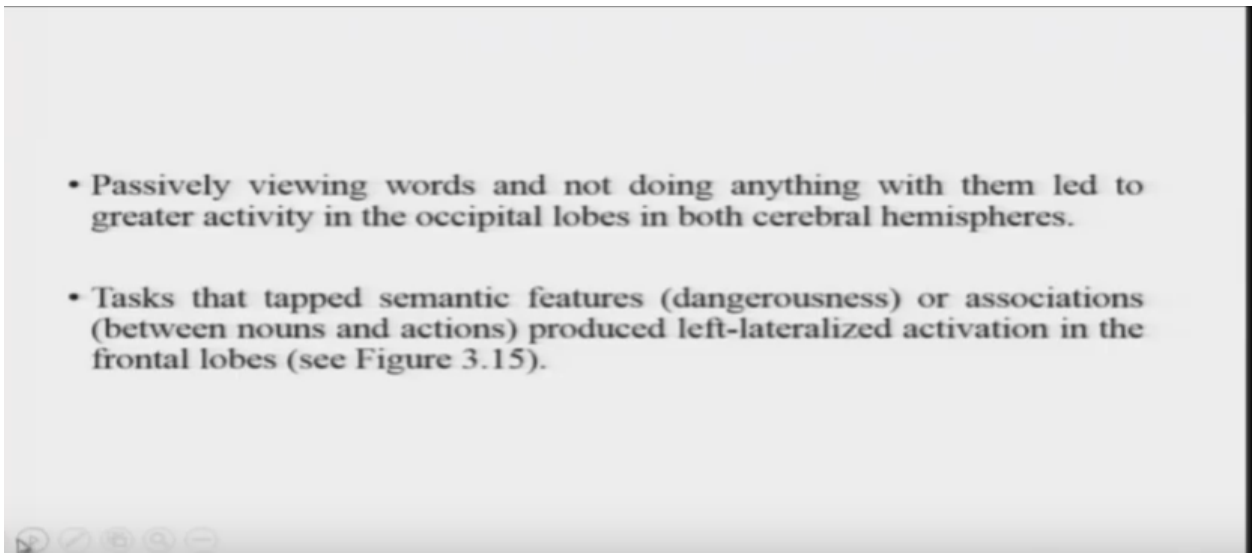

Now, what did they find they found that passively viewing words and not really doing anything about them, led to greater activity, mainly in the occipital lobes, in both the cerebral hemispheres? Tasks that is a tabbed semantic features that is dangerous animal tasks and basically it produced left lateral eyes activation in the frontal lobes.

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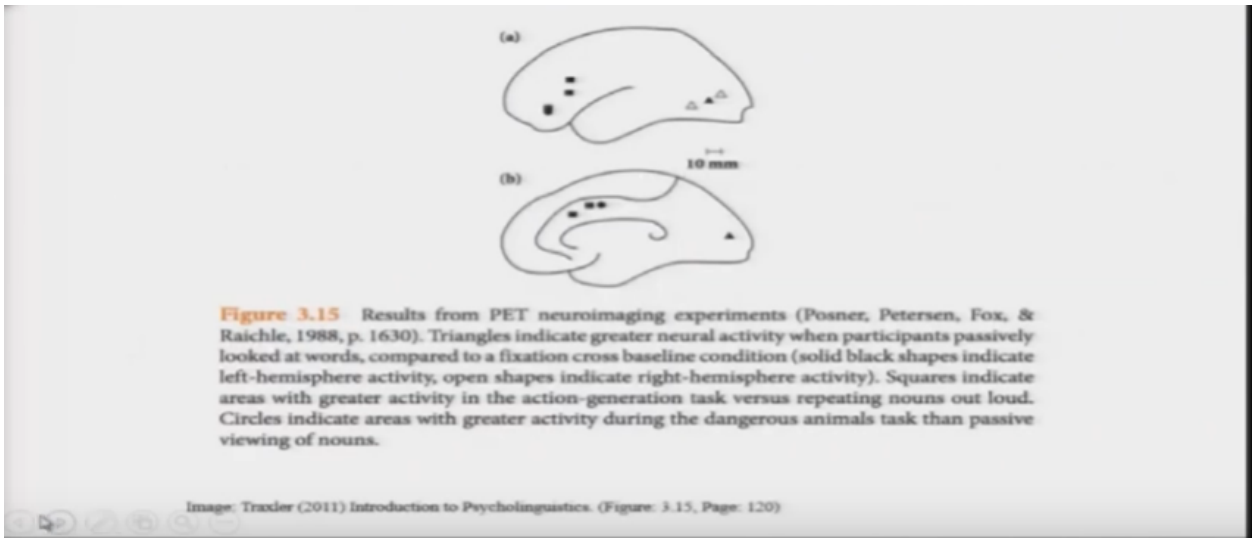

Figure 3.15 Results from PET neuroimaging experiments (Posner, Petersen, Fox, & Raichle, 1988, p. 1630). Triangles indicate greater neural activity when participants passively looked at words, compared to a fixation cross baseline condition (solid black shapes indicate left-hemisphere activity, open shapes indicate right-hemisphere activity). Squares indicate areas with greater activity in the action-generation task versus repeating nouns out loud. Circles indicate areas with greater activity during the dangerous animals task than passive viewing of nouns.

Image: Traxler (2011) Introduction to Psycholinguistics. (Figure: 3.15, Page: 120)

So this is happening in the second condition. So, here is the figure you can see that if you look at, the top thing, you'll see that there's triangles which is basically coming out of more neural activity, in the occipital lobes and then the squares are basically, where activity is happening in the action generation does, so you see the squares are basically in primarily in the motor cortex area and the circles are basically in the frontal kind of flow, basically you are talking about it's happening violet, really you're basically talking about the, dangerous animus condition. Okay?

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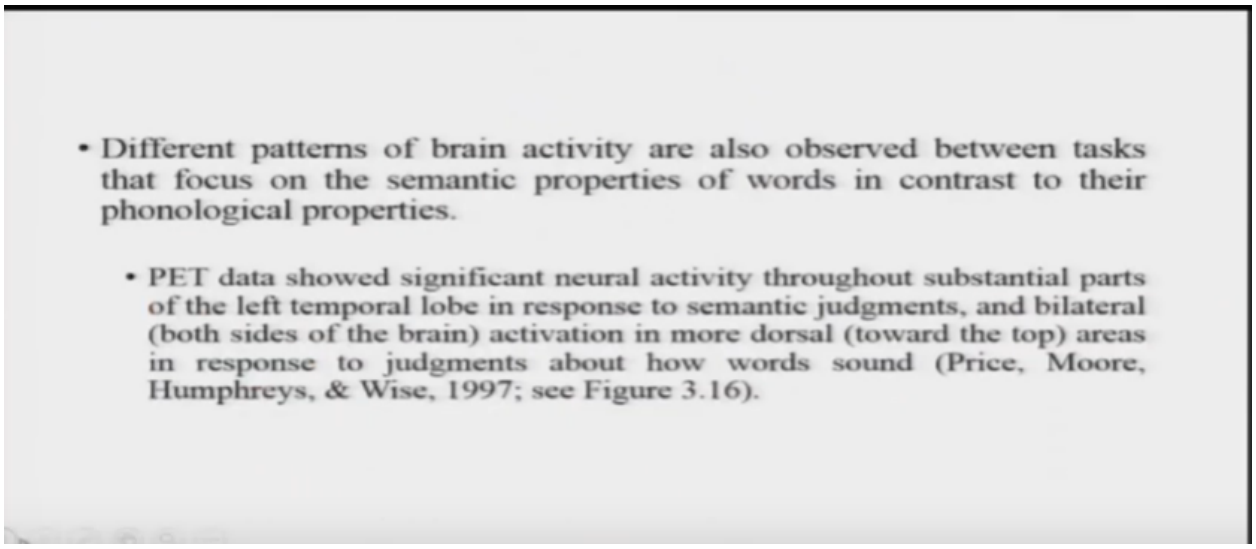

Also, in a different study, they found a different patterns of brain activity are is observed, between tasks that focus on the semantic properties of the words, in contrast to their phonological properties. So, in the last study we actually talked mainly about semantic properties, in this task we could either ask, participants to look at the phonological property ,whether their word rhymes, with this word or not or whether the word means this or not, you know the semantic versus phonological distinction. PET data showed, significant neural activity throughout the substantial parts of the left temporal lobe, in response

to semantic judgments, in by literally you know, activation and more dorsal areas in response to how words sound. So, activity in the left temporal lobe is happening and responsive semantic judgments and activity in the more dorsal areas, you know by literally is happening with respect to sounding. Okay? With respect to the sound of the word.

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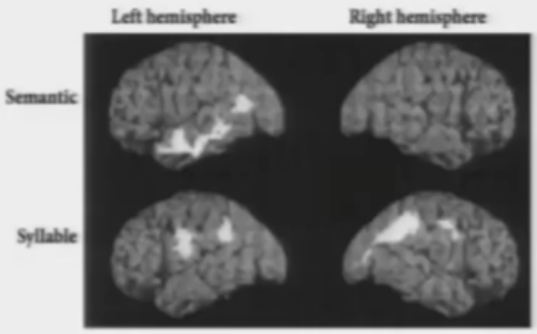

Figure 3.16 PET data showing the neural response to a semantic judgment task (top) and a phonological judgment task (bottom) (Price et al., 1997, p. 729)

So, here you can look at figure, again word from Traxler that, semantic judgments activate more of this area, in the left hemisphere where, our syllable judgments whether it is near the syllable rhymes with something or not, kind of is activating areas, both in the left and the right hemisphere and which is slightly more dorsal, to this.

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- Processing models assume a separate set of input representations for auditory and visual word processing (e.g., Coltheart et al., 2001; McClelland & Elman, 1986; McClelland & Rumelhart, 1981), and this division is reflected in different patterns of activity in spoken and visual word processing.
  - Auditory input more strongly activates Wernicke's area (near the junction of the occipital, temporal, and parietal lobes); and visual input may not activate this area at all (Howard et al., 1992; Petersen, Fox, Posner, Mintun, & Raichle, 1988).
  - Brain regions involved in auditory word processing include the superior temporal lobes bilaterally.

Now, there are several kinds of models that can, kind of you know try and explain the findings or wide such pattern of findings is emerging, one of the set of models could be referred to as, processing models. Processing models basically focus on, the process that is leading to this kind of you know activation being shown. So, processing models basically some of them, assume a separate set for input representations

from auditory and visual processing. So for example, they say that when you hear words, in the auditory input, versus when you read words that is you know visual input, could be, we could be, processed from different kinds of neuro neural circuits. And say for example, they say that auditory input more strongly would activate, something called the, 'Wernicke's Area', near the junction of the occipital, temporal, in the parietal lobes. And the visual input may not activate this area at all. Brain regions involved in auditory, you know were dressing, also would include the superior temporal lobes, by literally.

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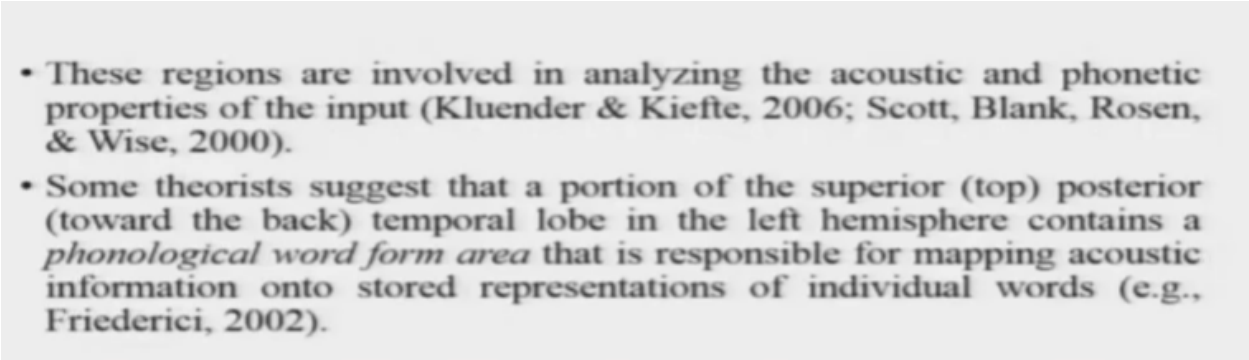

These regions, together are involved in the analyzing the acoustic and phonetic properties of the input. And some theories suggest that a portion of this you know, superior posterior temporal lobe in the left hemisphere, contains what is referred to as the phonological word form area. So, the area of the brain, near the superior posterior temporal lobe in the left hemisphere, basically is dedicatedly involved – you know, auditory word processing and that is why, it has been referred to, as the phonological word form area. And this phonological word form area is supposed to be, responsible for mapping acoustic information, to the stored representations of individual words. So, as soon as you hear word, the you know mode of access is the sound and this mode of access, you know primarily activates, the regions around the phonological word form area and connects them, to you know the other stored conceptual and other kinds of information.

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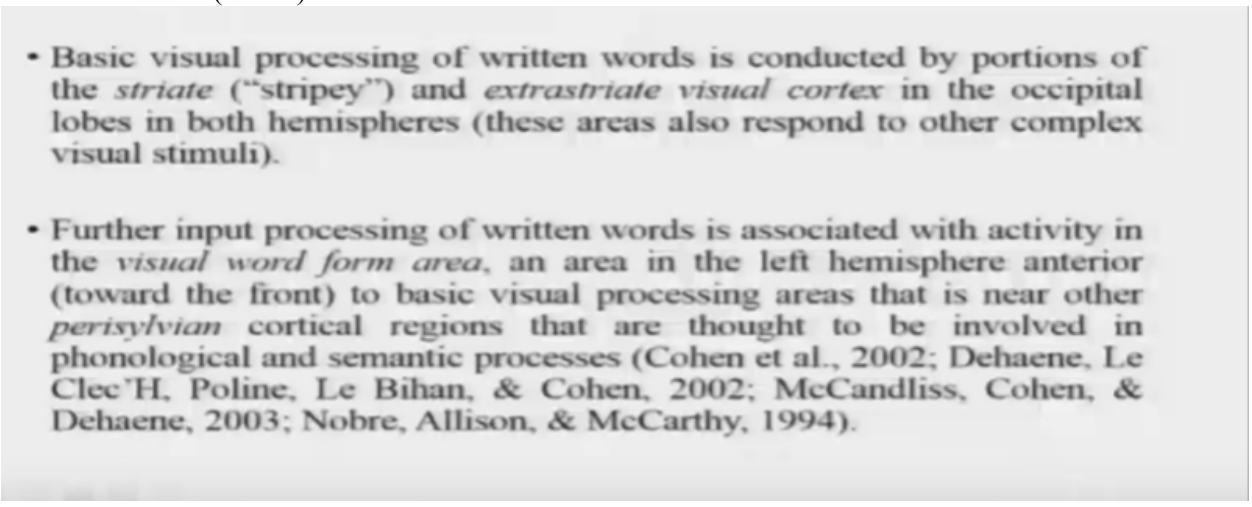

On in contrast, basic visual processing of written words you know, dealing with the script, how does the script really go about. Basically is conducted by portions of the straight cortex and the extra straight visual cortex, in the occipital lobes is something, it's the area at the back completely and this happens in the boat, in both the hemispheres. Also further processing of written words is associated, with activity in, what is referred to as the visual word form area and this area is in the left hemisphere anterior to, basic visual processing area, slightly further from the occipital lobes and that is near the, other perishable cortical regions, which are thought also bit to be involved slightly in the phonological and semantic processing. So, this visual program word form area is, probably something that will always get activated, whenever you are reading a word. Because, this particular area negotiates with the script, gets you the phonological representations and then later leads you to the conceptual, the properties of the words that you're dealing with.

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- This area responds to pronounceable letter strings, but not to spoken words or word-like stimuli; and it does not respond to complex visual stimuli other than words. Figure 3.17 displays the location of the visual word form area.27

So, this area has been shown to an unstable letter Strings, but not to spoken words over like stimuli. And it has been shown that, this area does not really respond to complex visual stimuli other than words. So, this could be the area of the brain that responds only to words, it rings which are pronounceable. And not to, say for example, either houses or faces or other kinds of you know, visual objects.

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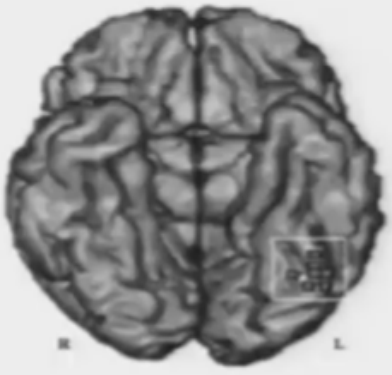

x = −42 y = −57 z = −15

Figure 3.17 The visual word form area (from Cohen et al., 2002, p. 1060). The left hemisphere appears on the right side of the figure.

So here you can see, the visual word form air you can see, on the left hemisphere there is this bunch of you know, stuff that is getting activate that is typically where the location of, the visual word form area has been found to be.

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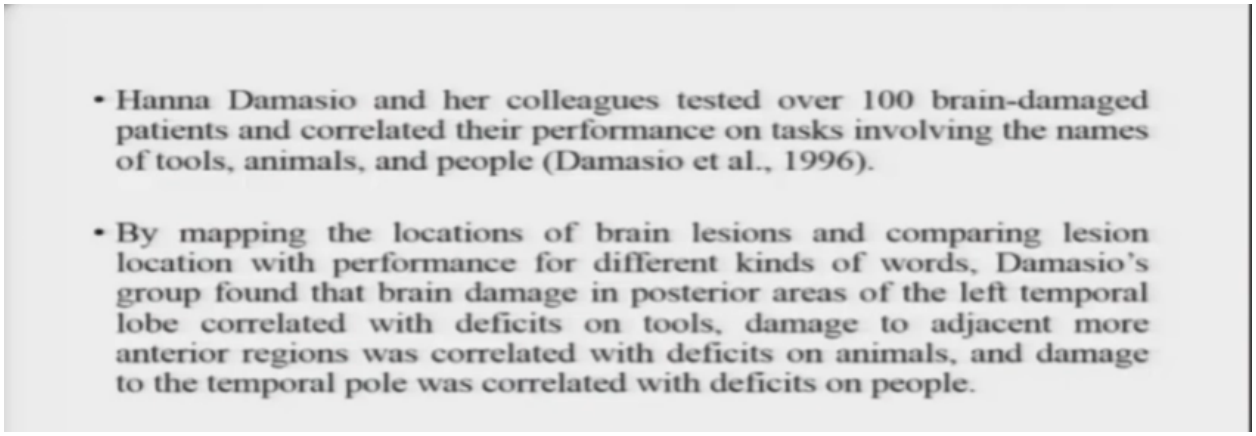

So, moving on Hannah Damasio and her colleagues, they were tried to test over hundred brain-damaged patients and they correlated their performance, on tasks involving the naming of tools, animals and people. By mapping locations of the brain lesions and comparing lesion location with performance to different kinds of words, what Damasio group found, was that brain damage in the posterior areas of the left temporal lobe, correlated with deficits to naming tools, damage to the adjacent more anterior regions in the same lobe, was correlated with deficits on animals and damage to the temporal Pole, basically was correlated with deficits to knowledge about people. Let's look at this a little bit more closely

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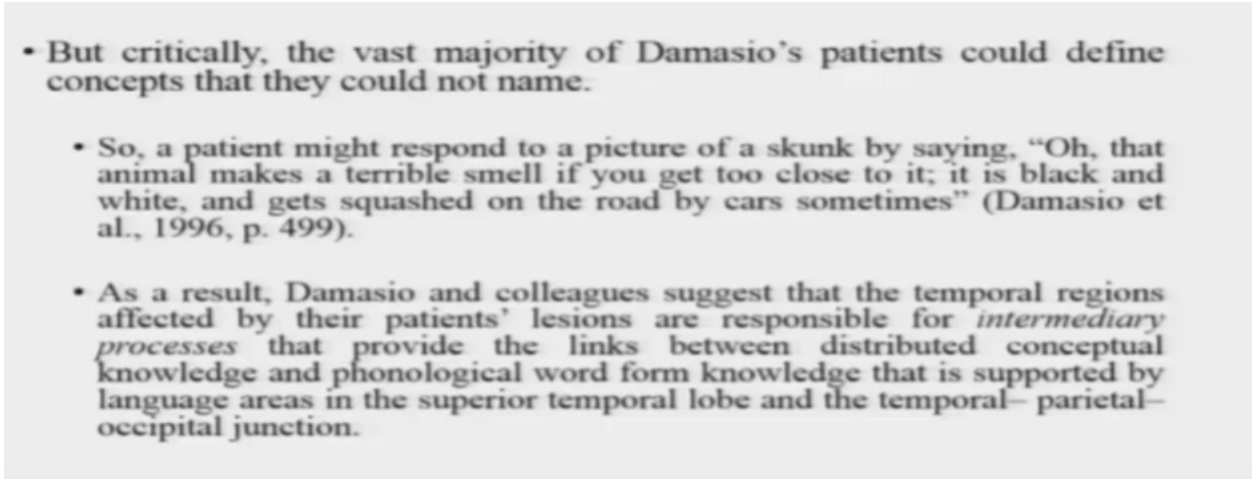

most critically, the vast majority of Damasio patients, could actually define the concepts that they could not name. so, the idea is even if there are deficits being observed, the deficits are limited to word form axis and not really the semantic information, they could define and talk about, the concepts that they were asked to name, but they could probably not name, these objects as well as normal individual would. So for example, a patient might respond to a picture of a skunk saying, oh that animal makes a terrible smell, if you, you know get too close to it, it is black and white and it gets squashed in the road by car someday, a skunk is a sort of a rodent animal that is commonly found in the United States, you can kind of you

know imagine, something very similar to a squirrel or something like, the actually slightly much larger than squirrel though. But, the idea is that you know about the concert, suppose I'm showing a picture for a cat, so you know something about the cat, but even though you're not being able to name, the word cat and you know name this you know, concept of cat. Okay? So, when they looked at the results, the Damasio and colleagues suggested that, temporal regions are affected and you know by the patient's lesions are responsible for this intermediary connection, between the word form information and the semantic information, about those concepts. And these intermediary processes are, those that typically provide the links, between distributed conceptual knowledge and phonological word for knowledge. So, conceptually as we said, when we began this discussion we said, that conceptual knowledge is probably being stored separately and word for knowledge whether this phonological or visual might be stored separately. So here, what they're finding out is that the temporal regions are being affected mostly are basically, being kind of found in as intermediary processes, between you know the phonological word form and the concept. Okay? Also, the they found that phonological word form knowledge is, probably supported by language areas, in the superior temporal lobe. And the temporal parietal occipital Junction, so there is this particular area of the brain.

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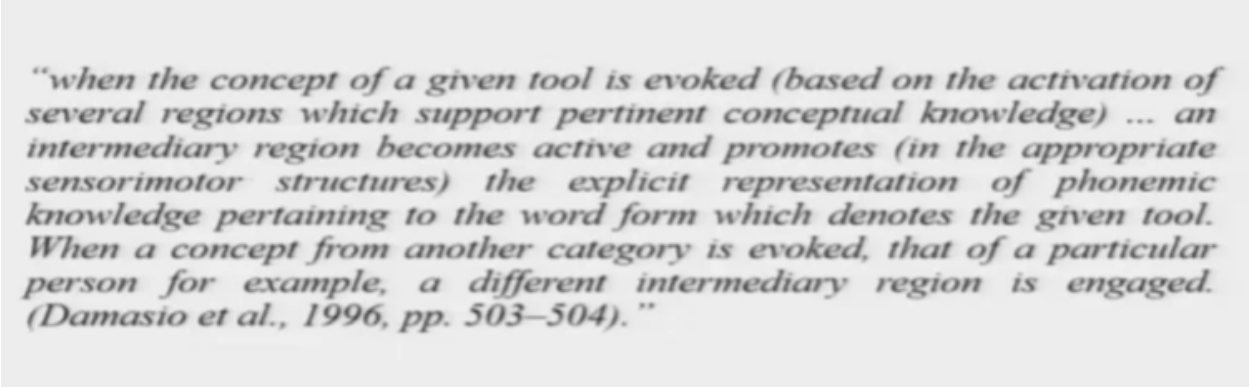

Now, this is something very interesting it's kind of gets started on, the neural basis of how lexical access might be happening. And at least there's one takeaway that you can you know, kind of conclude is that word form, related information is probably being stored separately, to information about the concept and about its meaning and so on. Okay? So, like to end today's talk by, reading out this quote from Damasio. Basically, coming out from that study and what they say is that 'When the concept of a given tool is evoked, based on the activation of several regions which support, pertinent separate knowledge, an intermediary region becomes active and promotes the explicit representation of phonemic knowledge, pertaining to the word form, which denotes the given tools. So, if I am saying hammered, there is this ham you know, him Andrew this is the phonological knowledge, which is associated with that tool, what that tool is and what that tool does is probably being stored separately. But, this knowledge needs to be linked with this so, so as to, make me named this whenever I want to. So, there is this set of intermediary process, which are connecting this phonological knowledge, with the conceptual knowledge about the tool. That is typically what the Damasio saying. So, this explicit representation of phonemic knowledge, putting the word form, which denotes the given tool. When a concept from another category is about that of a particular person for it example. A different intermediary region should be involved. So, tools for logical knowledge, different innovative process, people in a phonological knowledge, different imagery process and any other kind of concept different. So, the idea is that these different intermediary processes,

might be mediating the linkages between the world form and the semantic information, for different kinds of concepts. That is typically what you didn't take away, from this study or from them Damasio. And that should be all for today's talk and I will talk to you, something more about neural, basis of lexical organization in the next time. Thank you.