Advanced Cognitive Processes
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Lecture - 03
Knowledge –II

Hello everyone, welcome to the second lecture of the course introduction to advanced cognitive processes, I am doctor Ark Verma from IIT Kanpur. We are talking about language in this week and in the last lecture, we discussed a lot about what are concepts and how concepts help us categorize in the world. We talked about a couple of theories about how categorization is achieved, and how may this categorization help us organize our word into different blocks. Today I am taking one of those approaches, that says that concepts are arranged or organized in a particular manner in our brain or let us say you can think of this as a hypothetical network or a hypothetical organization, which may or may not be exactly the same as concepts as you have organized concepts in your brain. This approach is now referred to as the semantic networks approach.

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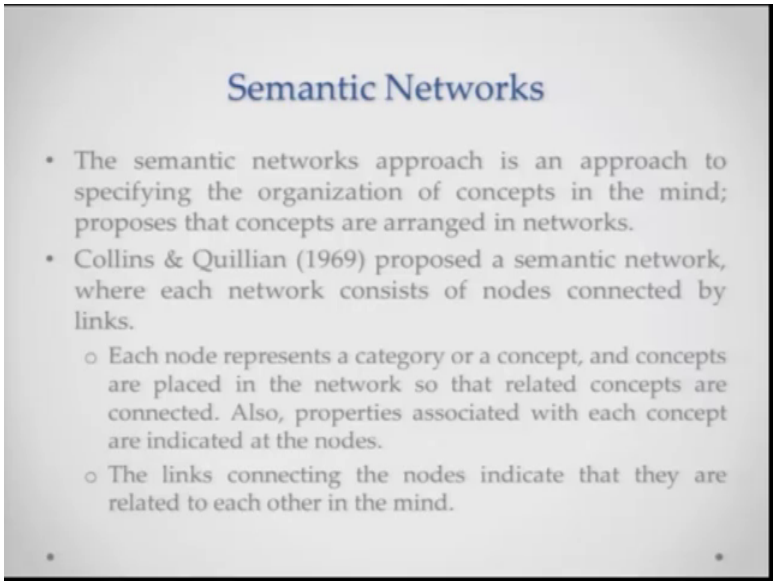

Now, the semantic networks approach is an approach that specifies how our concepts related and organized in the human brain; this was proposed by Collins in Quillian in 1969, and basically it is a system, wherein there are just seen as a network and in these networks, there are various nodes. Each node basically talks about a particular concept or

a category and different nodes within this network are linked by virtue of similarity in property or by virtue of relatedness say for example, a dog or a cat might be related to each other because both are pet animals.

So, this is again a brief description about this network, we will quickly see the examples and we talk about how these things are there. Now concepts or nodes in this network are linked by particular linkages, which is basically by virtue of their similarity or say for example, if they are related in the human brain.

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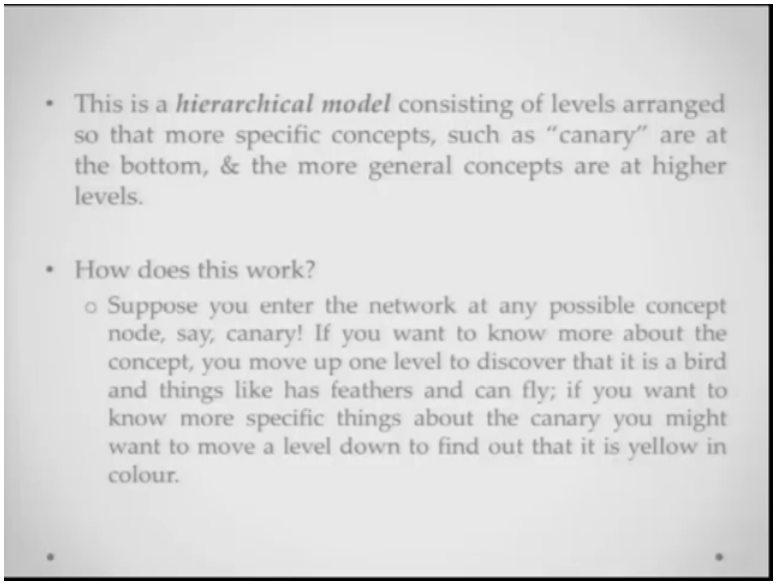

This is also a hierarchical model because it consists of levels arranged such that, specific concepts are at lower levels and more generic concepts are at higher levels. If I take an example of canary, canary is a generally at the bottom and more general concepts like that canary is a bird or that it is a living thing are higher up in the model. Now how does this model work?

Suppose you are entering such a network you know at any possible concept again because I talked about canary, let us enter this network at the word canary. If you want to know more about canary then you may go one level up, and you will discover that it is a bird and at the node itself the properties of the birds are dimension. Say for example, them they will be mentioned that it is it has feathers, it can fly, it has a beak etcetera etcetera. Also if you want to know about something very specific about the canary itself

you might jump one node below the node on canary, and you might come to know that it is yellow in color it sings a beautiful song things like that.

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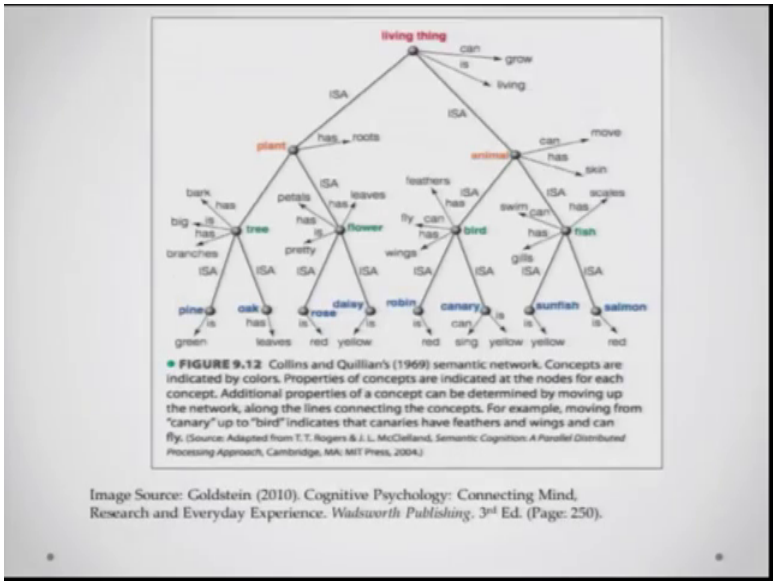

FIGURE 9.12 Collins and Quillian's (1969) semantic network. Concepts are indicated by colors. Properties of concepts are indicated at the nodes for each concept. Additional properties of a concept can be determined by moving up the network, along the lines connecting the concepts. For example, moving from "canary" up to "bird" indicates that canaries have feathers and wings and can fly. (Source: Adapted from T. T. Rogers & J. L. McClelland, *Semantic Cognition: A Parallel Distributed Processing Approach*, Cambridge, MA: MIT Press, 2004.)

Image Source: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research and Everyday Experience. *Wadsworth Publishing*. 3rd Ed. (Page: 250).

If you look at this network, this is the semantic network which was proposed by Collins and Quillian, you can see that there are at the top the most generic node that is of a living thing and the properties of a living thing are mention. Living things can grow, living things are living for that matter or they move around which is a probably not true in case of trees.

But again there is where it diverges; it diverges to two other slightly less general links like plants and animals, and again plants and animals are large families in itself. So, you see you can come down a little bit, where you have things like a bird and you have things like fish under animal, any of things like trees and flowers under plants. If you now go to these specific links, you will see the node of a bird has feathers, it has it can fly, it has wings. You will see that these links has have specific properties attached to them.

So, these links are basically relational links which express the properties of the node a bird has feathers. So, it is connected by the has link, a bird can fly. So, it is connected by the can link and the bird has wings. So, it is connected again by the has link. Also it is corrected on a more specific level by links which are like is. So, you have bird and then you have is a connection with canary, you might have is a connection with a robin or a sparrow. So, you can actually try and read it in a way that robin is bird, cannery is bird

something like that. Now you will see this network is fairly general though its fairly specific and informative as well. You can also see that both robin and canary are connected to each other in this network by virtue of this common link called bird. This is how exactly how this is exactly how concepts might be associated in our memories; when we talk about birds we can talk about all birds or most of the birds if somebody is asking us to let us say list you know list 10 birds, list 20 birds etcetera we will be able to recall the name of other birds, even if one exemplar of the bird category is given to us. This is pretty much what Collins and Quillian trying to simulate or trying to represent in their semantic networks model, let us learn a little bit more about this model now.

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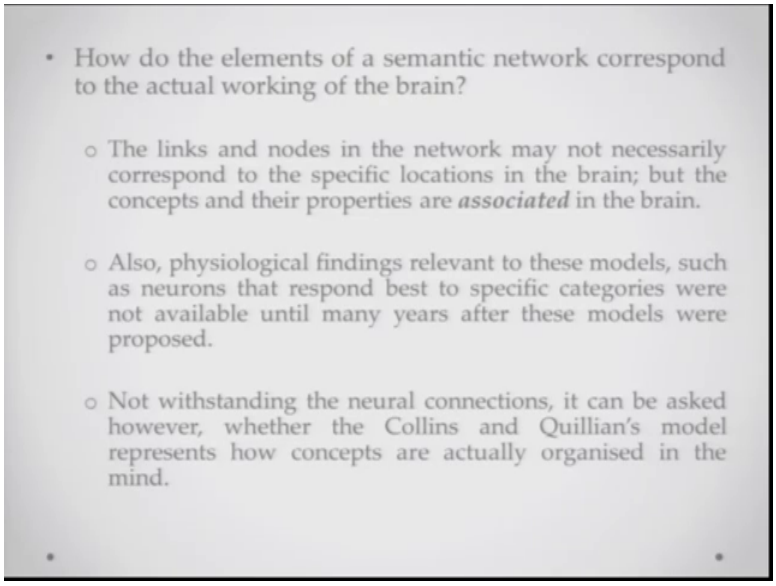

Now, how do these elements or how do the elements of these semantic networks correspond to the actual working of the brain you may ask. Now the links and nodes in this network may not necessarily correspond to specific locations in the brain. So, it is not exactly that this network is representing, how these concepts are connected in the brain, but they might actually represent they might actually prove analogical to the way these properties and these concepts are associated with each other in the brain; as I was again giving the example of the bird and the robin.

Now, bird and robin are both birds, and you can you know if you try and remember talk about them in pretty much the same way because they share other properties as well they have beaks feathers can fly etcetera. So, the semantic network kind strives to appropriate

these similarities and tries to represent these similarities in a way, that can be more easily understood by form of this particular network. Also and again this model was proposed a long time back, there has been of neuroscience research after this one has been proposed. So, there have been physiological models and physiological findings relevant to these models, people have found neurons that respond specifically to particular categories and not to other categories. Now these findings were not available at the time when Collins and Quilians had proposed the semantic networks theory; however, later evidences have in some cases supported and in some cases not supported their theory, as happens with most theoretical models in any science for example.

Now, not withstanding these neural connections or the lack of them, it can be asked however, whether the Collins and Quilians model actually represents how concepts are organized in the mind. We have a look at that as we move ahead.

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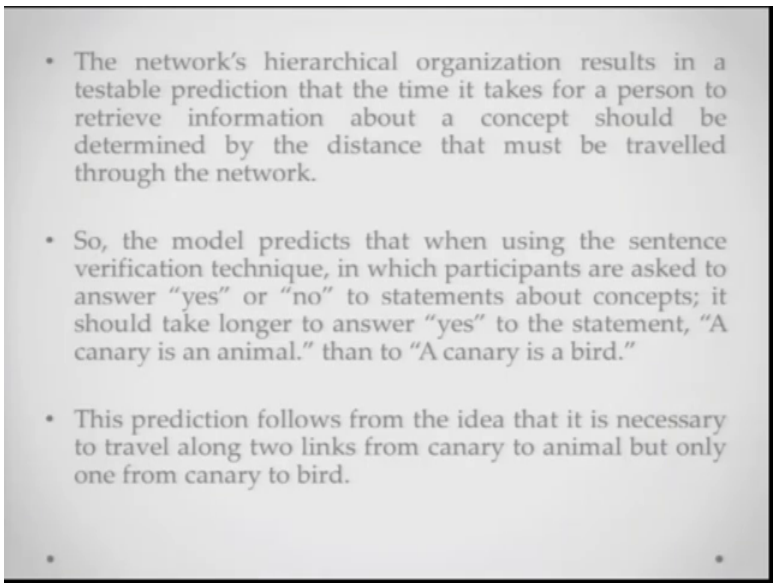

Now this networks hierarchical organization, it results in a very in a rather testable prediction that the time it takes for a person to retrieve information about a concept, could be determined by the distance you need to travel in this semantic network. So, the idea is if you want to test whether it takes more time to talk about a canary, you know that it can sing or something or they can take whether it should take more about more time to talk about whether a canary is a bird or a living thing. Now there is a particular

technique that researchers have used to test these kind of questions, and this technique is referred to as the sentence verification technique.

So, what they do in the sentence verification technique is that participants are asked to answer in yes or no to particular statements about these kind of concepts. You might be asked to say yes or no to the statement, a canary is a bird or a cannery is an animal or a canary can fly. So, you have to you know decide in yes or no to these particular statements, and different kinds of statements are tested and they are compared against each other and reaction times are noted down. The reaction times basically are informative of the fact that how many how much distance you had to travel in this network and the prediction is that, if you have to travel less distance you will be fast or the other way around; because you were fast it seems that you travels less distance in this semantic network.

Now, this prediction follows basically from the idea that it is necessary. So, again if I go to the question that whether canary is an animal, a canary is an annual yes or no a canary is a bird yes or no. Now again if you are comparing these two statements some people might think that it might be easier to respond to the fact that a canary is a bird, than to respond to the fact that canary is an animal. The idea here is or this prediction basically follows that it is necessary to travel two links from canary to animals. So, you go from canary to an to bird to animal in order to answer the first statement and you just have to go from a canary to a bird to answer the second statement.

So, the prediction of the Collins and Quilians model is that you will take less time to answer in yes or no to a canary is a bird versus a canary is an animal. If you look at this network here I think you will better understand what I am trying to say. So, if you see cannery is a linked to bird in just one way, and then there is a second link from bird to animal that you have to travel.

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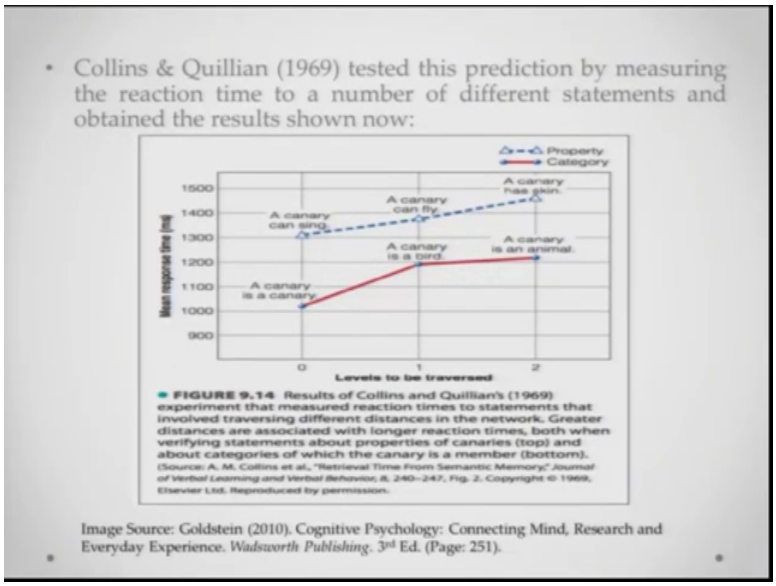

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So, this is pretty much what I was trying to tell here, this is exactly what Collins and Quillian actually found. So, they tested this particular prediction by measuring the reaction times, to a number of different statements and some of those statements are mentioned here. So, you can see a canary is the fastest among all, and then then is a canary is a bird and then the canary is an animal.

Here we are talking about categories you can also do a different kind of a test you can test for properties. So, a canary can sing verses the canary can fly versus canary has skin are also at different reaction times. But you can notice that a canary is a canary requires almost no distance travelling whatsoever. So, it is the fastest a canary is a bird requires one step, and a canaries animal requires two steps and is a accordingly slower.

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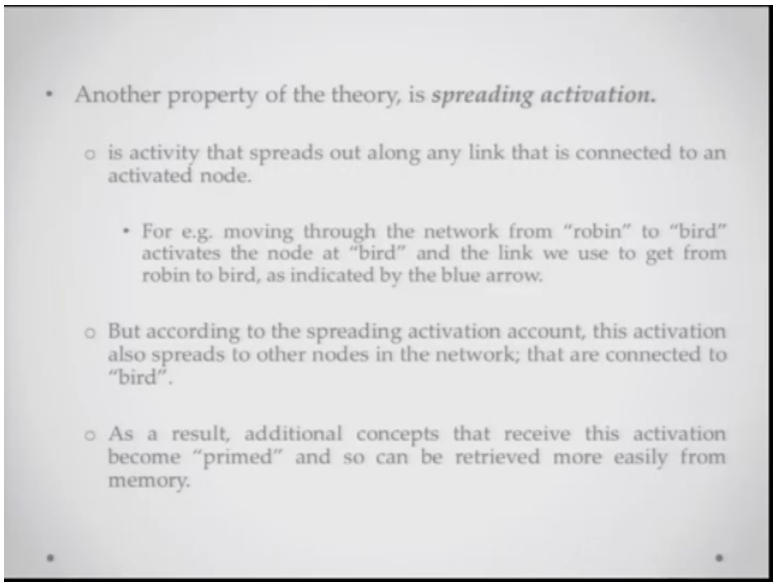

Another the property of the semantic networks is the property of spreading activation what is a spreading activation? By spreading activation one means that, there is activity on each node is spread out along any of the links that is connected to the particular activity. Suppose I am sure you a picture of a canary, and the canary gets activated.

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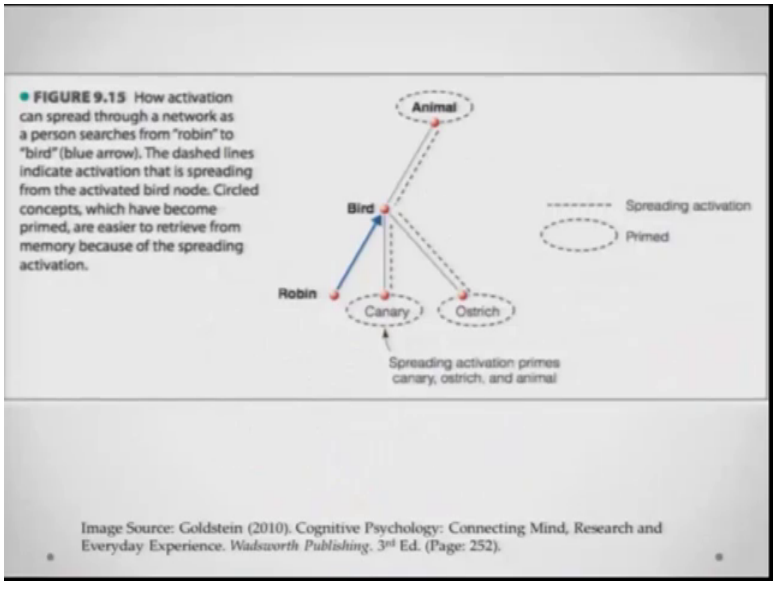

Now if canary is getting activated, the links which are the nodes which are connected to the canary will also get activity and you can see here. So, when a canary is activated, the

node bird is getting activated, the node that animal is getting activated, also the node at ostrich is getting activated the node at robin is also getting activated.

So, the idea is you can see these dotted lines as these dotted lines represent the spreading of activation from one of the activity nodes. You could have very well talked about an ostrich, and a similar activation pattern would have emerged. So, something that only said. So, if you moving through the network from robin to bird, it will activate the node at bird and also the links we used to get from robin to bird will activated, and you can see here they are activated they are represented by the blue arrow here. So, you are talking about robin, it activates bird it activates animal by the dotted line.

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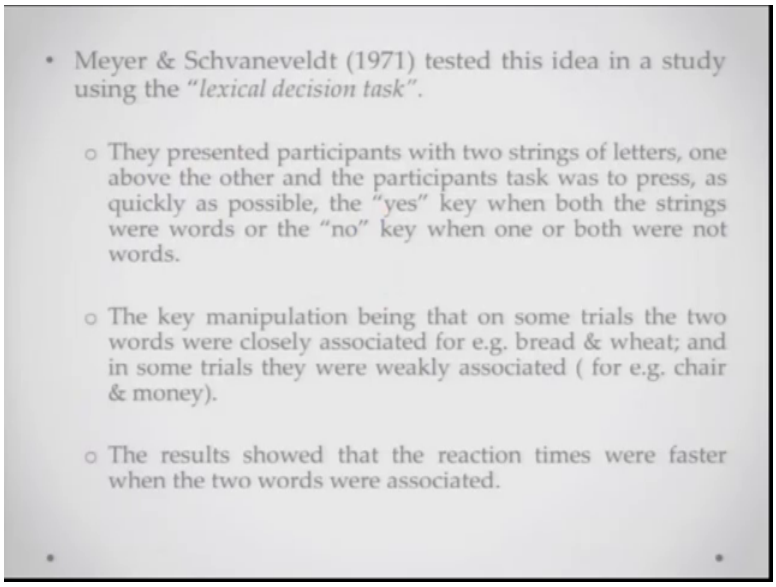

The key manipulation that one can do, but according to the spreading activation account this activation also spreads to other nodes in the network that are connected to bird something that only said. As a result additional concepts that receive this activation because you mentioned robin or you mentioned canary will become primed in some sense and they can also be retrieved more easily from the memory. Priming basically refers to that some kind of residual activation is communicated to these connected nodes.

Now, Meyer and Schvaneveldt they basically wanted to test this idea in a study using the lexical decision task. What is the lexical decision task? Lexical decision task is basically when you are a presented with the word or a pair of words, and you have to respond in yes or no that it is a word or a non-word. Now in their specific experience they presented

participants with two strings of letters one above the other and the participants stars was to press as quickly as possible the yes when both of the strings are words, and the no key when either one or both of the strings were non words. The key manipulation being that on some trials the two words were closely associated to each other say for example, bread and wheat and in some trials they were weekly association for example, chair and money.

Now, the results showed and we can see the results here showed, there is a reaction were so much faster when the two words were closely related to each other.

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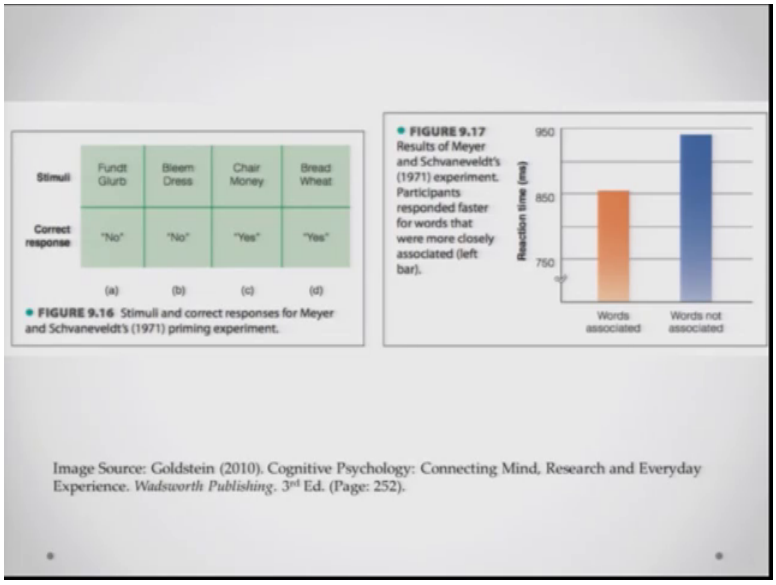

So, you can see here on the left these are example stimulus and then the correct response is there. If you see on the right in the results section, you will see that the associated words are reacted to much faster compared to words that are not associated to each other why is this happening?

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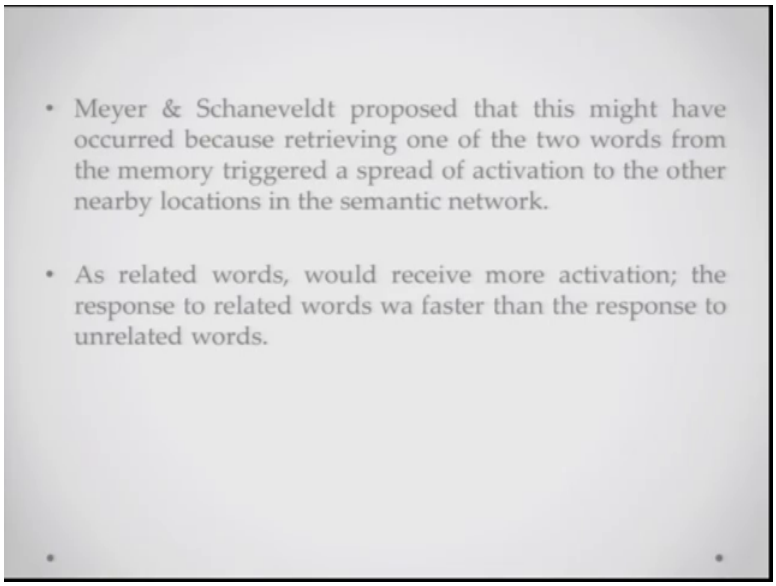

A Meyer and Schaneveldt propose that this might have occurred because retrieving one of the two words from the memory, triggered a spread of activation to the other node as well or the other nearby locations in the semantic network, and as related words share a lot of this activation answering in affirmative to both of the associated words a was much easier as compared to words that were not associated to each other. Because these words were not associated to each other than you have to the evaluate both of them separately and then give a yes or no response as required.

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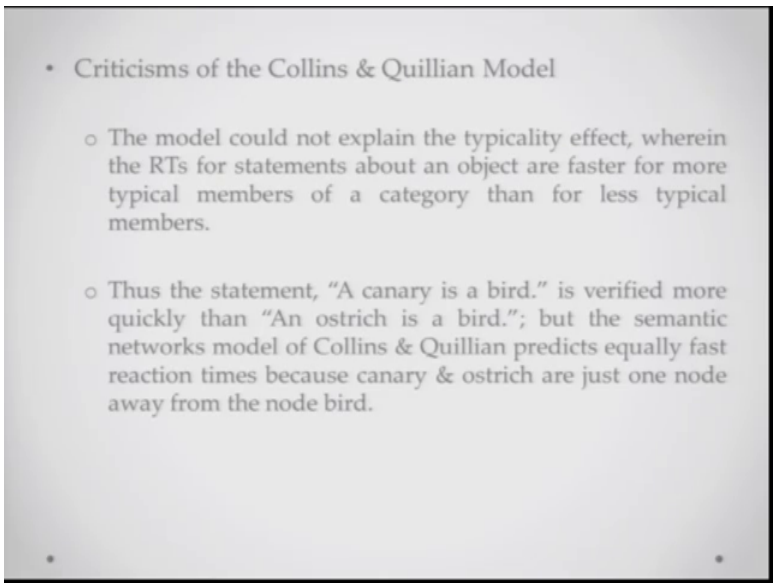

So, this is pretty much what Meyer and Schaneveldt did. Now the Collins Quillians model even though it is one of the more popular models in semantic network theory and it was a one of the first models that actually came along a this model also had some of its own problems. If you remember yesterday we were talking about the typicality effect what was the typicality effect? The typicality effect was that if you talking about let us say members of a particular category will tip more typical members or let us say the more prototypical members of that particular category are named first, and they are responded to faster than the less typical or less prototypical category members of the category. Remember we are talking about the example between say for example, sparrow being a typical member of the bird, highly typical member of the bird category and penguin or ostrich being less typical members of the category of birds, and bat being the least typical member.

So, if you remember that, we can talk about this (Refer Time: 15:36) now. This model could not explain the typicality effect. So, Collins Quilians model basically a could not explain by reaction times would be faster about an object a which are more typical and not really too fast about an object, which are less typical. Now the statement so for example, the statement of canary is the bird is verified more quickly than an ostrich bird in behavioural experiments, when the semantic networks model of Collins and Quillian predicts that this should be activated or they should be responded to with equal speed; because canary and ostrich are technically just one node away from each other.

So, this is one of the things that this model could not explain further researchers also try to question the concept of cognitive economy.

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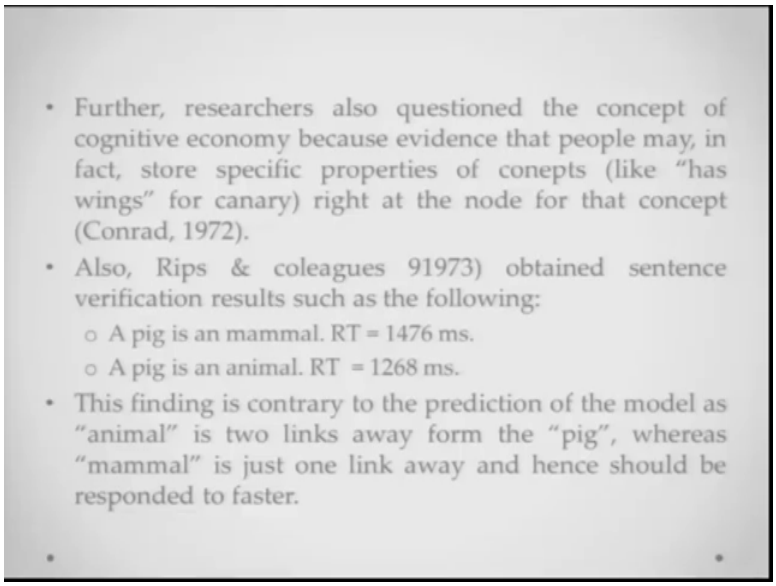

Now the concept of cognitive economy is this the cogna the idea is that, people in fact, may want to store all the information in one place. So, that whenever you want to pick that node up or remember that piece of information, everything is available at the same place. Now because of the principle of cognitive economy, some of the researchers proposed that people may in fact, we storing specific properties of concepts like has wings for canary, right at the node for that concept. You do not need to travel from canary to bird, to notice that it can fly if you can see this connection right here. So, if a to know that it flies you can you will have to in this network go from canary to bird and then you will see that birds can fly hence canary can fly.

Now, this is probably not the best way of storing this, because once you are primed with the concept canary you should have that information right away again this is what some researchers are saying. So, again this is again one of the criticisms of the Collins and Quillians model. Now Rips and coleagues they basically did this experiment and they obtained sentence verification results for a the following statements. So, the statements were say for example, a pig is a mammal and the other statement is a pig is an animal and you can see that the reaction times are different in these two statements. So, pig is an animal is reacted to much faster as compared to a pig is a mammal.

Now, if you go by virtue of semantics of the semantic network that Collins and Quilians proposed, mammal should actually come one level below animal and in that sense people

should be a able to respond to this much faster as compared to the statement that a pig is an animal. Now this finding is; obviously, contrary to the prediction that the model has and again this is one of the problems with this particular model.

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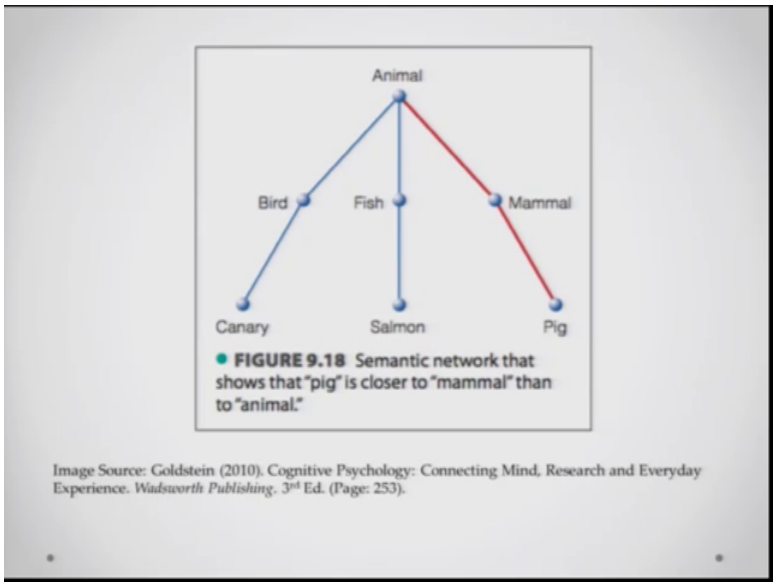

Here you can see that pig is a mammal is, just one connect is just one step and a pig is a animal is to safe. So, actually pig as a mammal should be faster, but we see that in the results it is not coming out to be.

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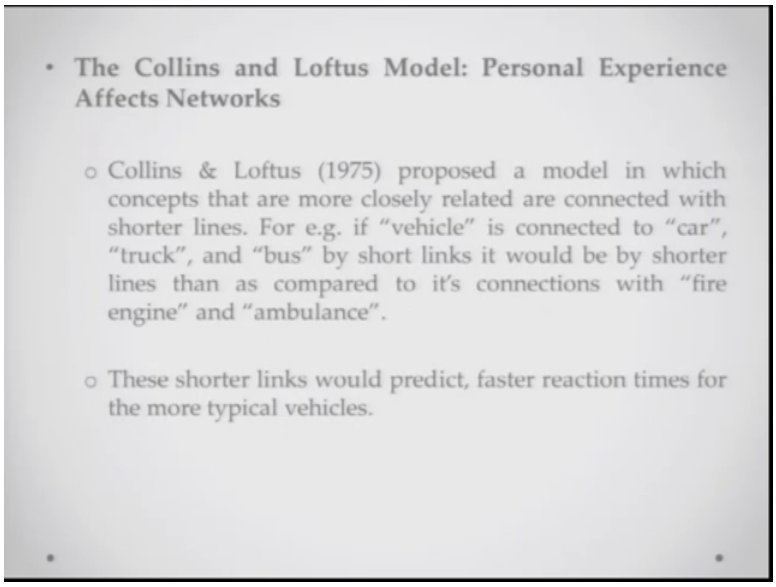

So, with these criticisms in mind Collins went on to work and you know better the current model, and in 1975 Collins and Loftus they proposed a different model they proposed a model in which these concepts are more closely related the concept that are more closely related are connected to each other with shorter lines.

So, the ideas if a particular concept is very closely related in your memory, the links between the two will be represented by shorter lines, which basically reflects in faster processing times, better accuracy and so on and so forth. So, far I will take an example that the book mentions. So, for example, if the vehicle is connected to car, truck and bus by short links, it would be by shorter lines car and truck and worse it would be by shorter lines then as compared to its connection with the fire engine. So, you have the category of vehicle and you have car, truck and bus, if you can see this model here if you see the category of vehicle, vehicle is connected with shorter line with car a or show a similar lines with car truck and bus but the lines for fire engine and ambulance are slightly longer.

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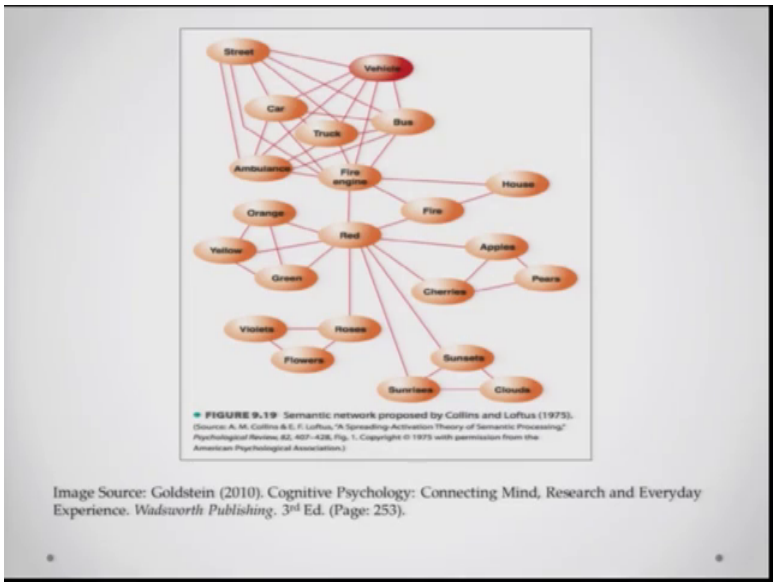

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So, this model kind of predicts that if you are talking about a car and you know when you are talking about the main category vehicle, your reaction times should be faster. This is an attempt to actually explain or actually factor in the typicality effect we were just talking about.

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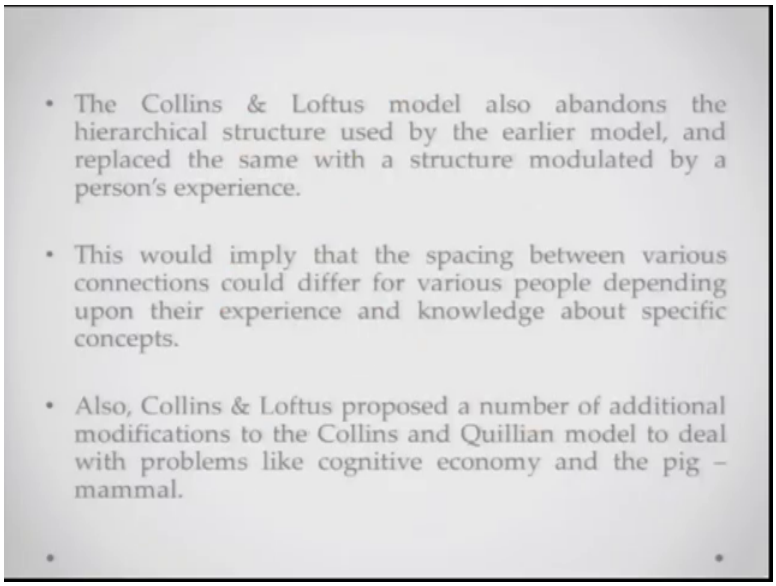

Collins Loftus model also abandons the hierarchical structure used by the earlier model.

So, earlier model had a basic level if I may say. So, at canary and it has a more general level at mammal or at bird and animal and living thing, and here in a more specific a level at a canary can sing etcetera. The idea is this and here in the kind of abandon this hierarchical structure and they basically replace the same structure as a structure that is modulated by a personal experience, your individual experiences. Because people actually move around they get you know the encounter various sorts of thing they pick up facts about these things they pick they noticed behaviour of particular things and all of that needs to get factored into the conceptual organization.

So, it was probably a good move that they kind of a are coming up with an model, that factors in personal experience. Because my experience with particular kind of things might be very different than your experience with the same kind of things and so, in my conceptual representation maybe I will be faster for saying a pig is a mammal, but because you know in your conceptual organization you will be faster for a pig is an animal things like that.

Now, this would basically imply factoring in personal experience that the spacing between various connections could differ from various people depending upon their experience and knowledge about specific concepts. Also Collins and Loftus proposed another you know a large number of additional modifications and small things here and

there to the Collins and Quilians model, to deal with problems like the ones we pointed out earlier problems of cognitive economy in the pig and big mammal problem and those kinds of things.

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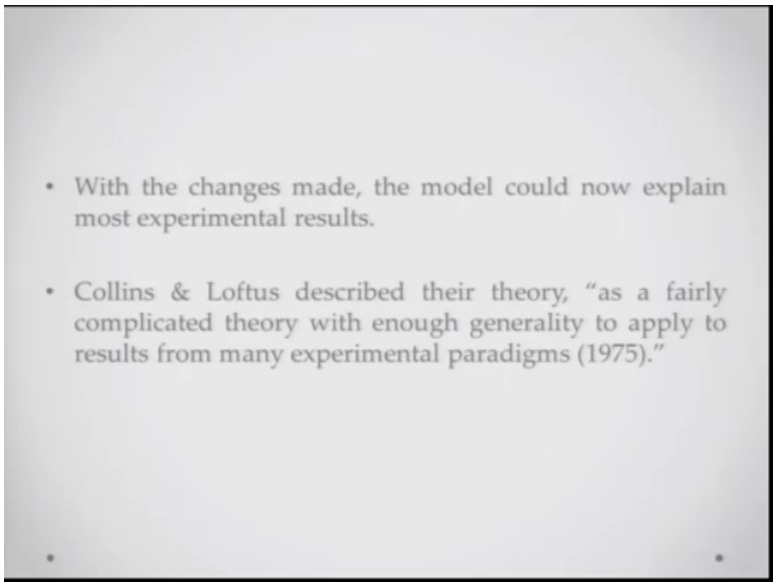

With these changes made this model could now explain most experimental results people were getting. Collins and Loftus describe their theory as a fairly complicated theory, but enough generality to apply two results from many and various experimental paradigms.

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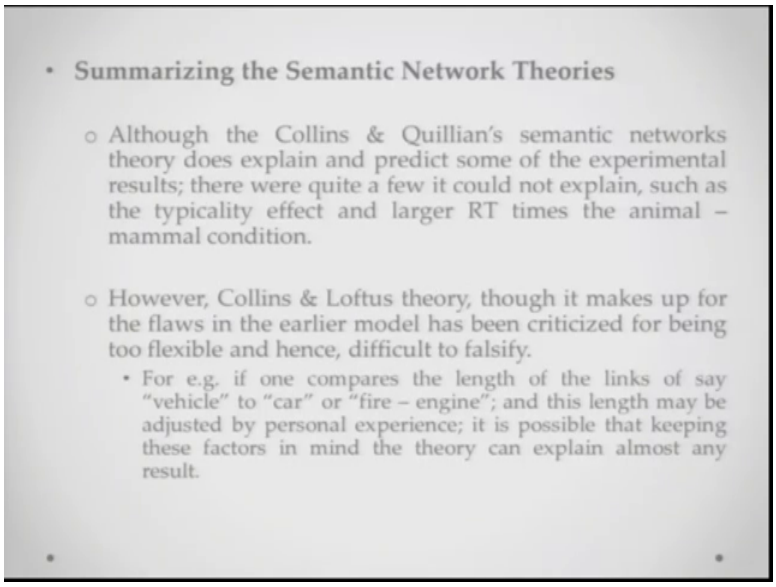

Now, this model kind of in that sense becomes very powerful. Now if you kind of look at both of these models Collins and Quilians model and Collins and Loftus model, you can say a few things about semantic network theories in general. So, let us kind of try and do that. So, all the Collins and Quilians semantic networks theory, it does explain and predict some of the experimental results are there was quite a few things that it could not explain. But the Collins and Loftus theory though it can make up for most of the earlier theories flaws it could actually explain most of the results, and because it could explain almost any result you throw at it becomes slightly difficult to falsify.

In the earlier course when I was talking about how scientific theories are developed, I have mentioned again and again that one of the most important properties of a scientific theory is, that it should be easily falsifiable or it should be falsifiable, you could come up with particular counter incenses and show that here the theory is not going to work. For example, let us say let us take an example from their network if one compares the length of link say from vehicle to car or from equal to fire engine, then this length can be now adjusted by personal experience.

Now, it is possible in this scenario that keeping these factors in mind personal experiences you know basic knowledge, all those intelligence, socio economics you can you know bring in too many variables that you want to, this theory can be able to explain almost anything. When you say personal experience you are probably talking about so many things. Now in this sense the theory becomes very flexible and the theory becomes very difficult to falsify. At the same time then it does not remain a very good scientific theory that one would watch by. That is actually one of the major criticisms that was held that was put forward against this Collins and Loftus theory Collins and Loftus theory of semantic networks.

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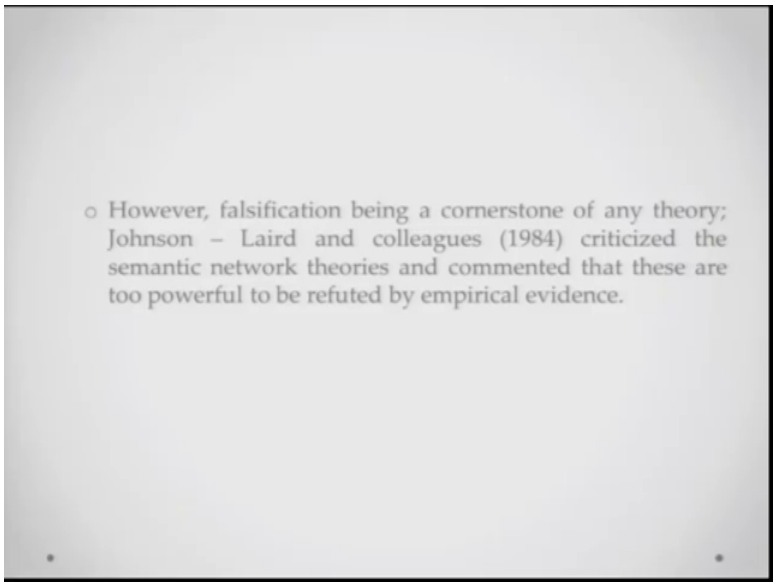

Now, for and this is pretty much what was actually summed up by Johnson laird and colleagues, because this criticized this Collins and Laftus semantic network theory and they commented that the series are too powerful to be refuted by any empirical evidence that you might be able to cut and gather.

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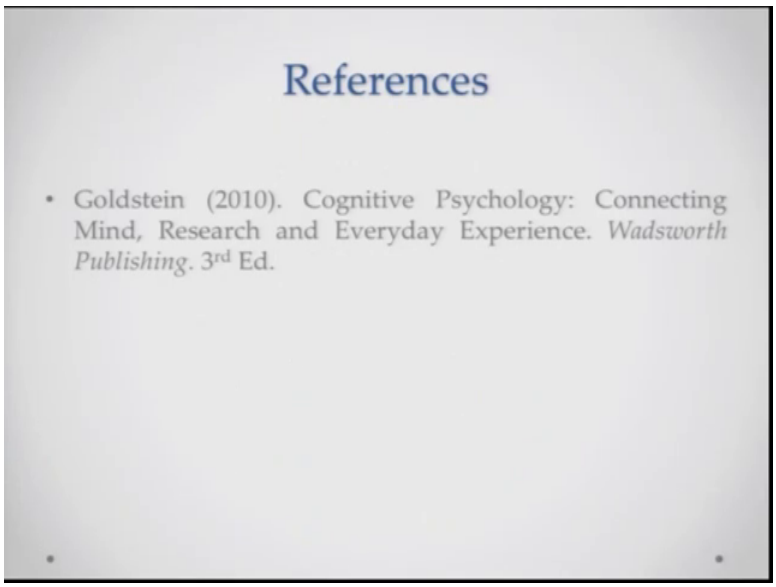

So, this is all about semantic networks from my side today and in the next class we talk about something other than a semantic networks.

Thank you.