Cognition and its Computation
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Lecture - 37
Learning Processes (Contd.)

Hello and welcome back to this session on Learning theories. In our last class we spoke about the behavioral theories of learning and we discussed about classical conditioning by Pavlov, we talked about Skinner and Thorndike. And in today's session we are going to talk about Hull's theory and we will focus a little on two of the cognitive theories. I will also give a very brief outline on Hebb's theory.

Basically this is just to give you an introduction to the learning theories because hereafter when you understand the neuroscientific principles that underline learning these you can trace back to these theories and try and relate them to how evidence shows that learning has happened within the human brain and also in animals.

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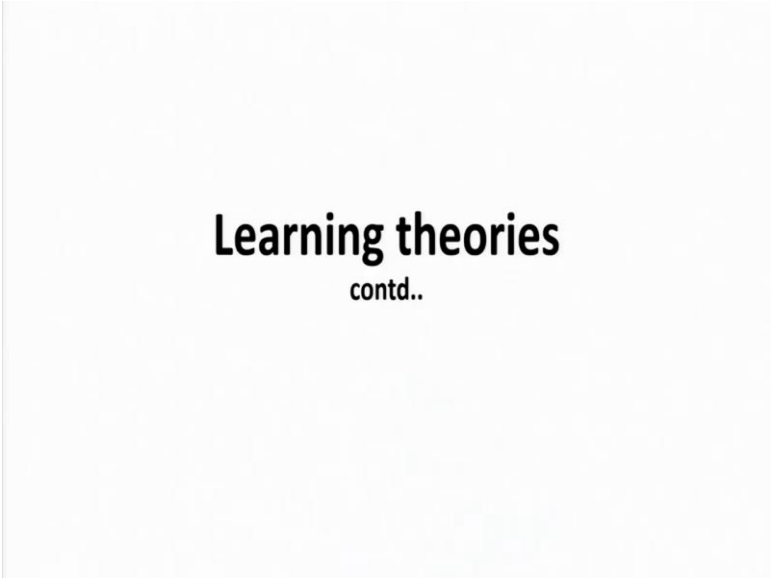

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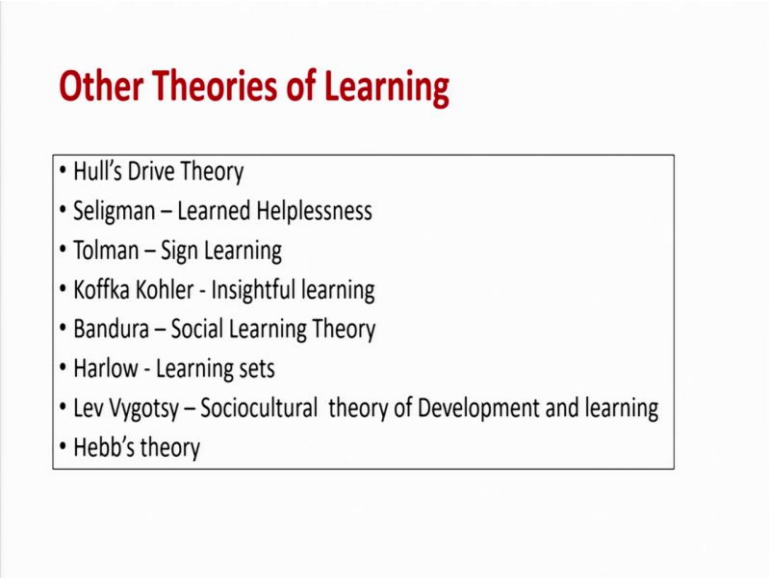

So, as I said today our discussion will focus on the different kinds of learning, but we must also understand that there are multiple learning theories and I will be talking about Hull's drive theory. But other than that there are Seligman's theory of learned helplessness. Bandura's theory of social learning, Harlow's idea about learning sets. And as I spoke about constructivism yesterday in the last class Vygotsy's socio cultural theory of learning and development is again a very important part. And finally, Hebb's theory we will be discussing these a few of them.

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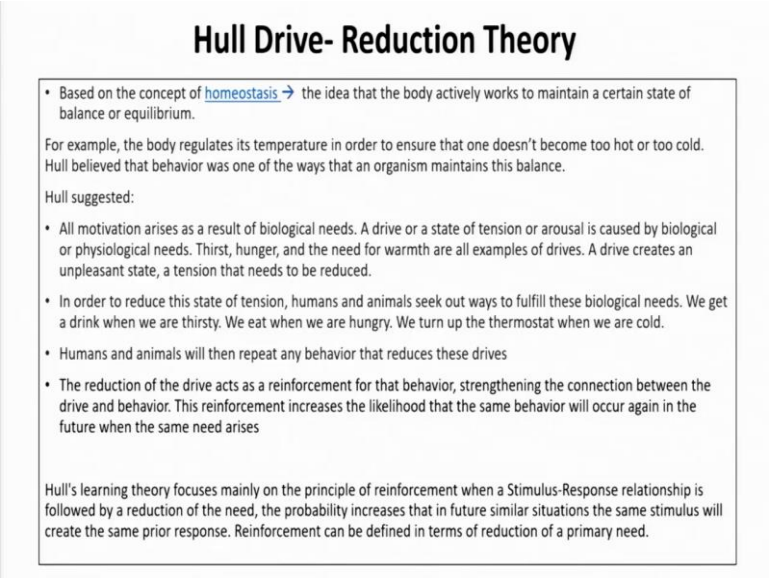

So, coming to Hull's drive reduction theory; most people who are familiar with psychology text will feel that this is a theory of motivation and might wonder why I am talking about this in a class on learning this simple reason being that this theory was inspired by the behavioristic theories of Skinner and Thorndike. And Hull based his concept on physiological terms. So, his idea was developed from the concept of homeostasis that is a sense of balance or equilibrium.

And as is known today through physiology the objective of any living organism is to maintain a certain state of balance or equilibrium. So, if we are if we have if we have over eaten to again get back to the same mass we either have a stomach upset and in digestion where the excessive a amount of food content is driven off or we omit; or if again if we have a less amount of food then we look out we search for food to fulfil or get the body to homeostasis similarly, with temperature and similarly with most of the body mechanisms.

So, Hull suggested that all kind of motivation is derived because of the biological needs. And this state of tension or arousal he termed it as a drive. And he said that for thirst, hunger, warmth need for warmth these are all examples of drives. A drive is creates an unpleasant state and attention and that the objective of the biological entity that is be it an animal or a human is to reduce that tension.

And in order to reduce that tension what do what does the animal or the human do they seek out ways to fulfil the biological needs. So, we look out for a drink when we are thirsty we look out for food when we are hungry we look out for warmth when we feel cold. So, all these drives are created by this need and the reduction of the drive. So, in whichever mechanism we reduce the drive that acts as a reinforcement and that strengthens. So, if the drive is reduced that strengthens the connection between the drive and the behavior.

And it is likely that in henceforth in such similar conditions and situations the same behavior will occur again. So, if the drive rises again or if there is a need again then because the previous behavior gave a pathway to the goal that is drive reduction then this pathway will be strengthened over time.

And Hull's theory was as you can well understand is very similar to thorndikes and Skinner mechanism that is I mentioned earlier. He was inspired by these two stalwarts

and it is based on a principle of reinforcement and a stimulus response relationship followed by a reduction in need. Now, reinforcement what he defines reinforcement as in terms of reduction of a primary need.

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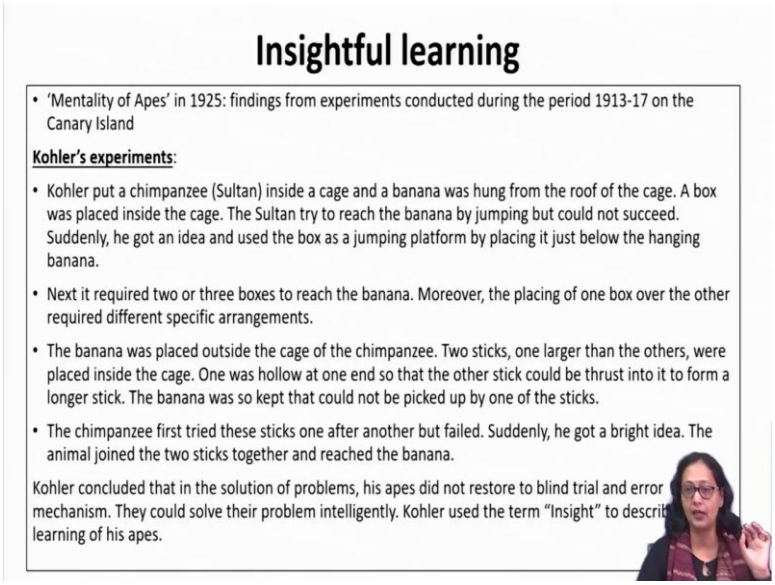

Now, this theory was again a very very important theory from the physiological point of view. And many of you may be wondering that I have again where is the learning mechanism and how is it why is it not motivation. It is a theory of motivation, but again as I repeat once again that because it drives on the principles of reinforcement mechanisms and it shows us how the drive reduction is learnt that is why it is also mentioned as a theory of learning.

And this principle is very very evident in we see that in many behavioral examples. If there is a certain way that your when you are hungry. Just to give you an example when you are hungry and you are in a different in a strange place in a new place and you have looked for food everywhere and you received you got food somewhere you found food somewhere in a cabinet and it reduced your hunger drive. Henceforth in a similar place like that or maybe in that same place if you have to look for food again at a time when you are hungry you will go back to the same place.

So, that just implies that there is some kind of learning so, some kind of a pathway that is created between the need and the drive reduction or the drive and the drive reduction. And the because it has given a positive consequence you will be looking for the

reduction of the drive in a similar place. So, this is we will move forward from the behavioral theories to the cognitive theories I was speaking about the different schools of learning and an emphasis on cognitive learning is on the emphasis of the cognitive learning school is on the organism.

So, initially the behaviorist they focused on the SR relationship or the stimulus response relationship. Skinner did focus on the organism, but it was from the perception of the organism being an active member participating in the stimulus response relationship. The cognitive school of thought they went a little beyond that. So, for cognitive psychologist they believe that learning is not restricted to just an SR relationship.

But the organism is assimilates information assimilates knowledge from the environment from the learning experience and that shapes his behavior henceforth. In fact, along with this they came up with the concept of insight. So, what is insight? So, insight is a sudden gist of an idea. So, it is like a bulb glowing that well there is a new idea that has come about which from the previous associations, but may be entirely different. And this is very very similar to the inventions that occur.

So, a lot of trial and error or a lot of learning goes before that insight has to happen. And this particular thought or concept of learning the insightful learning this was mostly worked by worked on by the gestalt psychologist gestalt is or this is a school of thought who believed mainly by propounders from the German school and they were the pre propounder of the gestalt school were primary propounders were Koffka Kohler and Wertheimer max Wertheimer.

And Kohler had worked a lot on insight experiments. So, the gestalt school believe that we see things as a whole. We do not see things as a as parts. So, the sum of the parts is can form a whole, but the concept of a whole is different from the sum of its parts. And you have come across the gestalt laws of perception earlier in learning Kohler's experiments on insight have been very very you know establishing and has created an impact in the in our ideas of learning.

So, what Kohler worked on was chimpanzees he had multiple chimpanzees, but the smartest of the lot was Sultan. And what Kohler did was he put Sultan inside a cage and he hung a banana from the roof of the cage and there was a box placed on the cage. And Sultan tried multiple ways to reach the banana which was of course, out of his reach

unless he stepped on the box. And after few random trials Sultan could understand that if he stood on the box then use the box as a platform then he would be able to get hold of the banana.

So, this was one of the experiments. Similarly, a Kohler tried out other experiments where he it was required to around two to three boxes to reach the banana and placing the boxes one on top of the other the Sultan could again with a couple of trials initially he tried with one box and then he tried throwing the box at the banana. And after multiple such you know random ways he realized that if he placed one box on top of the other he would be able to reach the banana.

The next was where the banana was placed outside the cage and two sticks were provided where if the animals put the two sticks together then he would be able to reach it again after a couple of trials the animal was able to get that and. So, these experiments were carried out with multiple chimpanzees. Surprisingly Sultan the smartest of the lot could get all these ideas and it came suddenly for all these experiments to gain to reach the goal other chimpanzees followed Sultan and learned it.

So, anyways he so, Kohler concluded that from his experiments that in the solution of problems the apes did not just use trial and error. So, it was not random effort that shaped their behavior, but they used some problem solving strategy and after a period you know after a period of trials that were required for gaining conceptualization of the ground or the environment. The animals used an intelligent behavior this he termed as insight to you know come to a solution of a problem and this is how learning happened. So, this is what Kohler had to say.

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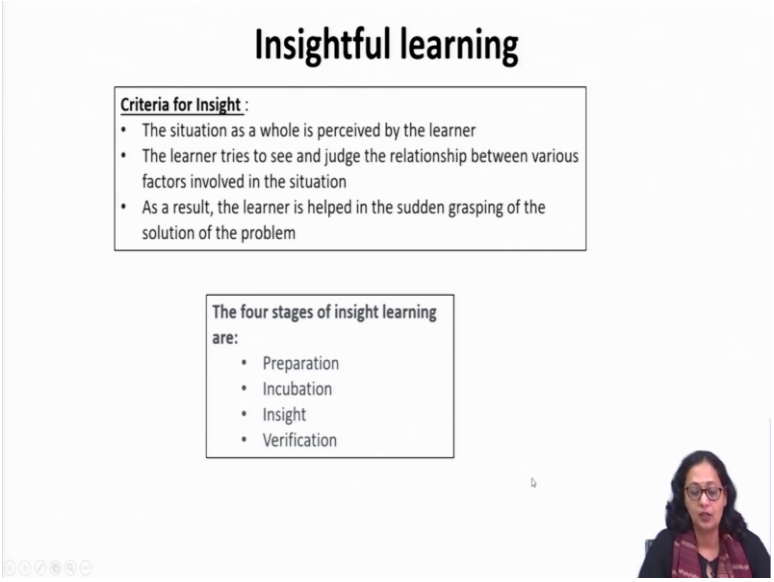

And from his experiments Kohler gave us some criteria's for insight. So, what is required for insightful learning? Number 1; the situation has to be perceived as a whole by the learner. So, this is again in tune with the primary concept of the gestalt psychologist of looking at a an environment as a whole looking at an object as a whole.

So, to solve the problem here the Kohler said that the animal had to see the situation as a whole. So, the stick the box the banana his own height his elevation how much he can jump to reach. So, all this was had to be seen together in a perspective to be able to solve the problem.

The learner tries to see and judge the relationship between various factors involved. So, it is not only seeing them as a whole, but also to understand the also understanding the relationship between each of these objects. So, the box and the stick the box stick and the banana and his own elevation his own height the stretch the length of the stick for picking adding the two sticks together the length of each stick and how much would two of the sticks be able to cover and how far was the banana; so, the relationship between all these objects.

And with once the animal is able to pick up the relationships and identify the connection between them there is a sudden insight. Now when this insight will happen? When the animal will be able to solve the problem Kohler could not tell us. In fact, we still do not know that how much of preparation is required for insight. But we know that there are

four stages of insight insightful learning. So, first is the preparation. So, as I was mentioning an idea about the ground of the environment or the of the experiment.

The incubation period; so, there has to be you know after all the trials have happened there has to be a period of space an empty space where nothing is being done. That is the time when the brain comes up with a new idea. So, this rest period or this incubation period is very very important for insight. And then the insight occurs and finally, a verification. So, it is not that I have just had an idea. So, creative ideas are creative as long as they help us to reach a goal reach some kind of a some kind of an end.

So, this end may not be you know fathomable at the very onset, but it has to be. So, just having the idea is not enough, but a validation or a verification of that goal is also important and. So, these are the four stages of insightful learning that Kohler speaks about as you can well understand this was this theory of learning is very different from the theories that we have been talking about so far of the behaviorist school.

This incorporates that there is something actively going on within the brain of the individual or in this case the ape to bring about some kind of an action. So, the relationship the associations that the animal consciously is drawing is helps in learning. So, this as the this is the primary theory of the cognitive school of learning.

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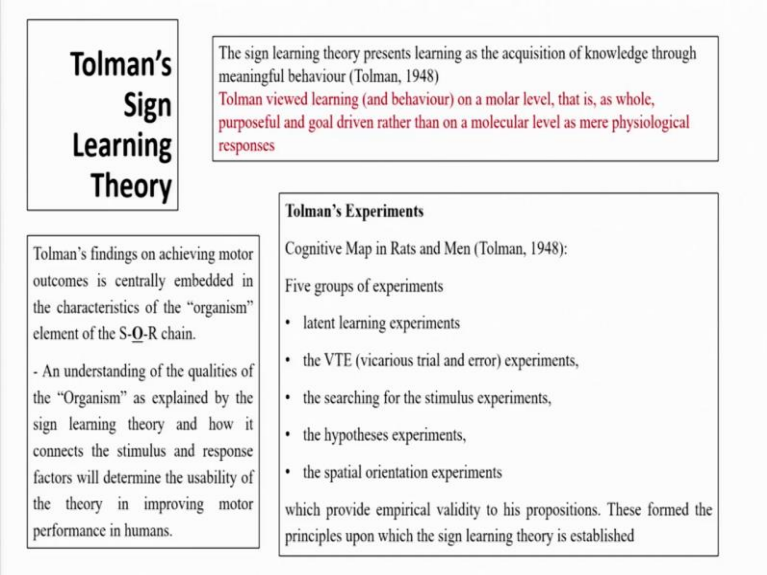

And from there we move on to another theory by the cognitive school and learning theory by the cognitive school that is Tolman's Sign Language Theory. And Tolman again was a cognitive psychologist he viewed learning and behavior from a molar level and again that is as a whole and the he spoke of learning as purposeful and goal driven rather than just physiological responses.

And what Tolman did was he conducted multiple number of experiments and specially primarily five groups of experiments and he showed that learning is not necessarily classical conditioning phenomena ok; or just stimulus response phenomena. So, he his experiments were on latent learning vicarious trial and error experiments searching for stimulus hypothesis experiments and spatial orientation experiments.

And his theory is very very important for understanding motor performance in humans and animals and. In fact, has been used very very effectively and efficiently in the area of sports psychology. What we most read about when we talk about Tolman is the spatial orientation experiments and. In fact, tolmans theory of so, Tolman spoke about the cognitive maps and. In fact, he this spatial orientation experiments gave us an idea about how we plan and place things and how we have a create maps within our brain to understand to a plan things ahead and you know that is how what he calls cognitive maps and learning.

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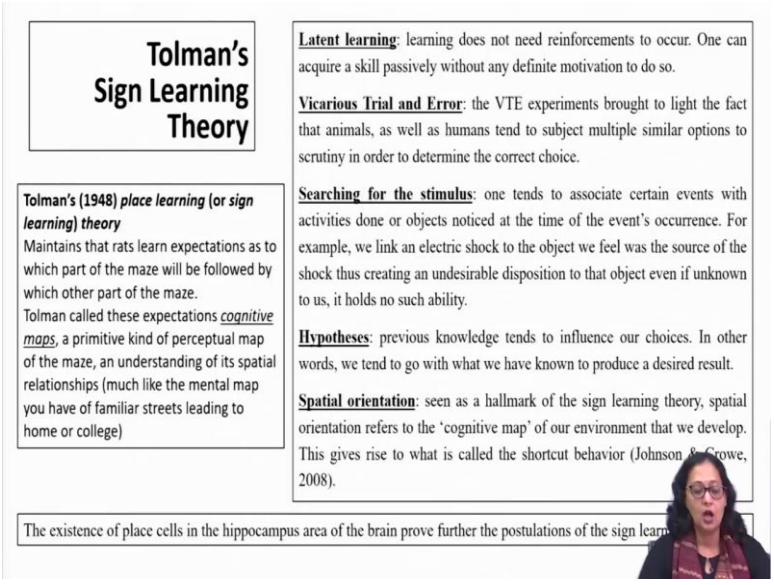

Now, this Tolman's place learning theory or the area idea of spatial orientation in this experiment he maintains that rats learn his experiments were primarily on rats though he wanted to translate those to humans as well. So, he his experiments required rats to move around in a maze and learn a maze and gradually Tolman realized that the rats you know learned some something called cognitive maps. So, it is a kind of a perceptual map of the maze and an understanding of the perceptual relationships the spatial relationships that the rat develops.

So, it is quite similar to you know how we plan our way if we are going somewhere. So, we have an idea about that place in our brain and we just by planning it in our head we can also think about shortcuts to go and. So, this according to Tolman is how we plan our choices. So, if we have multiple choices we our previous knowledge tends to influence our choices. And we will always take that path which will give us our desired results.

How do we know which is the path? It is again by past experience and we know. So, we take the path that by past experience has given us a desired result. So, this theory is very very well established in neuroscience as well. How? The existence of place cells in the hippocampus area of the brain show that this idea of cognitive map planning ahead planning a road ahead; you know or planning the moves ahead the optimal moves ahead of time. This is or learning this you know through the planning is very well expressed in the you know in the hippocampus in the place cells in the hippocampus.

And this theory is again as you can well understand it is cognitive theory of learning and it requires the individual in this case or the animal in Tolman's experiments the rats to plan out the action. So, actively think actively orient itself to the time and space and look ahead to I you know even through obstructions as to where the directions would be towards the goal. So, this again is cognitive learning theory.

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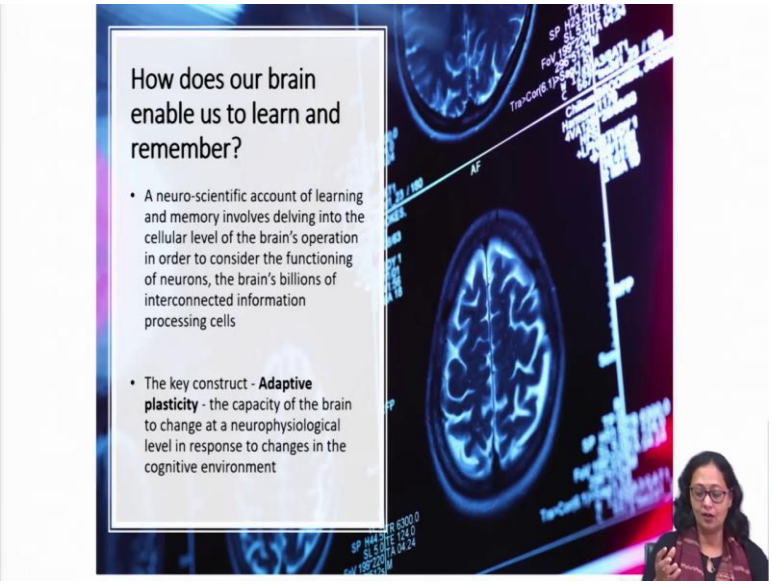

I will not speak any further about other theories, but moving on just how does our brain enable us to learn and remember. So, the primary idea is about adaptive plasticity I will not discuss adaptive plasticity here, but in very very basic terms when we are learning something the there are networks formed within the brain. In the next classes you will get to understand how learning happens. But in very brief ideas and the brain is capable of taking up to accept these changes and bring about very minute changes in the neural networks.

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Now, these this idea of neural networks is something that is very familiar to the artificial intelligence people.

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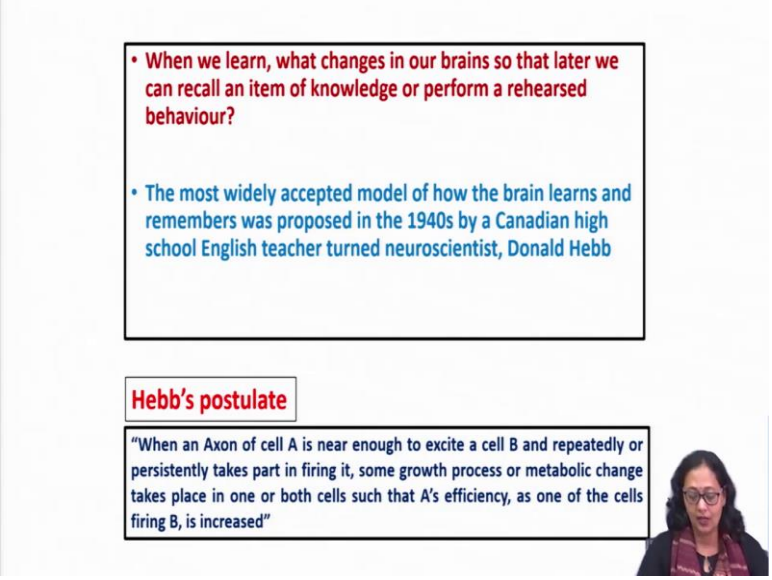

We will not be talking about neural networks from that perspective, but when we talk of neural networks the idea that was propounded initially came about from a Canadian school teacher and who turned into a neuroscientist and by the name of Donald Hebb. So, Hebb Hebb's postulate is something that is still followed and it was very well established and it was presented in the cognitive science symposium way back in the 50s in 1956.

And here what Hebb says is that when an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it some growth process or metabolic change takes place in one or both cells. Such that A efficiency as one of the cells firing B is increased.

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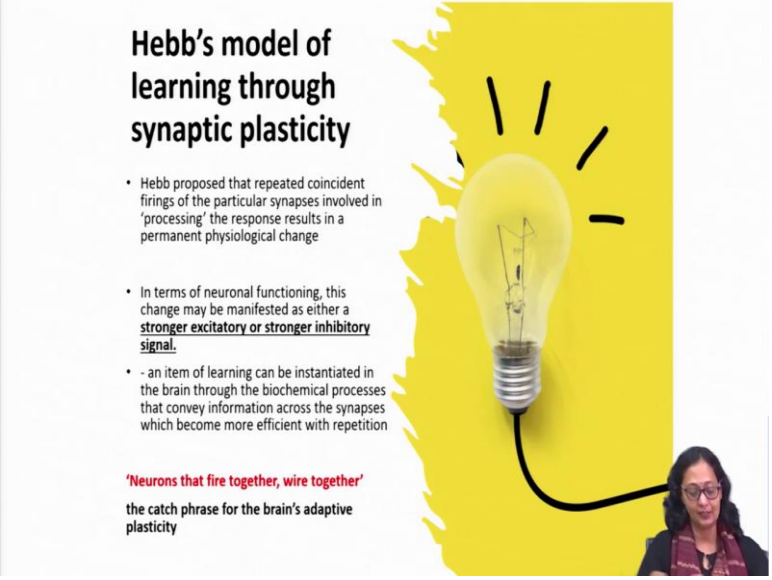

So, the in very simple terms for Hebb's theory it is said that if A is A has helped to spike up B then the probability of A firing as a A firing. So, that the cell B fires is increased. So, in simple terms the catch phrase used is neurons that fire together wire together. And it has been seen that this in terms of neuronal functioning this change is manifested as a stronger excitatory or stronger inhibitory signal.

So, when a series of cells or a networks get fired together for a considerable number of time and this is repeated there is a repeated coincident firing of the particular synapses then it brings about a permanent physiological change and this change can be as a stronger excitatory function or a stronger inhibitory signal.

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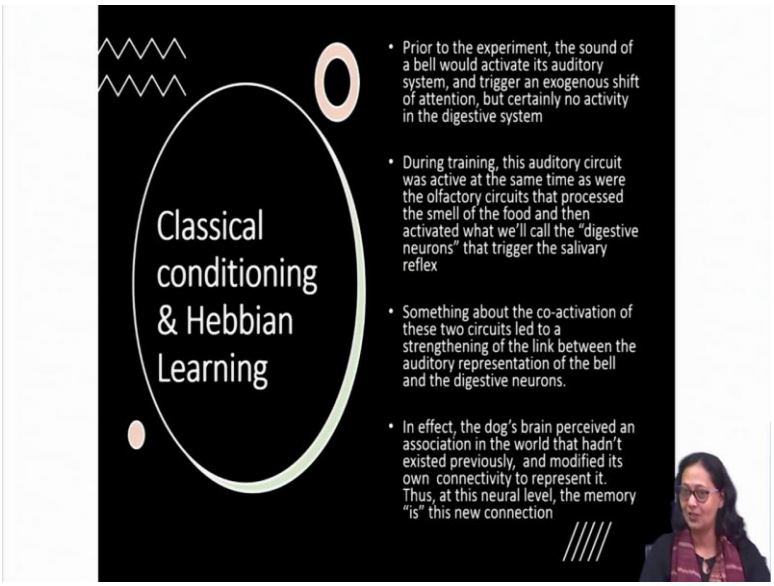

So, Hebb's model let us just take a brief look at Hebb's model and try and see how it whether it can explain classical conditioning. So, a just to go back a little on classical conditioning Pavlov's dog and Pavlov's dog during the training process has it is a hungry dog.

So, there are some intestinal movements that occur along with some sensory sensations from the olfactory circuits. So, these two and of course, the intestinal movements and the smell they pair together and there again is the salivary reflex. So, there are multiple circuits as you can see working together. So, one is the digestive neurons one is the olfactory circuits and these two paired together they trigger the salivary reflex and then the sound of the bell that gets paired with this as well. So, the auditory representation of the bell gets paired with the digestive neurons.

Now, you see when we talk of pairing what exactly do we mean? We mean a co activation of these circuits together. So, one circuit when one circuit is activated another circuit gets activated parallelly and this brings about a new kind of learning. So, the auditory representation of the bell by itself is enough to activate the salivatory circuit.

So, it does not require the visual representation of the food visualization of the food the auditory input of the food, but the sound of the bell the sorry not the auditory input the olfactory input of the food or the visual representation of the food even when those two

are missing the auditory representation of the bell the sound is already can trigger the digestive response the salivatory response.

So, this is how at a neural level a new connection occurs. So, the initial connection is activated by all the circuits together ok the bell is not a part of the circuit, but the other three the visualization the smell of the food and the salivatory reflex all according together. But when this connection has been made and the sound of the bell is paired with it. So, it coexists there is a co activation then the sound of the bell itself is able to trigger the response. Just to look a little more closer to home.

Say if you had if you had an unpleasant experience of fainting on the stage ok and the fainting before the fainting you had a slight tremor in the leg and butterflies in the stomach and dryness of the throat. So, these so, these are separate sensations from separate parts of the body engaging separate circuits and these were again you know mapped with the fainting response ok .

Now looking at a stage packed auditorium and then fainting on the stage that the next time one gets up on the stage and has any of those any of those circuits activated; the other circuits are very easily quickly activated. So, the only the tremor in the leg or just a butterfly in the stomach the slight sensation can trigger all the other responses together. So, it is that it is that pairing or it is that circuit activation that has happened across.

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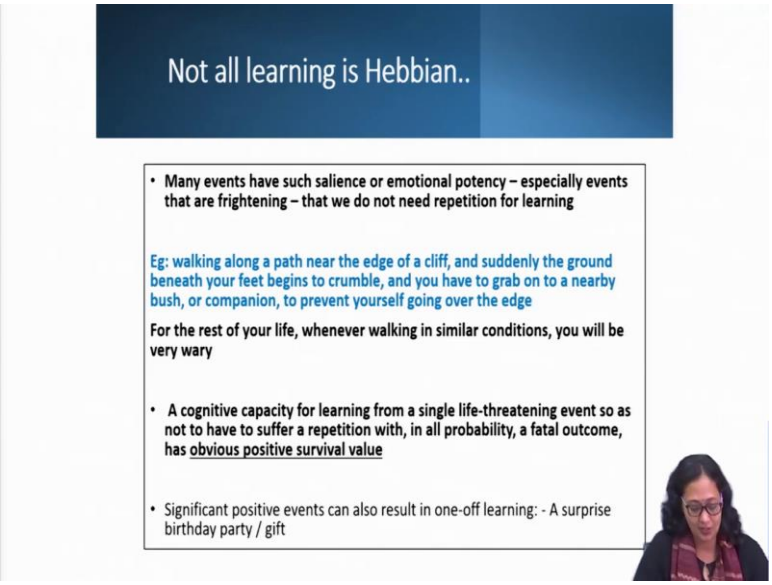

So, this is a very interesting way of explaining Hebbian theory through classical conditioning or rather classical conditioning through Hebbian theory. Now not all learning is Hebbian ok. And it need not require multiple pairings the example I gave you was of a single incidence and it need not always happen with multiple pairings.

If it is a fearful situation that you have undergone if you are standing by the cliff and the ground beneath you suddenly crumbles one experience is enough you need not be trained and paid for multiple number of times. So, anything that has positive survival value will be learned very easily and that is why our species has survived for. So, long if we did not figure that out we would be long gone.

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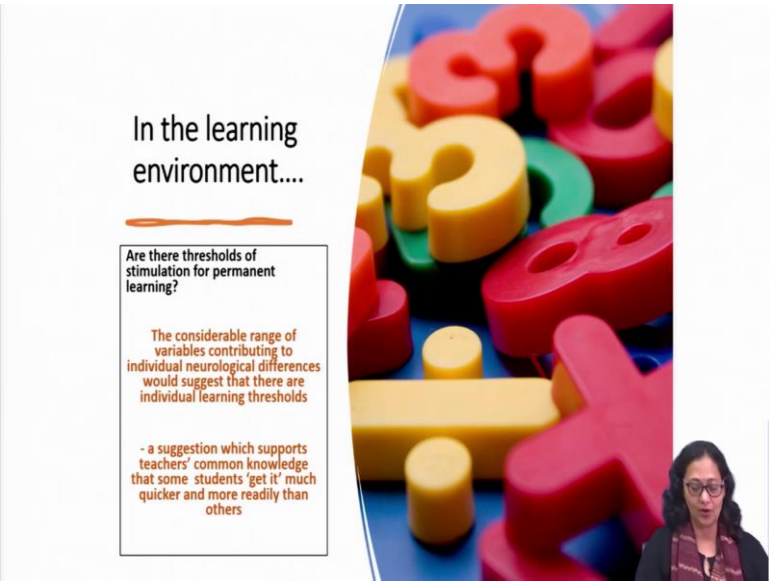

Now, in the learning environment there are thresholds so, other thresholds for permanent learning. So, educational neuroscience speaks of thresholds and there are definitely individual neurological differences that suggest that there are individual learning thresholds. And in the educational circuits you will often hear teachers say that well some people get it fast and others do not get it easily or readily as others.

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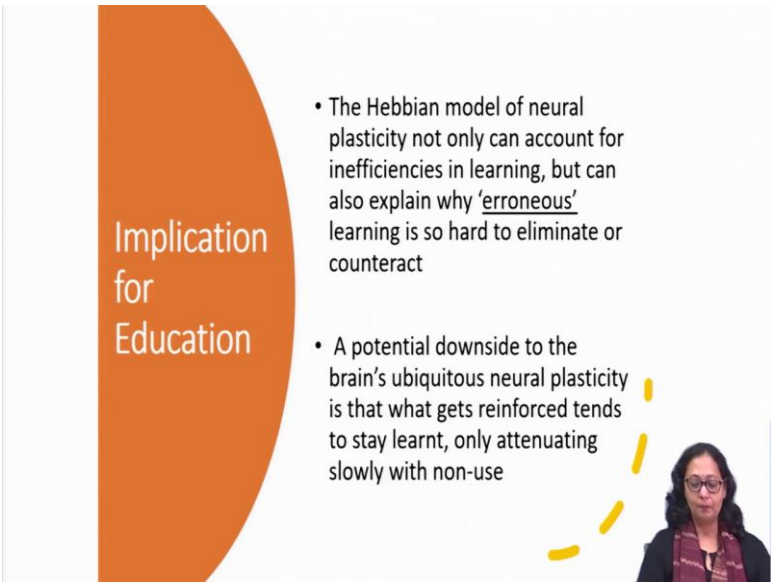

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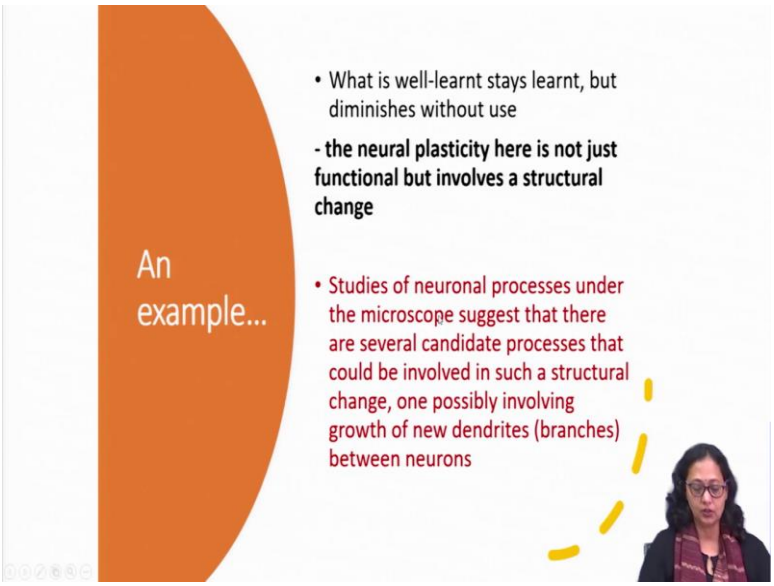

Now so, basically these are some of the things that I wanted to talk about today, but before I end this session.

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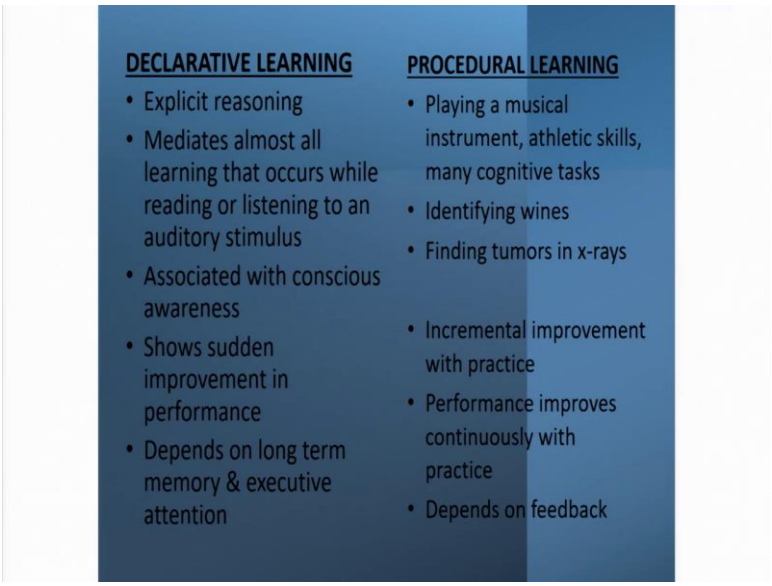

I would like to highlight on one more slide and here I this is primarily on declarative and procedural learning. So far whatever I have spoken about is as you will see we have talked we have talked about learning theories, but when we talk about learning there are some of it is again conscious and some of it may not be within our conscious control. So, we may not be able to explain how we have learnt a certain phenomena or even we may not know that we have learnt something that and, but that influences our behaviour.

And the concept of priming that is where the concept of priming comes in and this is also so, to discuss on this ground we must also talk about a little about procedural learning. So, for most of the declarative learning that we do that is where we are consciously aware we are associating events one with the other and because we are consciously doing it you know we can relate it in our memories we will be talking about this more in detail in the memory section.

But there are some things that we as I said that we are not aware how we learnt. So, you may have a neighbor neighboring somebody living in your neighboring room who plays a song in a different language every day and you have no intention of learning it whatsoever because you do not even know the language, but you have picked it up and if he suddenly plays a different song you are well aware that this is a different song.

Now how did you know it? You have not been conscious of learning it you have not consciously put an effort to learn the song not the tune then how did you learn it. So, this

these are some of the latent learning principles that do happen I spoke about Tolman, but so, you know this is again another aspect that he speaks of. The other is of procedural learning where when learning happens we are not able to explain.

For example, you will not be able to teach somebody how to ride a bicycle just by telling him to put his right leg on the pedal push it and the left leg on the pedal push it and so on and so forth. So, playing a musical instrument, learning athletic skills, doing cognitive tasks, you know tasting the developing a sense of taste identifying wines you know a these cannot be explained through language.

So, these are things that are learnt from a different in a different way as compared to declarative learning. So, obviously, you will see later that the representation in the brain for procedural learning is again different from the representation of episodic and semantic learning or declarative learning. You will see it as we go and we talk about episodic and semantic memory.

Now, while declarative learning shows sudden improvement in performance procedural learning shows incremental influence improvement in performance and definitely as you can understand with most of the skills practice has a very important role to play in procedural learning and it feedback also has a role to play. So, we fine tune our skills with feedback. So, well so, this is what I had to share in today's session.

So, we primarily spoke about Hull's drive theory we moved on to the cognitive theories of Tolman and insightful learning, then we discussed Hebb's Donald Hebb's theory very briefly cell assembly theory very briefly. And we moved on to just a short comparison of declarative and procedural learning. In the next class we will be talking about memory and its different theories. So, stay tuned.

Thank you.