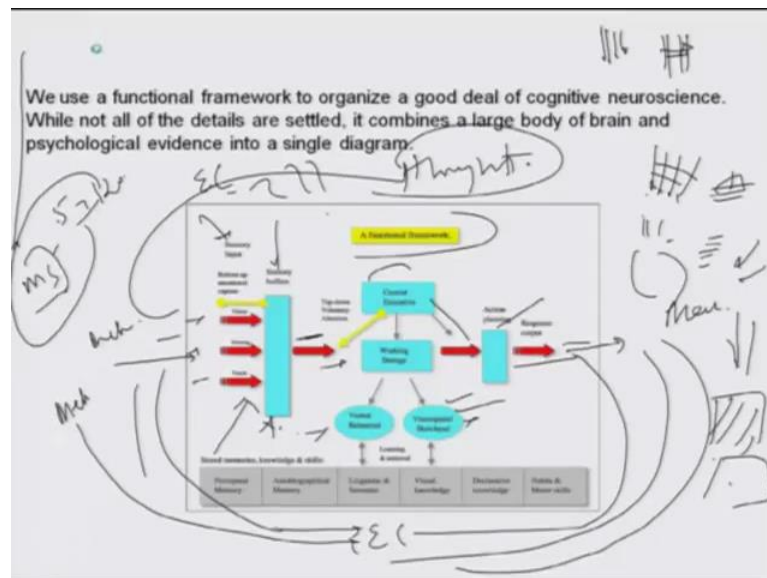


How The Brain Creates Mind
Dr. Alok Bajpai
Department of Humanities and Social Sciences
Indian Institute of Technology, Kanpur

Lecture – 13
Cognition and Emotions 3

Continuing from the last lecture, we were talking of network and probably got a good idea about how the receptive field increases from a small stimulus. By the time it reaches the brain things have already changed and that feed backs and all.

(Refer Slide Time: 00:31)



So, this is like a functional framework, just to broadly understand; there is a sensory input here vision I told you about the when we were talking about the whys and neurons are different very receptors are different hearing because they have to catch different type of energy transfer touch. So, sensory buffers, these are sensory buffers are what your sense organs. So, what happens this is a perceptual memory what you have seen top down voluntary attention these are functional framework.

So what happens, there is storage, these are verbal rehearsal, these are visual special sketch pack, it goes to central executive, central executive decides on action on planning,

and the response on output. So, mechanical energy comes in the form of a touch your brain finally goes to all your leprosy chemical activity what I was telling you. You response your movement probably is going to energy cycle completes broadly, ends it does not happens I am just giving an idea, but what happens if there is no response output, what happens of what comes and goes through thought.

So, this conversion of mechanical to electro chemical to again mechanical, wonderful linear; what happens to mechanical, electro chemical, and thought - big questions. We do not know. Now you see this world viscous special sketchpad. There is, when we talk of language or speech when you are talking observe it carefully, I tell you anything I say pen, you think about the pen in your mind, you know two processes are happening one is P E N, it will always get formed in your brain and if you are speaking pen then there is oral sketchpad.

So, there is a visual sketchpad which is even where I have been speaking, I said speaking, but my mind has already spelled S P E A K I N G. So, when I am talking there is oral output, which is a sort of audio sketchpad, but simultaneously there is also a visual sketchpad which is also getting activated. Normally we do not realize because we are so lost in speaking that you it is very difficult to dissociate your mind into two speech and all, but the there is a thing.

When I am saying there; T H E R E is happening in my mind. Probably, this is the problem of network which happens in dyslexia, lot of dyslexic kids will write what they are speaking. So, may be when they are learning the pattern of that spelling is not formed. Now where are these spelling should; I will stop here for a minute. It is appears very rosy, but it is not so rosy and that is where quantum physics and rest of the things have stepped in. Non-linear we know that fine the lots of input happen the sync processing unit can take all the data and create another dimension that is fine there is a lot of non-linear process that happens in the macroscopic scale.

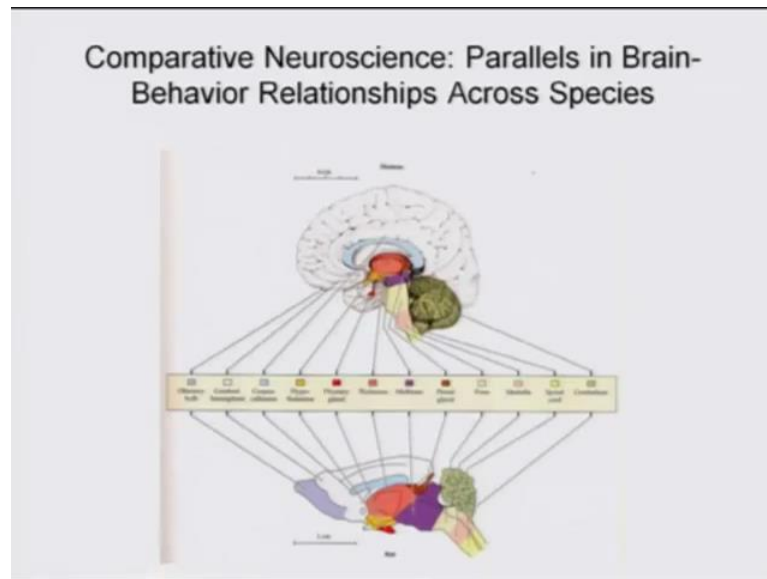
But people have talked of quantum processes in the brain both at the level of microscopic tables and at a higher level. The higher level the problem is that the problem is that the scale time is in milliseconds 10 to the power minus 3 , quantum processes happen at 10 to

the power minus 12, minus 15, that gap of 10 to the power 6 to 10 to the power 8 is still we do not know, but still it is very very alluring thing. Because, what we cannot explain is that when stimulus is going in all the nerves carry discrete information and the cross connection between the neurons are not there. So, these are neurons discrete information, carrying feature excisions they are not cross connected, they are only connected through network. So, this discrete information again combines to form a unitary image that is one thing that we do not know. So, this whole network thing does not explain this.

Second, if there is a definite number, definite station for every set of information then the brain will reach such variation and sealing very soon although, if you calculate it even if 14, 20, 15, percent of brain is utilized it still it can store billions of information, but theoretically and the third thing which is very important is again that associative learning thing once stimulus is gone in it has formed certain memory stuff that, same stimulus is never presented in the same discrete way it is never so clear, but it still stimulates the same energy. And the forth thing the rate of transmission is in milliseconds at least.

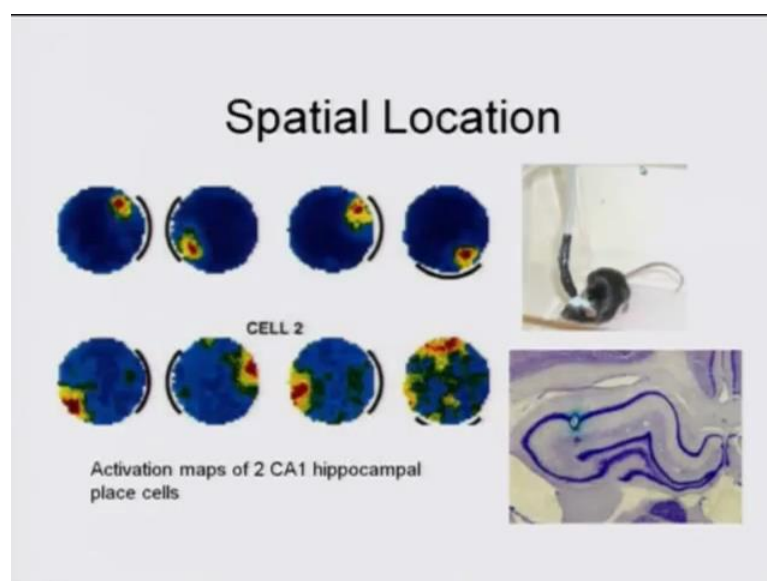
So, milliseconds point 5 to 120 meters as I told you in axons this can still explain the physical part of it that you see and you act you listen and you act what about the thought as I told you if I ask you to think you can immediately close your eyes and think about your grandmother sitting in the village, but if I ask you to send a signal reflected from her face it will take a lot of time speed of light, thoughts, what is it that is carrying thoughts is it a counter field we do not know, we really do not know. So, that is the big problems which, which happen when we start talking about and that is a lot of new physics has come in what has come in the lot of new physics about quantum and so, these questions which arise while we are translating our understanding from the neuronal level to.

(Refer Slide Time: 07:31)



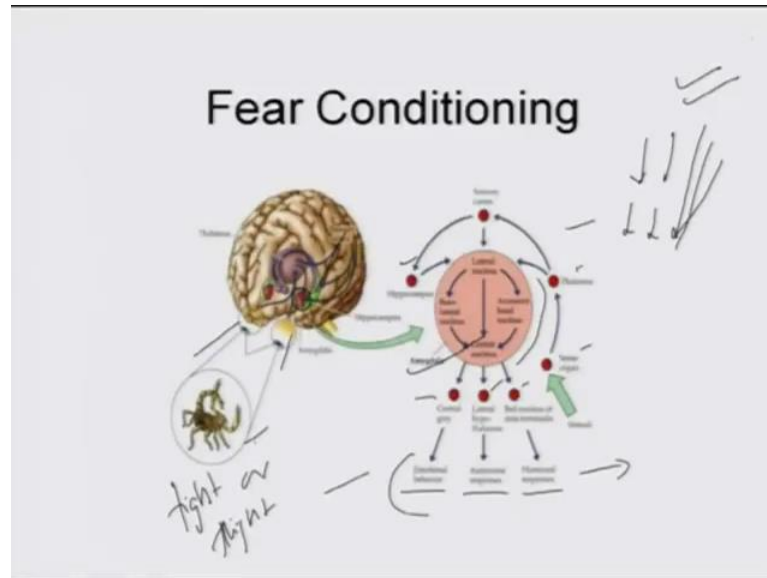
That behavior level which is not a new hole, new branch called transnational neuroscience has come up translating from the lab to behavior, they are trying to connect all these, but still there are huge gaps because as I said this is a hard problems are there this is just a comparative parallelism brain behavior relationship across.

(Refer Slide Time: 07:53)



Species lot of slides which may sound out of place, but they will all add up to it I told you about the neuronal.

(Refer Slide Time: 08:03)

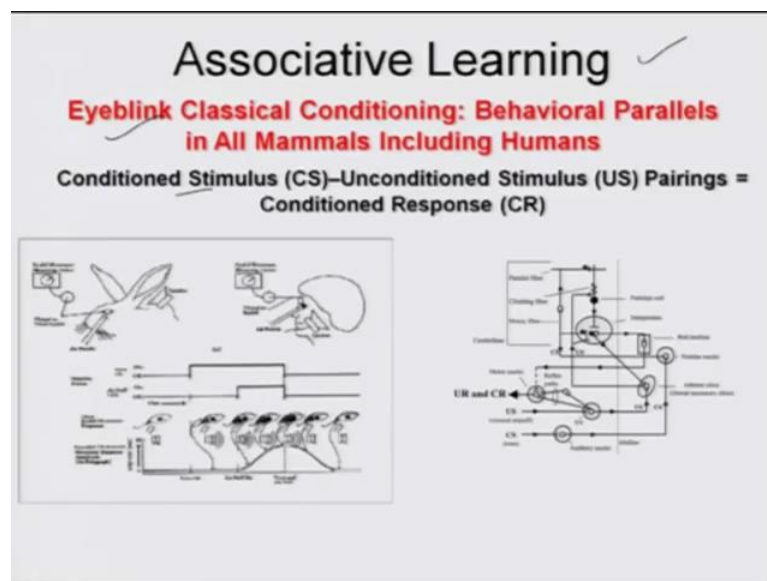


Take an example, take an example, of this learning in fear, you see this crab or it is a spider you it goes through the eyes image, it goes through the sensory cortex. There is area called Emic Della, which always gets stimulated at the prospect of fear or threat to it and. So, this is the this is the whole imagery, this is the emotional behavior which comes up there is autonomic response of controlling your swat, peopleary dilatation, like by sympathetic or parasympathetic nervous system or your tummy going into more action or sweating or trembling there is a hormonal response by (Refer Time: 05:55) also re stress hormones may go up these are a type of brain activity. So, gravia, hypo-thermal, bad nucleus, sense organ, thalamus, everything is got activated.

So, one simple response of some dangerous thing like a crab coming into you evokes not only a visual image it evokes your Emic Della, which gets ready for a response, your hormones, your emotional behavior, and what is an emotional behavior if you must have heard of fight or flight these are psychological theory of emotions. Now, when it comes to emotions whether you feel a bodily sensations first and then you feel emotional or you feel emotional and then you feel bodily sensations or something happens to your body

you feel emotional and there is nothing called fear it is your thinking which makes it fearful they all sorts of theory are there right from James, as to singer, cannon butt, and for the derivatives like this that bodily changes happen you feel emotion or you feel emotion that is why bodily changes happen or basically, you are having some feeling and you give a cognitive appraisal to it and then you feel still not resolved some understanding.

(Refer Slide Time: 10:33)



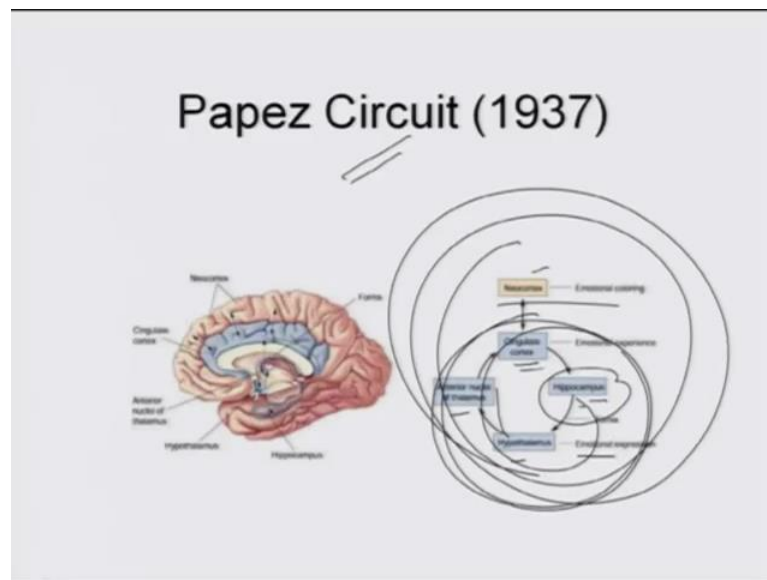
So, this is the associative learning I was to hop field network and habien. Like, eye blink you how Why do you blink? Because stimulus goes in and it will goes like this. So, that is the stimulus which is conditioned famous Pavlov thing associative learning a dog would salivate even at the bell that was associative.

(Refer Slide Time: 10:55)

Emotion: Normal and Abnormal

This is a Philip, which people get which lots of behaviorist people call it.

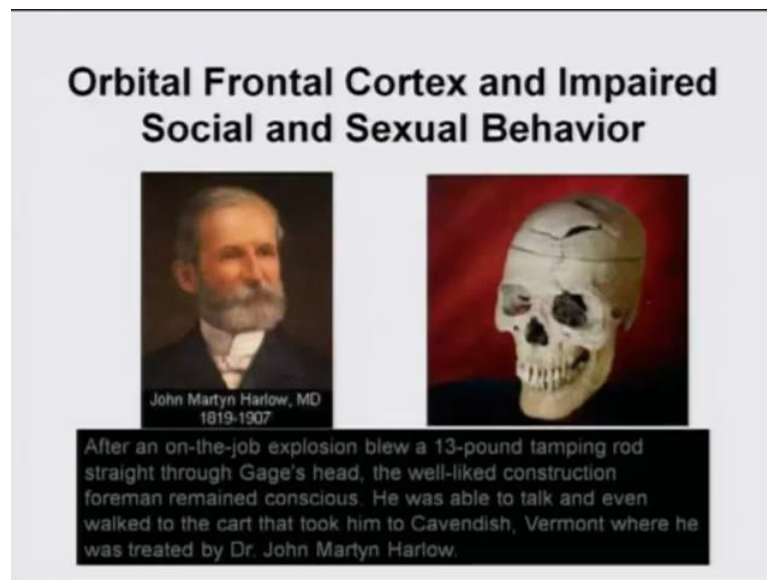
(Refer Slide Time: 11:03)



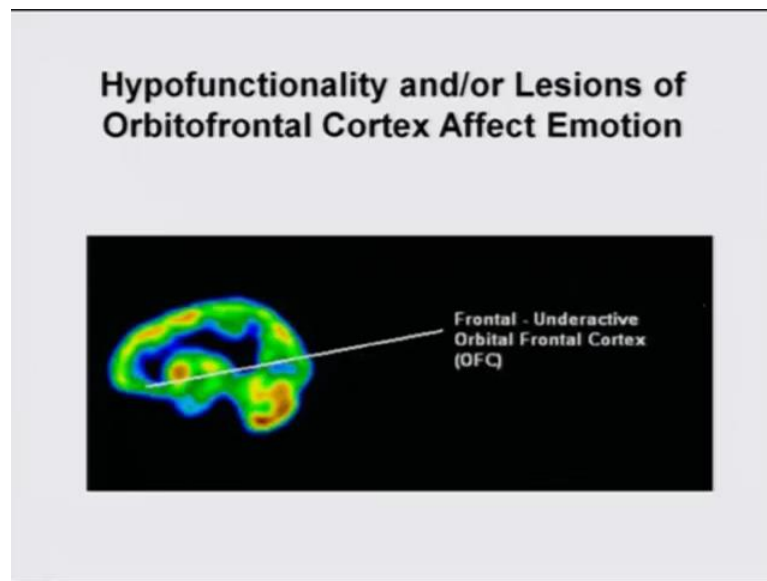
Papez circuitry is the circuit this is the circuit neocortex which are higher thinking ok. Cingulated cuirass, nucleolus thalamus, again thalamus, hippo thalamus, hippo thalamus this is the circuit where the emotional firing goes on and this is where learning also goes

on the Papez circuit, if it gets destroyed your immediate learning and emotional learning will go on. So, learning does not always go on with lot of thinking what you. So, lot of your thinking which goes on into your network is also emotionally colored because, these circuit singulate gyros, hippo-campus is the place where learning happens this is where reverberation repeated firing makes the whole thing get into more stable type of learning, but it is always colored with emotional expressions and emotional colorings. So, this is the essentially the limbic emotional circuit.

(Refer Slide Time: 12:10)



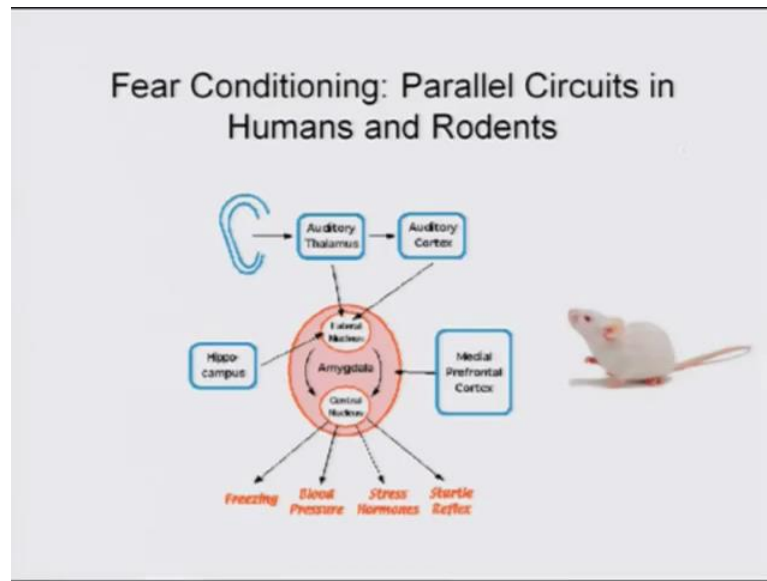
(Refer Slide Time: 12:17)



You remember, I talked to you about Phoenix Gage in the initially, how his personality changed. So, we still find. So, the whole debate is whether, this deeper area of brain is totally responsible and the higher thinking is not colored by emotion, but we are sure it is not so because, when this person was damaged with the tamping rod which went in he showed changes in sexual behavior and social behavior lot of which is not always cognition and well thought of and damage was in the frontal lobe that was probably a sign we still find people who have depressed some M R I and E G changes in the, in the brain.

So, hippo functionality and regional or lesion of orbit frontal cortex affects emotions. So, this thinking that the emotional brain is deep inside and the thinking brain the cortical brain which is make decisions, abstract judgment, it is not involved in it and not always true there is under active orbital frontal cortex and this affects emotion.

(Refer Slide Time: 13:25)

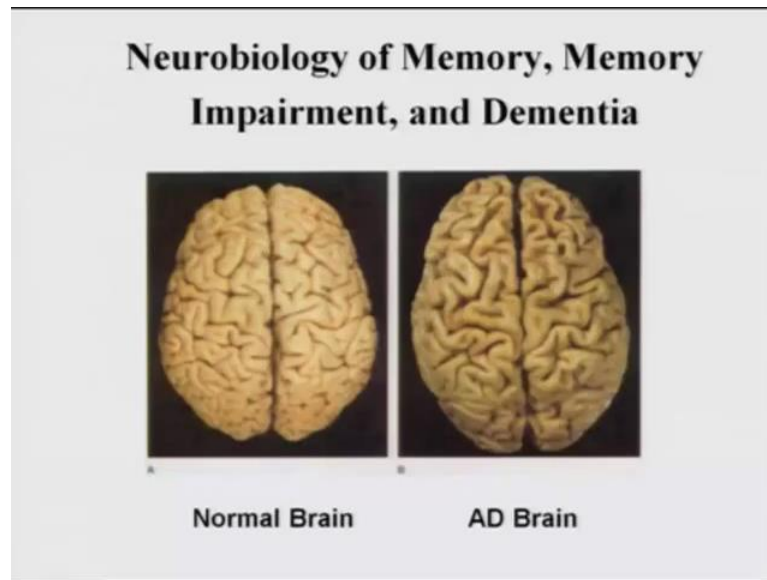


How do we know it? We know it in the people who had damage to the brain and by studying rats I told you it is the same answer. So, auditory cortex, auditory thalamus, medial prefrontal cortex, hippo-campus and this is the Emic Della and you know what happens in a fateful situation you freeze, your blood pressure changes, your stress hormones changes and startle reflex you are going in a dark and somebody suddenly, comes or somebody sitting suddenly go and touch they will go like all kids have when that new born kids we will touch them they will suddenly do this that is the startle reflex, which is a primitive reflex, when you are born there are a lot of primitive reflex one is a like grasp reflex or you put something they will always rooting reflex all these reflexes are covered when the brain matures.

So, you normally do not have it, but in situation of fear you go back to startle reflex when old people when the brain is thinking in dementia lot of this frontal things come out like, other something called perseveration comes out, you will ask one question and they will say something what did you eat food where did you go they will keep saying food, food, food, why? Because brain when it was evolving it was firing again and again to learn, so that is why you find it. So, difficult lot of people will say this kids do not listen, then we tell them not to do it, they will do it again and again, you know they are not doing it again and again, their brain is doing it again and again because they find it

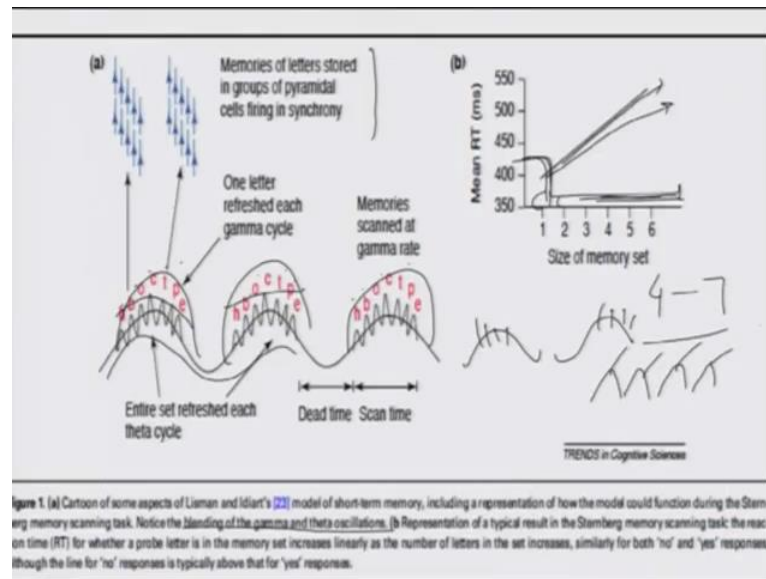
activity pleasurable the brain has to keep doing to learn to make and consolidate that the solid knowledge in the brain.

(Refer Slide Time: 15:24)



So, that the next time they do not form alter. That is what I was telling you about dementia this is a (Refer Time: 15:25) this is a brain which is shrunken and as I said the brains grow till 16, 17 years of age in this anaptions then, pruning starts then they actually start shrinking right from very early in like for some people the process is faster.

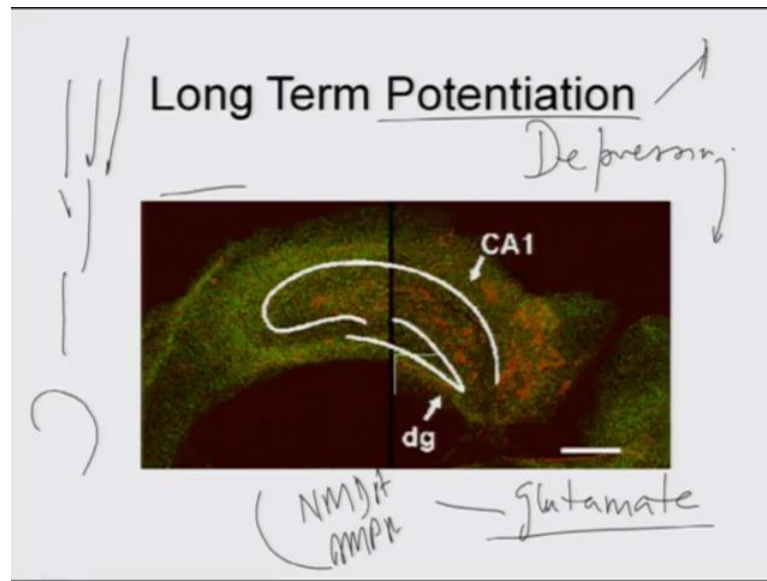
(Refer Slide Time: 15:38)



So, if you remember I told you this 4 to 7 hours riding over this is the type of stuff it happens. So, suppose you take the letters, memories of letter is to groups of pyramidal cells fire and sick running for example, one letter refreshes each gamma cycle this is a gamma cycle at 30, 40 heights right and these are like 4 to 7 herds see 4 to 7 rub approximately, 1, 2, 3, 4, 5, 6, 7, 1, 2, 3, 4, 5, these sets of 7 things are almost integrated see each gamma cycle is a possible type of uncoding which is going on and these respond through the cells, the pyramidal cells in a pocampus. So, every time this cycle comes in a recall they will keep firing. So, this is a blending of gamma and theta oscillations.

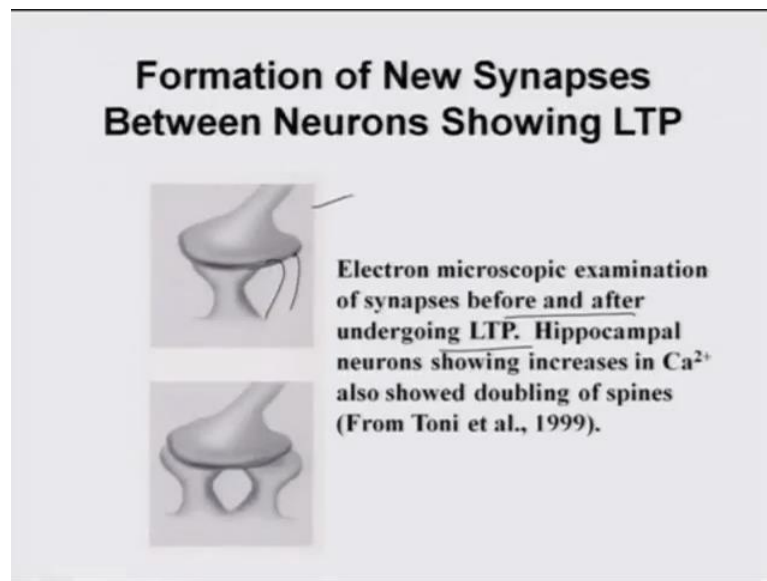
So, this is rebinstation of how model could be working like see if the reaction time shows in scanning task increases, as the size of memory set increases. So, they may if there is 1 word or 2 words you can recognize this faster as the number of size of memory set increases, the reaction time to give a single letter increases because, the brain would be scanning that set to recognize one, but the interesting part is, it is said in popular psychology and popular literature that brain stores memory in chunks of 4 to 7 or 7 and the theta range is 4 to 7. So, is it possible that each spike corresponds to a letter or one feature of that memory?

(Refer Slide Time: 17:46)



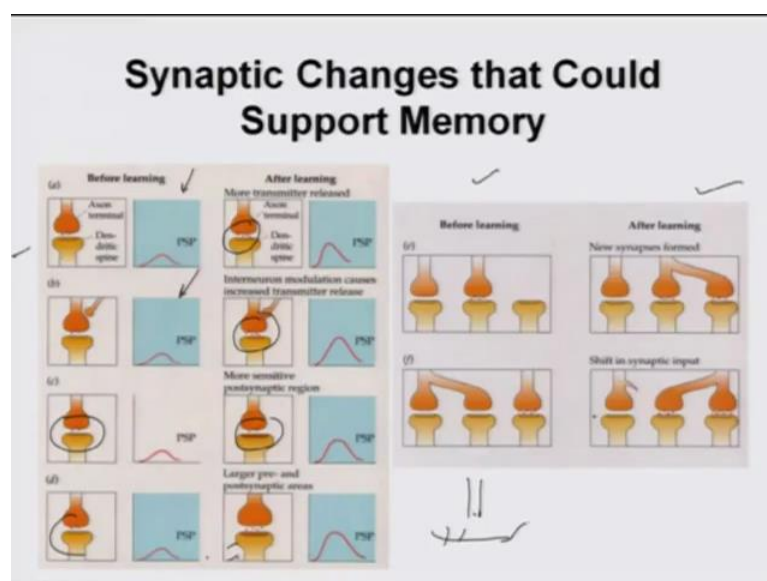
But taking it further it is not about electrical activity the chemicals switching again steps in there is something called long term potential and long term depreciation potentiating, potentiates, the synaptic formation and the increases the possibility of long term storage, where there is depreciation in a bit set and leads to extinction of these things and the neuro chemical which is held responsible is glutamate through its N M D A and A M P A receptors maximally, present in hippo-campus, this is a hippo-campus area C A 1 and all. So, this pre synaptic post synaptic firing through habian learning mediated through glutamate gets excited, and this long term potentiation means reverberating circuits with help of calcium, glutamate leads to synaptic changes and that is how a long term memory is formed.

(Refer Slide Time: 18:58)



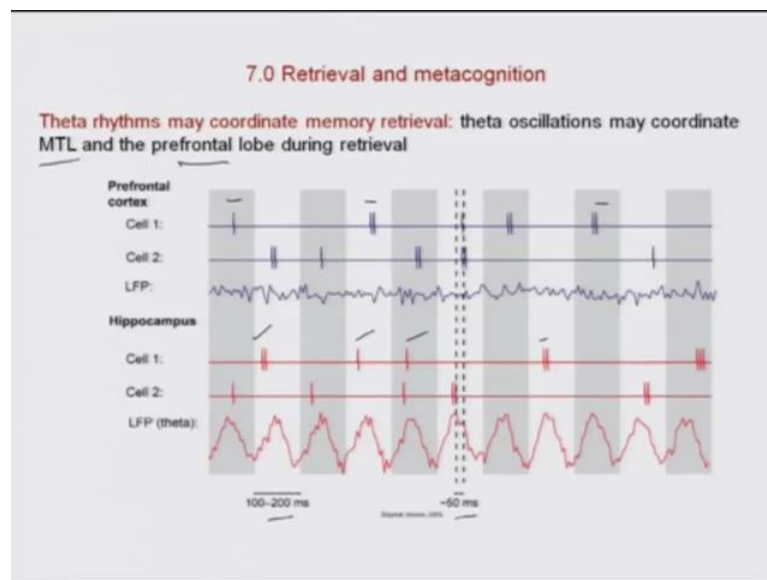
This is how it saying is electron microscopy synapses before and after undergoing L T P hippo-campus neuron showing increase in calcium also showed doubling of spines. So, this is before long term potentiation and this is after it. So, there is a definite change in the shape if you see it and once it is done it is done there is a long term memory.

(Refer Slide Time: 19:20)



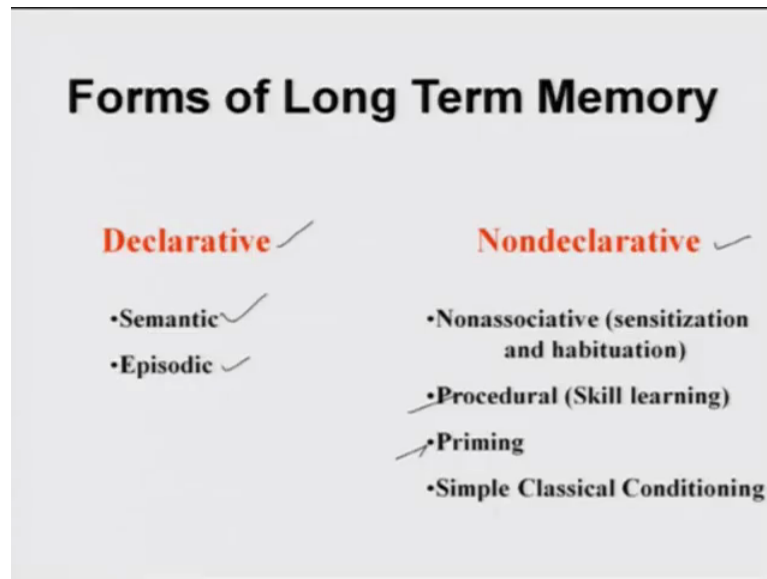
These are the synaptic changes that could support memory before learning see it (Refer Time: 19:25) then (Refer Time: 19:27). So, the changes in synaptic are actually what is happening is that that tree of den droids that you saw the way they connect with each other. So, there is a P S P post synaptic potential and see there is a chemical secretion here right. So, what happens after learning more chemical secret it more chemical, then more sensitive the post as the chemical comes in so there are larger post and pre synaptic s areas? So, this is before learning and this is the new synaptic s that are formed because, the more chemicals are degraded. So, more areas require to teach them. So, more areas unfolding goes on this is how synaptic changes.

(Refer Slide Time: 20:18)



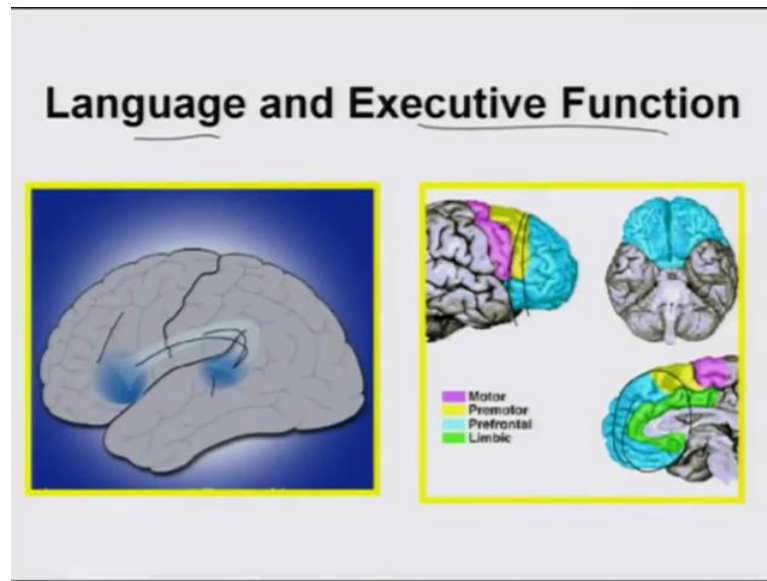
So, as I said I told you about the theta rhythms. So, all this is mediated through chemical gating, glutamate and gaba which is the inhibitory part. So, if gaba is more active long term depression will happen, glutamate with calcium. So, theta how to how do you retrieve in C, A 3 area of hippo-campus through habbian things this synaptics through C, A 1 recall may happen because C, A has a feedback system through almost has a triggering points or copy of the memory, but these things which you see these spikes. So, may coordinate medial temporal lobe which is hippo-campus and the prefrontal lobe which is the thinking brain. So, the activity between these two helps in recall, at 50 milliseconds at 120 milliseconds or 100 to 200 milliseconds.

(Refer Slide Time: 21:33)



Now, if you translate this into behavior, what type of memories do you see? A declarative memory and Non-declarative memory - Declarative Memory: is like all as a personal type of things the episodes in life, the meanings of the things, which you have allow actually incorporated in your brain system, procedural learning is skill learning, which is a deeper part of Basal ganglia which I told you in Cerebellum which. So, there are a lot of imprinting and lot of motor movements everything has gone through this priming and classical conditioning as we have talked about.

(Refer Slide Time: 22:14)



Now, almost connected to memory and when we are talking about the visual sketchpad and the auditory sketch pad while we were speaking. So, the big question comes what is thought? Action you know is thought language do animals think or there is something called thinking in pictures how do artist think they draw, how do musicians think not the lyricists, but somebody who creates music how is their mind creating music is that thought or is it different, music is different from thought, painting is different from thought, visualizing is different from thought, or they are just ways of thought and also as one of my friend just reminded me is that thought also we do not know what we cannot show thought in a concrete way, but thought changes your mood.

So, this whole question whether this limbic area which controls the emotions and the thinking area does not control. We talked about phrenology when I said that he got injury in frontal cortex and he developed sexual behavior and emotional lability and all. So, damage to the lateral part of the brain, this lateral part of the brain this part causes a different personality and if there is a damage to the internal part of frontal brain there is a different personality which (Refer Time: 23:54) pseudo socio-pathic, which is like an anti social personality and Pseudo depressive it is like depression, in depression there are change in metabolism and frontal lobe which and depression is sincerely a mood disorder, in mania so it is said that if somebody has a stroke a cerebral vascular

accidental, blood supply is hampered, the more neared to the it to the frontal lobe on the left side it is the more severe the depression is.

So, if you have on the left side that means what happens. Is the left side suppressed than the right side comes up or is the right side is damaged then there is a depression left side or mania. So, we do not know, so is it that on the left side there is a lesion, there is a depression, that means, the right side is overactive I am just throwing you a question, but if it happens on the right side then the mania comes out you become dis-inhabited. So, is it the right side controlling the left side is they in a reciprocal relationship? So, thought an emotional still remains the crust of the research which we do not have really on answers to it. We know that there are damages which will talk about emotions later also. So, with this memory thing very weirdest language stand and where does executive function stand.

You remember, I talked about the Brocas of aphasia damage to the frontal area this is the temporal and this is like a conduction aphasia they can speak, they can understand, they cannot do it at the same time.

(Refer Slide Time: 25:37)



So, they are unified in attention to attention working memory, generating ideas, initiating ideas, inhibiting ideas, lot of cortical function is about inhibition it means that if the brain damage causes you to be like an animal and you become violent and there is a klüver-bucy syndrome, as of the temporal lobe, bilateral damage, people eat too much, they put everything to the mouth become sexually active, some people are not abnormal, but they are still promised to us they may be dis-inhibited is there a problem in frontal network, is there a problem in the prefrontal (Refer Time: 26:19) which is not allowing them to function properly.

So, the people whom we call social pathos, criminals, for impulsive are they people whose network is faulty there is a risk, there is a huge risk, if we tell all this because then what will happen to the codes of justice, what will happen to the moral values of the society, what will happen to the control, because everybody will say oh my network is faulty I am not yet lost. So, nobody will own any responsibilities. So, for just for these reason we still do not function at the network level because, over that basic network of being like a: animal like or having a basic instinct it has layers conditioned by society where value system, morality, where guilt.

So, these are not abstractums they are incorporated into your basic higher networks. So, whatever you basic (Refer Time: 27:20) network throws your higher networks, your emotions, your safety net, your evaluation of the current situation, makes you decide what you want to do socially because, you have to survive in the society, because of the basic. So, these are all things it goes into we generate ideas initiate, inhabit, plan, setting goals, regulating and verifying.

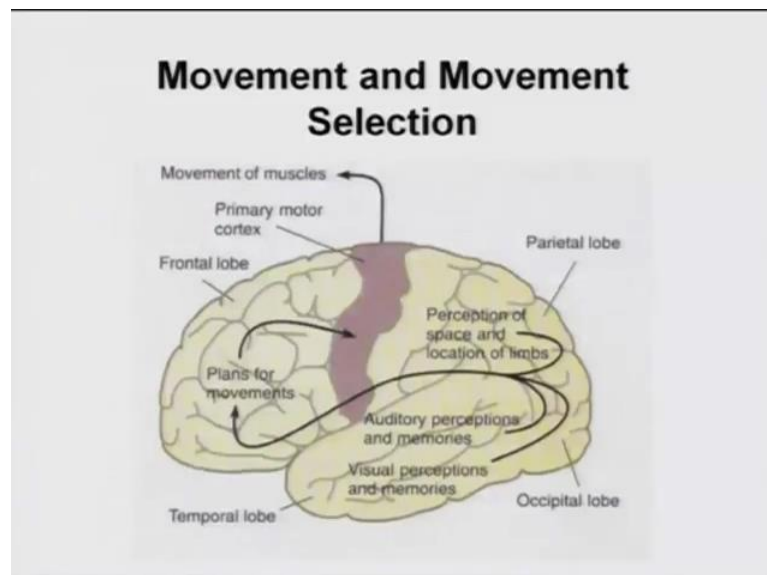
(Refer Slide Time: 27:44)

Dysfunction in Orbitofrontal Cortex

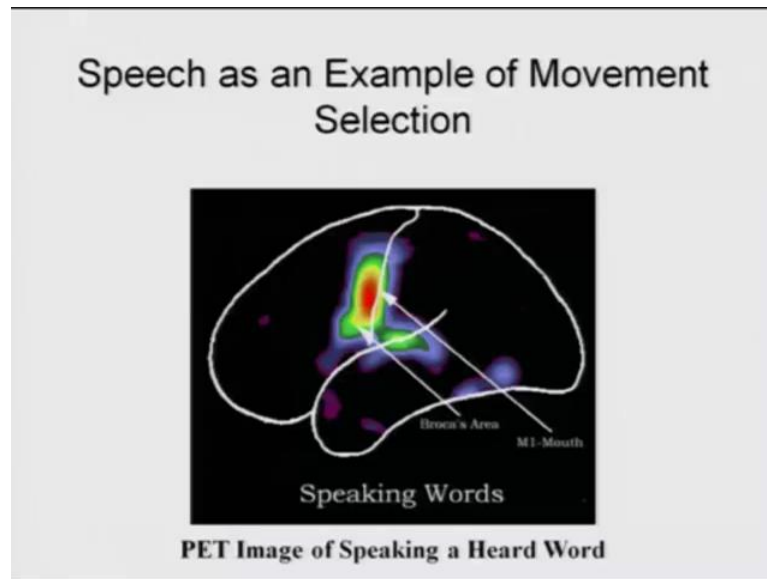
Pseudodepression • Outward apathy and indifference • Loss of initiative • Reduced sexual interest • Little overt emotion • Little or no verbal output 	Pseudopsychopathy • Immature behavior • Lack of tact and restraint • Coarse language • Promiscuous sexual behavior • Increased motor activity • General lack of social graces 
--	--

And obviously, temporally ordering, so as I was telling you this is the type of disinhibition which you see in the frontal cortex.

(Refer Slide Time: 27:51)

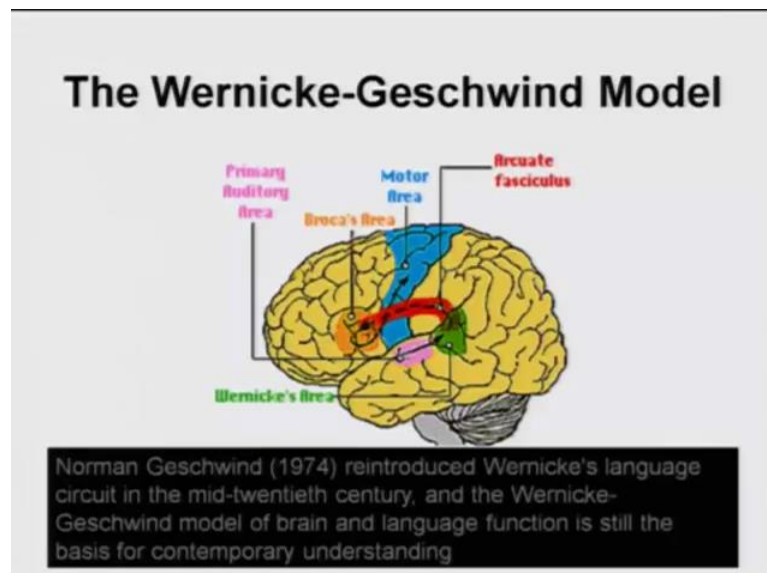


(Refer Slide Time: 27:53)



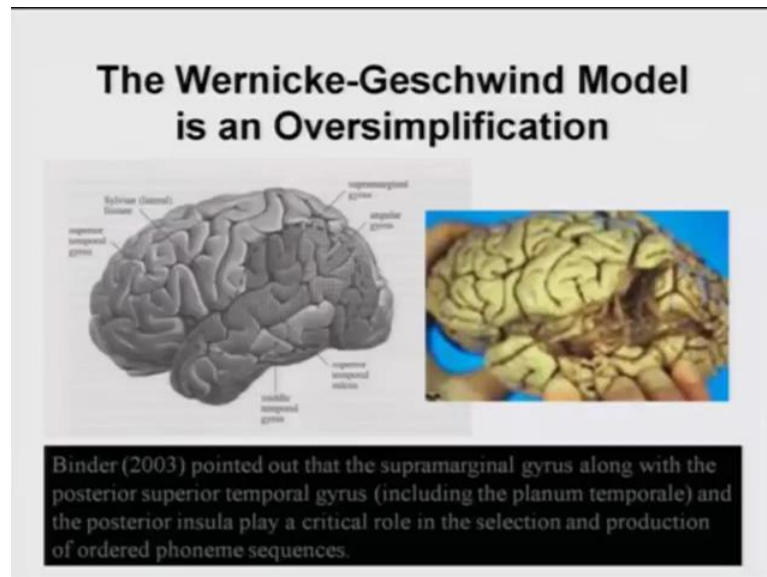
So, we will stop at this speech as I have already told you it is a sort of moment only. So, we will stop at this and.

(Refer Slide Time: 28:02)



Again this is again as I said Brocas areas and (Refer Time: 28:06) also motor act essentially, words are created, they are transmitted to the speech motor area and then you bring it out to their particular system. So, essentially it is over simplification.

(Refer Slide Time: 28:17)



When, I am telling you this there is a huge thing that goes in we learned this and then may be next lecture we will pick up something more about how the brain functions.

Thank you.