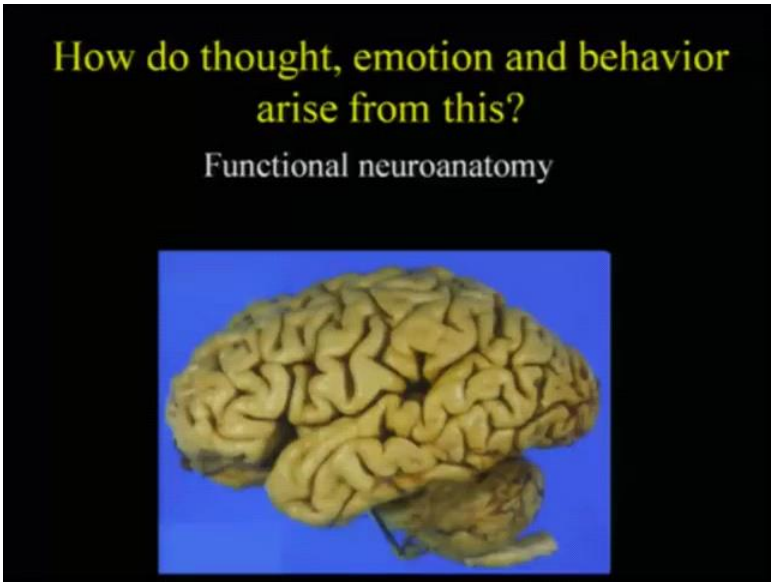
How The Brain Creates Mind
Dr. Alok Bajpai
Department of Humanities and Social Sciences
Indian Institute of Technology, Kanpur

Lecture - 03
Brain-3

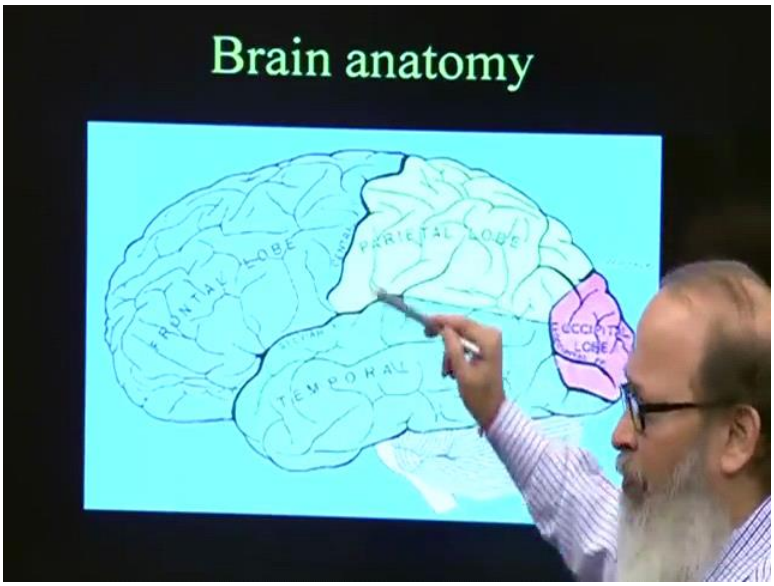
Welcome again. So till now I have shown you the basic brain structure.

(Refer Slide Time: 00:22)



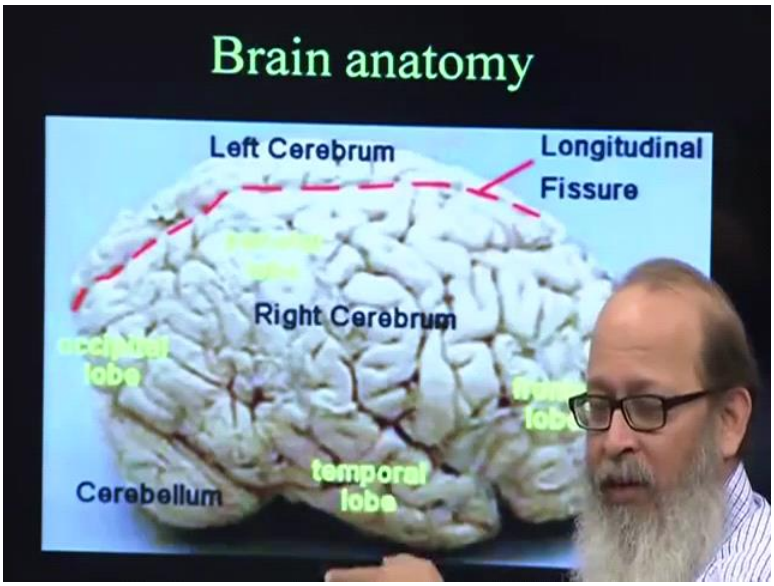
The brain looks like this, again just to reiterate frontal lobe, parietal lobe, occipital lobe, and temporal lobe cerebellum. So, we largely interested in this structure, when we talk of mind all though other parts to contribute, but how does heart, emotion and behavior arise from this.

(Refer Slide Time: 00:54)



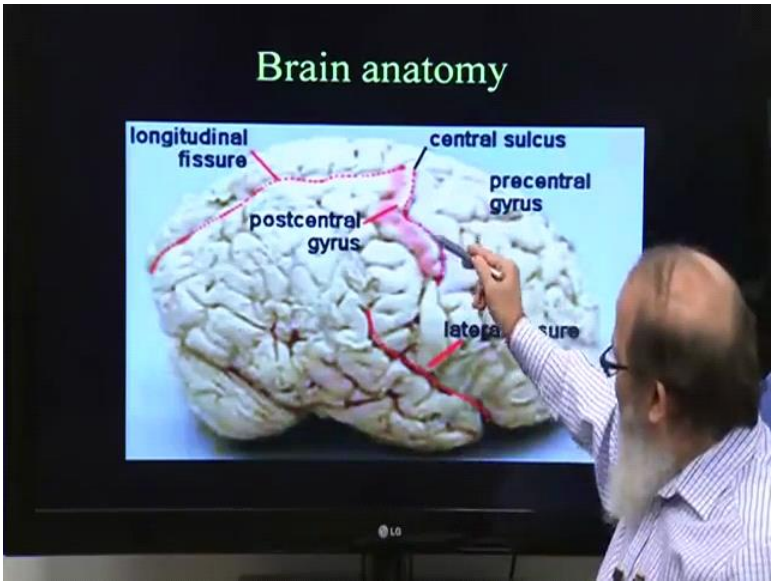
If you look at the brain anatomy, in if you are broadly I tell you the functions of the starting from the top this structure called parietal lobe. This is where all the sensations of the body go, now it has a representation various parts of bodies are represented from the top, like big to has a representation, maximum representation here, the face would be somewhere here, the fingers would be somewhere here, and mouth is somewhere here. So, from top to this middle area; various areas of body are represented. Touch, heat, pain everything first goes here, frontal lobe has a motor area; it is divided by this, what we call as Sulcus.

(Refer Slide Time: 01:56)



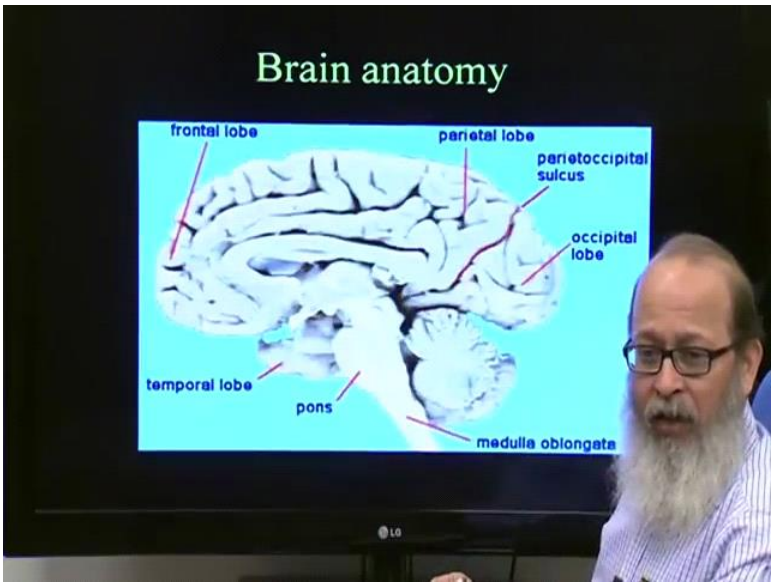
So, brain if you look at the picture of the brain, if you see this, it is a huge structure which is folded. Each fold the top of the fold is called gyro and this divisions are called sulcus.

(Refer Slide Time: 02:10)



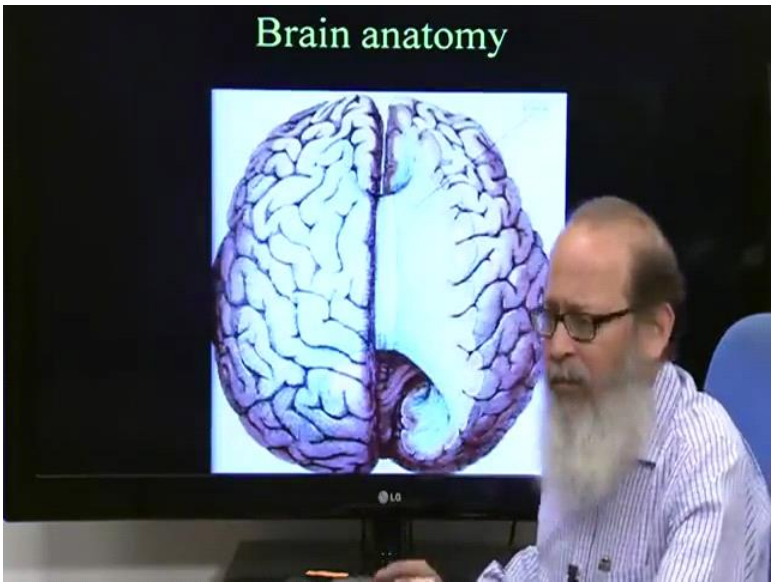
If you look at it, this is fissure, fissure is like a division between the 2; this is another one and that is how the all the lobes.

(Refer Slide Time: 02:22)

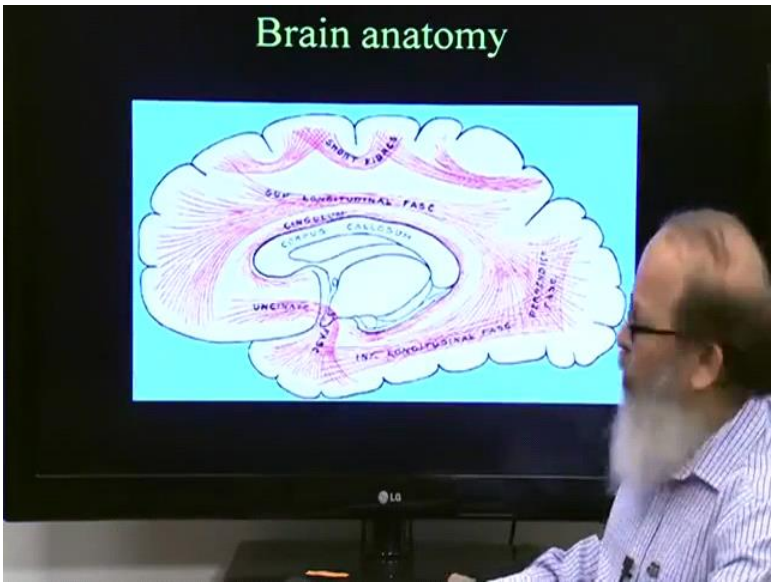


Actually get into shape, if you cut the brain from between, this is one of the hemispheres. So, the frontal lobe is where speech is generated, especially the left part of it; which is called Brocas area. Frontal lobe has motor area, which controls the opposite side of the movement of the body. Parietal lobe is sensation, Occipital is lobe where you see from all the signals from the eye go there to form the image. Temporal lobe is one where memory listening, receiving words; all those areas are within this temporal lobe. Pons and medulla are deeper structure, were the movements of eye ball muscles, the respiratory muscle and all that involuntary control of the body is done from medulla.

(Refer Slide Time: 03:29)

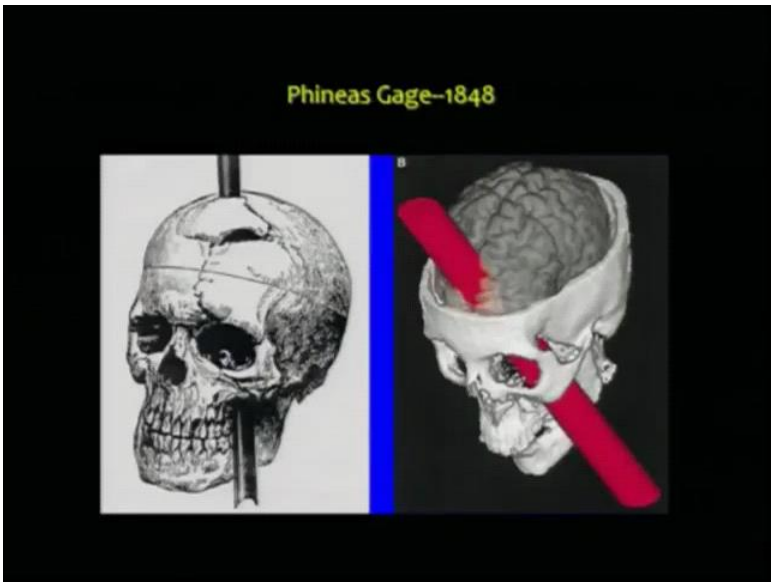


(Refer Slide Time: 03:33)



This is very very broad division I am telling you, if you look at anatomy as I was telling and this is the type of network, which goes 11 neurons have to be connected to each other, this is the type of bands of neurons, which connects its huge it is just a very simplified presentation of it, corpus callous as I told you connects the 2 hemispheres.

(Refer Slide Time: 03:54)



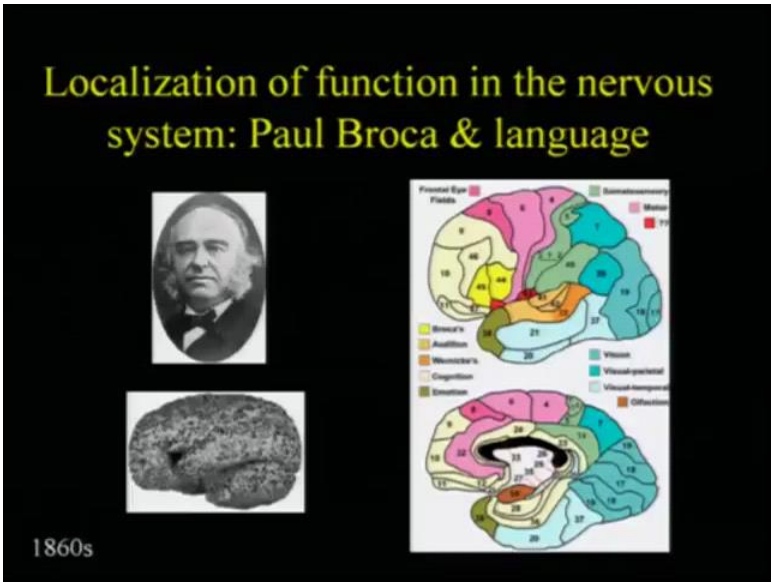
But still it does not tell you, how did we know that these areas have certain function; which does read this name call Phineas Gage in 1848 this he was the gentleman, whose working on a field, and this some this huge iron rod, actually blue of from something and actually went through his left frontal lobe, through his eyes. He sure of died with the type of injury, but he survived, but what was found that, his personality had changed. A man was quite, suddenly became very very explosive; given to anger out, unable to decide, make judgment and then it was assume that, probably this damage to the brain has change his personality; which was indeed so, because future research show that, the damage to this area of brain on a left side of a frontal lobe on the outside, which is the convex area can change your personality.

But if the damage is from within, the different change will happens, any psychiatrist text book will tell you. So, Phineas Gage by it was an unfortunate, but its injury told us a lot. Further understanding came from, this neurosurgeon work pen field. When he was operating in a Penfield patient because pilapsy is a condition, where people get recurrent seizers and some of them are intractable, there we are unable to treat them with medication.

(Refer Slide Time: 05:22)

So, when he was operating, he realize by putting electrical stimulation to certain areas, certain limes will move or certain other action will happen, that also help us and telling us that there are different areas of brain which has different localization of function.

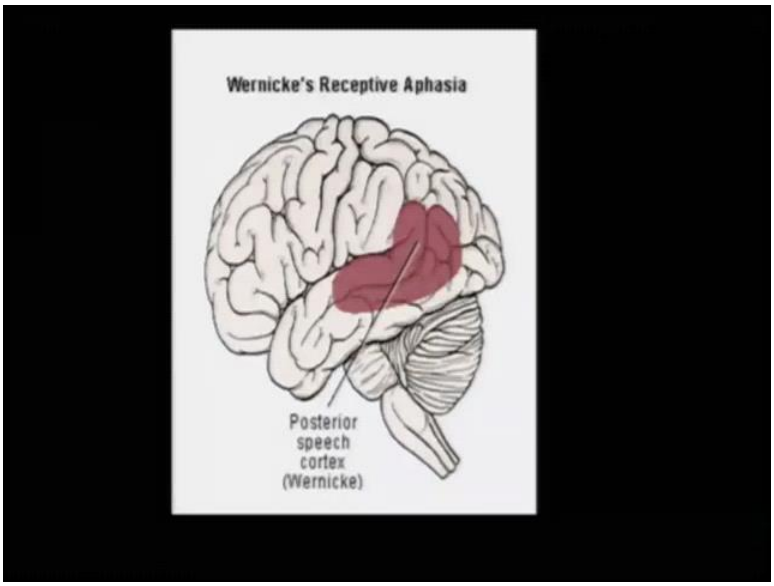
(Refer Slide Time: 05:51)



Another step was in our understanding was on Paul Broca. Broca found that there are certain patients, who have problem in speaking, in expressing their speech or even if they spoke in

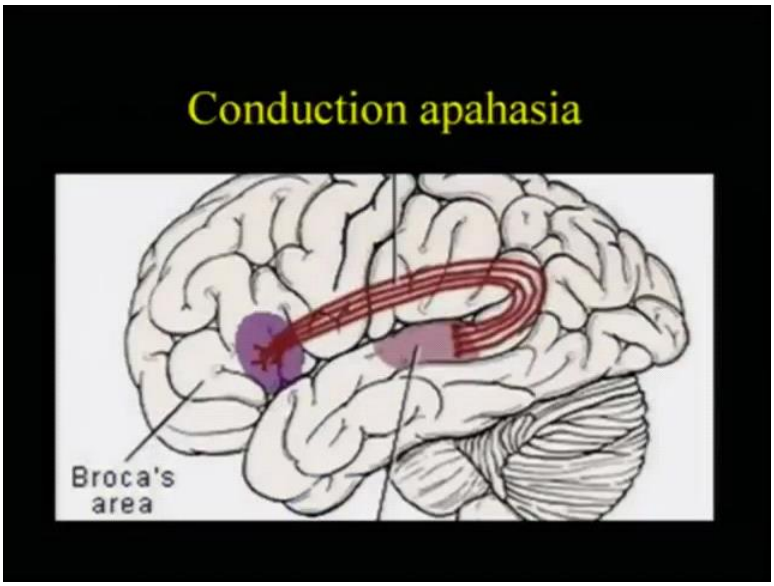
broken language, when this patience were studied way back what they found was that the certain area of the brain like here; this was damaged, because of a problem in blood flow, what you call as stroke or a in (Refer time: 06:30) and this study was more or less consistent, this founding s are very Robass and that let us we discovery of what we now call a brocades areas, it is in the left frontal which is call as Brocas area, and it damaged it causes Broca aphasia, and now we know that even in 90 percent people they speeches situated in this Brocas areas here and is damaged to Broca area we lead to what you call a motor aphasia problem in expression of a speech.

(Refer Slide Time: 07:16)



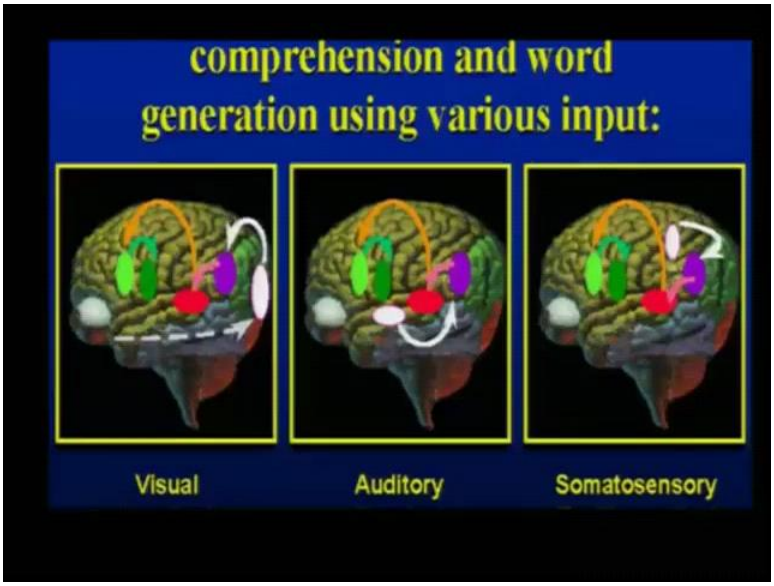
Beyond this, what was also found that, if this damage which was in the frontal lobe happens in the confluence of this temporal lobe, then people can a speak, but they cannot comprehend what was been said to them; that means, they cannot make a meaning out of the world. So, they could still hear from the ear, but they are not able to comprehend with these 2 discovery we it was further strengthen that there are areas localized, but that still could not explain that how do people still understand and reply and write.

(Refer Slide Time: 07:53)



So in some people, it was found that they can speak, they can listen, but still when it they cannot connect and that give us the first idea that they can be networks which are connecting areas, and this aphasia is called conduction aphasia.

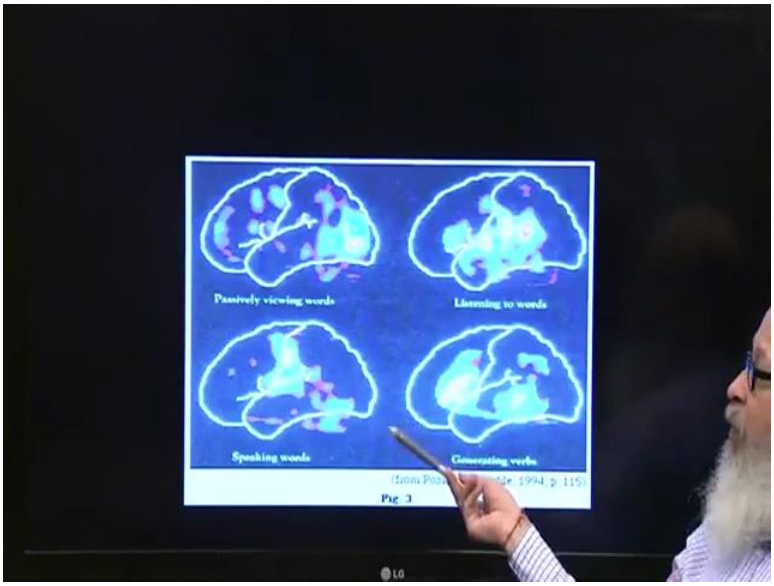
(Refer Slide Time: 08:19)



Now we have the whole imaging thing and I just give an example how the brain really works in the area of our gross motor activity. So, this is comprehension word generation which uses

various inputs and these are the type of areas which get activated. You can see the arrows; the image goes here, then it goes here, then the words are here, it is projected to the frontal lobe which makes a meaning of it.

(Refer Slide Time: 08:52)



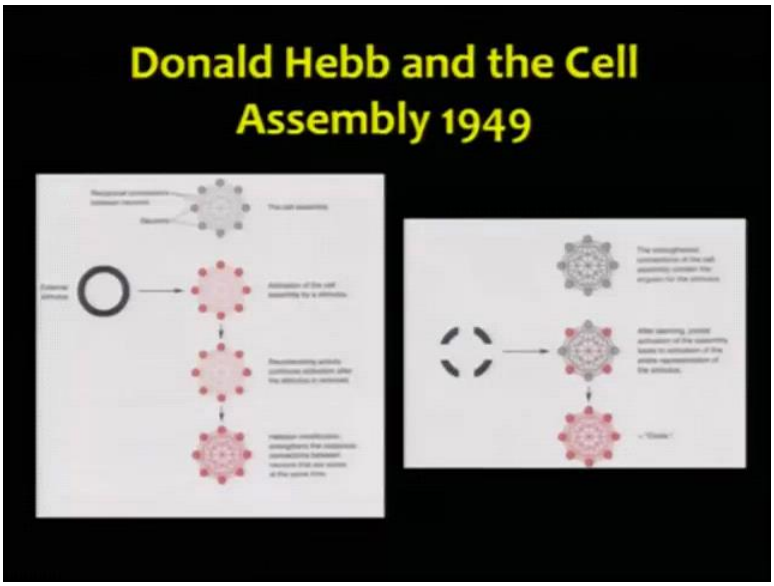
Similarly, these type of network, which work there are the type of areas, when you are passively viewing the words, when you are really not giving much meaning to it. These are areas as I said Temporal lobe listens; this is the frontal, parietal, occipital, and temporal. These are areas which get activated, when you are listening to the words temporal this is occipital when you are speaking the lot more areas get activated, because it has to look into the memory of the word and then reproduce generating verbs.

(Refer Slide Time: 09:31)

So, once people got this basic idea of that there may be connections between the areas then there was whole hunt for networks and connections. So, there I am just showing few of them Lashley was working with rats, rats are very smart actually. In fact, if you look at it whenever talking about whether we have a different form animal they have an indexes which have been used, colin encephalization in index, which is the size of the brain versus the cerebrum, the size of the scull versus, body weight versus, so many indexes which have been worked so. In fact, rats have encephalization, which is almost like human being. So, what is makes the different, is it the size, or is it the connection, let us discover that. Rats are very smart, when they are put in a maze and if the direction of the maze is changed or if obstacles are put in the way to get. So they have to have incentive to move in that maze and go and find a food. So, direction of the maze was changed.

But rats are after training lesions are made like, a stroke makes a lesion in the human brain, tumor or injury makes lesion in the brain, cortical lesions are made. then different location are also show, but rat still learn it, but if lesion is made which is not very specific and it is a larger thing, then they will get lost. It means Lashley said that it is not exactly the point of lesion which causes the problem, it is the size because if this bigger thing it will destroy the network.

(Refer Slide Time: 11:25)

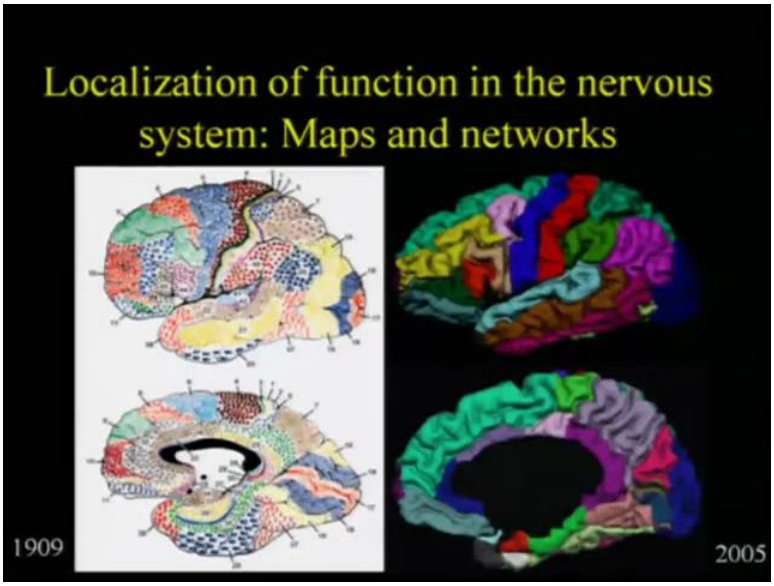


There was idea which Lashley brought out, but the real Philip came in understanding with this 1949 paper of Donald Hebb, which is available on the internet if you read it. Hebb brought out almost like what you there, this you call a network theory or a graph theory in mathematics. He said that we will discuss about Hebb further presentation also, there are connections between neurons reciprocal connections and neurons connect to each other by the function which they are sub serving. So, he brought out famous statement those neurons that wire together, fire together. He was saying a 10 to the power 11 neurons form the connections with each other, not all of them are connected to every at then neuron.

But look at it each neuron, out of this 10 to the power 11 neurons each one of them has 1000 to 10, 000 inputs coming to it. I showed you that axon and dendrite. So, the dendrites of each one of them receives 1000 to 10, 000 that increases the (Refer Time: 12:47) to 10 to the power 15, all of them are not be connected to each other, but each neuron in cortex those 6 layers, each neuron in cortex is just 2 or 3 (Refer Time: 12:59) neurons away. So, from one if you want to say point A and you want to reach neuron say point B so what will have a b and c in between or if say d to j, you will find to 3 each neuron is connected in the cortex trough a network and this is the theory of social networking also, like one of the best theory says, that each per person in a social network is connected to the other just by 6 step by 6 people, any you can connect anybody to anybody through 6 step, similar complicated networks appears in the cortex where each neuron

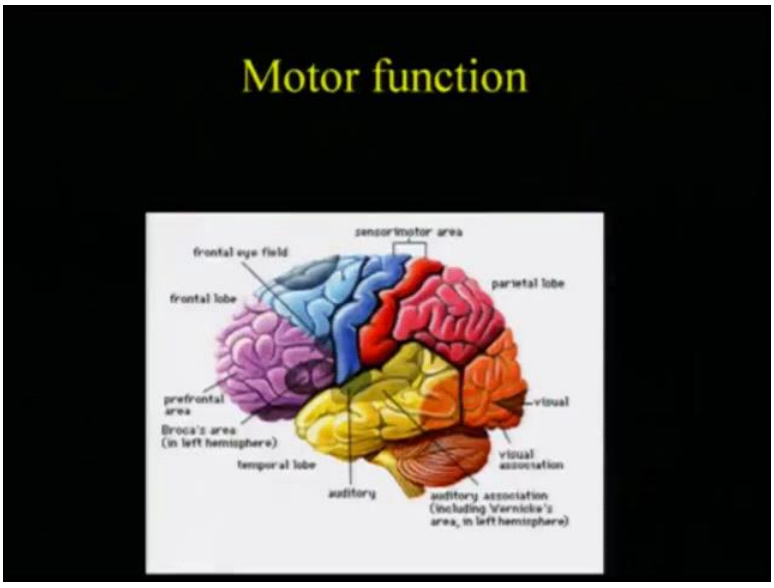
is not directly connected to the other, but each neuron has 1000 to 10000 connections, but if you want to reach from one neuron to another it will be 2 or 3 step. It is a type of network, with braininess form, how and why is something which we have to discover.

(Refer Slide Time: 13:57)



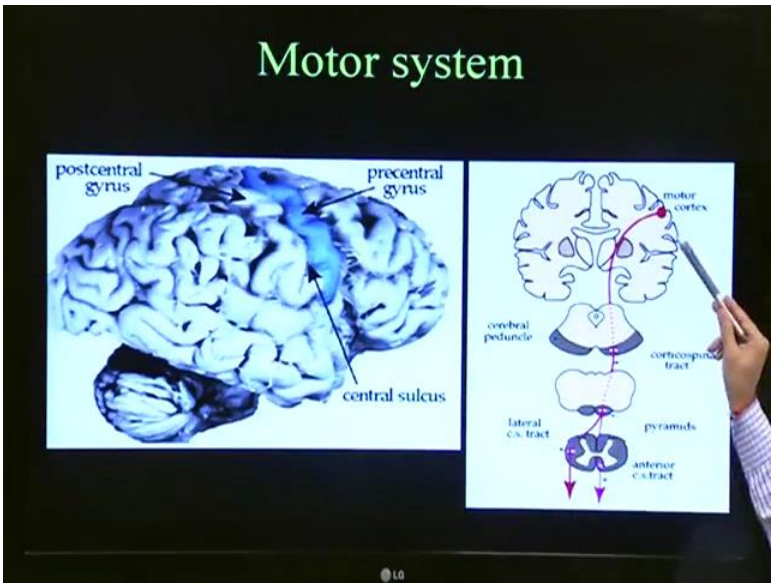
So, broadly it is understood that they are maps, then networks in the brain; this is the type of network which you see.

(Refer Slide Time: 14:07)



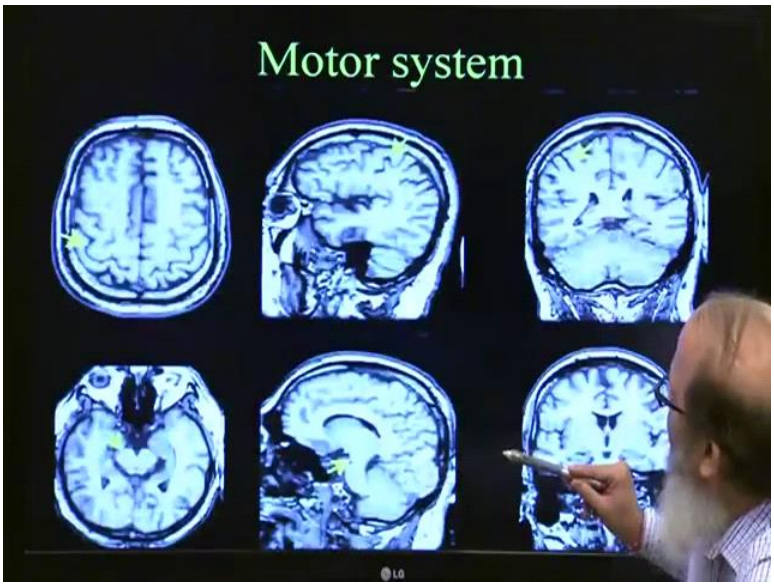
Just to look at one basic before we come to the mind and more (Refer Time: 14:13) and I tell you what are the difference between the mind and the body. Although we say that the structure and function they all entertain, this is the broad thing just look at it. This is the sensory motor area, sensory and motor sensation comes here. So, when I told you the example of prick and we remove your hand, what you do this spinal cord is doing it, but the information comes here; sensations come here, the sensations are processed, the signal is sent to the motor area, the motor area decides whether you have to pull your hand or push your hand in to whatever stimulus is there. Brocas area I already told you this is the auditory area, we are you here, this is the visual area and this is a gyrus, I was telling you.

(Refer Slide Time: 15:13)

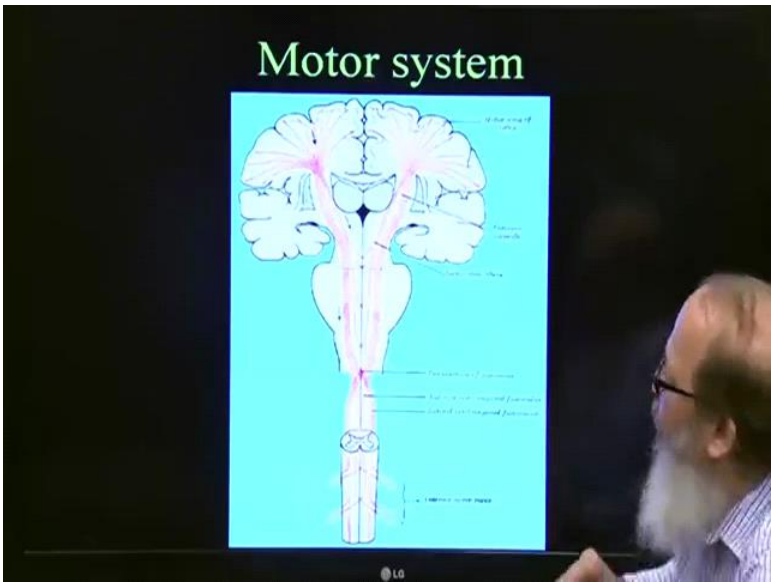


Now, if you just look at this in a simple way, this is the motor cortex in the frontal area signal comes to the spinal cord it crosses, it crosses here and goes to the opposite side. So, this is a type of this is the places were motor neurons actually work.

(Refer Slide Time: 15:43)

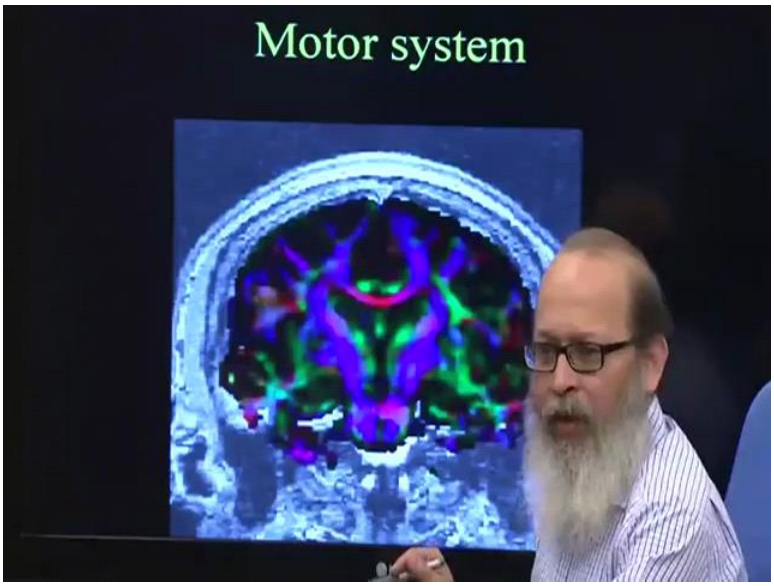


(Refer Slide Time: 15:54)

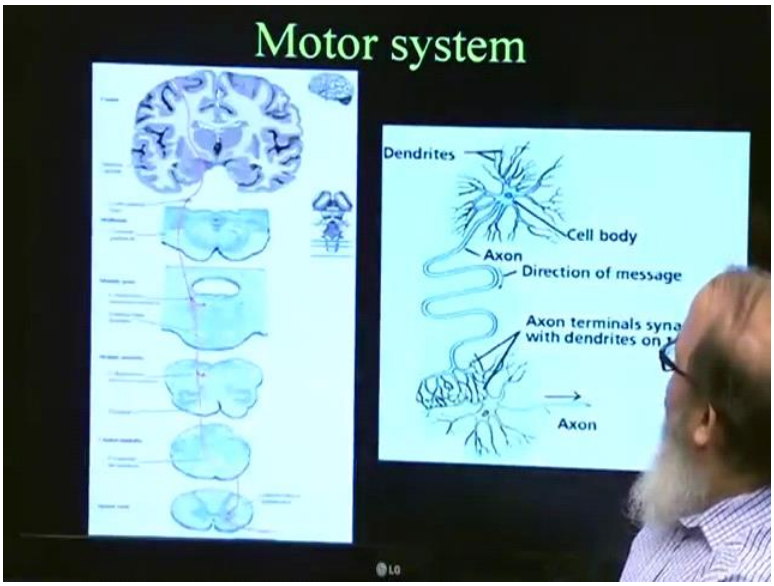


This is the whole picture. So, you saw the 6th layer where the white motor was originating, they form it. Here they come, here they cross here and go up to control the opposite side. The sensations also come there from the peripheral nerves they come up; they cross and go to the other side.

(Refer Slide Time: 16:18)

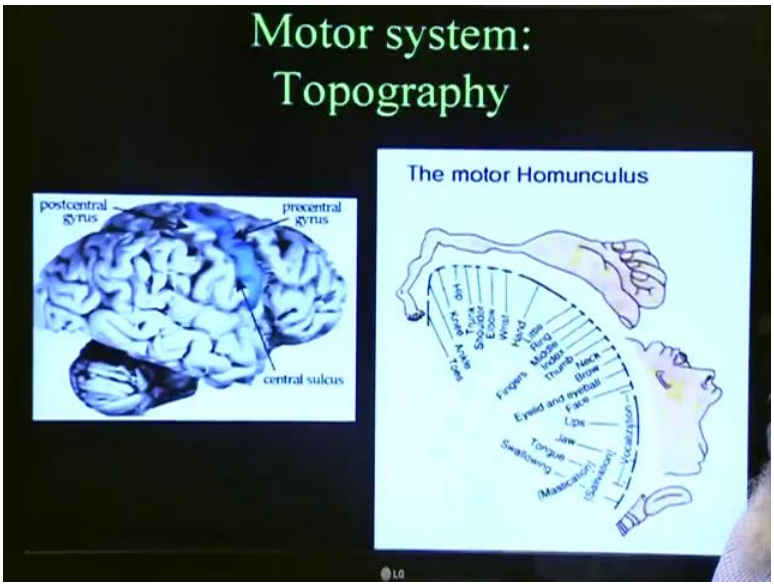


(Refer Slide Time: 16:21)



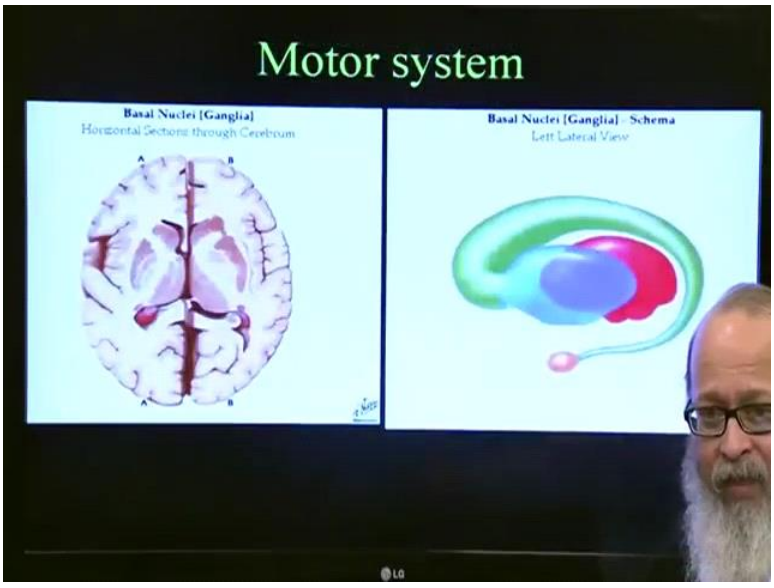
This is another picture of motor area, like again just you see this it is coming from the layer, all through this crossing and controlling the movement on the other side then other picture of cell body.

(Refer Slide Time: 16:39)



This is what I telling you how it is presented in the body, if you look at it; this area, your mouth has this much presentation, your foot is here like it is going deep like this, when it goes like this the whole presentation is here. And these are a body organs you can recognize it, thumb, the hand has such a big representation in the brain, in the sensory areas.

(Refer Slide Time: 17:11)

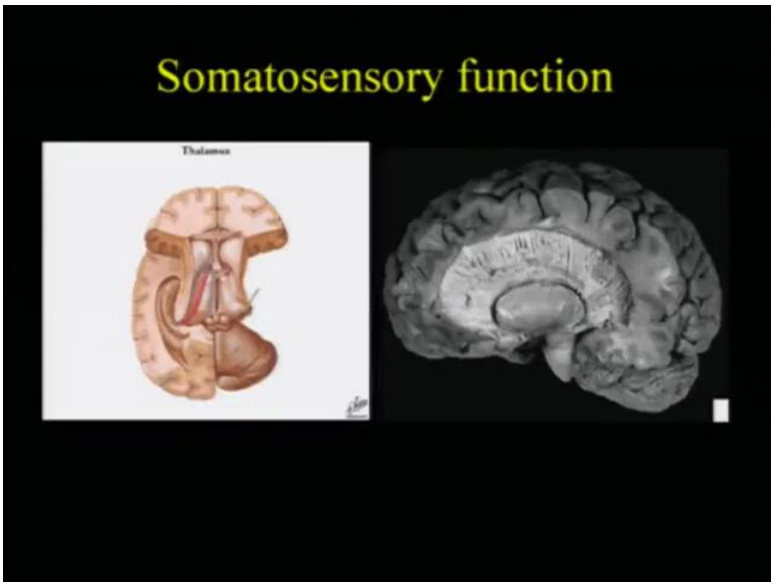


Then there is another structure call Basal Ganglia, which if you if you cut the brain like in this section, takeout slice of a lemon or orange, you will find this structure called Basal Ganglia. Basal Ganglia have lot of structure with in that Caudate nucleus Globus pallidus, Putaman. Basal ganglia are a structure, so this gives you the whole picture and there is a structure call cerebellum. So, this whole system forms the motor system. What is the motor system motor system is what controls your movement; I showed the picture of basal ganglia. Basal ganglia are deeply connected with the whole cortical layers, this is a structure in the mid brain is a structure called Thalamus.

Remember this Thalamus because Thalamus is the coordination center for all the senses which are coming. I will show you in the next slide, Basal Ganglia the structure deep structures, within the brain which are the decision makers for movement and was a common as disease which you would have heard about is Parkinsons disease, were people have tremors, their hands become very (Refer Time: 18:50) it is because of a certain chemical disturbance in the in the basal ganglia, the basal ganglia itself does not generate movement.

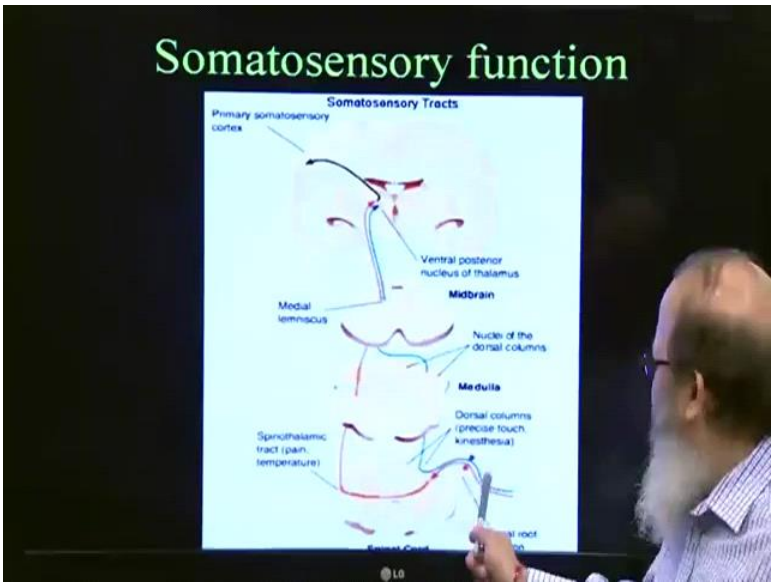
But it is eventually when the decision for movement is made that fine tuning cerebellum is another structure will lying almost at the base, you can see it here a cerebellum is about the fine tuning of movement. So, lot of people who have Tremors, lot of people who have difficulty in walking, if peripheral body is not damage, actually have a problem either in Basal Ganglia or Cerebellum. So, this is about the physical part of it.

(Refer Slide Time: 19:35)



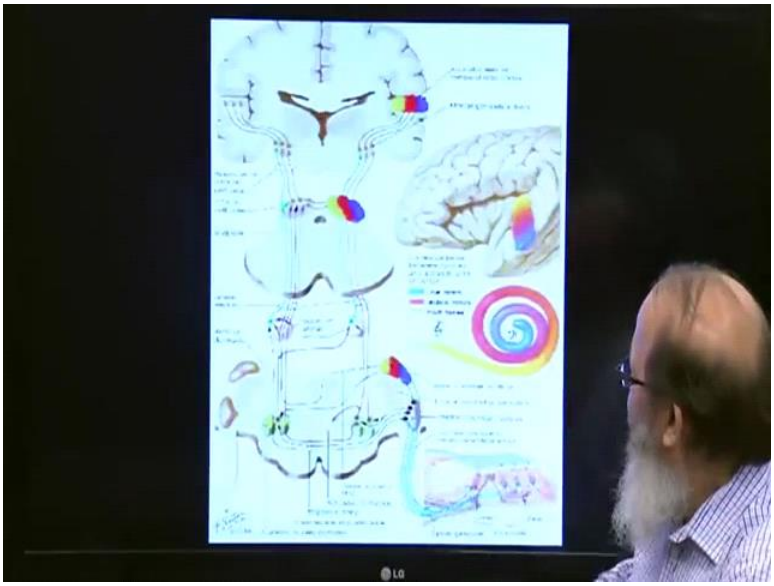
Physical part of it is like this Somatosensory, I was talking about Thalamus, Thalamus is a part mid brain, it is like if you have a huge computer department, you have centralized computer system, Thalamus is not only the rely center, all sensation have pass through thalamus, but all movement have to pass through Basal Ganglia it help the sensation goes to thalamus, Thalamus passes around the Cortex.

(Refer Slide Time: 20:04)

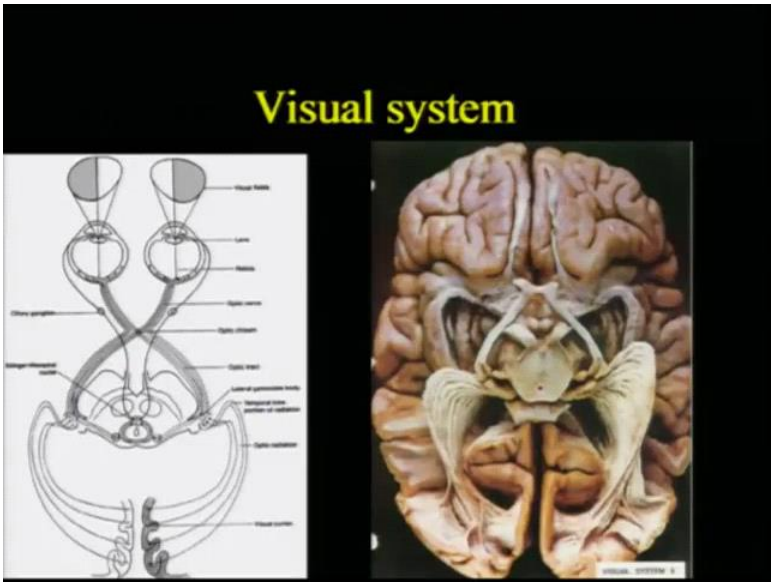


This is the Somatosensory, the sensations come from below and you can see this, it comes it crosses and goes up to Thalamus, Thalamus to that parietal lobe auditory function it comes to the Ear, see this vision.

(Refer Slide Time: 20:30)



(Refer Slide Time: 20:37)



Now, give a second and think, at a given point of time. So, many things are going into your head, the touch, where you sitting, the foot, I am sitting because my body is balanced properly, you are

listening at the video and looking at it because your body is balanced, you are seeing at the video at the same time you are hearing a voice. So, many sensations the temperature, the discomfort, the comfort everything is going in to your head, all the same time and your mind is taking all that at a given point of timing and creating a self it is creating a unity, it is creating you, you who is able to balance all these thing how does brain manage it with this so many neurons firing at same time, not all of them of firing, but suppose when you are watching this video at this time, see how many things happen you are watching your visual system is active, you are listening, you are sitting on a chair all those bodily sensation, your face in a certain balanced way, your body in the balanced way you not falling, your brain is firing continuously to make keep a certain tone in the body. So, that you just do not go flopping and this is how the brain manages the physicality of it.

So, why have I spending time on this, that this is higher function of the brain not the highest function; highest function may be thinking, but now people may this is not a part of the mind, agreed. But if you separate this there will be no mind either you cannot remove your body and really have a mind, because mind is also formed of all these sensations of what is going inside, what you are listening to me, you are listening to your voice at the same time you may have your phone ringing, all these things go on to make the mind. So, people who ignore all these bodily functions, do it at peril of removing a major important part.

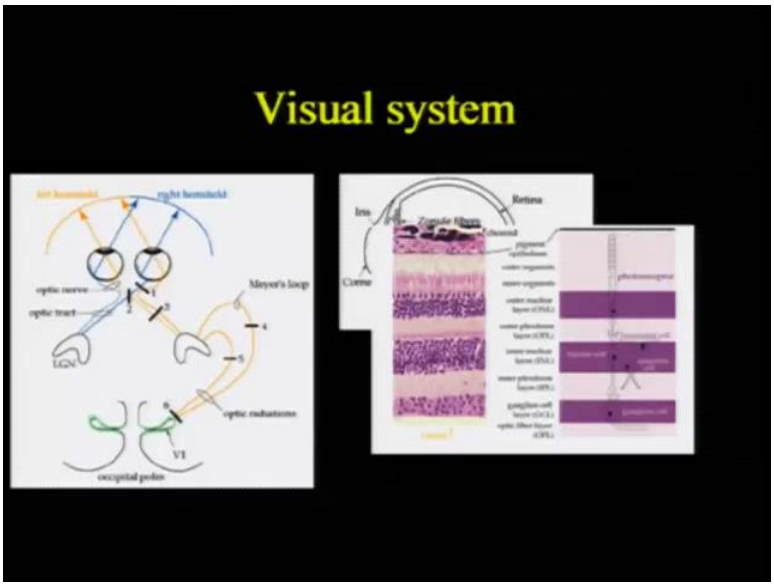
(Refer Slide Time: 22:56)

Now, I would also briefly tell you what happens with the auditory system, auditory system is there is a sound wave is a pressure wave, mechanical wave, it goes with in your ear there is a tympanic membrane, which it the ear goes in and shakes their 2 or 3 bones inside which again take that frequency, and pass it on the inner ear; inner ear has a membrane and a slightly looped structure called (Refer Time: 23:22) which has some calcium cells and all, the together they give you the balance the (Refer Time: 23:31) and the fluid inside with calcium, it keeps your body in balance.

So, there lot of people who get in a scan have a problem there, but this membrane is wonderful, all of you who have a studied the engineering in mathematics, with this wave the inner ear does not natural Flourier transform. So, Flourier may have discover, but brain is already doing it that membrane the higher frequencies are caught at the base, where it is attached to that outer structure and the lower frequency is towards the hand. And that fluctuates it falls on certain cells, which turn this movement to electricity. When we will talk about the functioning and electricity will see.

Similarly, when you look at the vision, so this is the visual system, this is your eye, lights fall on the retina; that means, a photon falls on the retina and changes (Refer Time: 24:23) the electron in a protein called Rhodopsin, that sets in Electrical current. The left side of the field goes to the right side of the brain Occipital lobe and vice versa and how does it happen, it crosses like this fibers which are coming from this side, will cross to the other side, and fibers which are coming from this side will cross. So the whole left side will go this side and this and this will come to this side. So, this is a right side of the vision this is a left side. I hope you get it is purely mathematics. So, left side goes to the right side, then right goes to the left again right (Refer Time: 25:46) field left (Refer Time: 25:49) field.

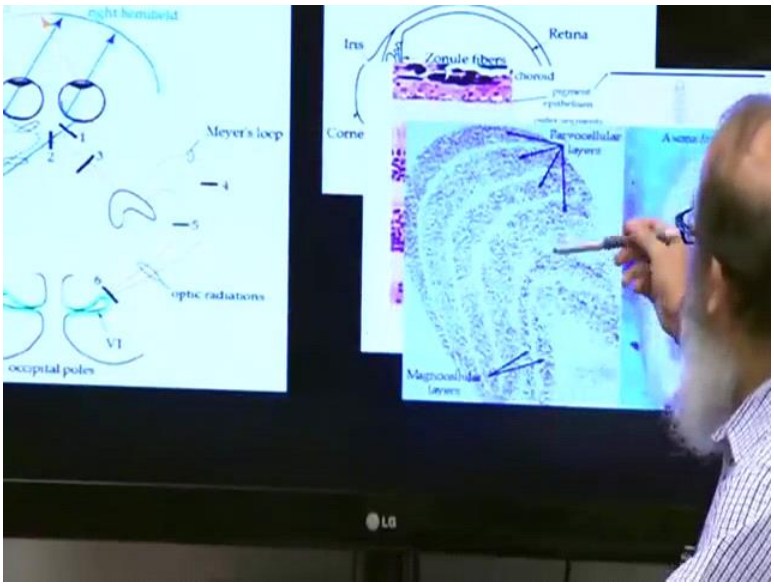
(Refer Slide Time: 25:45)



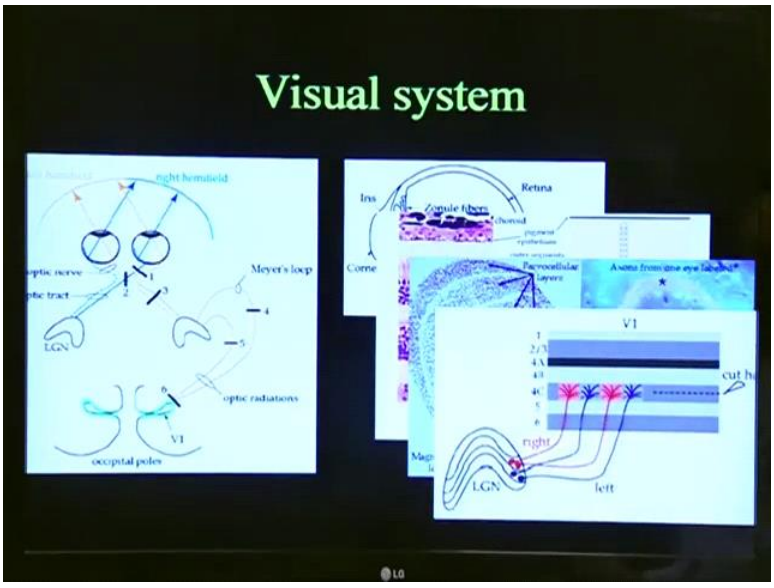
So, the whole left side this and this come to the right, and this comes to the left, in between again as I said this is a relay center, no sensation can pass relay center, even the auditory signal goes to the relay center and the visual thing also, it goes to what you call a Lateral Geniculate Nucleus, do not burden with the name, just understand the process you can always get the names on the books and all that.

The great part is that once the visual signal comes in, or the auditory signal comes in, as I said it is a furrier transforms within that Lateral the Thalamus that Geniculate Nucleuses, the auditory signal is presented in a ton topic presentation, but the frequencies are divided it is like a pattern, similarly visual it is a topographic. So, if you give present object whatever light is coming, it will be represented in the fibers itself in a topographic manner, is not that the whole object goes like this, it is presented in layers from left right left right left right signals from both eyes they are combined, till it reaches these layers, see these belong to 1 field 1 eye these belong to other eye right.

(Refer Slide Time: 27:21)

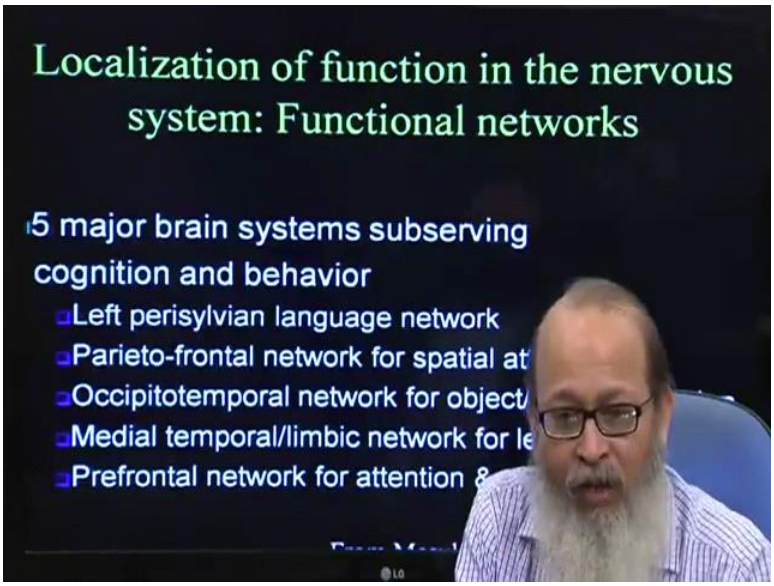


(Refer Slide Time: 27:42)



See you see this, axon from 1 eye is labeled, and this reaches the 6 layers of visual cortex which have very very specialized. So, lateral geniculate nucleus is thalamus, you can see this, this goes here left goes here each of this layers is. So, specialized that 1 of them will look at the adjust 1 of them will look at the movement 1 of them.

(Refer Slide Time: 28:11)



We will look at the depth, not all of them. So, to end with it you got it. So, it is a topographic representation. So, eye forms image which is again projected to the deeper center of the brain in temporal lobe, which decides what it is all about, the same image part of it image goes to the parietal lobe where it is located, which is the special time, temporal time and parietal is space to where is guessed in parietal, what is it goes in the temporal they again unite to form and send it to higher cortex which is a frontal lobe which is a network.

Now we come to the network and maybe I will handle this and the next lecture start from where I have leaving so that you can correlate how it the whole mind thing is form now.

Thank you.