How The Brain Creates Mind
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Lecture – 08
Dynamics-2

So, I think by now you would have got a whole idea of this complex structure called "Brain" and to the basics electro chemical activity, but how do you know it, how do you really (Refer Time: 00:30) into the mind, I think desire for a neuroscientist is ultimate kick would be to witness the life, brain going to the way and see what is happening there, but I am sure if you go in you will not find unless you reduce yourself to the level of neurotransmitter little, littlest man and see really electrical activity, but you cannot see electrical activity flowing in the metal wire also that is really get down to electronic level which is very difficult.

So, in absence of such technology, your rest all what do you see on video analysis all stimulated staff you see the lot of videos where is see the firing going on like piping up, I do not think that is happening in brain because it is as continues electrical activity chemical discharges all these going on. So, how do you pip, how do you really look in to the brain.

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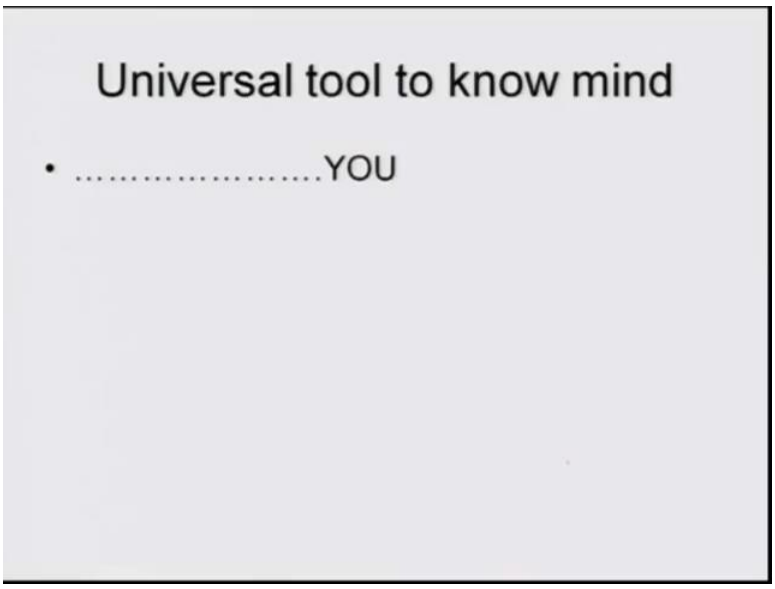

So, there is a universal tool to know mind, see the problem with brain research is, is one of the problems and why it is difficult to come you we has a human beings, will talk about this one we talk about the brain compute interfaces toward the last lectures, is that all that is we are doing it outside. So, if you try to catch a brain what you have to do is measure the activity find out some way of reflecting that activity, but all that is remember is indirect, that is all indirect evidence of it all city scan MRI, which will talk about now.

So, much before that when psychology philosophy, what was the way the universal tool to know the mind you is very difficult to know your own brain functioning is you, and how do you know, you know people by other people, you know your mind often by observing other people, their behavior, and their motivations, their thinks and that gives your idea what the other person seen, but how are you really able to look into the mind of other person before we go in to the modern technological advances of looking into the brain, nature was already doing all these experiments and that is one reason when I talk to about initially how Homosapien became a smarter, they became is smarter while living together why evolving possibly what you call mirror neurons.

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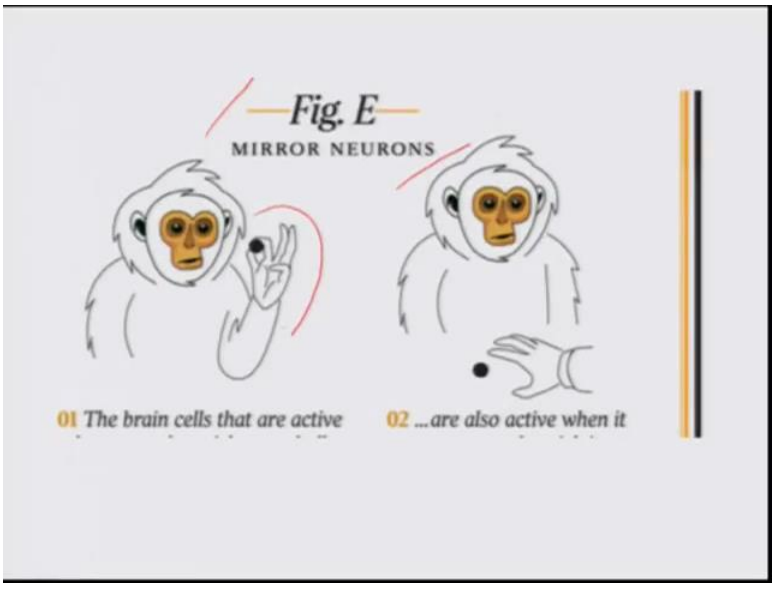

A part of the brain probably Insula or interior cingulate, gyrus this is one of the areas where I told about (Refer Time: 03:18) network.

So, look at this when this hand of the monkey, goes to catch a boll certain areas of brain are active, but base areas also get active, when see somebody is going for the boll; that means, the input which goes through your eyes or others senses, otherwise listen to music for that example music, must be showily going on, some mirror not that is how the communication developed, but there was a very very advance communications system. So, even there without words they do not have, they have different communications are all these coin and the sound jungle, we will find its not waste of communication, which is happening between species with we our brain involved something beyond that even when the sound and this thing not there even he was look at it, you look at your friend when the friend is sad even the person does not tell you and you feel that this person is sad, your mind for sees for facial expression that sadness.

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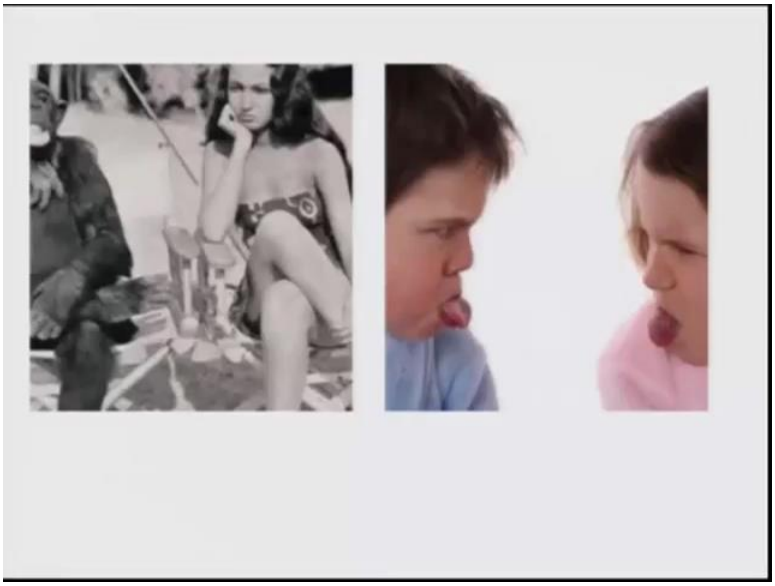

This happens to mirror neuron system and lot of staff goes on while your development mimicking, imitating kids imitate kids the something all in printing which Conrad Lawrence found in the ducks, that when the small ducklings are there, they fallow the same way of moving like the other duck is moving these I am printing.

So, we have social in printing, lot of social in printing gone and that happens through how does one human being, that is what the strength of human being was they could communicate with each other, feel about each other, this is the bases of empathy and sympathy an everything and that is how, but it is not only us we have chimpanzee have

it, monkeys you can see they always imitate you, these are because in primates, that is our lineage they have developed this area of mirror neurons and that probably keeps us lot of positive and negative emotions flowing.

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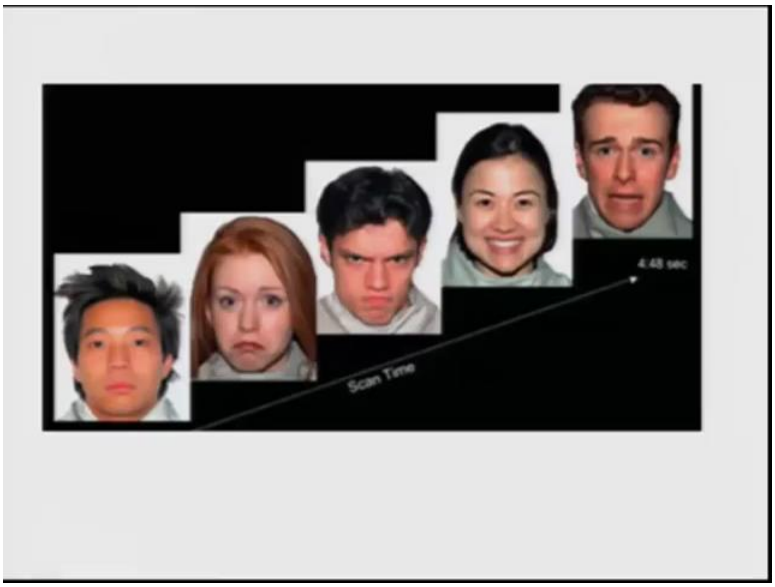

Which is this, they we know all these emotions, if I if I ask you to really say what is this girl doing you say the same thing because your mind knows it, you have to tell that she is smiling or this is serious this is disgusted.

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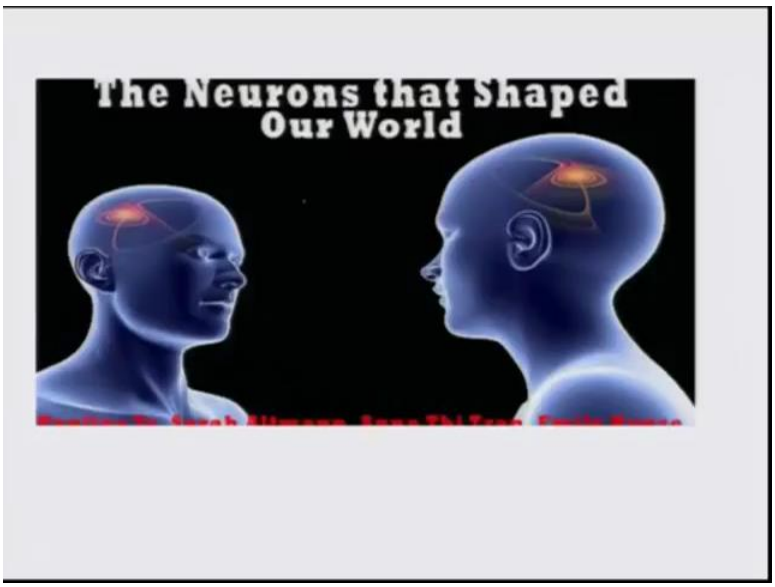

So, this is the neurons that shaped our world called “mirror neurons”, this is the universal tool to know people. So, lot of psychology probably with now we can tell them it is mirror neurons and all has observed the behavior of people, but imagine the people who were observing those other people were people themselves. So, the human beings are observing how could human being just that what is the other person doing is basically they which is the mirror neuron, which is telling them that is the conditional of human mind which has gone human brain, which has gone down through million years and that is the social cohesion. So, when I said that man is a social being, is a biological statement and it is not a sociological statement is it this is the biology, you are per force you have to live with other human beings you have to have emotion, no man can leave an island, so what happened beyond this.

So, this is natural technology and that is why said that what psychology definitions of emotions of cognition, of thought, of action, of behavior, of whether they are psycho no (Refer Time: 07:26) of behavioral paradise, we all use that same definitions, which are coming down from 100 years, we still do not somebody there may be different theories of emotional cognition, but definition remains the same. Whether if you want challenge that definition, then you have to find the new paradigm, to define happiness sadness or jealousy or attitude those definitions basic co definition remains the same. So, really do not know whether somebody talking, that this is sadness you that, that is sadness of not, but because that is the convention brain also manages symbols as the symbols of common cultural symbol.

So, this will remain a pen, all across symbols, but imagine when the first time somebody would have called at a pen, this association of word called PEN would have been association with this an its function, that how its stored in a memory, now suppose this thing would have been called a “biscuit” at the beginning, and the biscuit would have been call pen. So, you would be eating parle-g pens and you would be writing with whatever Reynolds biscuits. So, this is the type of symbolism which brain uses its like about metaphors.

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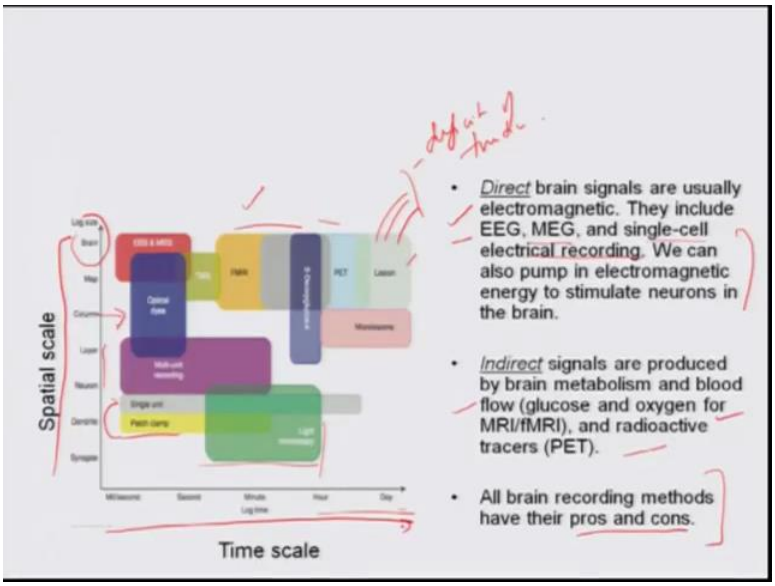

So, just now moving out the technology how do you do it, look at this scale, this is the time scale from milliseconds to days within days and hours and all you study behavior and this is the size, wright from synapse to brain, is a very interesting theme when you talk about is studying one dendrite or one synapse or one part of exon what you do, is milliseconds activity and you do a patch clamp, you put a micro very fine, micro it catch one neuronal patch of the brain of the memory and you see studied that is called a "patch clamp" over or above which you move to a single unit, you can study the structure take it freeze it, put it formal in do all that staff that you can do it in hours, as you increase from single neuron to a layer you have EEG and EEG at a full brain level or optical the use what you call optical genetics, functional MRI (Refer Time: 09:49) democracy legion if you remember (Refer Time: 09:52) gage when I showed you legion through (Refer Time: 09:56) through tumor through injury and the subsequent deficit, of function which comes.

But this you can study in hours and days somebody has a stroke, is a brain damage was the person recover from immediate injury, then you find this person cannot speech in Brocas area, that can be studied in days. So, this is the type of variety we have, now when we have variety of the problem, What is the problem, When you have variety? The problem is you have to decide you choose what you want to do. So, the question which you ask while trying to study the brain and mind remains the most important limiting factor you ask the right question, you choose the right technology, you do not ask the

right questions, you do not choose the right technology, if interested in fine what happens in one neuron go to this milliseconds to second areas, where I said between synapses .5 milliseconds you cannot, you measure in hours, your instrument measures something in hours it useless, if you are studying behavior you cannot take hours to week, if your studying something deficit created by brain legion; then you can study in days and hours, if you want to studied tissue, then you have do it in hours, otherwise go waste or minutes in EEG.

So, if you try to take signal now, now no think over about the whole network with electrical chemical activity going on now you want to measure it, you want to measure this activity of the brain with a say certain behavior, that why does the person feel sad now you want to studied, we really do not know all these details we are trying, we have lot of data, but you will ask me conclusively what happened in sadness this data, which come from 2 sources. So, direct signal means we touch the brain get the signal by some instrument, you cannot open up a live brain and put think, that is the unethical it will not be allowed. So, do you say brain is encase, in this scull for protection obliviously this is done for protection, otherwise your brain could have been somewhere in tammy and it would have been very very vulnerable to injury, some of protection plus also because we have moving on force, the brain was looking forward your eyes where from the side as you stood up your eyes came in front that, this is your interface even at the back is not interface is the different interface which has to come finally, to your brain.

So, direct (Refer Time: 12:53) usually electromagnetic, I told you what the electrical activity in the magnetic field these are called Electroencephalography magnetoen, Cephalography and single cell electrical recording, we can put pump some alter the magnetic field then see stimulate the neuron, indirect signals are measure by the brain metabolism and blood flow. I told you there is whole blood flow system and it uses energy like glucose and oxygen and radioactive think pros and cons is not right word maybe what you want look at it, is the right words.

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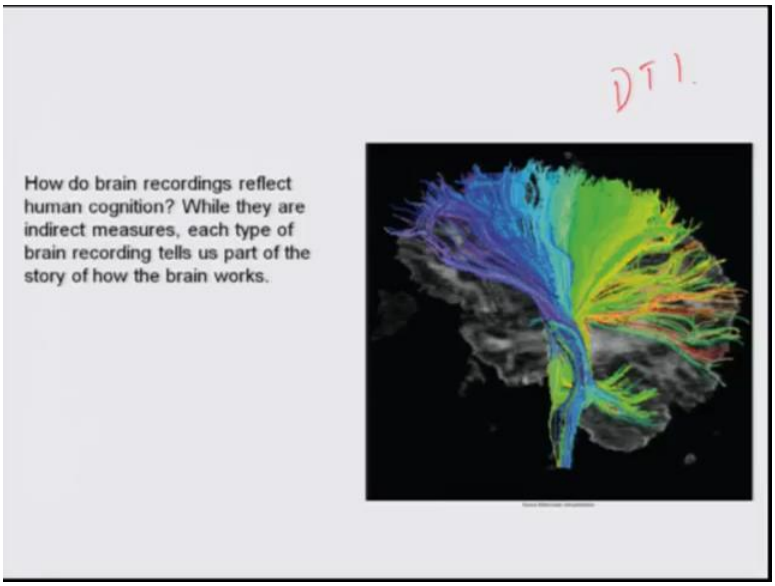

This is what you call it diffuse tensor imaging, which is just the image, do the brain recording reflect cognition, cognition involves your thinking, your judgment, your obstruct thinking, your inside, your language, you cultural references all these there all indirect measure; as I said you now if you ask me if you get a wave or you see some high colored area, does it reflect that the person this is this denote anger no because anger has lot of complex thing going on, in the one side of wave is not going to tell you it is indirect measure there is no one to one.

Let me give an example, if you have a fracture here, your brain broke, they have breaks and your x ray shows and you have plaster it, unites you cannot use or until decease broken this is very direct measure, x ray is the direct measure of bone injury, a city scan or ECG is not direct measure now if you ask that fine right now I am doing mathematics, and you take and am doing calculus and take my easy, is easy at direct measure of calculus no it an indirect measure, that is the trouble with brain, these is called defuse these is the very very latest technology.

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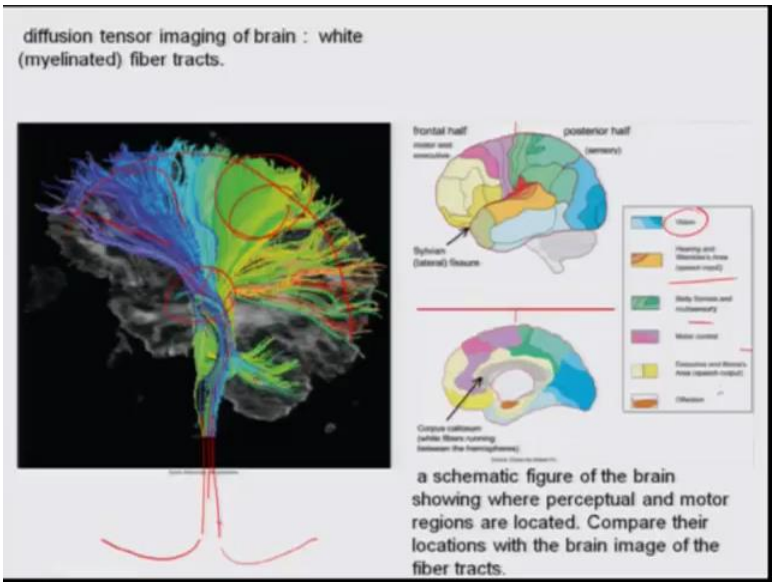

Let me start from this, I told about the white matter which has myelinated, So, this is the map of the white matter of the brain, this uses the movement of water molecules within the white metal, this is all colorful imaginary with technology is created, this is the white metal this is the whole structure of white metal, in the way see it starts from layers the 6 layers of 6th layer of it. They all come down is going to spinal cord; these regulate your movement, reflexes, everything all right. Some so you see the blue one there for vision right, hearing in one case this will this area, body senses this parietal lobe all right and then motor controller or faction or orange once are this.

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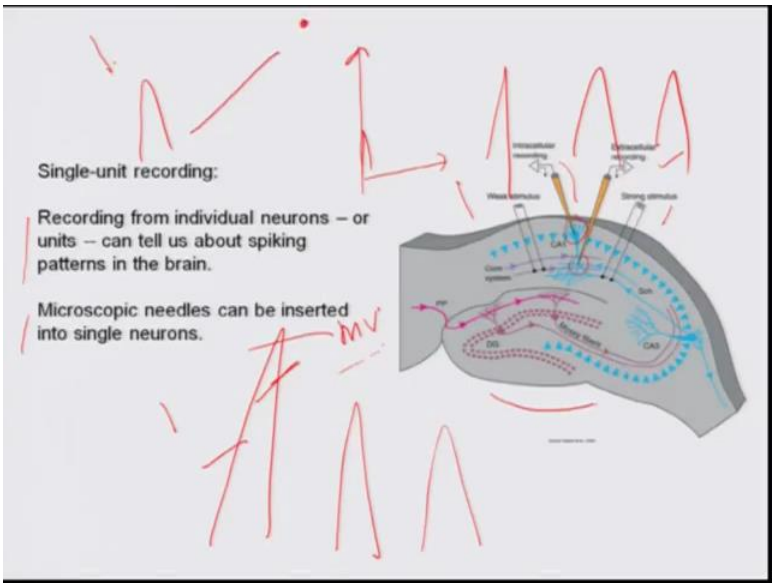

Is the latest stuff which is happening in imagine, in certain illnesses because we realize we are when we a looking for caller we do not know the caller of the most mental and neurological illnesses. So, we have (Refer Time: 16:29) down on this whether there is white matter decease. So, if this is again this normal structure, we find that there are differences in networks, then we can assume that there are white matter problem is existing in given patient, now if you want to go to this single unit recording, with in single unit recording you put this infra cellar put extra cellar think you give a stimulus or weak stimulus and this is a thinks from cerebellum, which is the small area which fined teams movement, use stimulate and what you see is an action potential.

So, action potential are very high milli volts, because this is surgeon serge of it, right these are call is spike, this is the spiking. Single unit recording of a neuron on tells you about the spike, but for that you have to really take of very fine electro, then really go one to like into the cells and beyond the membrane and then recorded, but is a very high that is an milli volts if you ask me put an electrode on the surface here, can you measure action potential, no it cannot, action potential also you cannot measure it vertically, but also it some distance action potential dies, because it is a short live cut goes like this is a spike, this spike if you are this spike is here will measure it here, if you want to measure say point 5 millimeter away from that is spike you will not get it.

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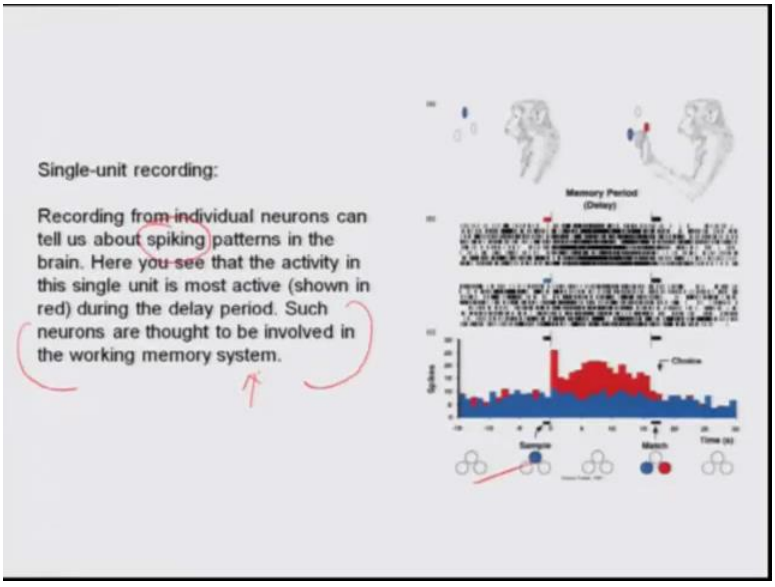

So, individual neurons can only tell you about the spiking pattern. these are the spike maybe I told you if you remember the when the womb is, within the womb and (Refer Time: 18:53) getting activated, initial motor discharges as spike this spike keep happening.

Now, these is spike what value do they have, when we talk of memory will talk when your memory networks being formed at that time spikes and certain areas are very important.

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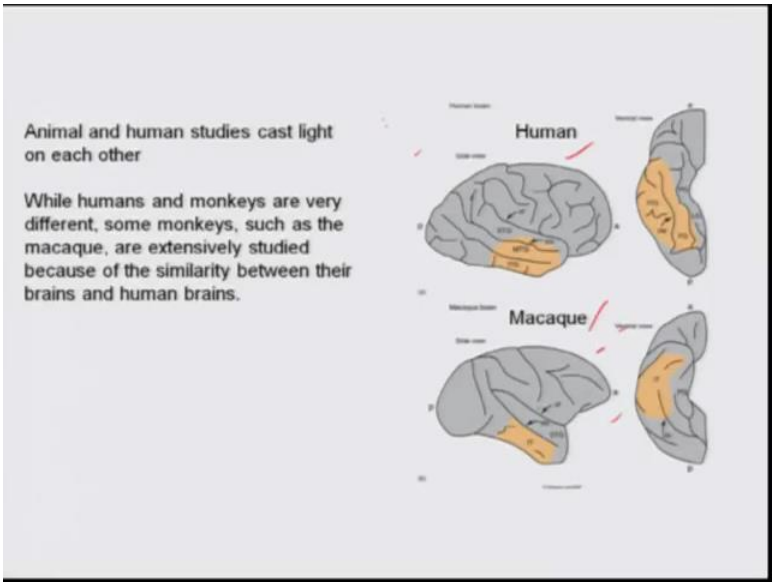

How do you how do you study this single neuronic you cannot go into a live brain. So, what do you use is this, we use the primates, this monkey macaque monkey, I think I am pronouns it right, whatever which is called these have been used the animal experiments, these there is become difficult do animal experiments because of animal rights an all, but wherever they can because there is a similarity in the structure of human and this monkey, if you see yes almost stimulus structure. So, this data they lot of research done on rat brain and I told you why encephalization, the size of the brain, the network of brain (Refer Time: 19:49) we the size of the skull and the body, almost similar in human beings plus rats are good learners.

So, when it comes to lot of this learning and memory experiments, rats of the preferred more, because rats learn fast in maze in all that so, but because the structure is similar

here, your say this which assume we can extrapolate, the data even neurons are the same; obviously, network is the same.

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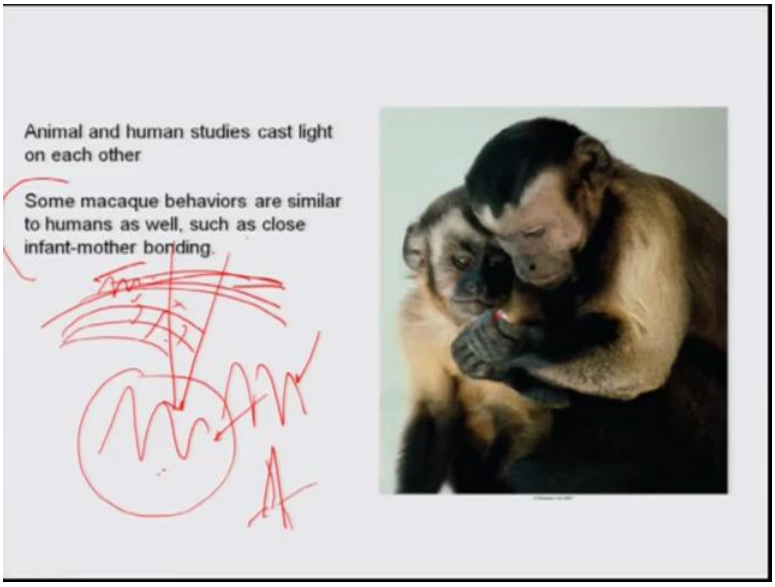

More than that the behavior is the same, now, we see at what level we have talking, we have talking of certain behavior, we are trying to find it neural correlates of it because you cannot live in this. So, we find what we do all these (Refer Time: 29:38) see whether the same wave a chimpanzee have a lot of similar behavior like group valence or male behavior, monkeys do lot of the what we do are you its catch a monkey do all these staff the lot of neuroscience student will find this monkeys war wondering around with electrode.

So, from single unit what do, you do you either increase the area to study electrical activity which is one way of doing it and the way to way it is that you put intra cortical electrode, now intra cortical electrodes is not be single neuron; it will be more neurons, assembly of cells, these the area which will have it into the power 3 neurons, that will give you the electrical activity, but it will its till be the not the same as you record from the scalp because this will be is still be a deeper structure. So, what electrical activity happening deeper structure, is different from the surface electro which pickup from the cortex the first 6 layers.

Here it is happening because of the dipole business, here it is happening because of the is spread of the electrical activities, even when you are doing it with 100 neurons; hundred

neurons according will be different from single neuron, it will further different from this cell assembly because by the time you go up the already arranged in to the columns and all that. So, the lot of activity happening between cortex here. So, these activity being recordedm these activity you have to come down here also you may finds spikes it specially in epilepsy if you have really take up deep thing epilepsy is one of the illness of people get into certain (Refer Time: 22:35) and either the contract or loss of consciousness, so once they come here, then you may find spikes if may be similar, but still it is a different quality of signal.

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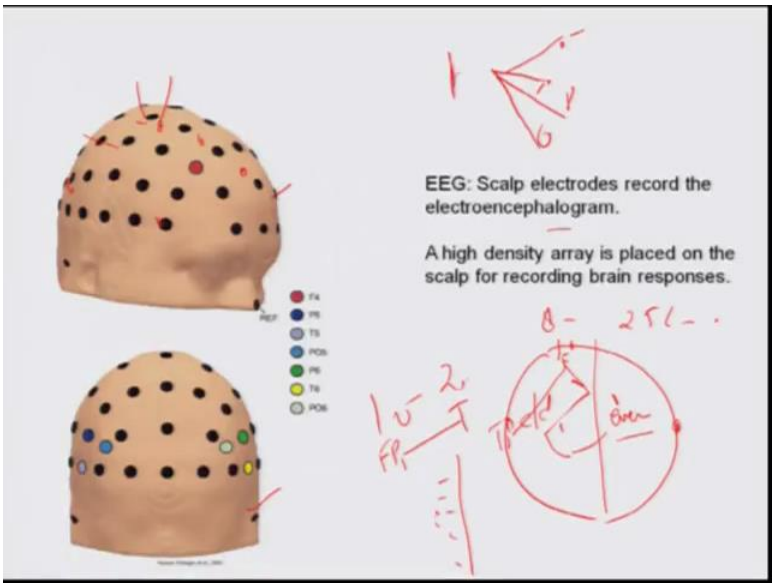

So easy is what is available to us normally, clinically and in lapse what you do you take a cap or take electrode is the made of similar and high density array or it can vary from 8 to 256 or more, depending on what you want to look at it. You put it and then what you do is form of montage. Montage is like this is frontal, then these are all arrange in the what do you call it 10 20 system is start from front of parietal then you go to frontal to parietal, temporal, occipital, central and between this electro once you want bipolar think like you can have a FP one to this is the odd even think, odd on left side, even on right side FP one t one this can form a montage, that you left to manage on the machine; with reference to either ear, which is the supposed to be the neutral there is do not have electrical activity or you can just have law.

So, you can form array of it each array may be 1 2 3 4 is call a montage we have montage or you can have a unipolar recoding; that means, that all these electrodes frontal, temporal, parietal, occipital all are connected to one source A one like left ear, these a Unipolar. Think all electrodes are connected to one source electrode, grounding electrode, reference electrode right, and rest of it on the other side to the other one or you can have a different combination, this is then type of waves which is you see, I will we can talk about EEG later on also as.

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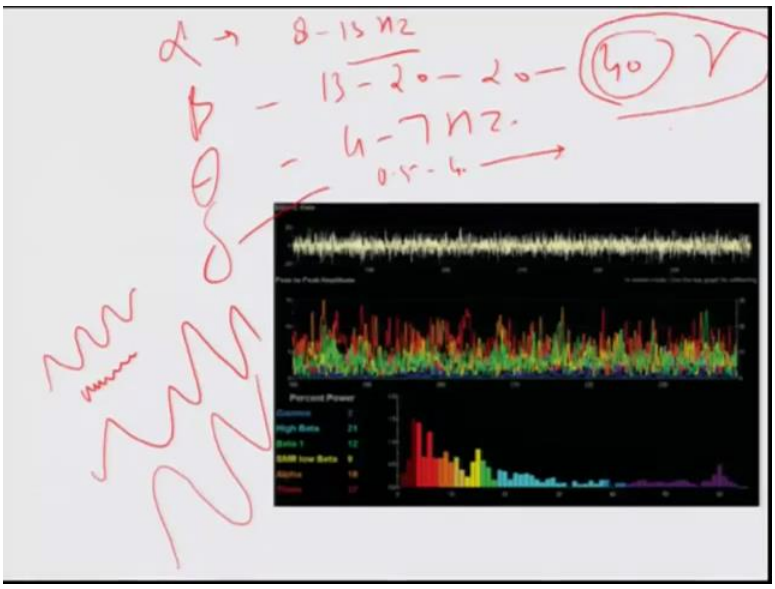

Normally what you see, once you put this what you sees alpha waves which is 8 to 13 hertz, you see beta which is 13 to 20 and then 20 to 40 is what you call gamma oscillation, which is not normally recorded you have to do some extra mathematical technique, show it then you have this, than you have this, theta this is theta, I hope 4 to 7 hertz this is delta point 5, 2, 4 this 4 hertz is the slowest activity and has the. So, the power, that amplitude of these waves is universally proportional to the frequency. Beta is fast very slow amplitude, Alpha like a rhythmic wave; higher slow wave are Theta. Delta is the most rhythmic, normally what you find if you close your eyes is 8 to 30 hertz that is the nearest resting frequency.

Now, this is oscillation, will talk about oscillation may be later, because that is important we should just remember this briefly. Oscillations will not happen if everything is firing into exited removed; Oscillation will happen; excitation is covered by the controlled by

the inventory staff, that leads to oscillation; these are brain oscillation which are going on and on you do not find delta in normally away brain, we find in sleep and some other when the brain is damage because that is sought of slow, wave front when your brain is active when you are doing mathematics, reading, it shifts to beta, when you are trying to memorize it shifts to theta. So, this whole interplay and this 40 hertz is called "gamma oscillation", which binds everything which is supposed to way that is the interplay of this.

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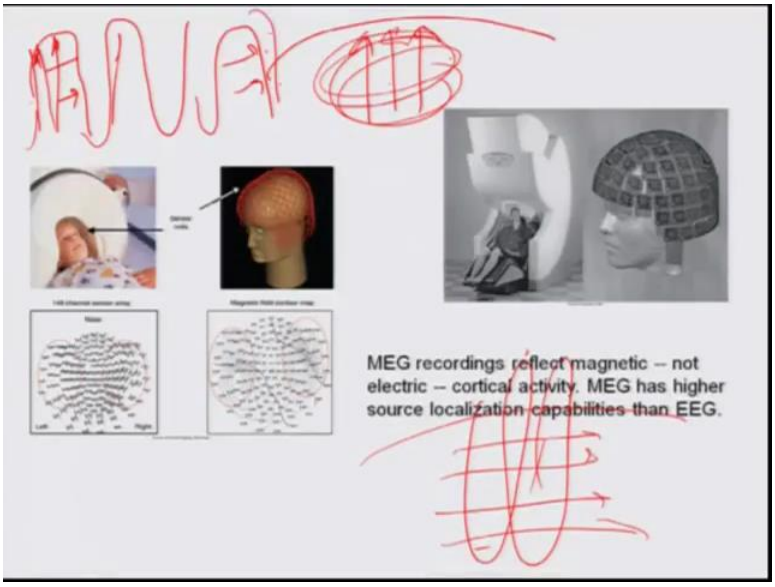

So, when there is electricity, there is magnetism. So, that advancement what it do a magnetic magneto and Encephalography, which is different problem with EEG is that you have a wave, but you cannot localize it, where is it in the brain is coming from magnetic and Sufnography has a better social organization.

But remember I told you there are column and many columns. So, if these are radially oriented neurons in a column, this is the magnetic field, paradise, thumb rule. So, this signal which is going within the brain cannot be picked up. So, MEG pick and, but if there are tangential. So, this is the surface, this is the magnetic field of all these this cannot be picked up, you cannot go in the brain, but this is the surface all these tangentially this is the magnetic field, this can be picked up. So, MEG fix up the field of the tangential fiber tangential means running parallel to the. So, you see this gyri, this is the elevation and this is the sulci. EEG fix up from this from this. So, whether they

oriented like this they are oriented like this, they are oriented like this. EEG will pick up right MEG will pick up only if you look at it these type of fibers and that is why MEG is better if you if you can, MEG is gives better source localization.

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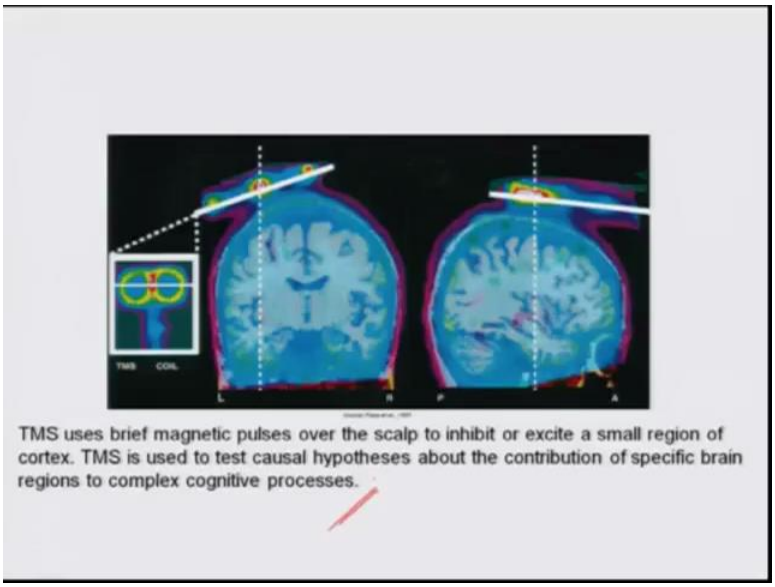

So, TMS as I said transcranial magnetic stimulation, is used for treatment also it is stimulates certain area of brain and then you record the think. So, you can stimulate a certain region. So, just to wrap up will break it bring the whole continuing the same thing in the next lecture, this TMS is just extinction of you put it magnetic field stimulate a certain circumscribe area and then see the behavioral consequences may mainly use from memory or emotion, but it still, it this thing has to come to popularity.

I will end this and may be just pick up in the next lecture continuity of these tools. So, this gives you a whole platform to jump into the higher functioning.

Thank you.