Demystifying the Brain
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Lecture – 18
Consciousness - Segment 02

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Hello welcome to the lecture on Consciousness. So, in the earlier segment of this lecture, so we talked about the link between stimulus and awareness. In fact, throughout the lecture we never talked about how the experience this; the conscious experience that is stimulus creates. We only talked about the responses in the brain right, which part responds to vision, which part responds to altered stimuli and things like that, we never really consulted the subject the experiencer right, we never brought the experiencer in to the picture.

So, in this lecture we start began to do that in the first segment, but in the first segment we only talked about this kind of a variable relationships between the stimulus and the experience that creates. So, for example, we had given some examples of color perceptions.

So, color we know from physics is rigorously defined by the frequency of the of the light in the wave the wave frequency of wave length of the light, we have seen examples in the previous lecture, where the curve color perception varies a lot in from person to

person it can depend upon the lighting it can depend upon the contexts, and it can depend upon whether you are saying the original image or it is after image and so on so forth. So, it is lot of variability that comes in when you introduce consciousness. So, we got a bit of feel of that in the first segment. So, this segment we now look at neural substrates so, what happens in the brain when this kind of a variation in consciousness, our conscious interpretations of stimuli occur.

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Let us begin with a curious experiment call the rubber hand experiment. So, in this experiment the subject sits on a table, both the hands are you know placed on the table like this palm down. And so, in this case this lady her left hand is actually behind that white screen.

And what you are seeing we what looks like her left hand which is right in front of the white screen, is actually a toy hand a dummy hand it is just a rubber hand only thing is it is a designed. So, that her actual hand her actual right hand and her this kind of a dummy model of the left hand both look very similar.

And the screen is plays such that the lady cannot see the see her actual left hand which is behind the screen, and you see the experiment is actually touching with both his hands with his left hand he is touching the rubber hand which is placed in front of the women, and with his right hand he is touching the actual left hand of that subject the women. So, now the experimenter actually starts stroking the rubber hand which she can see which is

subject can see, and also her actual left hand which she cannot see, but she cannot she can feel.

So, her brain is actually receiving two stimuli the visual feedback from the rubber hand which looks like her left hand, and as the person stroke the hand she can see that and then this somatosensory or touch feedback from her actual left hand, which is behind the screen which is also touched by the same person and stroked. Now this stroking now has a pattern now he is stroking two hands one rubber hand one real hand he make sure that this stroking is done in this same way, the rhythm of the pattern of stroking is identical with both this hands with rubber hand and the real hand.

As this happens like for a minute or so, right and then the subject starts feeling that the rubber hand is actually her own hands she starts identifying herself with that rubber hand it is its she starts like owning it up, she starts you know she starts imagine that imagining that it is part of her body, and you know in one experiment which is slightly dramatic they actually took a hammer and try to bang on the rubber hand.

And the subject jumped up in alarm thinking that you know she is going to get hurt, but it is only the rubber hand. So, the identification is so deep. So, what is happening here you know can we rationalizes and explain what is going on. So, this subject brain is receiving input visual input from the rubber hand, and the touch input from her actual hand, and both this inputs are actually similar the patterns are similar. So, now there is a theory that right brain tries to identify objects, and the right based on their attributes using what is called feature binding. So, look at these simple questions.

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So, I am looking at this red cricket ball it is color is red and it is a round in shape right. So, both are visual properties. So, now imagine there is a region in the in the brain the visual cortex of the person. So, let us say a and then there is some firing pattern responds to the roundness of this object, and there the firing of this neurons represents round the property round this another region be where the firing represents color, and this particular firing pattern represents red.

So, now the brain should know that both this properties correspond to the same object they belong to the same object. So, because any object is basically a combination of certain properties the basic property is could be very small not very large in number, but different objects come with a different combinations of properties you know in terms of colors shape and so on.

So, how does the brain know that both this colors both this properties represents the same object they are associated with the same object. So, the feature binding by synchronizing firing this theory, says that these two sets of neurons one representing the round the shape property of the object, and other representing the color property of the object, they actually firing and synchrony. So, therefore if you look at you know these two pools of neurons in different parts of the brain, and record from them the fact that both are firing in same tells you that both neurons are talking about the same object.

So, basically the integrity of the object is interpreted by synchronizing in the time domain. So, basically what this theory says is if you are looking at an object, and the you know you are looking at different aspects of the object right, and these different [as/aspects] aspects you know they activate different parts of the brain. So, all those different activities represents the same object. So, therefore they firing sync so therefore, they are shows synchronize on correlated neural activity.

So, when different tools of neurons which respond to this same object or different properties of the same object with the fire and synchrony or show correlated activity, then you perceive the subject perceives that all those neurons are looking at the same object are interpreting the same object. So, the oneness of the object is interpreted by the brain by translating it or coding it in terms of synchronized activities of neurons. So, correlation replies identity. So, just look at what is happening in the rubber hand experiment.

So, the experiment is so kind of cunningly designed. So, that the pattern of visual feedback know the movements of the finger of the experimenter, and the pattern of the somatosensory feedback or the stroking pattern of the experimenter on the real hand both are identical. So, therefore, they corresponding neural response to both this stimuli some in different parts of the brain also are probably identical right.

So, therefore, the person is interpreting that both this stimuli are coming from the same object her actual hand. So, which is which was a mistake, because normally it does not happen right you never have a situation where right some replica of your hand is stroke, and then right and then your real hand is also stroke, and the same way that kind of thing you know this is here, it is experimentally created in a very cunning way, but that does not happen normally. So, that kind of a falls correlations do not arise in real life experience, but in this they are creating that kind of a falls correlation.

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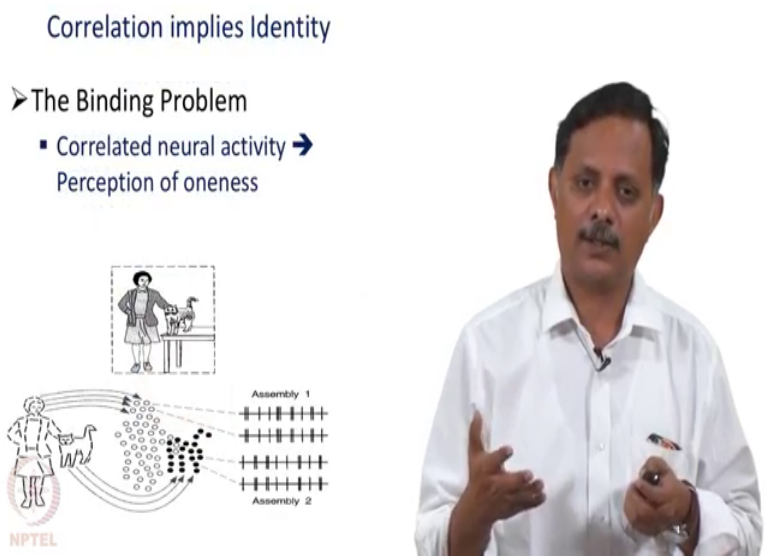

That falls correlation is creating a falls identity the falls interpretation of identity ok. So, basically by tampering with the correlations among neural activities, you can tamper with the way we perceive the world with the wave interpret objects in the world ok. So, now this is a theory, but and, but is that any a experimental evidence for this theory.

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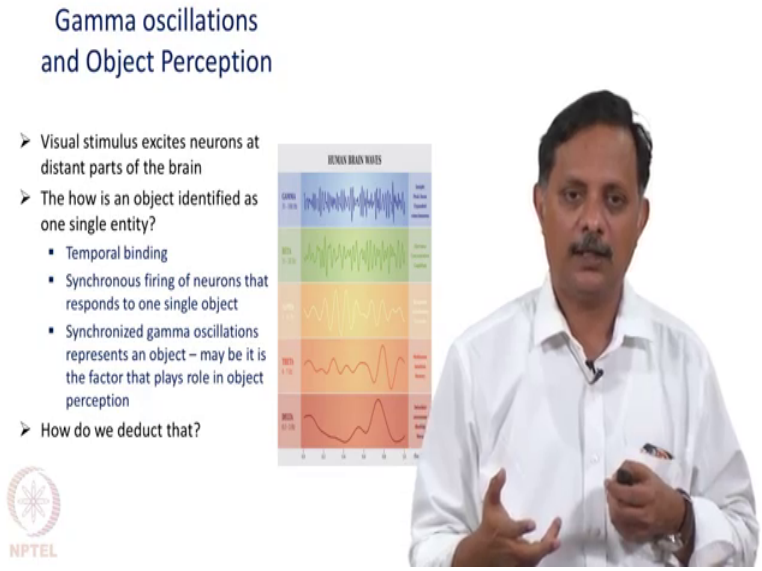

So, people have found that. So, this kind of a correlated activity particularly happens in a certain frequency bands. So, whenever you are talking about synchronization 2 neurons are firing there you know for them to be synchronized, they have to be oscillatory they

have to have some firing they have to fire at some frequency, and then this sync at the frequency brain has many frequencies, I mean when you taken e g or electroencephalogram of a brain, you will find that this spectrum of the signal has the multiple bands. So, some of the more important bands that you find in EEG or shown in this figure. So, this is a gamma band which goes from 31 to 100 hertz in this beta bands.

Which goes to some 16 to 30 hertz the alpha band which is same in your in a quite meditative state is between 8 to 15 hertz the theta band from four to 7 hertz, and delta which is only seen in deep sleep right is from 0.1 to 3 hertz. So, now, it turned out the there is some evidence that when you are looking at an object or a multiple properties of the object is a big responded to by different parts of the brain, neurons that respond to all this properties firing synchrony in the gamma band..

So in fact, some of the pioneering work on this topic was done by German lab, held by you know angels, and grey, and singer and you know (Refer Time: 08:57) and others. So, what they of they have performed experiment with cats you know cats visual cortex. The so, they presented a moving bar of a given orientation to the cat and we know that in the visual system, we have this neurons with respond to oriented bars, and also some neurons respond to oriented bar moving in a given direction.

So, they found they measured from neurons in different parts of the visual cortex of the cat which respond to the moving bar, and they found that all those neurons shows synchronization in the gamma band. So, that was a major discovery so, the kind of ideas that have been floating around in fact, this idea was first proposed by Von der Malsburg; a Christoph Von der Malsburg, and that idea turned out to be true and this kind of a future binding by synchronization seems to be true and there is you know this refer to discover more and more examples more and more evidence for that kind of a feature binding.

But that still only talks about object entity how do we understand an object by combining and assembling it is various properties how do you understand that, all the properties of object are actually in associated with the same object, how do you understand or encode object integrity, but that does not say anything about the object perception.

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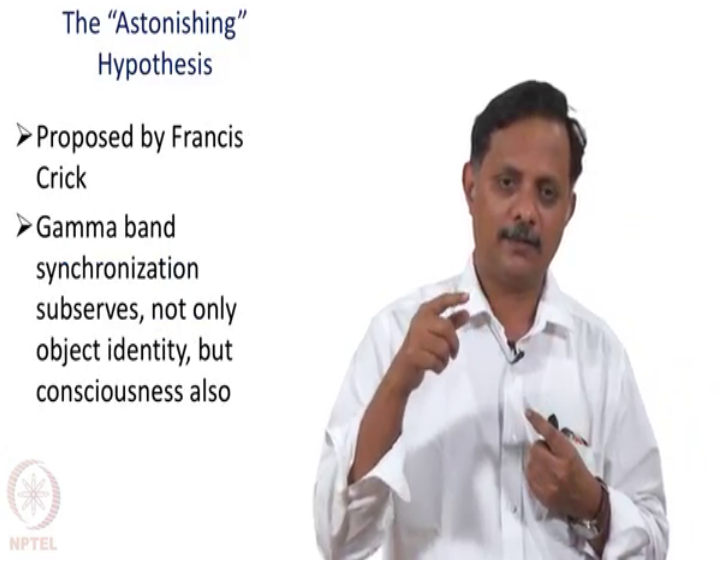

How do you see the object how do you experience the object it does not say anything about that. So, here is where there is a theoretical lead that was you know perform it was propose by you know Francis crick, in what is called a astonishing hypothesis, what crick had suggested is that gamma band synchronization of source, not only object oriented is what you discuss, but also consciousness so; that means, unless the activity becomes synchronized in the gamma band does not enter consciousness, and whenever it synchronized that is when you become aware of it is there is any evidence for that.

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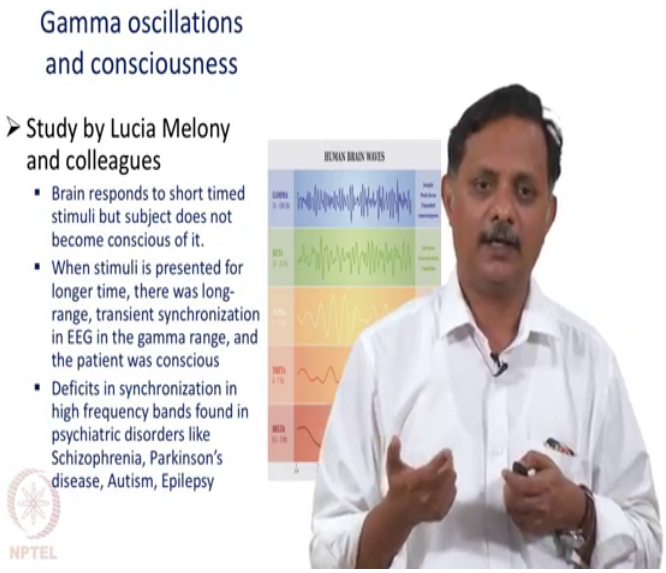

So, the study by Lucia Melony and colleagues they presented a stimulus to a subject, and thing is when the subject is presented with a short stimulus a brief stimulus, then you can find that the brain is responding to it you can see it in EEG you can see it in at single neuron level also, but if it is too brief than subject they shows no evidence of sensory awareness of that stimulus.

But when you present for the longer time right, you will see that is synchronized activity across the large spatial skills like in the brains. So, there is a long range say transient synchronization in EEG in the gamma range when the patient was conscious, and contrarily right in psychiatric conditions like you know Schizophrenia, Parkinsons, Autism, Epilepsy this kind of a synchronization is somewhat weaker. So, that deficit in this kind of synchronization so, this synchronization has some correlate with your you know conscious experience of the stimulus.

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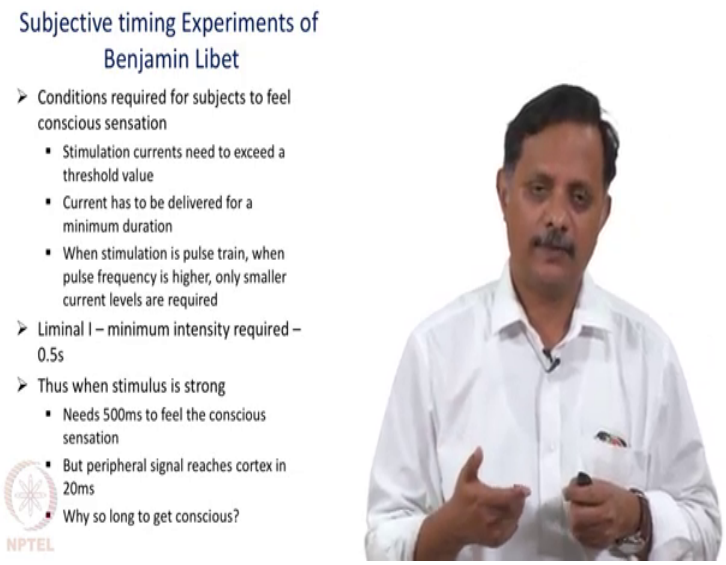

And very interesting set of experiments have been done by Benjamin Libet on what is called the subjective timing. So, we talked about the fact that are you conscious or not when you present it stimulus, what is it take to become conscious. So, we just said that unless stimulus is presented for sufficiently long time we do not become conscious (Refer Time: 11:51). So, that is a basic condition for you to become something conscious, but the other interesting question is when do you become conscious.

So, I present a stimulus to you right at exactly at what time do you become conscious of that, and here you have some very interesting results that emerged in the studies of Benjamin Libet. So, thing is in this studies so the actually the cortex of the subject is patient is exports, and the you know they put electrons on the cortex and electrically stimulus the cortex.

So, the initially play with so, they current the current is pass into the cortex and the current pulses right, the current amplitude and the current frequency and the pulse duration these are vary, and this search for what is the minimum condition right that it what is the minimum stimulus minimum stimulus that it takes to produce consciousness in the subject. So, what they found is even if you are current intensity is slightly lesser in the present same train of pulses sequence of pulses, for a longer duration right the person becomes conscious.

But thing is there is a minimum that you need minimum current level that you need for the person to be conscious, and at that minimum you have to present for sufficient duration. So, this minimal stimulus right present to the to the cortex which produces the conscious experience in the subject this Benjamin Libet calls it Liminal 1, and at this minimum current intensity we have to present the stimulus for about 0.5 seconds right for the subject to be conscious of the stimulus ok.

So thing is so if you so what is interesting is when you know stimulate the cortex, you need to stimulate it for nearly half a second before you find that the subject feels that stimulus the effect of the stimulus, but what is interesting is what happens when you actually give a peripheral stimulus. So, suppose you are stimulating somatosensory cortex. So, that when you stimulate at directly in the cortex, then you feel that somebody is touching some part of the brain.

Depending upon where you are stimulating. So, let us say I am touching I am stimulating the kind of a middle figure part of the somatosensory cortex, and when I stimulate there you subject will feel that his or her middle finger is being touched. Now I in other experiment I actually touch the middle finger, and then I ask when does the subject become conscious of this stimulus.

So, if you directly stimulate the cortex you know right it takes about half a second for the person to be conscious of it right, and then cortex is right there I mean your brain your

mind you would think is right here in inside the brain somewhere, and your you are think that the hand is far off from your brain. So, it is much further from your mind and therefore, if you stimulate the hand you have to should take longer for it to enter your conscious awareness, but the results are different ok. Let us see what happens in actual experiment.

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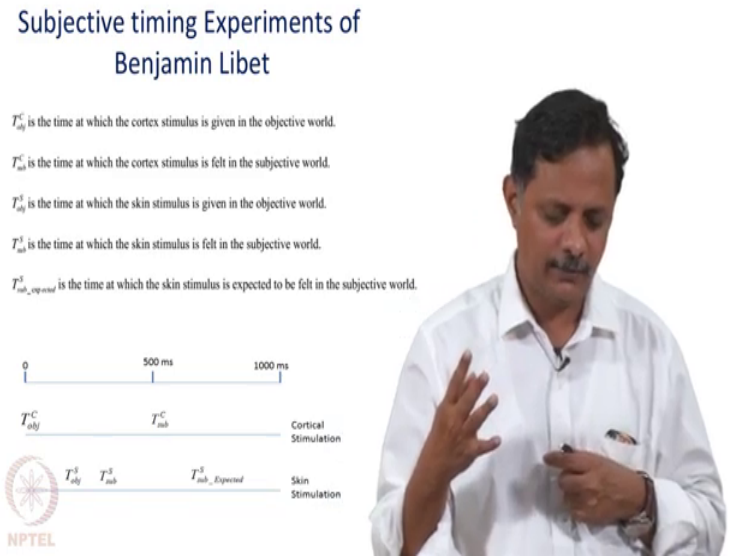

So, here we have defined five quantities C indicates cortex, and S indicates stimulus or skin stimulus given to the superficially, and object represents objective world. So, the this time so T C subscript object means. So, the time at which the stimulation is given to the cortex. So, that is in the objective 1 and that you can measure with your clocks and stuff, then T C sub is a time at which the cortex stimulate is stimulus is felt in the subjective world..

So, then so the so the gap between the T C obj and T C sub; that means, time at which you begin your stimulation, time at which is the subject feels that he has felt the stimulation, the effect of the cortical stimulation is about half a milliseconds this what you can see in the so the in the middle line see that in the middle line. Now there are three more time quantities T S obj and T S sub that is the time at which the skin is stimulated in the objective world, and the time at which the subject feels that the stimulus is received, in the subjective world that because that is something subject does not knows.

And then there is a third thing which is the T S sub, but expected you know when do you think the stimulus the skin stimulus would reach the subjective person you know the subject of this the subjective conscious awareness of the person. So, normally what do you think is when the cortical stimulation is given the gap between the T C object T C sub is about half a second.

So, you think that same thing gets carried over even when you stimulate the finger or the skin, actually you would think that it will take even longer, but you know quite paradoxically the T S sub is actually very close to the T S obj so; that means, the time at which they feel the stimulus is received is actually much quicker than what is expected so; that means, if you summarize this result, when you stimulate the brain directly stimulate the cortex directly.

It takes much longer for the stimulus to enter the consciousness that is you in the conscious self, when you stimulate the skin it is entering the conscious self much quicker actually it takes only a few tense of milliseconds compare that with 500 milliseconds you know for the cortical stimulation. So, first of all one big question that arises in interpreting this kinds of experiments, how do you measure something like subjective time for example, I have a thought you know I have a thought that I want to go and drink some water and that thought occur at certain time. Now how do you time it I mean it cannot compare the thought with some clock and how do you do that.

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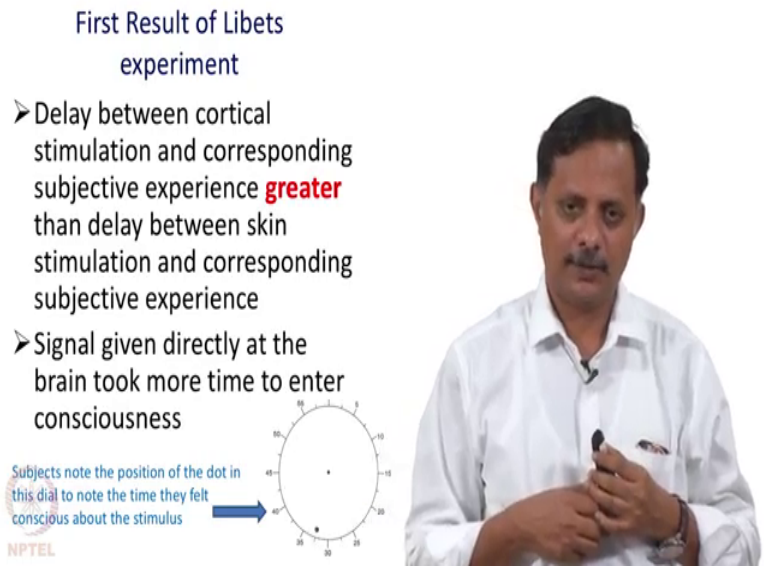

So, what the expend what they have done is the subject is shown dial on which there is a dot moving round and round, that yes received that stimulus you know it is felt that stimulus. So, at that point he looks at this dial and sees where the dot is on the on the screen on the dial, and then you remember that location, because in this dot is not moving very fast. So, that is kind of the subject remember the location of the dot with reasonable accuracy, and that is given to the experimental later, and then the average is over many times and that is how your time the subjective event ok.

This, these are subjective timing experiments ok. So, therefore, when you stimulate the finger or the skin right it actually reach the consciousness much quicker.

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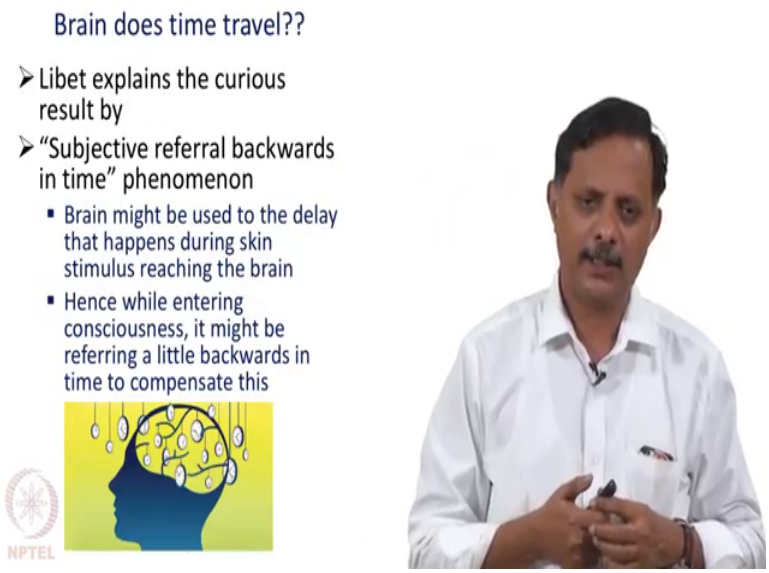

I means the stimulate the cortex Benjamin Libet has a very interesting interpretation of why this is happening, he calls this is a subjective referral backwards in time. So, basically what he is saying is like you know when brain knows that when you give a stimulus, or it to reach a conscious self it is anyway gonna take 500 milliseconds or half a second this happens all the time. So, if I want to more accurately judge when the stimulus is occurred match it will introduce a correction all the time. So, that I am better of right in determining exactly when the event has happened. So, your conscious self or you know brain was making this correction all the time right.

When you when you gets stimulus from outside from the through the regular natural channels of sensory stimulus, but then brain does not normally gets stimulated directly in

the cortex, I mean that is a unnatural thing which has began in the recently. So, brain does not do this correction, when you do cortical stimulation, but when you give stimulation peripherally in this skin, it introduces kind of a correction.

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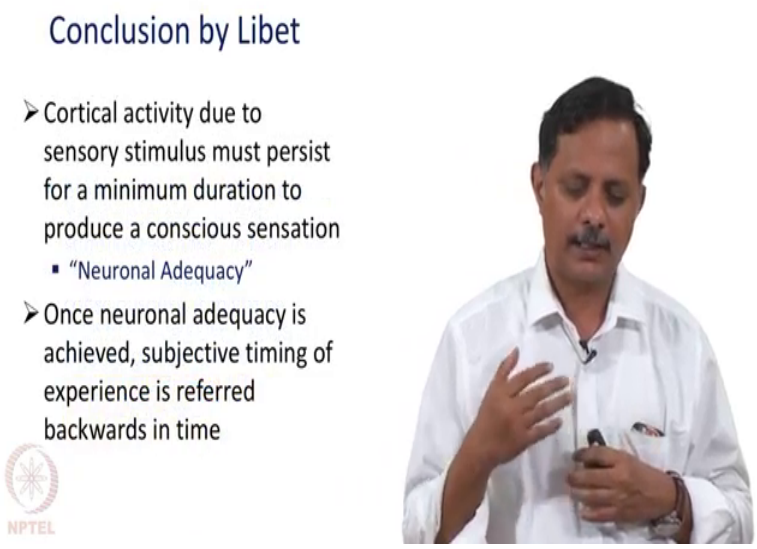

So, the conclusion by Libet are the cortical activity due to sensory stimuli stimulus that perceives for a minimum duration to produce conscious sensation, and they he calls it the neuron adequacy. So, you need to have activity in the neuron for a minimum amount of time when you get minimum generate minimum activity in the brain right for that to become enter your conscious awareness. And once the adequacy is achieved the subjective timing of the experience is referred back backwards in time, because brain knows the evolution, these always these delay, between the external stimulus coming from the external world and the subjective event that it produces ok.

So, that is some interesting experiments about a subjective aspects of sensory stimulus right, in the last segment we talked about how the stimulus is experienced, in the until now in this segment we talked about when the stimulus experience, and we saw some aberration very interesting aberrations. And now we will see, similar aberrations which seemed which will you know shatter our kind of initiative believes about the motor side or how actions are performed.

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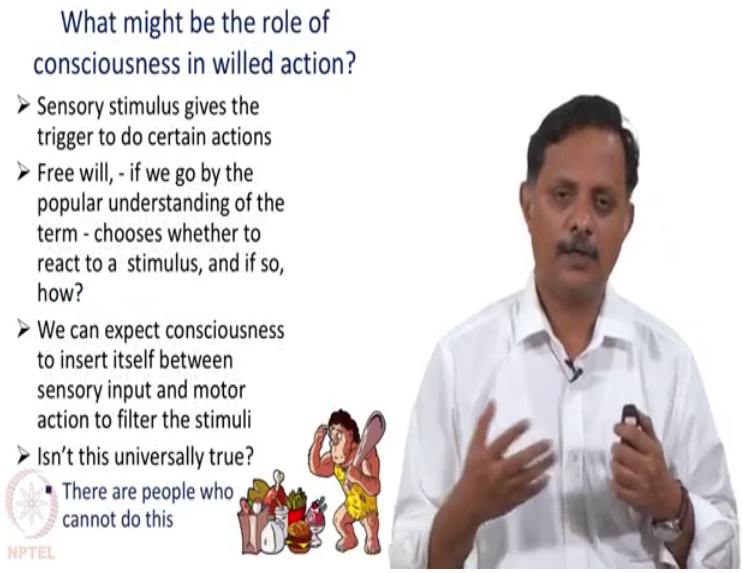

So, we all I mean even if you look at it your text book on neurology or neurophysiology. So, they divide actions into voluntary you know involuntary moments for example, if you step on a pin, and then you involuntary by reflex right you withdraw your foot that is we called involuntary, you know you do not there is no conscious involvement in that kind of a response whereas, you know you are sitting quietly, and then suddenly you get up and go and drink some tea or something like that. So, that is a completely internally driven a voluntary moment ok.

So, that is what is called generally freewill I mean this all the debates, you know in the philosophical circles whether there is a freewill and all that, but if you just go by the popular understanding that there is such a thing called freewill right, and how does the freewill work. So, normally what you would think is your will or your you know your motivation or intention to move starts first, and then somehow that gives rise certain activity in the brain neural activity in the brain, and depending upon which part of the body you want to suppose you want to move your right hand. So, then we know that that is controlled by the left brain left motor cortex, and then somehow activity appears there like magic almost, and then from there it you know it goes to the spinal code and activates your hand.

So, how does exactly does freewill work. Now we would assume that even with this sensory stimulus between sensory stimulus, and the motor response there is some kind of

a subject is a cell a kind of a conscious agency and agent, which inserts himself or you know herself between the sensory input and the motor output right, and then this is what determines whether you want to act, or how you want to act and things like that ok.

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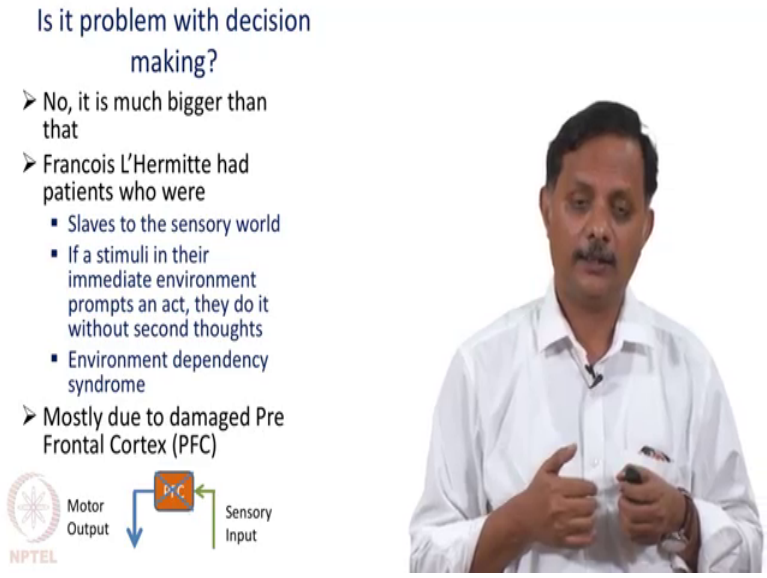

But it is that is what you assume, but there are patients in which this kind of interaction this kind of a gating, this kind of insertion of the conscious self it does not seems to be happening ok. So, it is not simply at a question of decision making because in this subjects said it by François l Hermitte right, this people are slaves to the sensory world. So, if you show them for example, a pen right they are just picking up and start writing on a any surface, if you show that in a comb there is just pick it up and start combing their hair, even though there is no need for it at that moment they would just start doing that, or if you give them a tooth brush they start brushing them immediately ok.

So, if you or if you shows them a bed may be they just go and lay down on it, right even if it is inappropriate for that context I mean lot of people, and it is maybe day time or something. So, they are completely their actions are completely driven by the external stimuli there is no self or agency which inserts itself right between the sensory input and the motor output, and decides whether two act and if so what exactly should be the action.

So, you should this cartoon picture in the bottom, we have discussed in our on early lectures on organization of nervous system, that between the sensory input and the motor

output there is a high region of the cortex the peripheral cortex right, which perform rational and all that, and it is here there is a damage in this subjects and so, they are not able to they become slaves of the external stimuli. In fact, this condition is called environment dependency syndrome. Now ok, but that does not happen normally.

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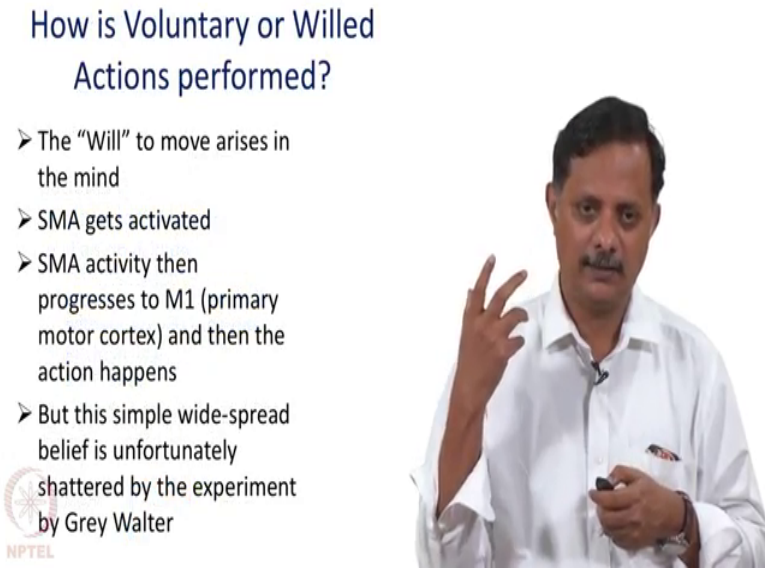

So, a normally in normal subjects you know, we have the feeling that we have a will, and then that right if you look at the normal account of how we think we move on our own, it goes something like this right, the will first arise in the mind know you have an intention you have a thought I want to do something, and then actually if you look at the functional imaging scans.

So, people who are engaged in voluntary moment that is the subjects are asked to say they will lift their finger, on their own at a self a point and point a time there is no stimulus which is telling them do it, they decide on their own and make a simple moment, and when that happens people found that, the first activity seen in the supplementary motor area. And in that happens bilaterally supplementary motor is located more medially, and it activity happens bilaterally after that the activity, then slowly progresses to the M 1 to the counter lateral side.

So, what begins as a bilateral activity, becomes unilateral becomes actually counter lateral, because of opposite side of the part of the body which is moved, and then the activity flows down towards panel cords it would to the hand then moment occurs. So,

the normal sequence of event that would imagine is a first the conscious event the event of will right when you want to the intent to move then the brains activity.

Whether it is a SMA or primary motor or whatever some kind of a some activity some event happening in the brain, then the actual moment, but actually this simplistic believe that we all carry with this all the time, and that is what our sense of self is based on this simple believes seems to be scattered by this elegant experiment by Grey Walter.

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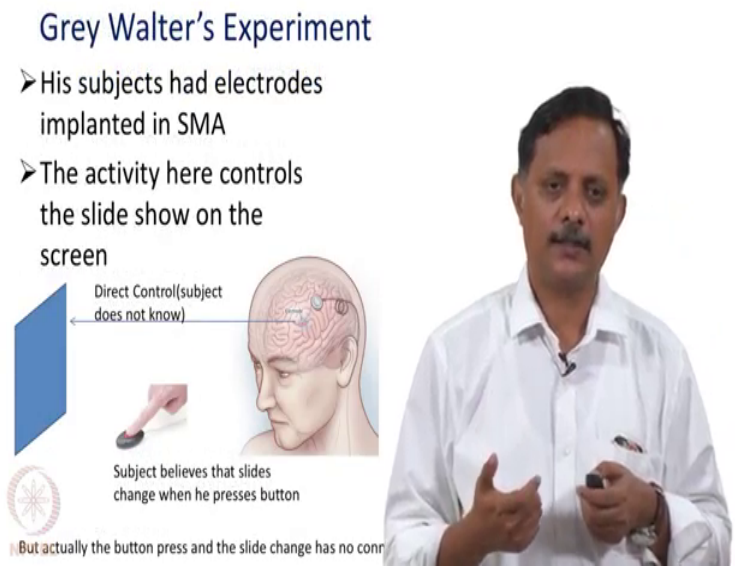

So, in this experiment the subjects had electrodes implanted in the SMA. So, they can stimulate the SMA, and then subjects can actually press a button, and then in front of them there is a screen, and there is also a there is a slide projector which change the slide on the screen. So, what they were told is by pressing the button they can change the slide on slide projector that is what they were told that actually it is a it is a lie that is there is no connection between the button and the slide projector.

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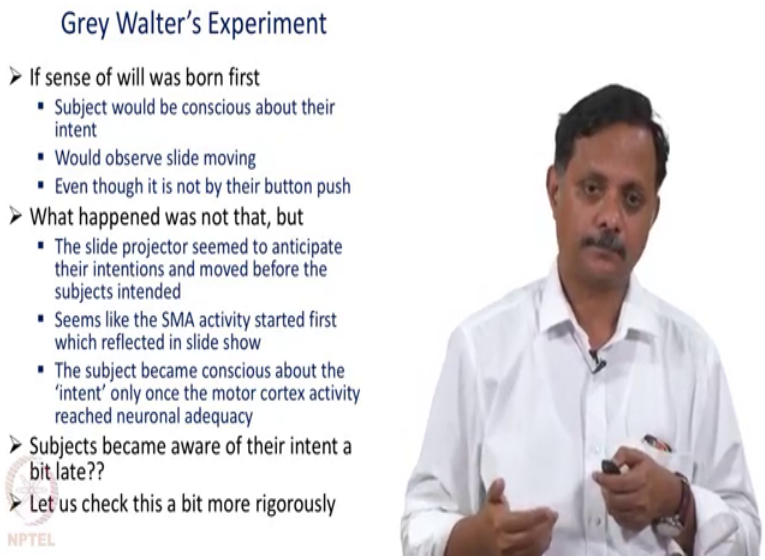

So, what does actually happening is, they picking up a electrical activity in the brain from the SMA, and that activity whenever they see the activity there; that means, there is intention has began. And the use of the activity to control a liver a machine which will activate the slide changer and then slide moves forward, we saw that kind of you know in sense preventing what is the subject is wanting to do.

So this subject keeps pressing, and then you know the this the it sees this slide moving. So, normally if you think that is a sense of will is born first, the subject will be conscious about the intent first, and then would observe the so would observe this slide moving, but actually what happened was the slide projector seems to be seem to seems to be anticipating their intensions, and moved even before the subject has intended not even before pressing, the subjects which is barely feel right actually even before they had a intention, this slide is already preempting their intension and moving ok.

So; that means your SMA activity began begins first, and that activity is driving this hidden machinery, which is moving the slide projector right, and making it change, and then this person simply presses the button right after the activity started in the brain, but that has no connection to the real change in slide. So, they feel that the actually the it is has the slide changer knows their mind, and responding even before their actually think of changing the slides ok. So, the subjects became aware of that intensive a bit late. So, that looks like let us look at it more closely.

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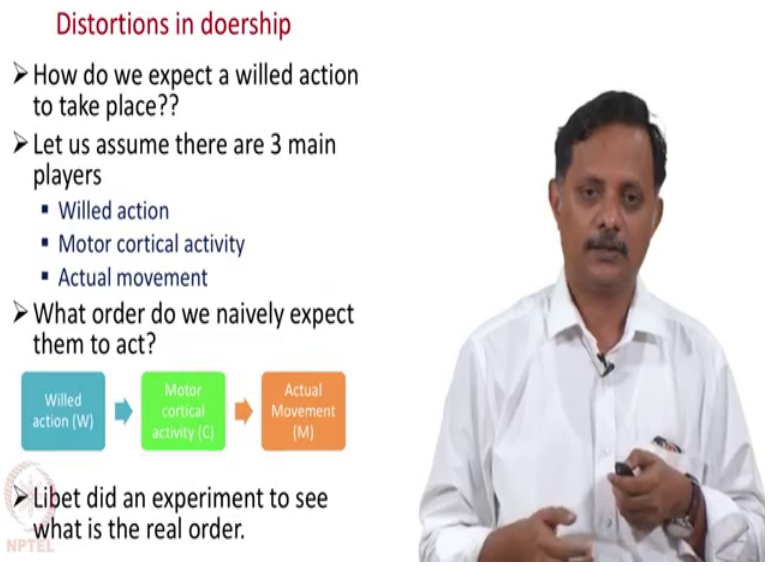

So, normally whenever we do things on our own by willed action by what is called voluntary activity, you would you know there are 3 events, which take place the will they arise they arising of the will, the will event and the motor cortical activity in the brain, and then the actual movement.

So, the normal sequence in which this three events are will be thought to occur that what we believe, is will first motor cortical activity later, and then the actual movement, but so whereas, Benjamin Libet has done a experiment to show that this sequence is not quite correct ok.

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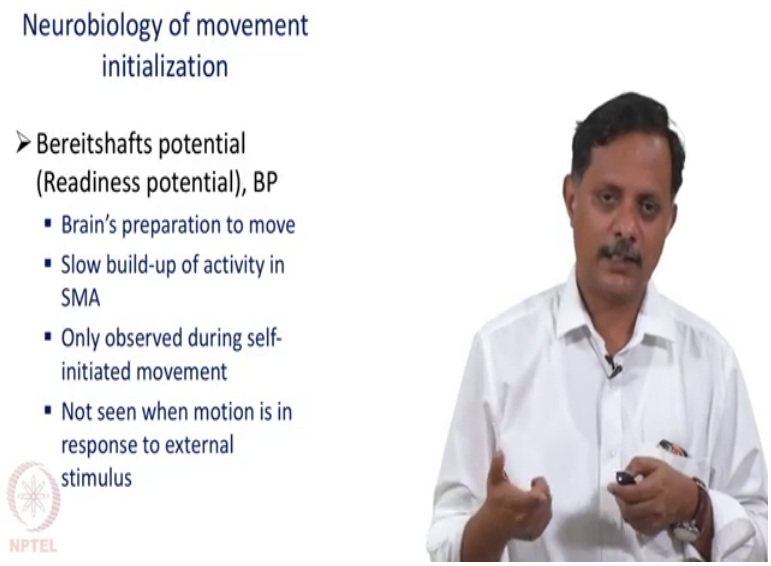

To understand the experiment we have to mention that there is this thing called readiness potential. So, like I said whenever you move things right on your own voluntarily, the brains activity that is observed when you perform voluntary action, is quite different from the brains activity when you perform say stimulus driven action.

So, suppose somebody is will ask you to move your hand then you immediately when you see the stimulus, if move the finger right that activity the brains activity that you see say in SMA and motor cortex, is quite different from what you see when you have when you are moving your hand at your own self appointed moment. So, what exactly happens?

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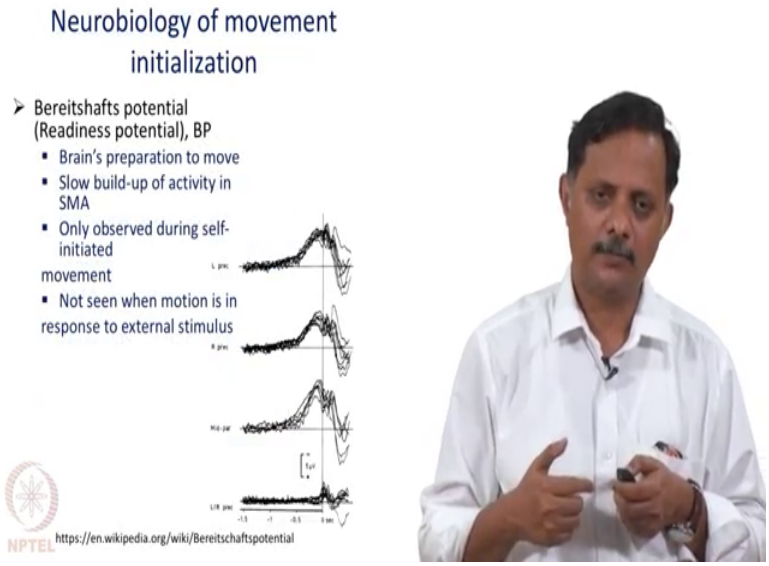

So, thing is in when you in case of voluntary movement, when you decide to move on your own, brains starts preparing for that event well in advance almost like you know close to a second or you know more than half a second before the event. So, in this graph in this you see some graphs on the right side. So, you see the third graph from the bottom right that is the mid parental. So, this is flows to the mid line.

So, here you see that this activity is building almost once more than 0.5 seconds before 0, 0 is the time when movement has occurred ok. So, so it is well in advance the moment is you know the activity is building up in the brain. So, this is called motor preparation; that means, brain is preparing for movement preparing getting ready to move all getting charged up to move, and this takes a long time in case of voluntary movement whereas, if you adjust responds to stimuli that happens much quicker you do not need that happens may be one milliseconds or even less than that ok.

So, this is called the Bereitshafts potential in German and familiar English word for that readiness potential basically it convinced that the brain is getting ready to move right in the form of this kind of a voltage.

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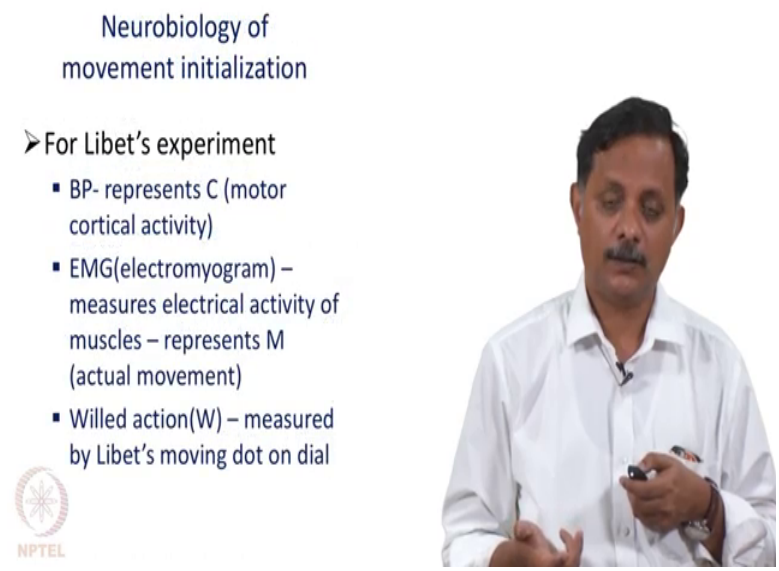

So, now Benjamin Libet experiment looks at this kind of measurements from brains, and subject subjects are engaged in voluntary movement. So, like I said the BP or RP has a potential is called represents C a motor cortical activity, then you can measure the movement by hooking up you know the person with electrodes. So, that the electrodes pick up the mussel activity the muscular activity, and that at that kind of measurement is called the electromyogram myo you know denotes muscle.

So, that measures the electrical activity in the muscle that event represents him which is actual movement. Now this is the third event which is willed action that is when does the will even occur. So, the 3 events that you have to measure and compare them so, again like before the willed action event or will event is measured by using this kind of a moving dot arrangement.

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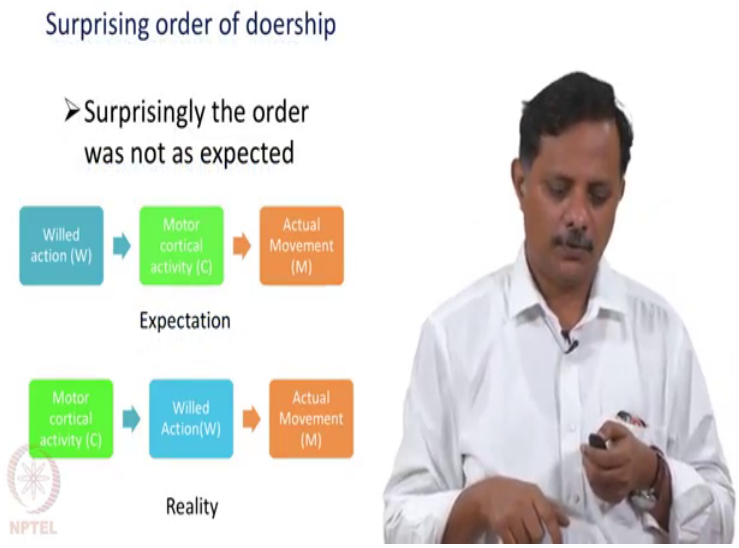

So, this surprisingly normal order the initiative order which would expect is will first motor cortical activity later, and then actual movement, but what Libet experiments shows has shown is motor cortical activity first, and then will and then actual movement. In fact, you can see that that pretty much what is happening in Grey Walter experiment.

So, there the motor cortical activity started first, and subject felt that you know they are already preempted I mean they still thinking about already the slide has moved only thing is in, Grey Walter experiment they have not actually measured the time at which the will occurs, but that what is the done in the Benjamin Libet experiments, but basically intuitive the qualitative result is same in both cases will time of will event is happens later after the motor cortical activity.

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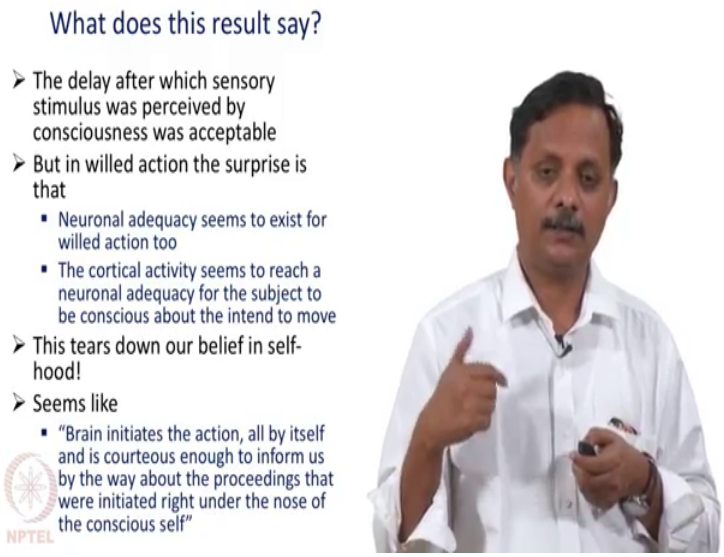

So, what does it mean it basically tears down that you know the idea that simple belief on which our lives are based, that we are the bosses I mean so, there are certain things which you would do by conversion somebody asks you to do, and you do it, but that such certain things that you do in your own, but even when those things where apparently you are doing completely on your own voluntarily right. It is also brain decides to move, and do it, and then you are informed you the conscious self is informed by the way.

So, it is like brain initiates the action all by itself, and it is just courteous enough to inform you by the by the way right about the proceeding. So, that was initiated right, and knows of the conscious self it is like you know brain decides a move your hand, and then it says by the by right I am moving your hand I just want to inform you right, you have no control over it. So, that is a bit scary, but it is what the experiment seems to indicate.

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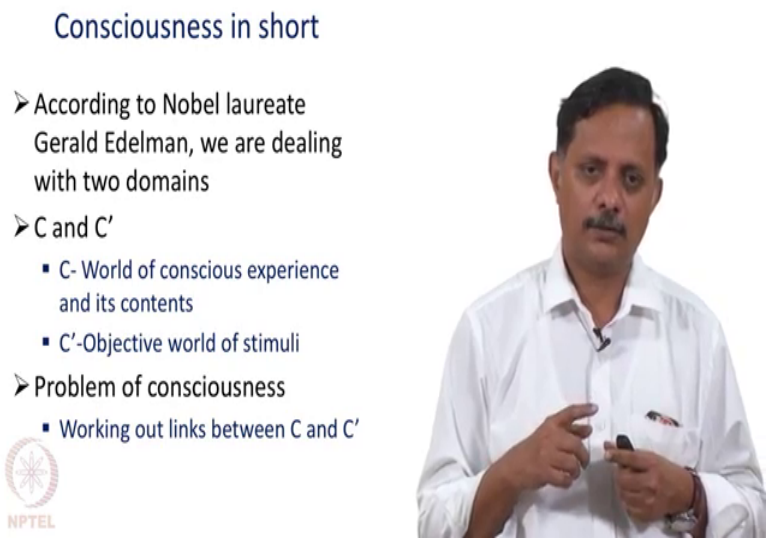

So, conscious Gerald Edelman and Nobel laureate right who was dealt with question of consciousness so, talks about the two realms the C and the C prime, C is the world of conscious experience, and it is contents and you know what you feel what you experience, you know when you are experience and how intensity to experience, you know all this all the contents of the subjective, world you know your emotions, and moves and all that I mean it is difficult to quantify all that it difficult to measure that put numbers on that, but there is they exist we know that right.

And then there is the objective world of stimuli you know we have lie it is and you know pressures, and sounds and all this that you can measure, and quantify right measure with your you know experimental equipment. Now the question is the big question is consciousness is research is how are these words related right, if I give a stimulus, and I know what stimulus it is I show a color blue which I know is definitely blue, because the wave length that comes from it can be measured by device, and you know it is that wave length is corresponds to the blue, but when you show it to a person and certain conditions the person might think it is green something like that.

So, that can be a discrepancy between what is out, there in the world and what is experience, in there right in the in your conscious self. So, linking these two and working on the relationship and all the variability and the richness of the relationship is the big

challenge in the conscious research domain right. Now so at Dahaene and co workers have done this interesting masking studies.

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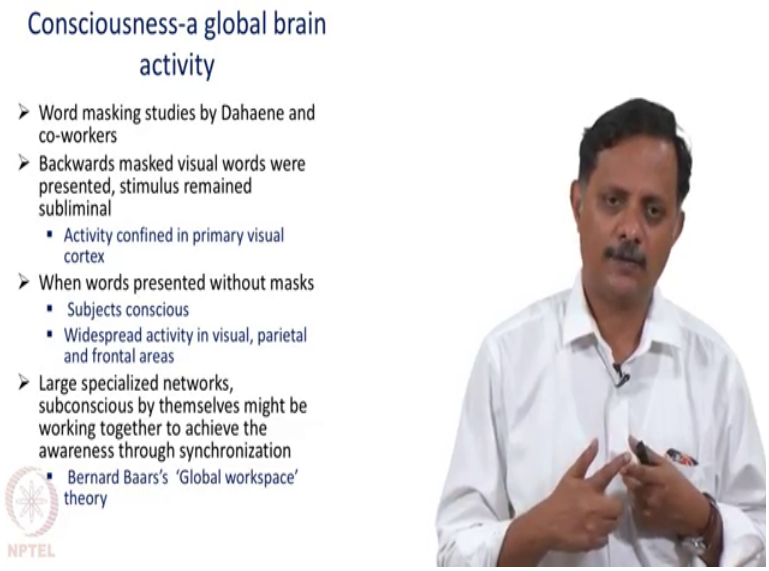

So, where there were shown some visual word some words visually. So, they were shown very briefly, and then after that the word is masked. So, they would not know what was what the word is because you know it is presented for a brief kind. So, we know that there is sync called neuron adequacy it unless stimulus is presented for a very long time sufficiently long time, it does not enter your awareness.

So, in this case the words suppose for a short time, and then they have masked by some other stimulus which covers it up. So, when they do that you know they have found that there is activity in the primary visual cortex. So, brain is responded to it, but the subject does not is not aware of it ok. So, so you see already that kind of that kind of discrepancy between brains responses, and the subjective subject responses, but when the words are presented without mask for a longer time right, then subjects are conscious of it, but if a very interesting difference between the kind of brains responses that does in this both cases.

In the first case when the mask stimulus presented that activity was confined to the primary visual cortex. So, basic lower sensory areas, but when the activity when the word was unmasked and, presented for the longer time the subject became conscious.

And there is wide much wider spread activity in the visual parietal, and even frontal area; that means, can we say that unless the higher areas of the brains hierarchy, these are parietal on the input side and the prefrontal on the on the motor or executive side, unless these areas are involved right in the response to stimulus in the brains responses to stimulus, the subject does not get any awareness of it right brain respond you can measure those responses in using all sorts of you know (Refer Time: 34:33) equipment, but the subject is not aware of that.

So, using based on this kinds of studies you know Bernard Baarss proposes global workspace theory, basically what he proposes that it has large specialized networks you know it sub conscious by themselves, might be working together to achieve awareness to synchronization.

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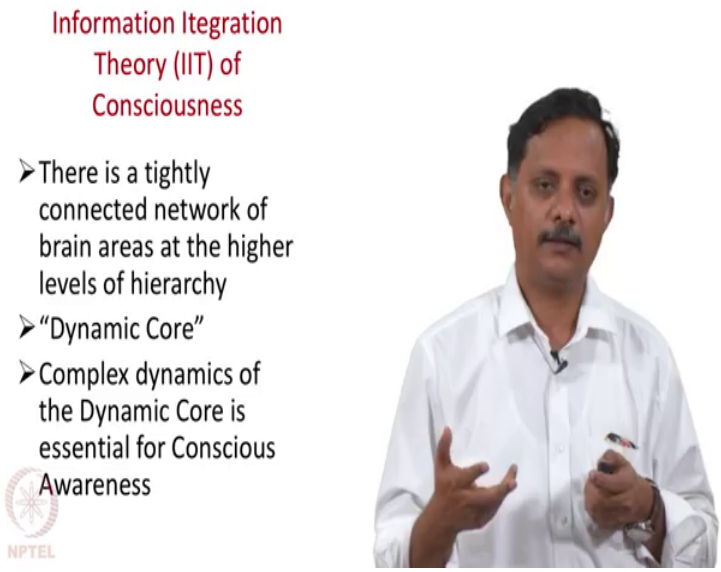

There is a very interesting theory proposed by you know Tononi Giulio or Tononi and Gerald Edelman.

So, what they propose is that there is slightly connected network in brain areas, in high levels of hierarchy right again between parietal and prefrontal and so on. They form a very tightly coupled network and they call it the dynamic core, and the dynamics this dynamics of this core must be sufficiently complex, and what we mean by complex I mean they are they are able to define that mathematically using ideas from information theory.

So, from computer science information theory, and these theories have found some evidence in lot of data we have from EEG from people who are in different states of consciousness. So for example, in the case of a subject undergoing the huger that is huge activity in the brain, but subject is actually unconscious by that is happening. So, you can show that the activity in this case has the actually it has high amplitude, but has low complexity of dynamics according to theories of Tononi and Edelman, then there is also physical theories of consciousness.

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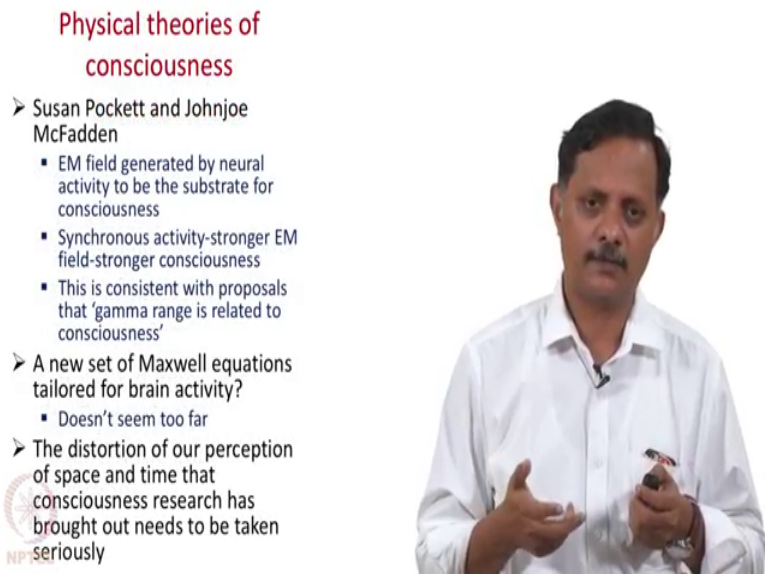

So, for example, Susan Pockett and you know Johndow Johnjoe Johnjoe Mcfadden have proposed at the electromagnetic field generated by neural activity, there is substrate for consciousness, and then synchronized activity in this EM field right is a correlate for consciousness. So, so it is not just a signal, but also looking at the EM field, and then they then another question is do you have to modify the maximal equations that you study electrical engineering to study the field propagation in the in the brain.

So, these are all open questions, and one more question that arises is when you start looking at physical theories on the brain is that you know in conscious consciousness exp experiments, you see lot of distortions of space and time right, you are event in the external world is something the time duration in the internal world it something else right.

And then you are measurement of space is something in the external world and something else in the internal world. So, normally we take this distortions as a kind of aberration we take the physical world as the standard right as a as a absolute reference, and with respect to that we take the response of the brain with the if we take the interpretation of the subjective self has some kind of an aberration, you know some kind of a variable thing, which as we constantly checked and validated in calibrated with respect to what we know as the time and space in physics.

But may be in future right these aberrations cannot be taken as simply aberrations, but we have to deal with it. So, then we have to have a even a physical theory of consciousness which can you know integrate this aberration that are found in the conscious experience domain research, and also that aberration the kind of theories of space and time, has they are has their formulated in physics. So, maybe we in future we will develop more comprehensive theory of consciousness. Which kind of a includes our understanding was space and time, as it as it occurs in physics.

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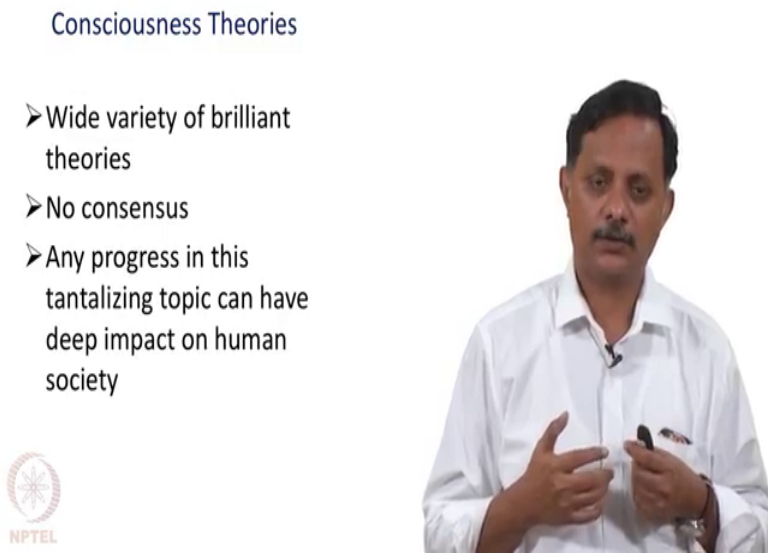

So, right now the situation there are wide variety of brilliant theories and in fact, there are lot of theories that originates from counter mechanics and there is now people talk about quantum gravity micro attributes in neurons, and how they are related to consciousness and so on, but there is no consensus you know you know all this theories,

and then different pockets of theory which is the situation with most questions in the brain, and lots of theories with consensus.

So, is always very hard problem and lot more progress has to happen, but if that progress can happen, and we can really understand consciousness from scientific point of view, I mean not like how the religious people have been discussing it, or how psychologist have been talking about, but purely if from a scientific point of view by the standards of you know empirical and objective science, if you can have theory of consciousness in future. I mean that will probably make a major impact right in human society and civilization.

Thank you.