Demystifying the Brain
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Lecture – 17
Consciousness - Segment 01

Hello so, finally, at the end of this course we have come to the topic of consciousness so, any elaborated discussion of the brain must you know address a question of consciousness because this like a grand finale the consummation of any discussion of the brain. So, in this lecture we have two segments segment one we will talk about consciousness and brain and we will talk about history of ideas a little bit about how people thought about consciousness, how people address a question of consciousness and then the second part we look at more neural substrate say how can you construct neutrally grounded theory of consciousness. So, consciousness has been a long topic I mean this is long history of this you know the ideas of a discussion of about consciousness.

People have you know from various domains have commented on it, philosophers have discussed it, religious people have discussed it. In India you know we use Sanskrit word [FL] let this lot of literature ancient literature on the topic of consciousness, but what is new what does that has develop in the last few decades is that people have began to develop a scientific approach to the consciousness. Even in scientific domain for a long time people would not even acknowledge and there is anything called consciousness.

So, people took a purely materialistic view on consciousness and kind of suggested that it is a brains activity that generates consciousness and then it just a name given to the brains activity there is nothing else that whereas, people are moving away thoroughly from the kind of a extreme position of materialism and then you know trying to consider and accept existence of consciousness in its own right and then the question is this illusive thing called consciousness which is private, which is subjective.

How is it will related to this measurable objective thing called brains activity now are these two things related. So, that is where then I am not saying we have a final answers and things have people have still in discussing about it so, things are still vague there are lot of arguments and we do not have a final theory of it, but we will talk a little bit of

works of fun you know words all the excitement are going on in this area or in this lecture.

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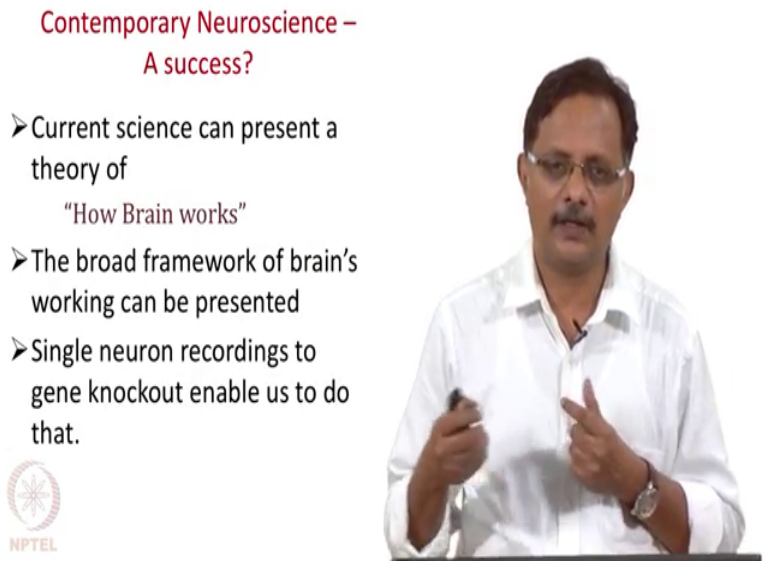

So, far in this course we have seen you know this where this contemporary neurosciences are succeeded right we have know we have been able to present a theory of how brain works. So, for example, it can discuss gears and wheels of the brain if you look at a visual stimulus which parts of the brain can response to it and where does this you know go from there and from there on where does it go and so on so forth.

The whole sequence of signaling that happens is when you present a stimulus to the brain right you can we have lots of data about the brain from you know single neuro recordings. So, from in electro physiology to gene knockout and so on so forth so, we have a lot of detailed descriptions how brain works when you look at it through various physical instruments and that is what is now celebrated as a success of that contemporary neuroscience.

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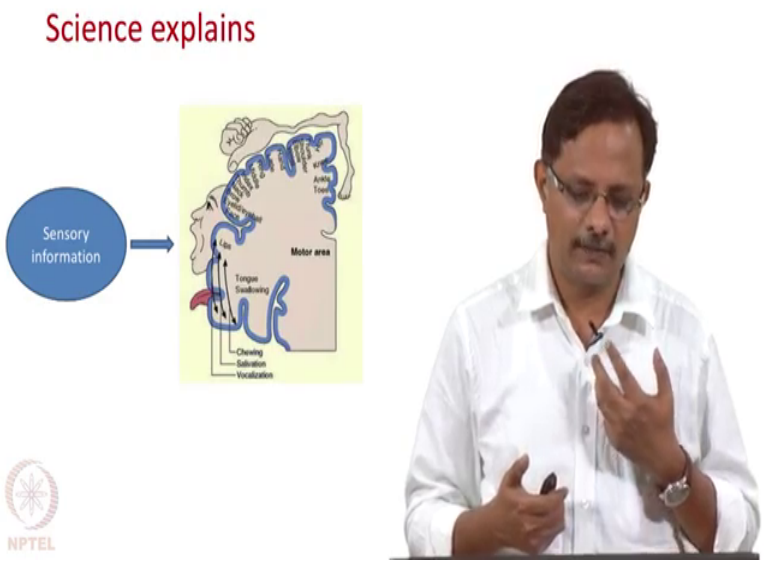

So, when you give a sensory stimulus you know you can explain how the brain responds to it as it is seen by your measuring equipment right.

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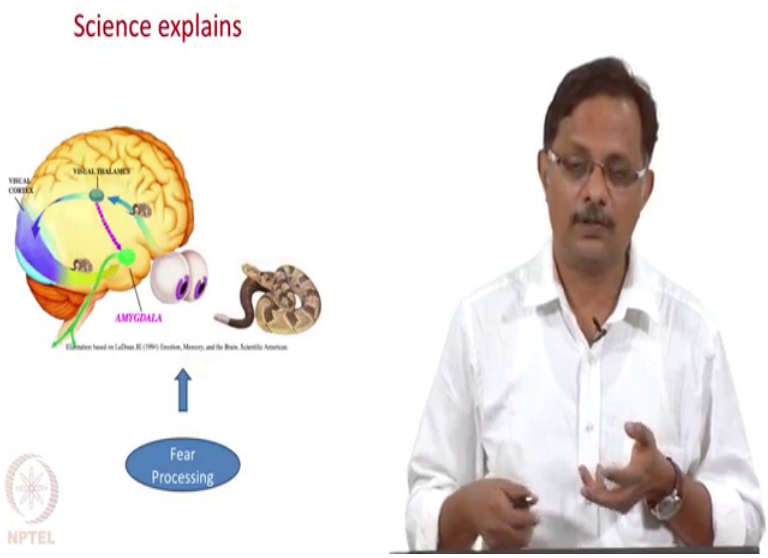

Or when you give a emotion stimulus like for example, snake then how does your fear system in the brain responds to it how does amygdale responds to it all this things right neuroscience can explain right.

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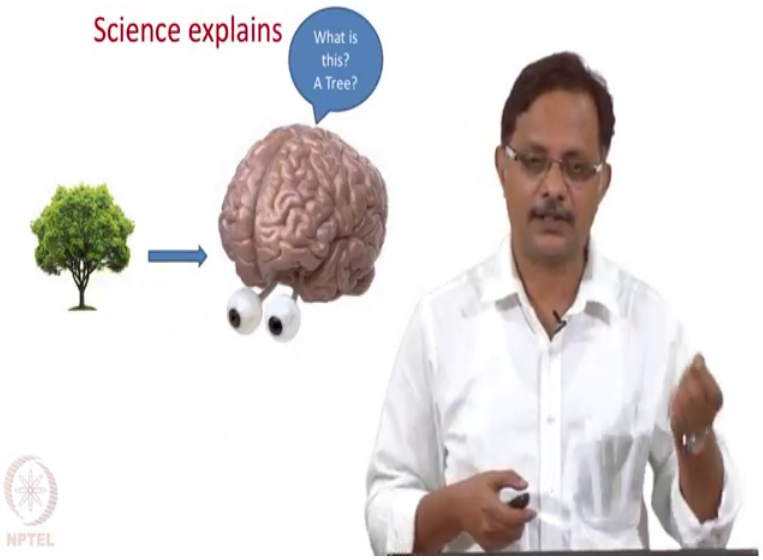

So, you look at a stimulus like the tree right which is outside out there and then brain looks at it and then this response in the brain, but it recognizes it asks a question what is this and answers right though this is a tree.

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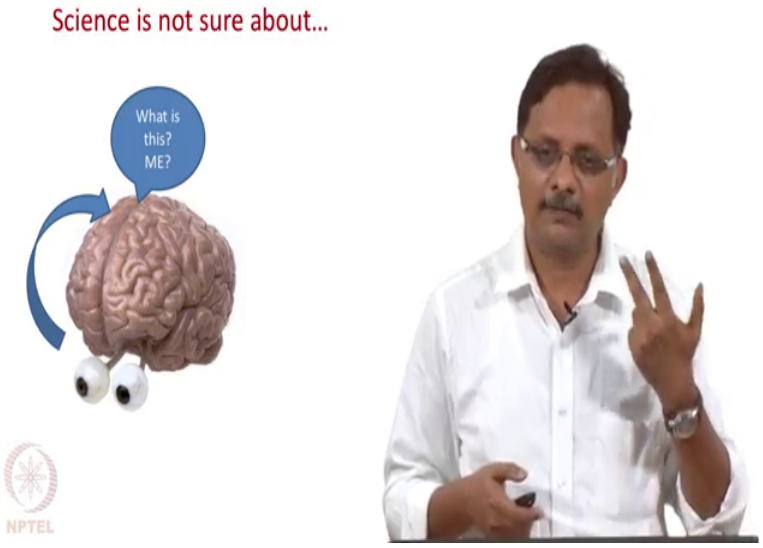

But when the brain tries to look at itself and look at its own experiences and what is it that is behind its experience behind this perceptions behind this awareness right. There is a kind of a something called me that is having this experiences and perceiving this you know having this perceptions right and having this awareness the substrate to all this

some kind of a me which is what we think right because we think that we are having all the experiences. What is that mean? Right here science and of you know is goes up in throws his hands up in the air and it is not very clear.

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So, this big mystery is what is this real me and how did describe it in neural terms in heartcore neurobiological terms right, this still not very clear this is a big question in neuroscience. The one of the problems with this questions is that let us take a very simple example think of the color blue ok.

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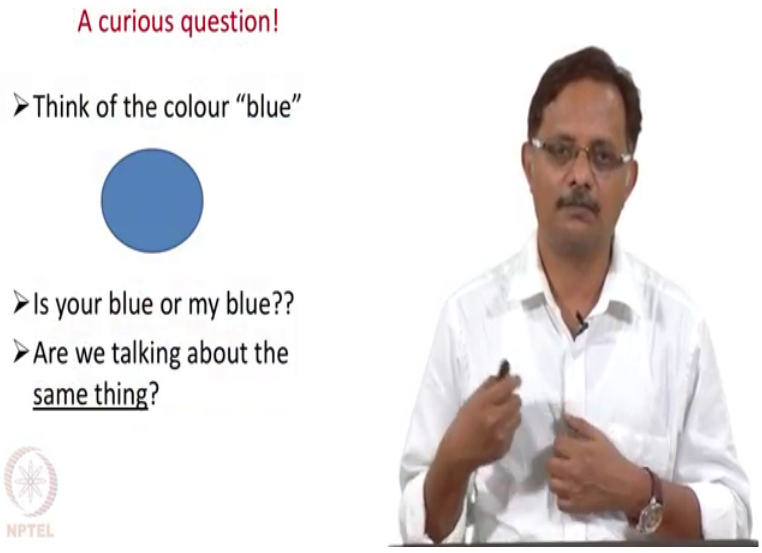

So, you look at something and say it is blue and then the person next to you also looks a same thing and now says it is blue agrees with you right. Now, the what is the guarantee that both of you having the exact same experience of this color you know of that object that you seeing in front of you.

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Thing is its need not be always be the same for example, there is this kind of a big debate that went on this puzzle went viral on the net. So, the question is this three pictures are shown these are three pictures of the same dress, the photographs are taken different lighting conditions and the question is what is the real color of the dress and is it like you know white with a kind of a golden lining or is a blue with a dark lining black lining.

And this is the whole internet community has divided two big camps right not able to decide on which is the real color of the dress. So, basically what happens is in color perception when you look at a colored object so, this the two things that determine the color perception one is intrinsic color of the object which determines what kind of wave lengths are reflected by the object right and you know that enter your eye second thing is the color of the light source right.

So, that will also change the kind of a effective color of the object, but thing is a visual system the color processing system in the vision has over the you know through evolution as learned to pretty much cancel out the effects of the color of the lighting

source and find out the intrinsic color of the object, but that is not a full proof mechanism.

So, therefore, when that starts failing right you will see a lot of variability in your perception of color and that is what the you know basis of all this arguments about the true color of this particular dress.

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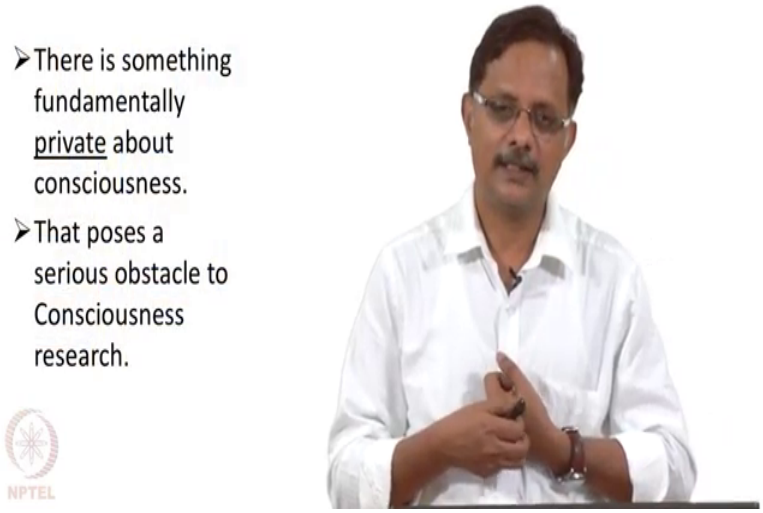

So, you can see that in this example you can see that there is something fundamentally private about consciousness. It is your consciousness as well as suppose to my consciousness or your perception as suppose my perceptions right and this cause a serious problem in consciousness research because if you want to do research scientifically on anything.

So, science is all about objectivity you dealing with things that you can measure perceive objectively and it is on that basis that people can agree you can agree on something that is objective that both of us can measure with equal instruments with identical instruments, but if something is basically subjective basically only you alone would know it is very hard to make a science out of it ah.

So, how much can we do when how much can we make progress when there is fundamentally a kind of a serious obstacles in studying a thing or a principle like consciousness scientifically so, that is one question.

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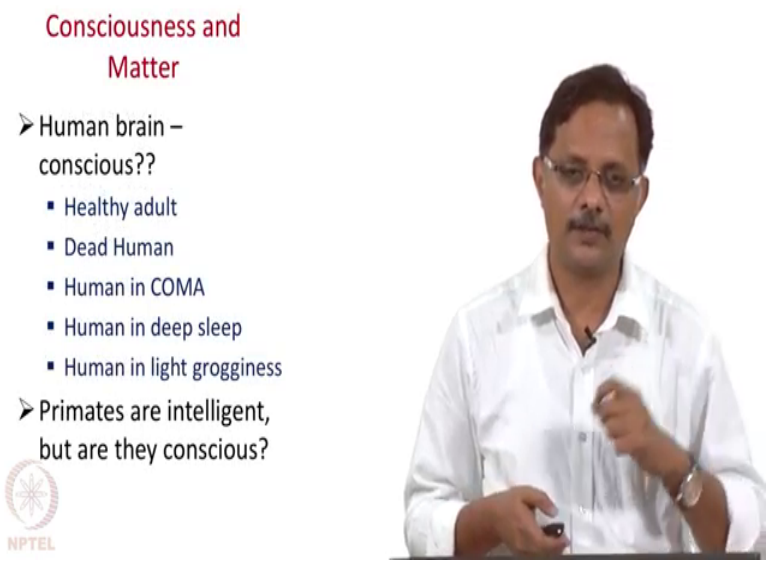

The second thing is when you talk about consciousness we are we are basically discussing particularly in the context of neuroscience. We are basically discussing its relationship to matter which is this space of matter here the human brain. Now, we now agree that we are conscious because of the brain right and. In fact, so long ago if you look at history of neuroscience our first lecture there was a debate about what is the seat of consciousness, what is the seat of the soul right. What is what organ the body is giving rise to this sense of consciousness so, they have all sort of arguments if they propose series of propose and Aristotle said you know heart is seat of seat of the soul.

But now right in the current world we kind of agree that the brain is creating sense of consciousness there a allow brain and consciousness relationships is kind of I mean that essential relationship is agreed. Thus, lots of shades of consciousness right for example, a healthy adult will have a certain kind of consciousness right a conscious state of mind and a dead human a dead brain does not have any consciousness you know we can I think easily agree on that and also a brain in coma will have very low electrical activity right.

In fact, people thought its zero activity, but I mean this very little residual activity even in a comatose brain right and then if you look at deep sleep the waves, you know the electrons of the gram or the EEG waves shift to very low frequencies in deep a sleep characterized by you know large amplitude waves like spindles and all that. So, similarly

if the brain is slightly groggy you know if you are slightly groggy right then again the waves are different.

So, thing is so, we agree that even when we talk about consciousness right there are shades of consciousness the levels of consciousness right, in even in our common experience and then accordingly the brain condition is also slightly different so, even consciousness there are shades of consciousness. Now, what about primates or what about other animals are animals conscious right.

For example, not only monkeys or primates even lot of mammals sleep and further people have taken EEG of sleeping animals and they found that the lot of parallel between EEG of humans and EEG of sleeping animals. So, for example, in humans when we are dreaming the it is called REM sleep or rapid eye movement sleep you know in this condition your eye is moves very rapidly under your closed dilutes. So, that kind of a REM or a REM sleep has been found even in a lot of mammals. So, thing is can we say that there also dreaming, I mean why can't we say that?

So, these are all open questions and so, these are all the questions that arise when we discuss consciousness.

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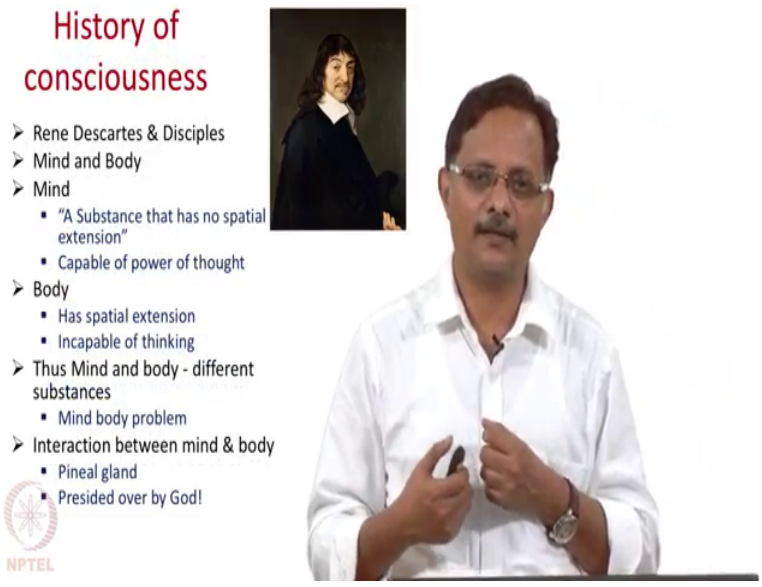

So, now let us go back a little and look at some of the historical landmarks of this whole discussion on consciousness and because history is huge, but we will take one decisive

point in the history of consciousness you know from a philosophical point of view, which made a major impact in a in the modern scientific understanding of consciousness. I mean there are not so, right nowhere being right, but actually, but it is very important turn of events in the history of a consciousness in the philosophical domain. So, if you look at Rene Descartes right we know him for his work on electrical geometry and all that and he and his disciples have thought about in speculated about the nature of mind and body.

So, Descartes you know made a very simple trenchant division between mind and body so, he said there are basically two different relves two different domains right. He spoke of substances you know he said about mind is like a substance that has no special extension. Now, if you look at matter you know substances as we know has matter it has a special extension it has certain size certain, you know height and width and all that, but he said mind is a special kind of a substance which does not have any special extension and this substance is capable of the power of thought.

Then body on the other hand has a special extension it is in capable of thinking by itself so, mind and body different of senses and they come together and somehow right this mind happens in the body. Now, one philosophical question that arises is if mind is so, fundamentally different from the body right, how can they talk with each other, how can they interact right.

Here he says that this very special organ in the body and although it is made of matter right. This organ is able to express the activities of the mind and he said this organ in the brain is a pineal gland now, we know that you know pineal gland it is not you know does not plays any special role when it comes to consciousness and does not. In fact, it is not a very important gland the primary gland is a pituitary gland, but somehow you know Descartes has a fixation on pineal gland right and the second question that arises is fine.

I mean this two mind and body are interacting with the pineal gland has a stage, but how can that interaction happen because they are. So, fundamentally different that are here he brought in his you know his trump card right by proposing that because this interaction is presided over by the god by god right god himself or herself is presiding over interaction between mind and body which is occurring in the pineal gland.

So, therefore, once god steps in right anything can happen so, that is how it went on and his students also kind of propagated that kind of a teaching and see thing is you might have notice that in a history and science ancients had this tendency to insert the idea of god, whenever they were not sure about some phenomena and they did not know how to explain it. They would simply insert the idea of god and thought that that would complete the explanation, but actually does not come, does not explain in this thing does make more confusing.

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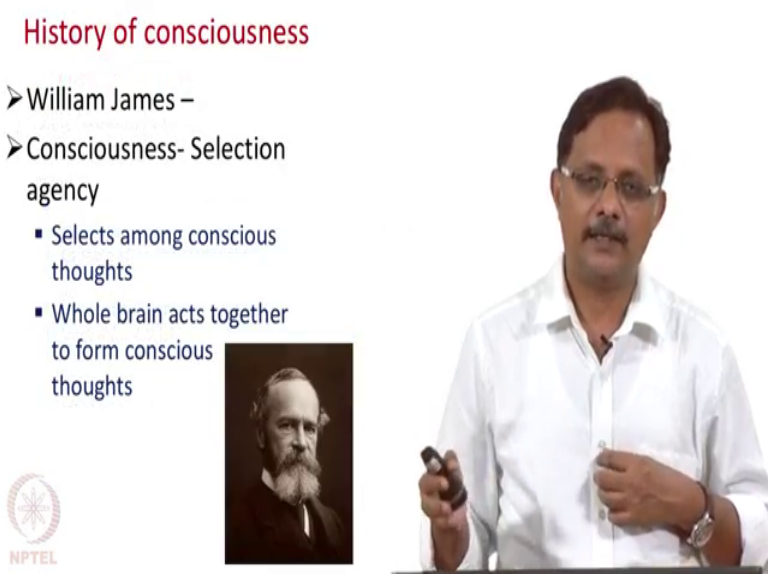

So, much later in the nineteenth century right American psychologist William James proposed a theory of consciousness which and which has completely done away with god right. He left the god out of it equation and his he talks about consciousness as a selection agency.

So, basically we have you know all this conscious thoughts and conscious basically selects from thoughts selects out of thoughts and you know may be enables you to make decisions and he says the whole brain acts together to form conscious thoughts. So, conscious has a selection and mechanism which is a very interesting idea and which is a accord by right much more recent theories of consciousness and second is that something holistic about consciousness.

I mean it is the whole brain phenomena and whole brain acts together interacting that is part of the brain interacting with each other right and that is kind of a holistic the

interaction global interaction producing consciousness both of this ideas are very insightful and they eco very well where some of the more recent theories of consciousness.

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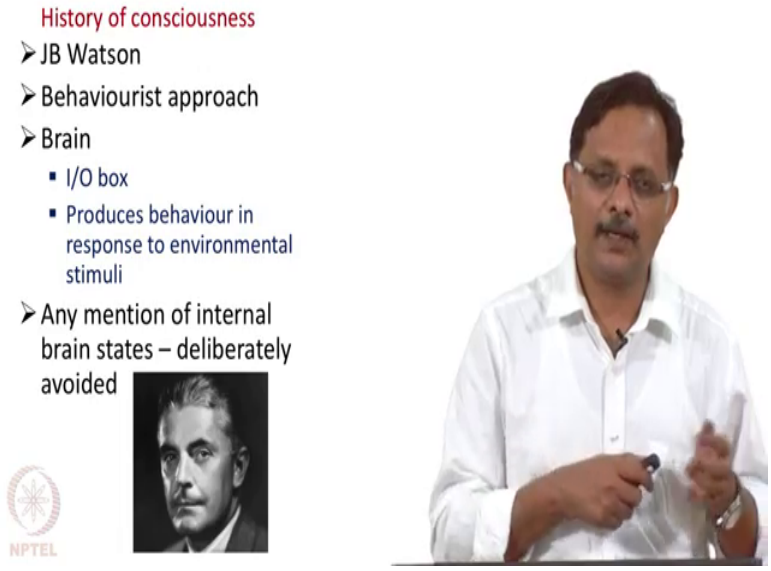

So, if you go back so, that James worked mostly in the late 19th century and if you look at the turn of century in the early part of the 20th century right. The theories of consciousness kind of delegated to the background because of the emergence of the school of thought like behaviorism right in neuroscience as we have discussed behaviorism in our one of the previous lectures, behavior is treated brain as black box. It is a black box input to this black box are the stimuli sensor stimuli output is motor output right presses of the button or you know amount of saliva that you produce when you salivate things like that. So, both inputs and outputs of this box are strictly measurable and quantifiable.

The nature of the brain is expressed in terms of this quantifiable inputs and outputs, any invocations of mechanisms or gears and wheels of the brain was simply dismissed right away as unnecessary in a useless hypothesis right. So, this box produces behavior and response (Refer Time: 14:29) to stimuli.

So, they did not want any mention of internal brains rates partly because we dint know much about brain and the internal mechanisms of the brain in the early part of 20th century. So, whenever people invoked brain sets they were talking from a side point of

ignorance so, theories were not very sound. So, to do away with all us complications right I have Watson and Skinner and this whole school of behavior is they took a very strict and a trenchant position and try to describe brain function purely in terms of inputs and outputs.

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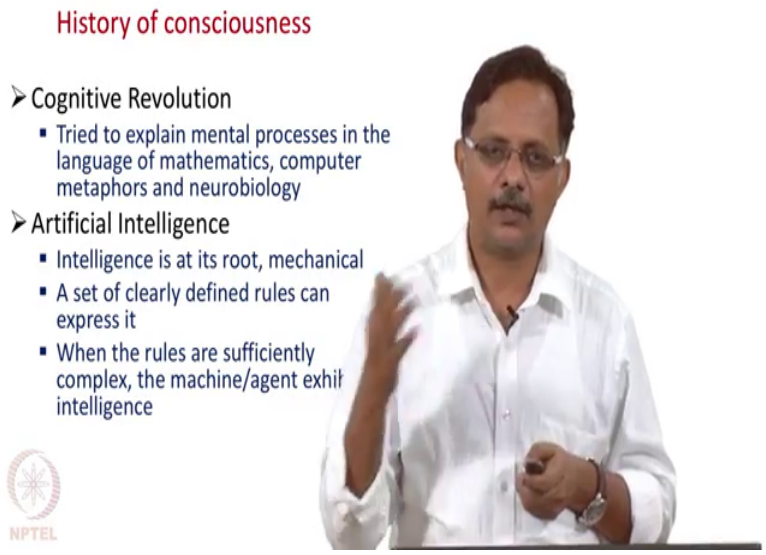

So, later on came the cognitive revolution the second half of 20th century, they try to explain mental process in terms of in language of mathematics right in computer metaphors and neurobiology. So, the basically they said information goes into the brain it goes from area to area in the brain and each area there is a very definite process information processing step that takes place and then right. So, therefore, cognition is reduce so, some kind of a sequence of information processing steps.

So, there was a huge attempt to describe every brain function in terms of a series of innovation processing steps on that is described as the cognitive revelation. At about the same time artificial intelligence also came on the same and the AI objective is to understand what is intelligence you know so, that you can built artificial intelligent you know devices and you know in and machines.

So, the basic premise of our AI is intelligence at a due it is mechanical is a very algorithm right any complex intelligent behavior can be reduced to a series of rules. So, basically it is like the fundamental principles of cognitive revolution have in carried over

to the domain of engineering and computer science and you know that gave us to the revelation.

So, basically the rules are sufficiently complex then the machine or the agent explicit intelligence behavior or complex behavior in which we think is intelligent.

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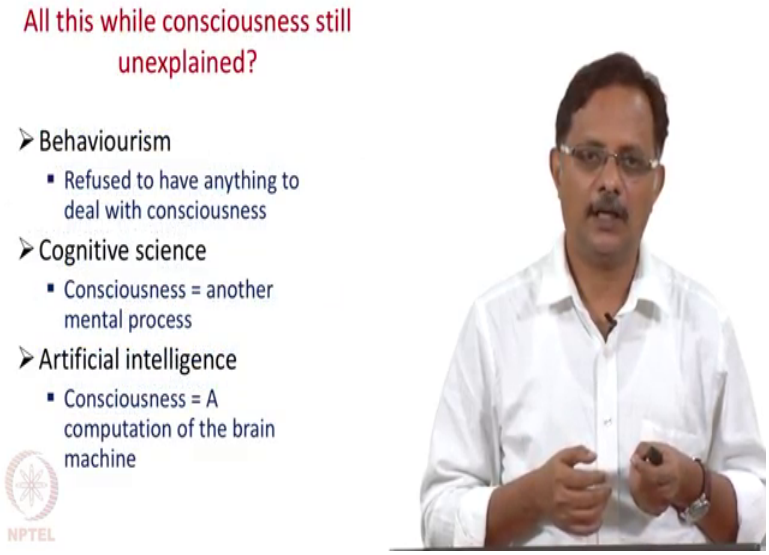

But so, all this while you know consciousness still unexplained because behaviorism did not want to anything with do with consciousness and cognitive science set. Consciousness is basically a information processing step that in a long sequence of steps and AI basically is tend to device machines so, there is no question of even considering consciousness. Basically, they said you know this the complex machinery of a machine right of a machine is basically consciousness is nothing more right in a machine does not consciousness. So, therefore, even in a brain which perform those kinds of competitions there is no consciousness per say or like it is this complex steps that we call consciousness just another name for it there is nothing different called consciousness.

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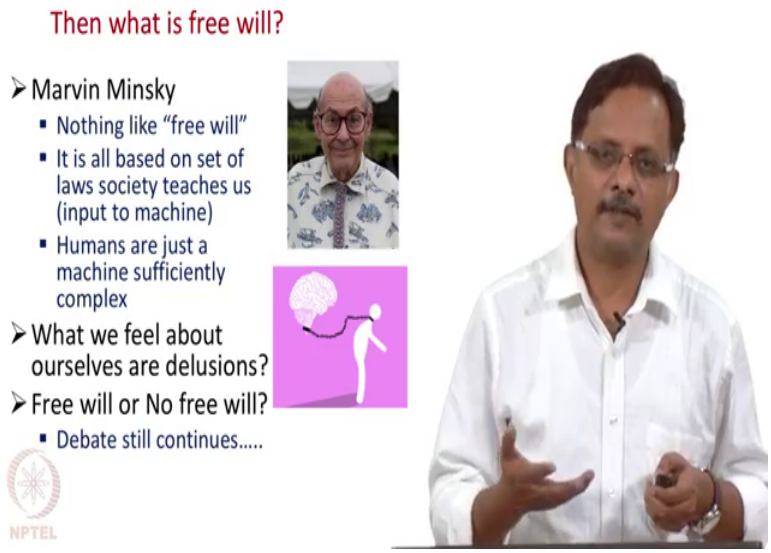

So, Marvin Minsky one of the major protagonist of the early AI revolution, clearly said there is no such thing as a free will it is just an illusion. Since, everybody says there is free will and kind of you know kind of under a spell, under a dilution that we have free will, but otherwise we have just do not have any free will. We had just like machines and you once are just like a the complex machine and so, there is there is no free will. So, point is so, if particular talk to religious people from philosophy they might argue that there is a free will, whereas the AI people took a strong extreme position saying that there is no such thing as free will.

It is just the effect that you see when a complex machine is operating, but point is that community is really know anything about free will because they never really studied the question in depth from a scientific side point both had their own opinion they arguing with this with their opinions so, the debates still continues.

But what is interesting is more recently you know the last couple of decades people have studied the question of free will from a purely neurobiological point of view and arrive at excellent in sights. So, we will talk about some of the so, people have moved away from this kind of a sterile argumentation right between the free will community and the no free will community and arrived at some insights into how to talk about this thing called free will. So, we will look at some other stuff in the second segment of this lecture. So, let us first look at some curious experiments and we will talk about consciousness or actually

one aspect of consciousness which is perception because sensitive awareness right. When you are aware of aware of something the two sides suit brain response to a you know you can measure the response using electron or EEG or FMRA etcetera.

So, that is all objective side of it, that is subjective side of it which is you as a subject so, right you feel that you are saying something you are experiencing something you are saying colors you are saying moving objects or whatever you so that is the conscious side. So, we will talk about this conscious aspect of seeing or this perception aspect of seeing so, then we will ask what.

So, what is the connection between these two you measures so, when you are saying something you feel you are saying something you reported and then the experimenter who is you know taking measurements on your brain reports something, I see certain activity in certain part of the brain. So, your perception and your experiences the details of that and the measurement details of the experimental do this thing match are is there is any connection right between these two so, let us talk little bit about that.

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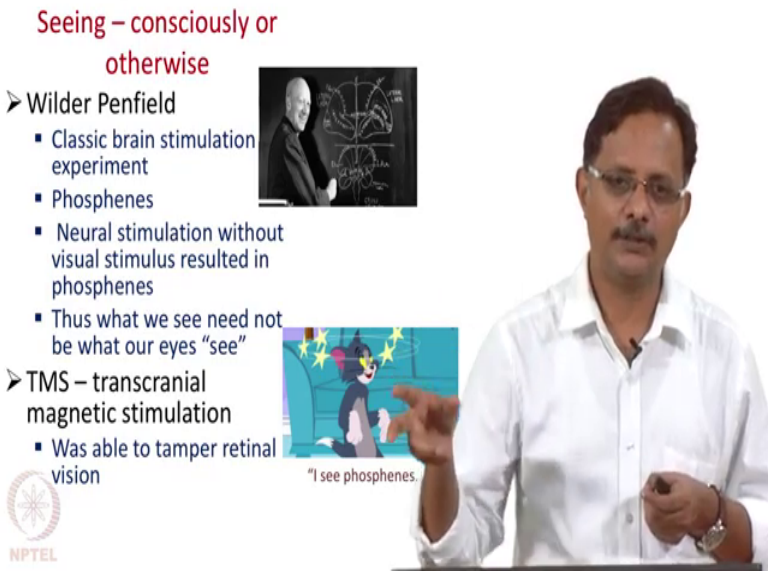

So, if you go back to the earlier experiment the classic experiments of Wilder Penfield on brain stimulation so, when Penfield's you know stimulated various parts of the brain people reported different kinds of sensitive experiences right if you recall from our early lectures.

So, for example, when we simulated the visual parts of the cortex that people reported they that they see flashes of light called the first Phosphenes and sometimes when the when simulation was done by two electrons simultaneously, they could see two Phosphenes.

I mean when he brought the two electrons closer and closer and closer that two Phosphenes merged into one so; that means, these a example show that the some connection between the stimulation which we can measure you know you can control the current levels and you can control the position of the electron and all that and these are objective properties and the some relation between those objective properties and what you are experiencing subjectively right. So, and further when simulation was given for a very long time.

So, and starved sometimes people saw the Phosphenes for much longer after simulation was removed sometimes even could see the Phosphenes for two minutes. After the stimulation was removed so; that means, you have when you have activated the cortex the effect of the activity has probably lingered in the cortex was several minutes and that is what may be you are seeing so; that means, what you are seeing is really not what is out there, but basically the kind of electrical activity and that is happening in the brain that is what you are seeing.

So, similarly so, stimulation in case of Penfield he was actually he expose the cortex expose the brain and injected currents and stimulated the brain and that is what is producing all this experiences, but you can also do stimulation use more non visibly using something like transcranial magnetic stimulation where you shoot a magnetic pulse you know the and magnetic field. So, the cranium and the scalp is quite transparent to magnetic field.

So, if you can if you shoot a magnetic pulse at your head right it penetrates the cranium the skull and the scalp and can act on the cortex and can produce local currents in the cortex. So, people have found that when you stimulate the visual cortex using a TMS that will produce again consciousness which can tamper with your vision. It can obstruct right what you are seeing in the in the real world.

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Take a simple example like this so, in this picture you see a black and white image and then just keep focus on this image for about 20 seconds and it does not it is not clear what is image is because actually it is a negative of an image. So, focus on it for about 20 seconds and then turn your attention away towards some kind of a white wall officiated background right and then see what happens, you can very easily see that this is a this is a picture of a familiar person a famous right a person a personality.

So, what is happening in this case is actually negative of a person right and when you are looking away after a long exposure to the to this picture right the activity in the brains seems to flip. So, neurons which are stimulated now become suppress and belong which were suppress before will get overactive and then so, Penfield's producing some kind of a negative of the negative which is the positive and then you see that real picture out there on the screen. So, you can try it out these experiment by yourself and you can you know find out who this person is.

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Take another example here so, there are two birds one is a green bird, another is a red bird. So, you focus on the green bird first you know look at for about 20 seconds then shift your attention from the green bird to the cage. So, when you do that you will see an afterimage of the bird right as the afterimage is located is caught inside the cage.

But the what is interesting you will see afterimage in different color right the original bird is green. So, when you see the afterimage you will see a magenta colored bird sitting inside the cage so, similarly if you look at the red bird for about 20 seconds and shift attention to the cage you would not see a red bird in the cage, but you will see a cyan bird in the cage. So, what is happening again here like in the previous case is when you look at the object you know which is a red or green bird for a long time. Then shift your attention the activity is shifting to so, activity initially corresponding let us say red color when you are shift your attention, the activity shift is changing over to the colors corresponding to the complimentary color of the original color.

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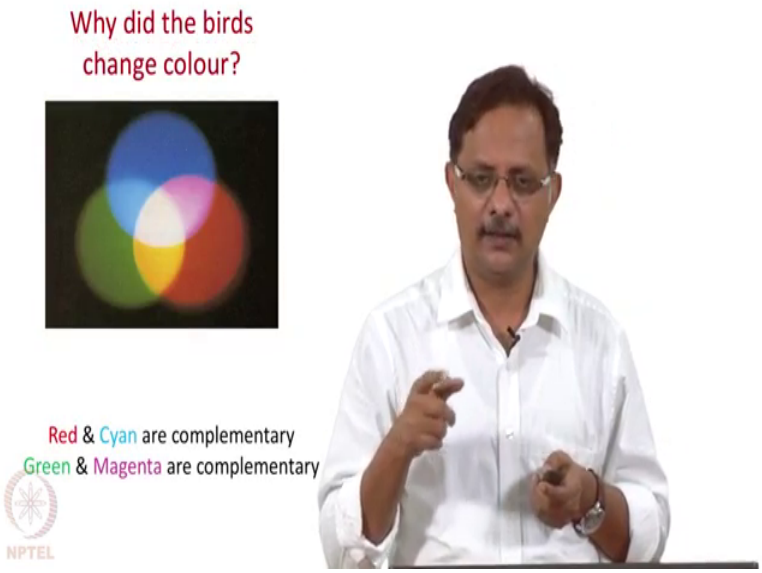

So, cyan and red are complimentary and green and magenta are complimentary therefore, you see we shift your attention cyan bird or a magenta bird.

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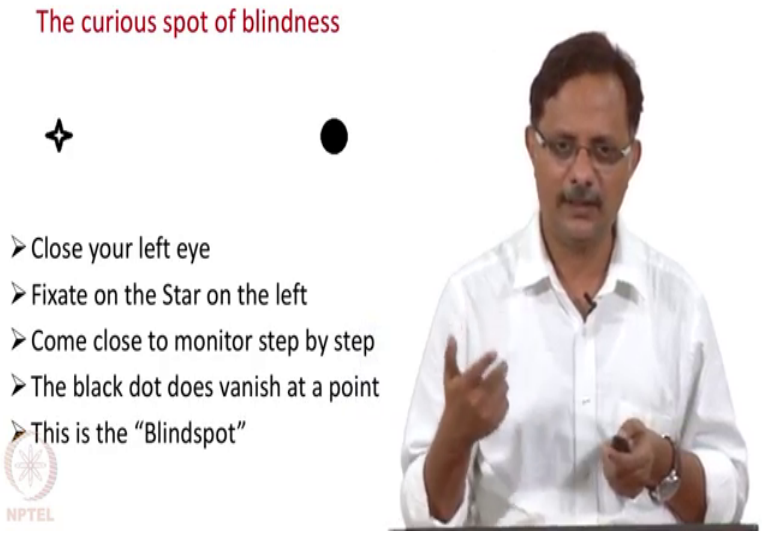

Let us look at one more example so, you might have all heard of the blind spot in the eyes. So, to test that so, in this picture you close your left eye right and keeps staring a the start pattern on the screen and move closer and closer to the star pattern or you can take a printout of this kind of slide and may be do it on a piece of paper. Come closer to the monitor step by step at some right closing your left eye at and then keep focusing on

the star. At some points certainly you will find that you will you keep continue you continue seeing the star, but at some point that back dot on the right side suddenly disappears from your field of vision.

So, that point is called blind spot so, basically blind spot occurs because in the retina right you have bunch of this proprioceptors, is a point in the retina where there are no propriocepters so, it cannot see light there. Normally, we do not notice because if we look at two images of the world and then so, where there is no light in one retina the other retain there is a light.

So, there is a kind of bent fuses this images and fill up fills up the gaps so, you do not feel the kind of a black dot right in your visual world. So, this so, you do not notice it, but if in this kind of a very controlled experiment right where if you close one eye you can make the blind spot in the retina fall on a certain object or a pattern on in the real world like in this case a black dot and then you will see that the dot disappears.

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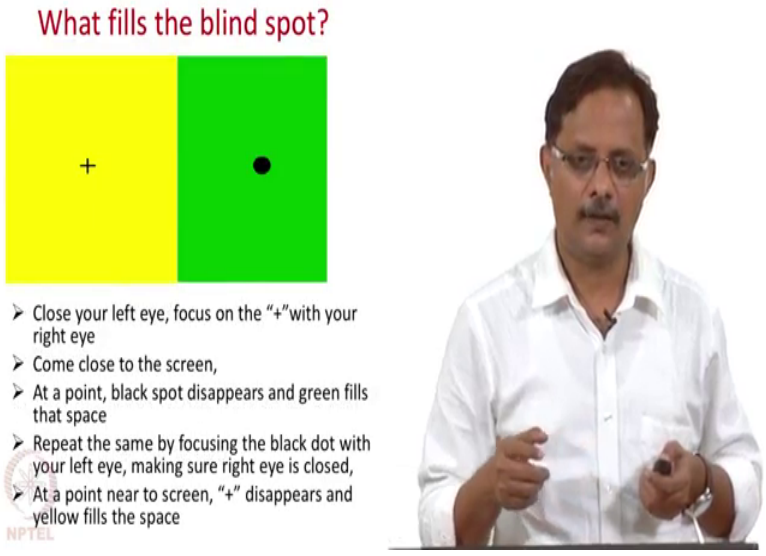

Now, let us do this very interesting experiment which was described by Ramachandra and Richard Gregory. So, this experiment again you shut off your left eye and then focus on the plus sign and get closer and closer to the to the pattern on this screen. Until, at some point you are black dot which is on the right side inside the green square right the black dot disappears.

When you see that and then when the black dot disappears, what happens is the little patch of patch of black and it was originally black, but once it disappears what happens is what is a color of that patch you will notice that that the patch now became green. So, earlier it was black and then now with when the blind spot is super imposed on the region. At the black dot disappears and that part now looks green so; that means, brain is actually filling a because this is no real green there is no actually a black dot there, but when you are blind spot fell on the dot brain kind of filled up that part that part and made it look like green.

So, this is another example to show you that what we are seeing is not always exactly what is out there you know brain makes a lot of stuff right, where in which missing information very often brain interpolation makes the stuff you know by the internal mechanisms and that is what you are actually seeing.

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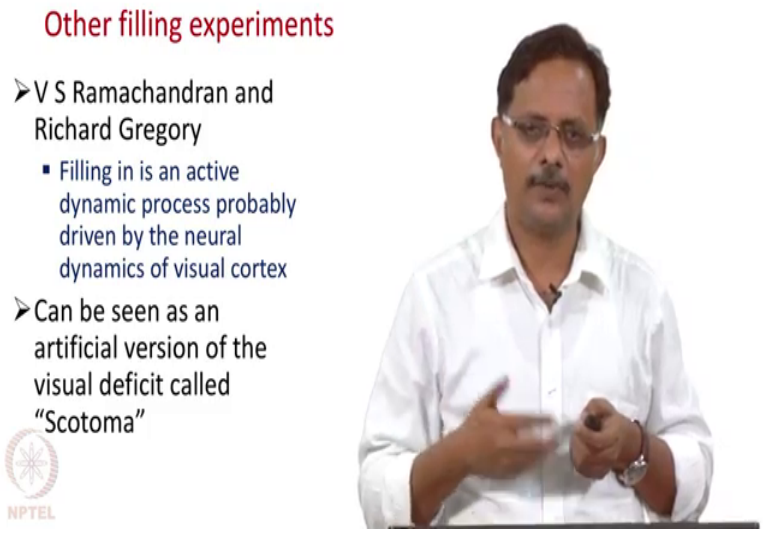

So, there are more complex phenomena that have been described by Ramachandra and Gregory in their works. So, another interesting example is the visual deficit called a Scotoma.

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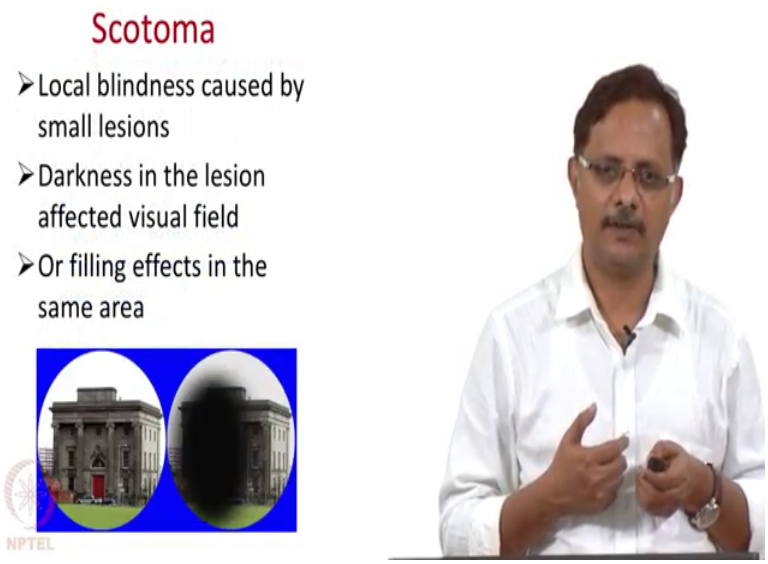

So, basically when there is so, previous example right the see we see we do not see a certain part of visual field because of the blind spot which is there in the retina which is there in the eye, but some time because of injury to the brain. So, injure at the visual cortex so, there is a small injury to the visual cortex right that part of the brain cannot see. So, the enough information have from the world goes to the optic you know goes to the part of the brain. Since, that is the cells there are dead right it would not able to see anything. So, if you looking at some scene right if the Scotoma falls on certain object in the scene that part looks kind of a you know darkest region ok.

So, even in and a set and in such conditions people have shown the certain filling effects appear because brain tries to interpolate, brain does not like ignoramus brain does not like missing information. So, it likes to inter like to interpolate and this aspect of interpolation has been brought about right brought about by a lots of very interesting and very elegant experiments. So, that takes us to a very interesting phenomena called blind sight.

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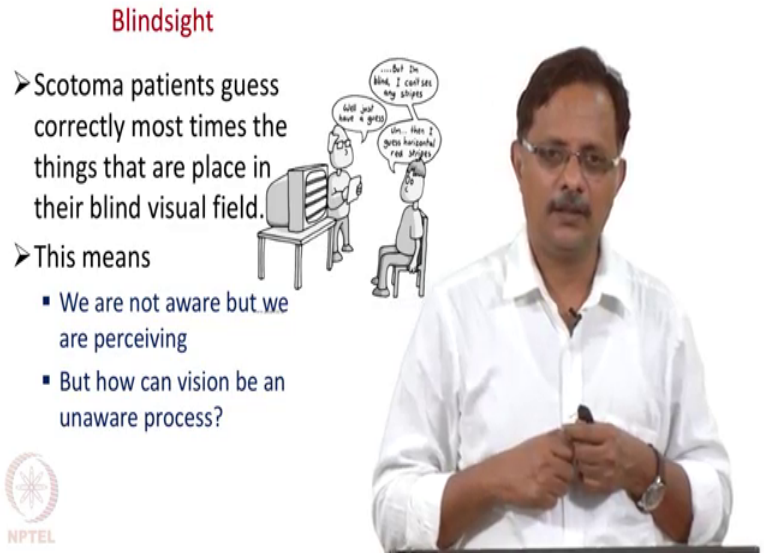

So, this Scotoma patients sometimes so, we seen that you know there is a part of the visual cortex which cannot process light information. So, it cannot see, but just because we cannot see it does not mean they do not have the information. So, this so, what is very interesting and very puzzling is that seeing something visually and have an experience visual experience of it is not the same as exhibiting visually driven behavior.

So, let me clarify this so, in there is this subjects who exhibit a kind of phenomena called blind sight a symptom called blind sight. So, this people they are practically blind because this they feel that they are not aware of anything they are no there is no visual awareness. They do not see this you know the world of visual world of color light and all that, but they can very often show visually significant behavior. For example, if you throw a ball at them and say hey I am throwing a ball try catch it they might be able to catch it with reasonable accuracy so, how is that possible they cannot see at all.

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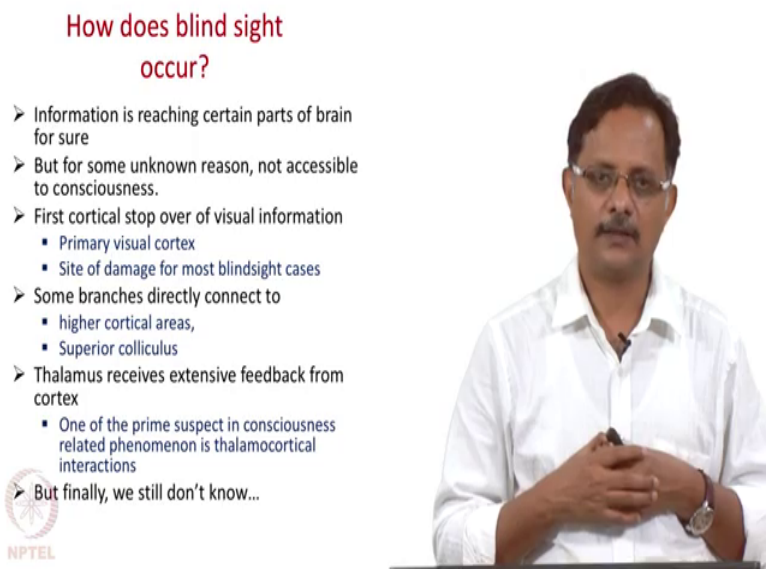

So, how does it occurs so, thing is so, if you look at the what happens to light information when it enters the brain right from the eyes. So, light is captured by the eye and it goes to the optical you know goes it is to the first top over of this is thalamus and from where it goes to the visual cortex and from there it goes to the higher cortical centers and it also branch of this also goes to another structure called you know superior colliculus and the thalamus to the which is the first top over also receives feedback in the cortex.

Now, the damage to the brain is only in the cortex the information has already entered your brain from the eye it has gone to the thalamus. A copy of it to the also distribute colliculus so, other parts of the brain are looking at the world only your visual cortex hasn't got the information. So, when you say you are not able to see right the when you are able to see only a dark patch and you are not able to see what is really there. It is your conscious self that is not able to see, but brain is able to see other parts of the brain is able to see it may be that these are the parts of the brain, that are driving your motor output and a guiding your hand right towards may be you know the act of catching a ball. So, may be that is how blind sight is occurring.

So, we still do not know we still do not know exactly how does brain produces behavior of blind sight, but found these are some valid arguments that you can put forward to account for something like blind sight then let us look at binocular vision. So, we know

that we have two eyes right and both eyes are actually pointed in a forward direction. Unlike in some animals where two eyes on the two sides of the head like you know dog or a cow for example, two eyes are kind of a two sides of the head where as in us and cats we have eyes are both eyes are in the front.

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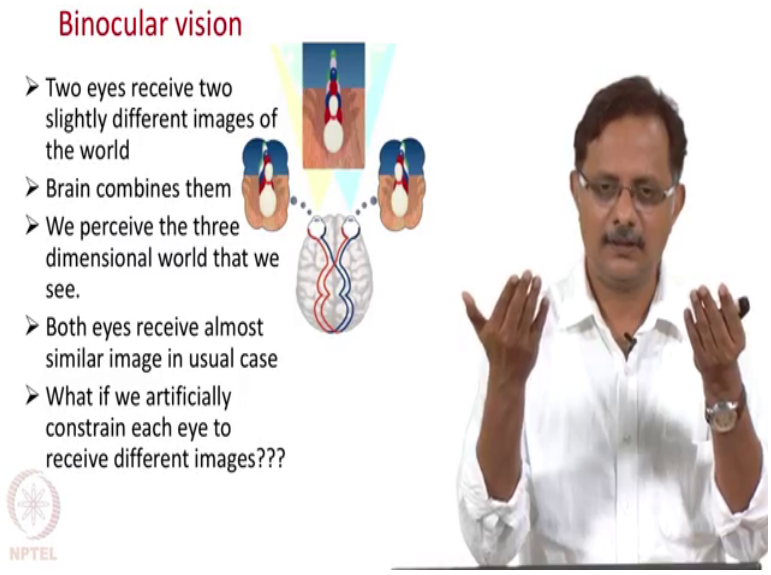

So, brain when the brain reactive these two images which are not identical, but only slightly different right. If eyes are two one side of the either side of the head then the image at the two eyes are receiving will be drastically different, but in our case when eyes are pointed in same direction the two images are not identical they are looking at the world from the slightly different when touch points.

But they are quite similar the image are only slightly shifted from between with respect to each other. So, we look at we reactive this images and somehow fuse them and by fusing them we are able to concept the depth you know we are able to perceive the death in the real way this called a binocular vision or a stereo vision. So, basically for stereo vision to occur the both eyes should see the world in a similar way do which should look similar and brain actually superimpose these two images in some in some fashion compare these two images point by point and tries to extract depth information about various objects, but are there in front of you.

Now, consider what happens when the two images that you are looking at are not the same not even closed how is it possible because the two eyes are looking at the same

thing all the time. So, you can artificially constrain what the eyes are looking at by using a special device called the stereo scope.

So, basically you are you know you can see through a viewer and then you know you can have some kind of pattern just implied to both eyes and which is controls so, that you see one part on to the left eye and one pattern to the right eye.

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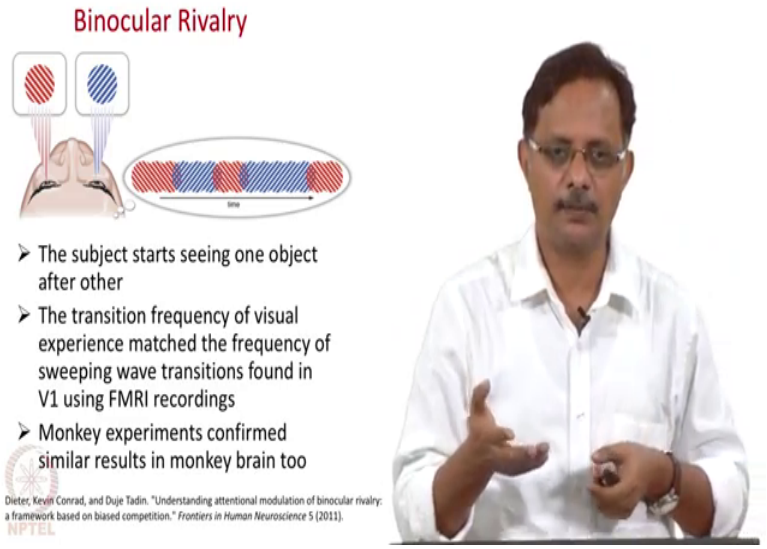

So, for example, in this picture you can see that kind of a red stripes with a from the different orientation are shown the left eye and rights and blue stripes with the 45 degree orientation are shown to the right eye. So, now, it is impossible to fuse these two images because they are not even closed right and you cannot fuse them and construct any 3 d depth information.

So, when subjects are shown this kinds of totally different images right in a stereo scope they found the experience something very interesting. They did not see, they did not have the experience of seeing red stripes on the left and blue stripes on the on the right, but they had the feeling of seeing red stripes in both eyes for some time right and then that percept change and after sometime they saw blue stripes.

So, blue 45 degree stripes with on both sides for some time then the it change the percept change. After that the again saw the 135 red stripes or sometime so, on and so, forth. So, instead of the eyes quarreling about what they are seeing right saying that the seeing

different things. Both eyes seem to have agreed that they have the seeing the same thing, but they are seeing it alternatively they seeing the same thing, but seeing it alternatively.

So, these are explain of this kind are called binocular rivalry experiments because here the two eyes are in a in a state of rivalry. They are looking at opposing things, but brain somehow arrived at a consensus and giving showing the subject that is you the same percept, but this percept is alternative ok.

So, now that's what this subjects sees right subjectively, but what is actually happening in the brain when this happens. So, the they actually track the activity of the brain when this happens and found that so, when the subject is seeing say it is a red stripes because one kind of activity in even throughout even right and then subject is seeing blue stripes because it is a different kind of a activity throughout even.

So, the activity itself is not different you know it is not we do not have two masses of activity one corresponding to the red stripes one corresponding to the blue stripes. It is only a single activity that activity is changing between very slowly because a percept this percept changes very slowly right through time and the activity changes in the in the V1 that is the primary visual cortex also synchronize with changes in with the pattern of changes in your percept.

So, I something that you feel subjectively right which is not this and which is very different from what is actually presented to you from the world outside right. You are subjective percept has a very strong correlation bit with what is measured in your brain. So, this kinds of binocular rivalry experiments have been performed on monkeys also and the similar results have been produce with monkeys also. So, this example that we have seen is are from the from the domain of vision, but similar experiments are being done on with other sensory modalities also.

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Take for example, the sense of touch right you know the sense of touch you know. So, for example, you touch something right your there are sensors in your in your fingers right these are called the mechanoreceptor. A signal from here goes by a certain nerves goes to a spinal cord and essence through the spinal cord and reaches your part of your cortex called the somatic sensory cortex.

We discussed in our earlier lecture on the organization of the nervous system and that is when you have the feeling of the, of this experience of touching something. One more source of this kind of a tactile information is a what is called proprioception so, when we have this kind of mechanical experience of the of the world you know that is hard and it is that is soft or fluid and all that all this properties of the world are process by your somatic sensory system and skin is only one part of that skin is only one sensor that is feeding information to the your somatic sensor system.

The other major source of it is what is called proprioception that is so, you have a so, your muscles in your you know in your joint you know control your joints they also have sensors right which feed information to a brain about the joint angles and the and the configurations of a joints and things like that and these also important because when I am let's say holding you know an object like a mouse right to hold that object I have to shape my fingers into certain conformation ok.

So, that shape of the fingers is conveyed by the sensor which are present inside the muscles and this sensors called proprioception. Proprio is basically position and Ception is you know perception it is like a position perception of our joint angles and our joint our configuration of the joints.

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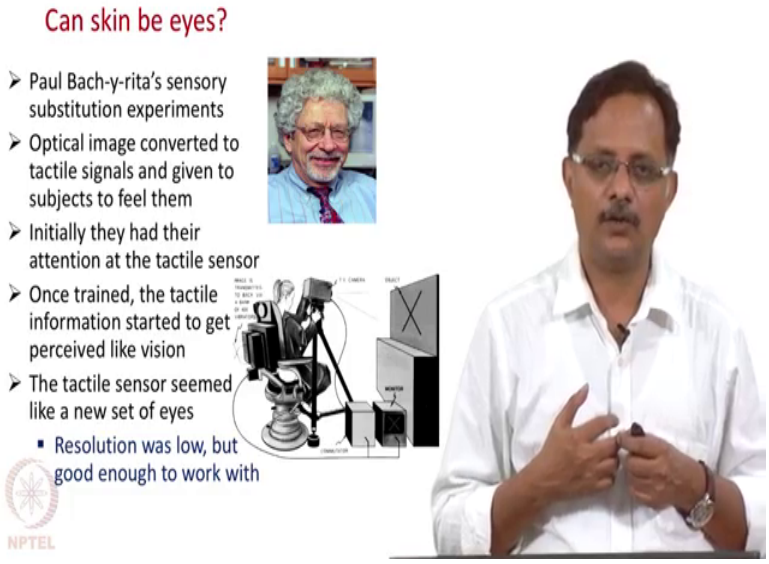

So, now so, Paul Bach-y-rita right who is performs some interesting experiments to restore vision to blind people by letting them use somatic sensory sense are or the tactile sense as a kind of substitute for visual sense. So, basically what is on this experiments we have a camera right camera grabs a visual information about a same in front you and that visual image that is grappled by the camera is used to activate the bunch of tactile sensor. So, these are bunch of small array of 20 by 20 vibrators which are slapped on to the back of the subject right so, whenever so, the certain part of the image is active you know there is a light is received by the part of the image that the corresponding sensor you know the tactile sensor needles a current.

So, you get a little shock right in your back so, you have the pattern of shock that you shock that you receive on the back vaguely corresponds to the pattern of light that you receive in the image. This is resolution very low; obviously, because I mean a rich images now converted to a very coarse 20 by twenty image because a number of fibers that go from each retina to your brain is 1 million. So, these are very rich this has very high resolution the so, all that rich information is now reduce to a very low resolution

array of 20 by 20, but people receive that kind of a somatic sensory feedback right and using that they were able to have some kind of a experience of the visual world because what is interesting here is the input that I receive is originally visual because it is obtained by camera, but that is getting converted into a tactile stimulus which is what they are receiving in their back and because you do not have eyes in your back.

So, it is skin which is receiving this input and then from that the patients or the subjects felt that they are able to see something right.

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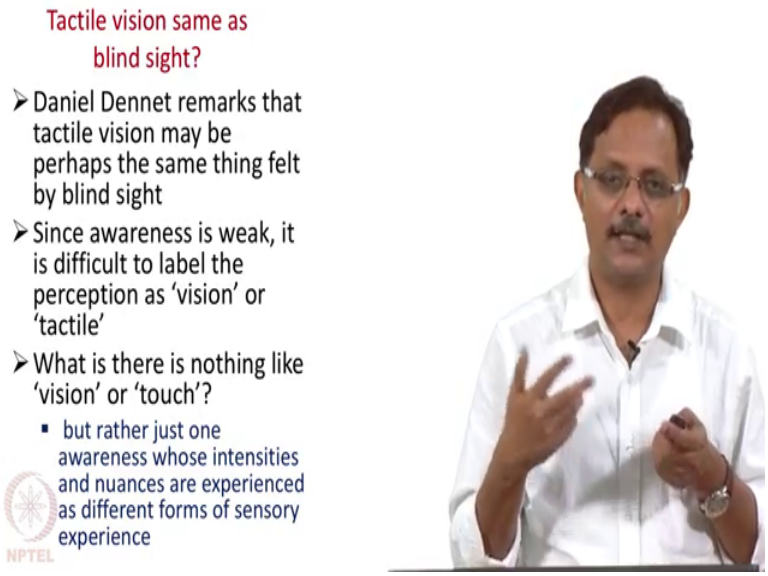

Now, the thing is say is that there is what they are saying we call it actually vision or is it tactile. I mean because it is difficult to argue right because original input is vision what they are actually receiving is tactile. So, whatever they are aware of is it a visual image or a tactile image. It is difficult to say because they themselves are not able to decide whether it is a visual image or tactile image, but they are able to see some they are able to experience something.

So, one question is this tactile vision as same as blind sight, is it the kind of thing that is going on you know in the blind sight kids. So, basically here we are looking at a kind of a border line between vision and touch or something that is so, weak right between vision and touch, but something that is experience that is consciousness ok.

So, all this experiments give you show you a nature of consciousness from certain points of view, but in so, it shows how mysteriously it is how difficult it is to understand and quantify right what is consciousness. So, with this let us end segment 1 of the lecture consciousness from in this in next segment, we will look at more neural substrates and so of so, more interesting experiments on you know when you study consciousness from a neurobiological point of view.

Thank you.