Advanced Cognitive Processes

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Lecture - 10
Mental Imagery – IV

Hello and welcome to the course advanced cognitive processes I am Ark Verma from IIT Kanpur. We have been in this week talking about different aspects of mental imagery last lecture was about cognitive maps wherein we talked about different aspects of cognitive map and how for how closely related is our perception of these cognitive maps with respect to our actual navigation in the environment. So, we talked about distances, we talked about some of the biases that are there size alignment bias rotate rotation bias and those kind of things.

Today I am kind of trying to put all of this all of the things that we talked about in this chapter on mental imagery I will try and put all of them together and I will try and work with you towards the resolution of this debate again if there is a resolution possible that is between the analog and the proposition representations and also in the latter half of my lecture today talk a little bit about the fact that you know how the different brain areas are involved in processing visual imagery and whether there are similarities or differences in the brain areas that are activated in actual visual perception and visual imagery again that could be done for other things as well.

So, let us because we are getting to the close of this chapter now let us revisit the imagery controversy and what have we been talking about you know we know that there are 2 points in the imagery controversy.

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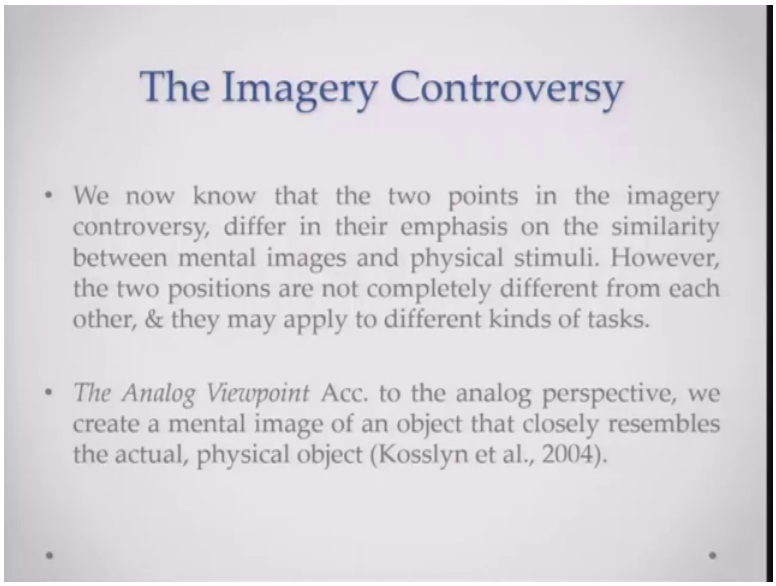

And these 2 points basically these 2 opinions they differ in their emphasis on the similarity between mental imagery and the perception of actual physical stimuli; however, the 2 positions are not in any way completely different from each other and they are kind of there are sort of common strands in both of these things you know they both might share a lot of explanations as well.

Let us look at the analog viewpoint again according to the analog perspective, we create a mental image of an object that closely resembles the actual physical objects we are kind of creating an analogue representation which is exactly like to the representation that we create and you know to the object whose representation we are creating exactly.

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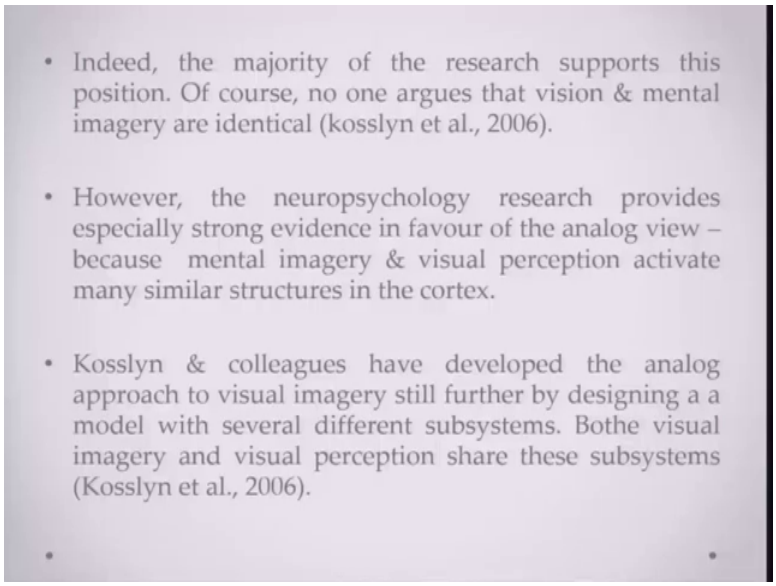

So, the majority of research you remember in the lecture before the last one we talked about research with imagery in size, imagery in distance, imagery and the shape and those kind of things and it saw that a majority of the research has supports this position the majority of research supports the analog account. No one are used that vision and mental imagery is identical, but still they say that they very similar to each other we seen across the examples and experimental studies we talked about we seen that these 2 things are very similar if not exactly identical.

Also the neuro psychology research we will talk about that later provides especially strong evidence in favour of the analog view you know it tells us that a mental imagery and visual perception a as phenomena activate pretty much very similar areas in the you know in the cerebral cortex.

So, it is again a collocation and thing as well now Kosslyn and colleagues have been developing you know the analog approach to visual imagery and if developed this still further by designing a model that has several different subsystems, some of which are shared using visual perception and mental imagery as well. So, a lot of these say subsystems that they have actually designed are shared by visual perception and visual eventually.

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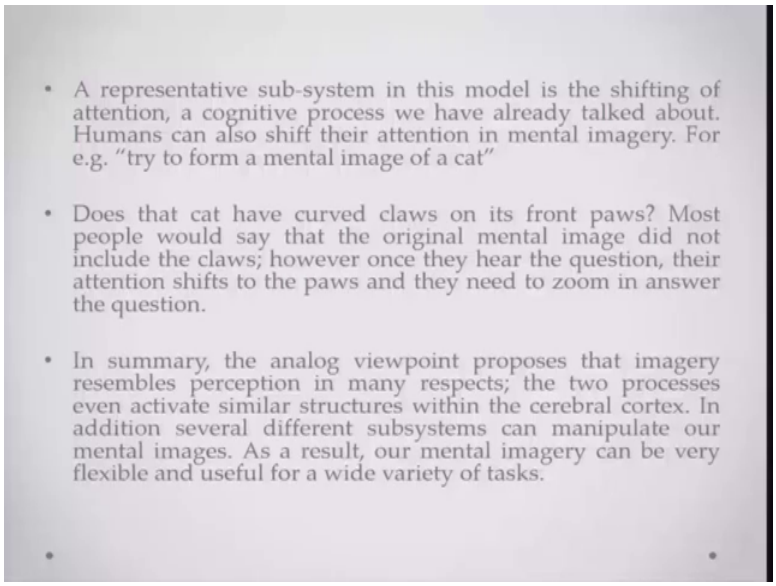

A representative self system in this model basically developed by Kosslyn colleagues is the shifting of attention and they say that we shift attention in much the same way during mental imagery versus when you are actually perceiving the objects and they could be an example.

Suppose say for example, I asked you to form the mental image of a cat and then later I asked you the question does this cat have curved claws on it is front paws? You will think over it you kind of take a bit of time, take some moments and then you would probably you know be able to answer this question. Why is this happening? Why are you taking so much time because you have created the picture you should easily be able to pick this up and tell me the aspect is at most people would basically report.

Later that the original image actually did not even contain the claws probably contained mostly the torso of the cat, maybe the whiskers, eyes, ears, tail, legs not really exactly the detail of what the claws look like because you are not really attending to that entire thing when I asked you about the claws then your attention kind of zooms in to the legs and then zooms in to the claws and then only you can actually tell me.

So, it is basically you are creating that mental image of the claw because you want to answer my question just like you are shifting that attention, focusing that attention much like you would do if I asked you to you know look at the cat and tell me whether the claws in front are curved or not. So, in summary the analog viewpoint proposes that

imagery resembles perception in so many respects and the 2 processes even activate similar structures in the brain. In addition, the different subsystems which are responsible for both mental perception and mental imagery are shared and they kind of share a lot of functions.

Now, what happens is a result of this very close functionality of mental imagery and visual perception is the fact that are mentally visually can be very flexible, it can be useful across a wide variety of tasks.

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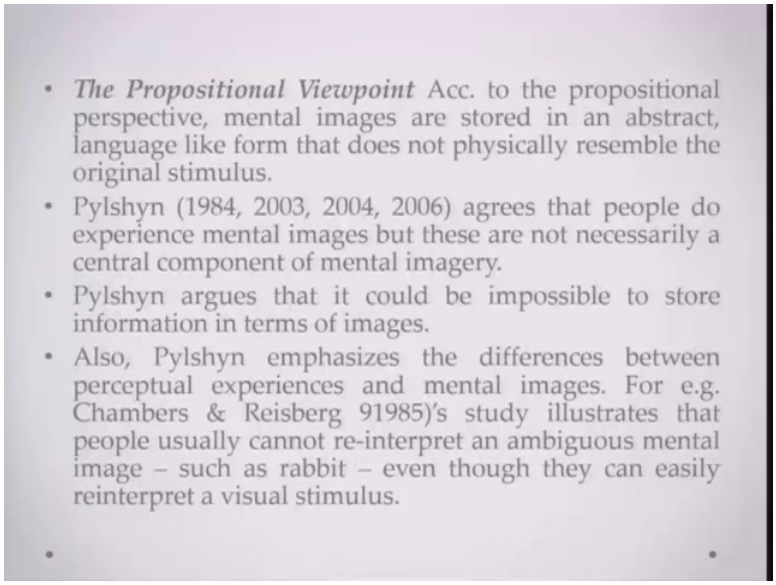

Now, let us come to the propositional viewpoint what is the propositional viewpoint? The propositional viewpoint basically says that mental images are stored in an abstract language like form that does not physically resemble the original similar. So, the form in which you are storing let us say the layout of this room does not necessarily have to be the image of this room, there could be other things as well I could say that you know the door is on the right and there is a table on the left and there is a at the corner there is a vase or something some things like that I am going to store this all in a description and again when I have to draw this I can draw this verbal description use this verbal description to draw the painting of this whole thing does not mean necessarily that I am storing the entire snapshot.

So, this is what the propositional viewpoint argument is and as I have been talking earlier lesson Pylshyn was one the people who proposed this and who has been arguing about

this. So, Pylshyn also agrees that people do experience mental images, but these are not a necessary component of your mental imagery that is what Pylshyn says he argues that it could be impossible to store the information in terms of just images, it is just like it is probably very difficult how many snapshots of area you traverse will you capture suppose for example, how are you taking cross with you a video camera and it is a high speed camera and you are taking it across at the room or the street that you are walking in, if it is a fast enough cameras probably capturing a 1000 let us say it is a typical 1000 Hertz, 2000 Hertz camera it is probably writing in 2000 images in a second.

So, in that sense there is too much information the file size will be too much it is probably going to be very impractical to be able to store information in that way. So, Pyshlyn kind of emphasizes that there are differences between the perceptual experiences and the way mental images are represented or mental images are constructed for example, if you remember the chamber chambers and Reisberg study, people could not mentally give the second interpretation unless they actually drew it from their memory.

So, it is basically about the ambiguous figures and experiment so, it illustrates that people could not really reinterpret an ambiguous mental image such as the rabbit or the duck even though they can easily do it when you are visually perceiving it. So, there is a difference between how visual perception works and how the mental imaging imagery works, again in summary you just again you take a step back you look at evidences from both sides it might.

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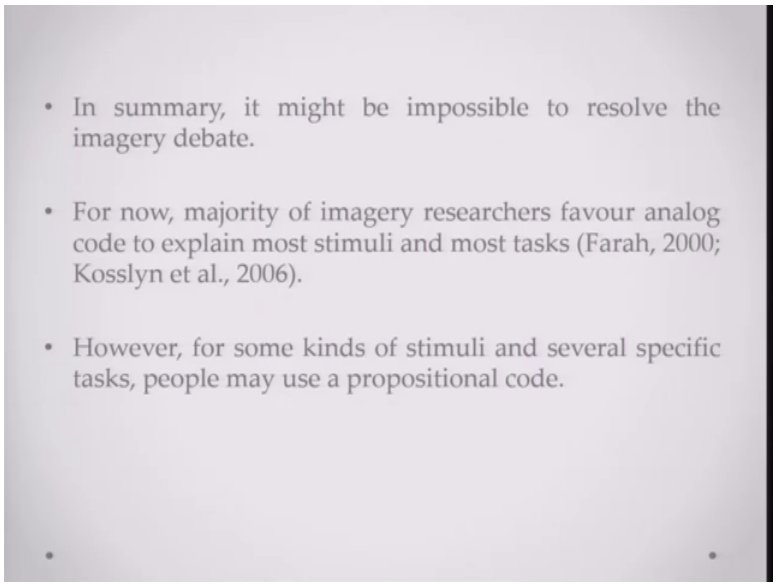

Actually be very difficult or let us say rather impossible to resolve the debate between whether it is exclusively analog or whether it is exclusively propositional for now the evidence that most of the researchers are going by is that they favour the analog code to explain most of the stimuli and most of the tasks; however, for a specific kinds of tasks, for specific situations people have also accepted the propositional code or the propositional representation of mental imagery.

So, this is this bit about the debate between the analog and the propositional code. Now, let me draw your attention to a slightly different topic you might have heard many times that there are gender differences in so many of the abilities that humans have things like mathematical ability, verbal ability and special ability. If these 3 were the only abilities that you would not know what to talk about and you might have heard that again and again that men are better in maths and women are worst in maths and those kinds of things.

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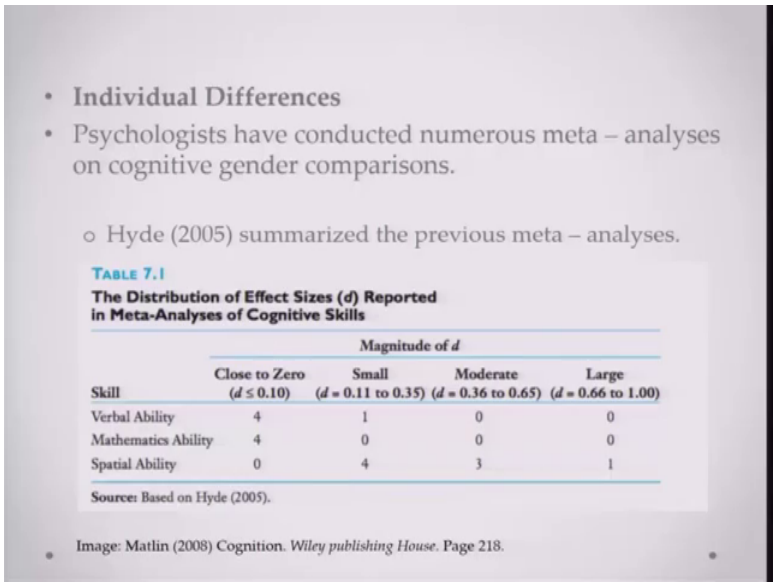

So, height in 2005 put together several meta analyses what is a meta analyses? Meta analyses I have talked about in the earlier lecture, in earlier class meta analyses basically when you put together experiments about particular phenomena all of them together you look at all of that data and look at what is the overall evidence that is being generated from so many of these studies put together.

So, those are meta-analyses hide actually summarize so, many of the earlier meta analyses done in 2005 and she published a paper and for borrowing this figure from Madeleine and it shows that again you can see that to the left the d is 0, where is the difference let us say or the sensitivity you can say is 0 and to the right post you can see that the d is very large. So, if something is closer to 1 then you see that there is a very a large difference between the ability if it is closer to 0 the difference is much less.

So, you can say the d is close to 0, you will see in verbal ability there is close to 0, basically there are a very few differences in males and females, in mathematical ability also there are very few differences in males and females, but in spatial ability you see there are. So, many of these studies which say there is a large difference in one study there is a moderate difference in 3 studies and there is a small difference in 4 study. So, overall there is documented a difference of a gender difference in at least the spatial ability.

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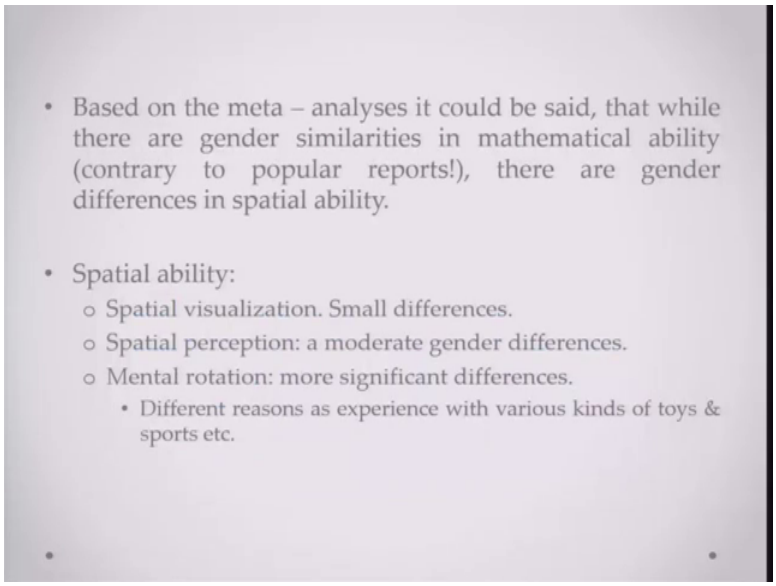

So, based on the meta analyses it could be said that while there are gender similarity is in mathematical ability and verbal ability contrary to what you know you keep hearing in the news and you keep hearing people seeing around you, there are actually gender differences only in spatial ability that is pretty much what they found also in spatial ability there are things like spatial visualization, you are imagining a vertical place or spatial perception, you are kind of perceiving the spatial aspects of the environment and mental rotation.

Out of these 3 as well the largest amount of gender difference have been observed in the performance at the mental rotation kind of task in the task that it requires some kind of mental rotation there is where the only significant difference in the gender is there is found and again most of these things I am actually a not a really huge supporter of gender differences in different cognitive abilities.

So, the whole point is that you know the difference in cognitive abilities with respect to you in spatial abilities could be attributed back to the kind of experiences they have, children and males and females have different exposure to a different kind of toys that they are exposed to different kind of practices and those are the things that could be contributing to whatever gender difference you are observing across these meta analyses.

So, this is again something to clarify now let us move to the third part of today's lecture let us try and talk about the brain a little bit, now we look at different aspects of mental imagery and.

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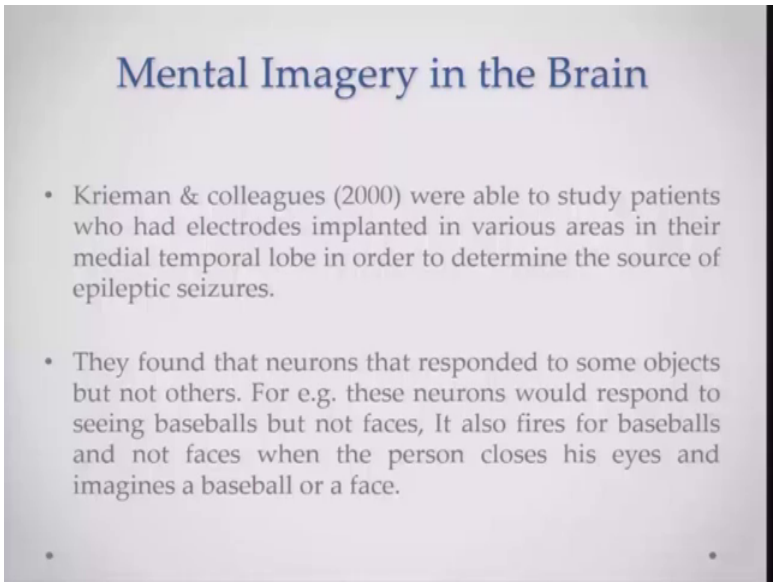

How you know the brain figures in here so, let us first talk about at the neuronal level. So, Krieman and colleagues in 2000 they were able to study patients who had electrodes implanted in their medial temporal lobes, and is basically electrodes were part of to determine the source of where epileptic seizures are coming from. Now, they found that neurons that responded to some objects they were particular neurons that would respond to particular objects, but not so many other objects, but there was a speciality about some of these neurons that these neurons would respond to seeing baseballs.

But not faces also these neurons would respond to imagining baseballs as opposed to imagining faces. So, they will not only fire up when somebody is actually seeing a baseball right in front of them they were also fire up when somebody's imagining a baseball.

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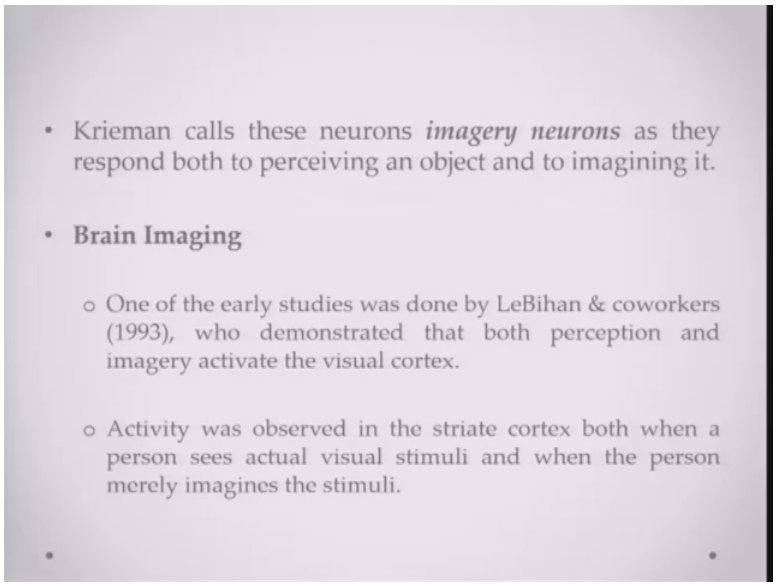

So, Krieaman basically calls these neurons as imaginary neurons because they are responding to both perceiving an actual object and imagining that particular object. So, that is about the neuronal level let us talk a little bit about mental about brain imaging so, one of the early studies in brain imaging was done by Lebihan and coworkers back in 1993 and they demonstrated that both perception and imagery activate the visual cortex, activates similar areas across the visual cortex.

Now, activity was observed across the straight cortex both when a person sees the actual visual object right there and when the person is imagining this particular issue off so, both of these things were both of these activities were causing some activation some lighting up in the straight cortex in another brain imaging experiment.

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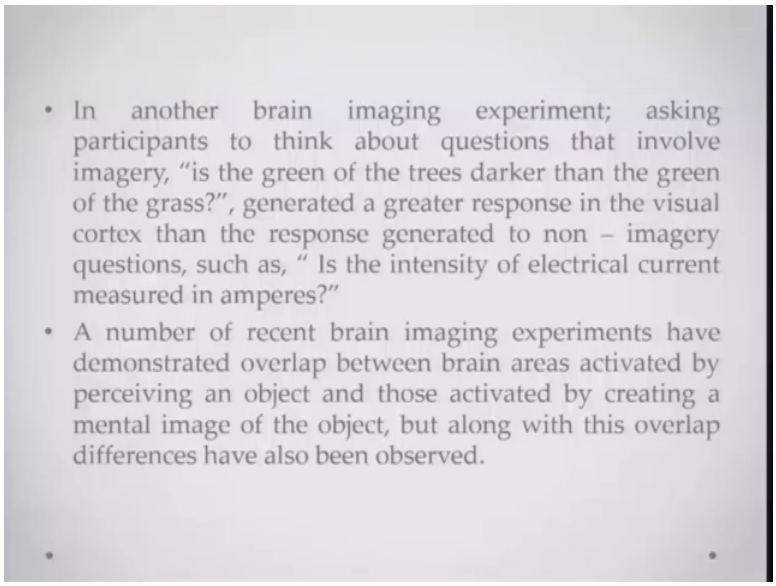

The experimenters asked the participants to think about questions that involve imagery. So, I could ask you questions like is the green of the trees darker than the green of the grass so, if both of those things are not right in front of you will have to imagine you know the trees you seen or the grass you seen and compare their colors.

So, these things would generate a greater response in the visual cortex as compared to the response which is not really elicit mentally as I suppose to the question that does not really elicit mental imagery things like a question like is the intensity of electric current measured in amperes. So, you do not really need to do any mental imagery you know here to answer this kind of question so, when mental imagery is there, there is larger activation even in the visual cortices so, that is again something that they found.

Now, there have been a number of very good recent brain imaging experiments and they also demonstrated an overlap between brain regions getting activated by perceiving an object and those activated by creating a mental image of a particular object so, but along with this all of you will find the some differences that have also been reported I will talk about one of the major studies that I came across.

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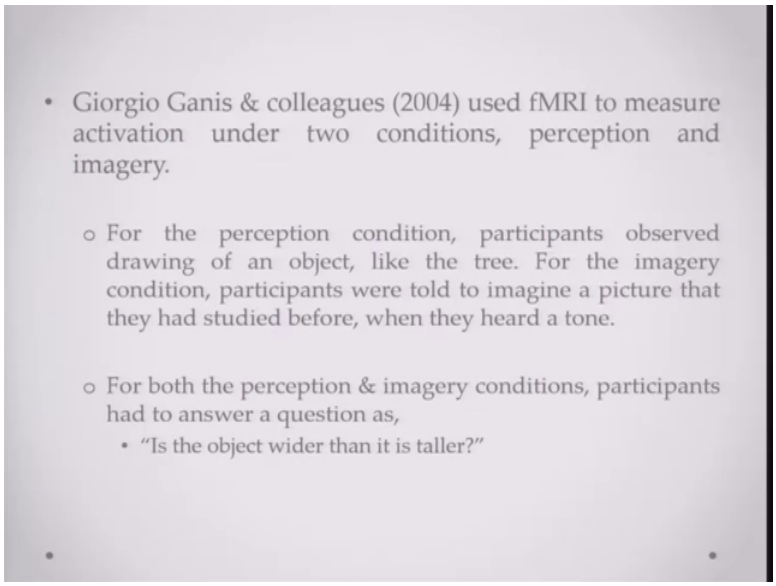

So, Giorgio Ganis and colleagues basically used fMRI to measure activation under 2 conditions and the 2 conditions were perception and imagery, for the perception condition the participants observed the drawing of an object like a tree, for the imagery condition the participants were supposed to imagine a picture that they have studied before.

So, they have seen the tree in a picture and then the picture is no more there and have to imagine the picture of the tree so, this is the perception and the imagery condition, for both the perception and the imagery conditions in this experiment participants had to answer a simply question and the question would be something like is this object taller or it is wider. So, you just have to tell me something about the dimension of this mental image or the dimension of the picture in the perception case.

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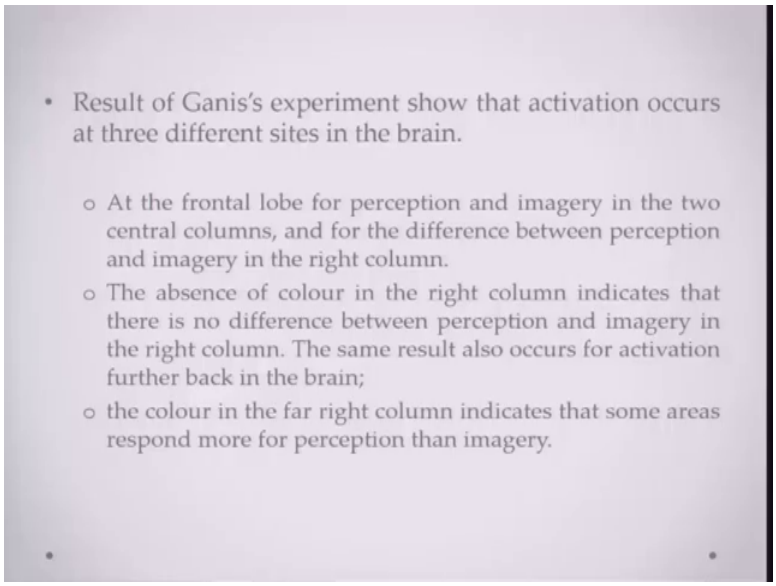

The explained result from Ganis's experiment shows that the activation occurs at 3 different sections. So, they basically recorded activation from the frontal, from the middle and on the back of the brain and what they found is that at the frontal lobe there is activation for perception and imagery into central columns and there is a difference between perception and imagery in the right form. So, I will show you the results directly.

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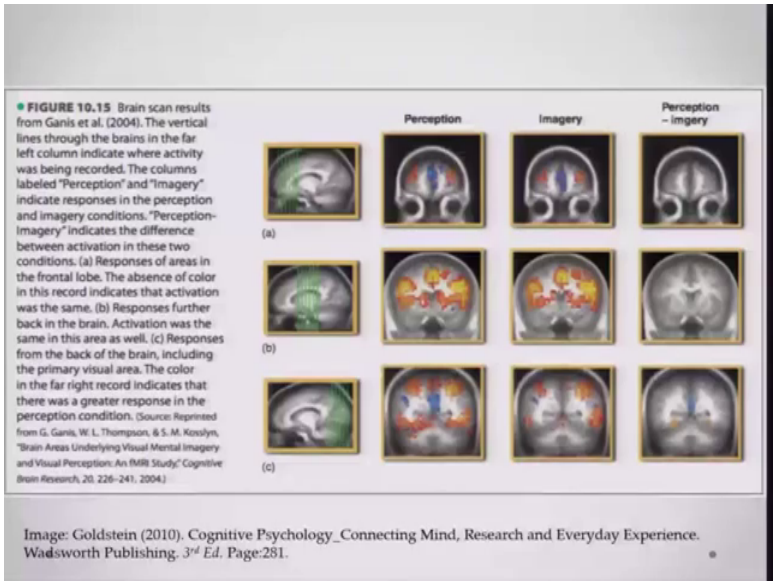

Image: Goldstein (2010). Cognitive Psychology_Connecting Mind, Research and Everyday Experience. Wadsworth Publishing. 3rd Ed. Page:281.

So, these are the results from Giorgio Ganises experiment in the first column the left most column you see the area that was being recorded from and then you see the perception activated areas and use the imagery activated areas and then you see the difference areas.

So, what is the difference between perception minus imagery? Are there any areas accurate in perceptions that are not activated in imagery? Now, if you look at this panel is basically the responses of areas in the frontal lobe, you can see the recording is being done from the frontal lobe and you will see pretty much very similar areas are activated in both perception and imagery and there is therefore, you see no color in the right most column that is perception minus imagery.

Similarly, you look at the middle part of the brain and you again find no color in the rightmost column here which again tells you that exactly same area so, activated in perception and imagery conditions at the back of the brain though there is a difference you will see some color in the rightmost part of the perception minus imagery when you are talking about the back of the brain which probably might be attributed to the fact that for visual perception there is actually some physical stimulus and this physical stimulus needs to be processed which might not be the case with the imagery part. I will actually elaborate a little bit more about this fact when you are talking about one of the neuropsychological. So, this neuropsychological study this is again something that was found by Giorgio Ganises experiment.

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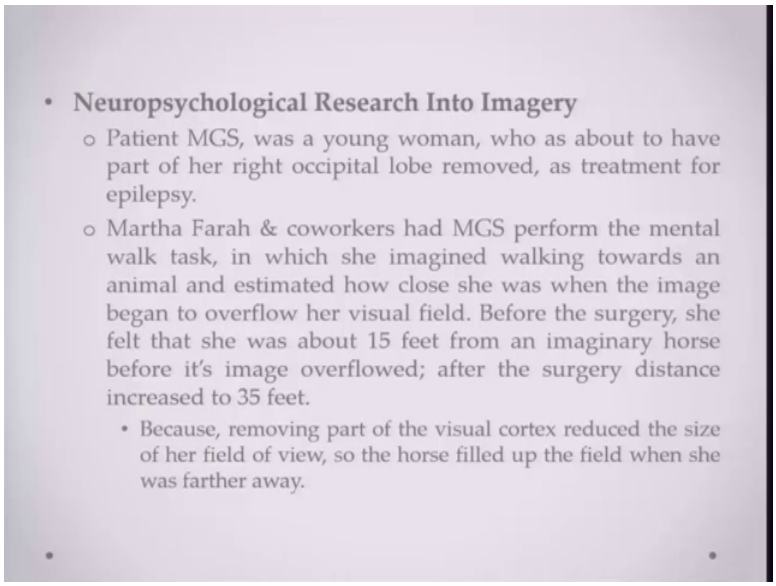

Now, let us move to the neuropsychological part of the studies, now there was a patient MGS which was a young woman who was about to have her right part of the occipital lobe removed as a treatment for epilepsy. So, Martha Farah and colleagues they basically had MGS perform the mental walk tasks the one we have talked about in the last class you have to walk towards a particular thing and indicate when this thing is over flowing here which should feed.

So, MGS was walking toward a particular object and she could say that it is around 15 feet there in this object I started overflowing there we should feed. Post surgery again the same task was done and it was seen that you know the MGS reported that this object was overflowing the visual field from as far as 35 feet now earlier it was 15 feet now it was 35 feet and why is this happening? It is happening because removing a part of the visual cortex has also reduced the size of her field of view and so, the field of view kind of fills up much quicker as compared to when it was in the pre surgery condition.

So, again you can see that there are some close relations at the brain level when you are talking about visual imagery and we are talking about meta perception.

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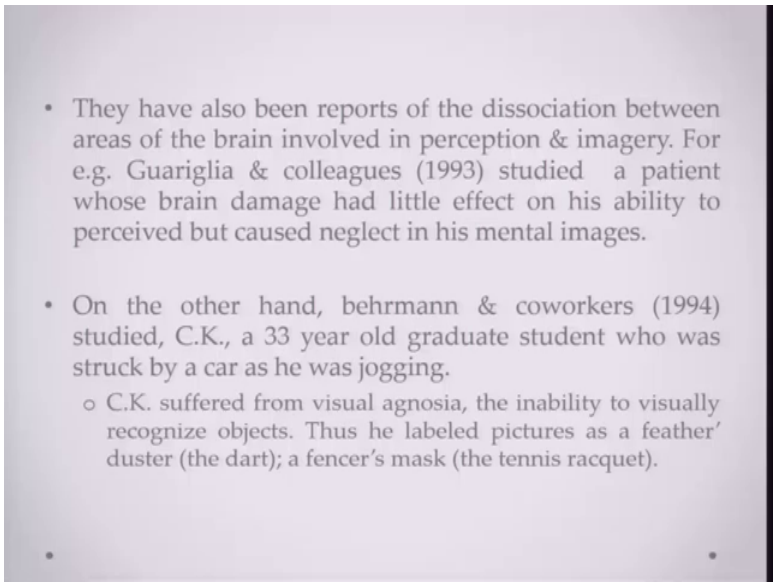

They have also been reports of dissociation between visual perception and mentally imagery for example, Guariglia and colleagues in 1993 they studied a patient whose brain damage had little effect on his ability to perceive, but it had created a sort of neglect in his mental images so, this is one kind of patients that they have been found.

On the other hand Behrman and coworkers in 1994 they actually came they were studying a patient called C.K, it was a 33 year old under graduate student who was struck by a car as he was jogging now this patient was interesting in the sense that this patient was suffering from what is called visual agnosia, again if you want to talk about and learn about, more about visual agnosia you probably can defer to the earlier course, but visual agnosia basically is an inability to visually recognize objects it is not an inability to perceive things so, the person can perceive different aspects of the object. So, it is this shape, it is this color, those kind of things, but people generally are not able to integrate all of these feature level representations into a whole and say that this is this particular object.

So, this person who was suffering from visual agnosia and he started to label thing if you are talking to him about a badminton racket he would say that this is the fencers mask is basically just seeing the center where the net is there and he would basically label it as the fencer mask because he is not being able to integrate the handle to this net. Now, C.K. could recognize parts of the object.

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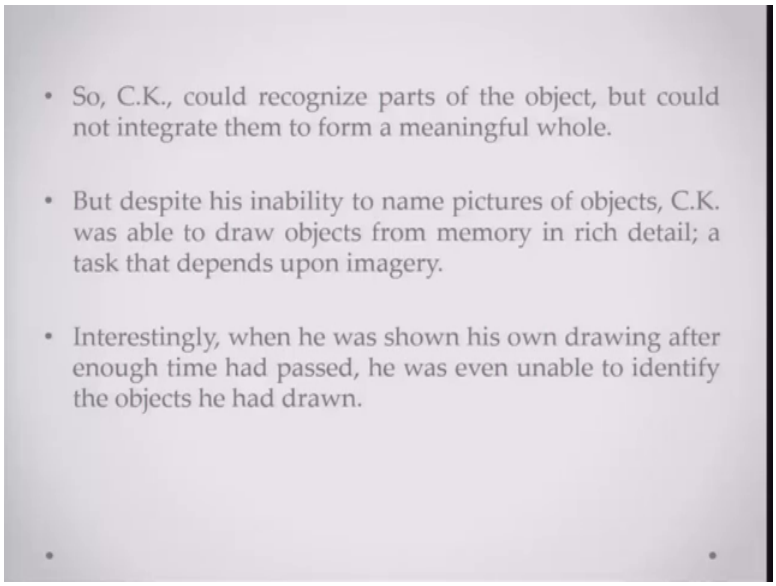

But, again could not integrate them into a meaningful whole, but despite his inability to name pictures of objects, C.K. was able to draw objects from mental imagery in completely rich detail and same objects and this task basically depends upon what is called mental imagery because if you have to recall something and draw it; obviously, you are making use of what is your mental imagery.

Now interestingly when C.K. was shown his own drawings after a particular time has passed so, that he would have forgotten that he had himself drawn this when she was actually shown these drawings he was again unable to even identify the objects here, drawn he kind of showed no recall of the fact that he is himself drawing these things and the fact that again he would not recall a racquet that he is drawn himself will again label it as a fences mask.

Now, this is something strange, this is a sort of a dissociation there is happening between visual imagery and visual perception. Now, Behrmans crease are trying to explain this from a slightly theoretical point of view and what they are saying is.

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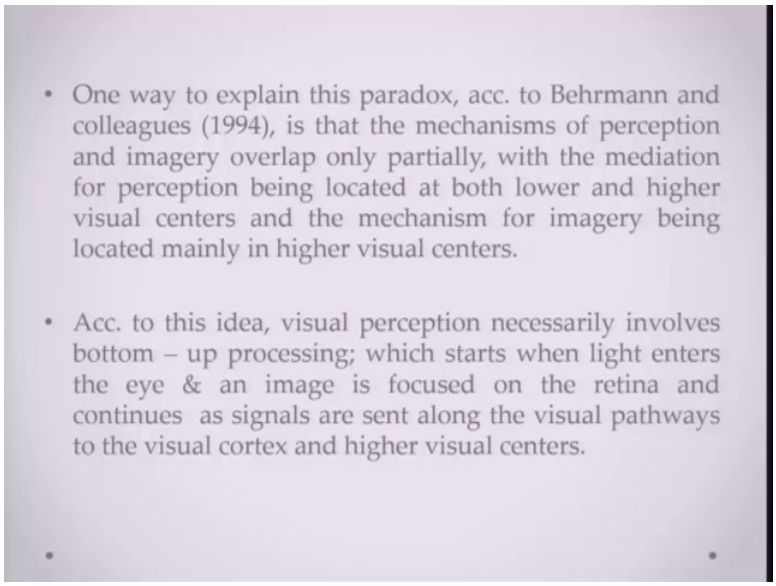

Is quite possible that mechanisms of perception and imagery are overlapping only partially and how and there are some regions that are mediating some mediation is there from perception which is located at both lower level visual areas and high level visual areas and the mechanism for imagery is basically located mainly in the higher visual areas. So, how does perception work if I try and revise one of the last course I have given you, the idea is the visual perception necessarily involves what is called bottom of perception, it starts as early as when the light is entering your retina and when an image is formed and then this goes to the through the visual pathway.

So, early visual areas primary visual cortex v1, v2, v3 others and then it goes to high visual areas where things are combined together. Where you know you start combining these edge level and featured level descriptions into particular objects so, that is how visual perception works.

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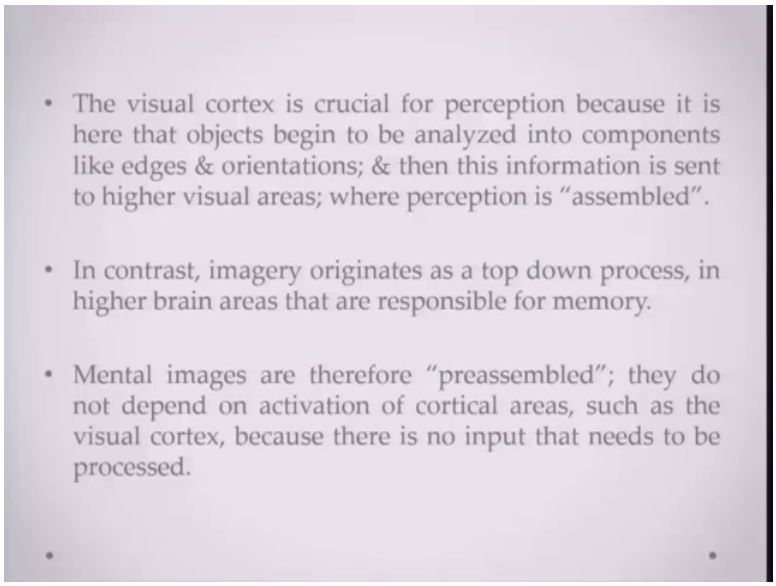

Now, they are saying is the visual cortex is crucial for perception because it is here that this integration of components or the analysis of the incoming signal into components is happening and then this information goes to higher visual areas where all of this is integrated and assembled together to form a unitary and solid perception of a particular object.

Now in contrast imagery might not need all of this visual input imagery is probably performer is probably operating at whatever you already have, now you have a preassembled version of let us say a particular object and imagery basically needs to just pull out those preassembled versions and that is why mental images are supposed to be probably they are accessing the preassembled version. So, they do not really depend upon the activation of cortical areas so much as the visual cortex because there is no input that needs to be processed here.

Perception will actually depend on activation starting from the retina to the primary visual cortex to the visual association areas, but imagery in that sense candy pick up from the visual association areas and then again you can perform all sorts of manipulations that you want. So, this is little bit about how brain and you know mental imagery might be related and how there could be probable links between visual perception and visual imagery.

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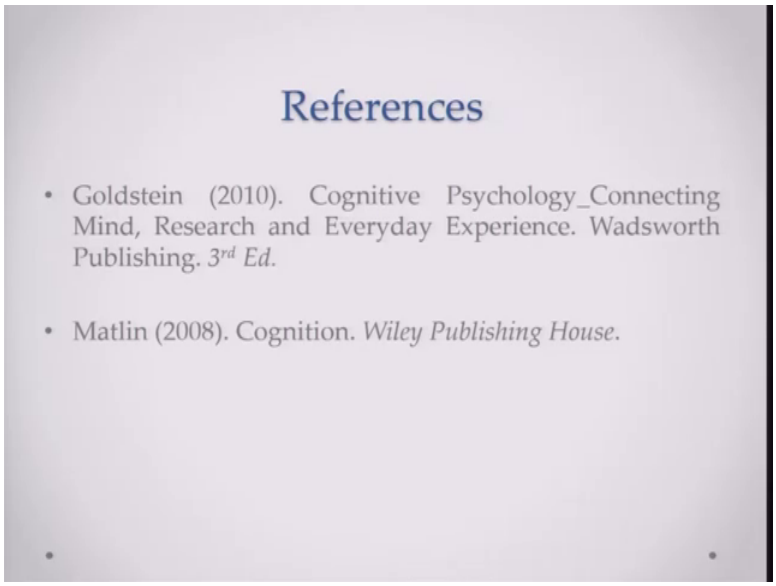

I think I have come to the end of this chapter on mental imagery, I hope you like the chapter, I hope you liked all the information represented here and then we will meet next week with a new topic.

Thank you.