Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Basic Cognitive Processes

Lecture: 22
Perception & Action

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Hello and welcome to the course basic cognitive processes I am Dr. Ark Verma from IIT Kanpur.

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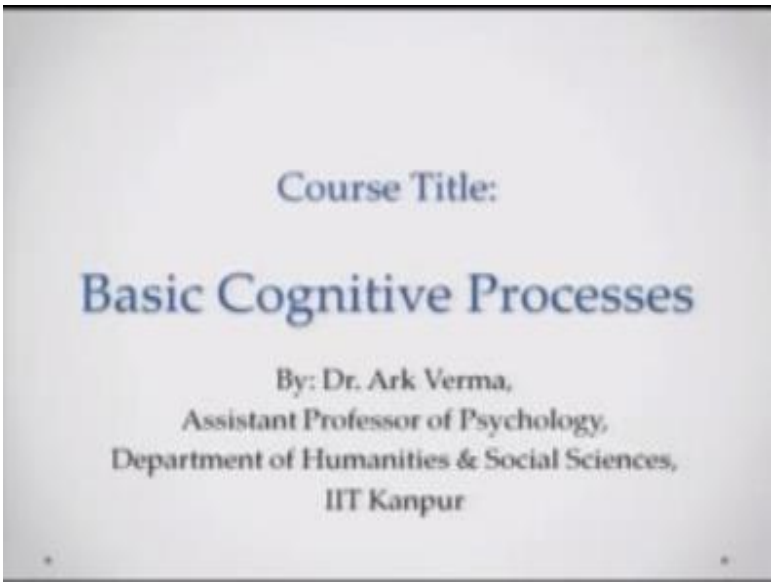

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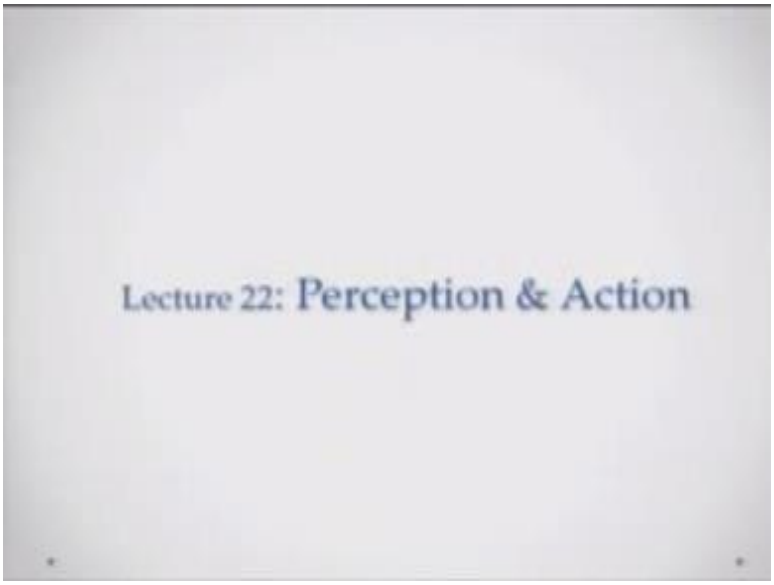

Today we will be talking about the link between perception inaction you have seen till now that we have studied visual perception in a lot of detail we have seen different aspects of perception the theoretical issues and we have also seen in one of the most recent lectures about how visual perception helps us recognize and interact with objects in the environment in the real world. We are trying to now go towards the position where we try and say that perception is not really a passive process perception is almost an active process and basically it changes the way we interact with the environment.

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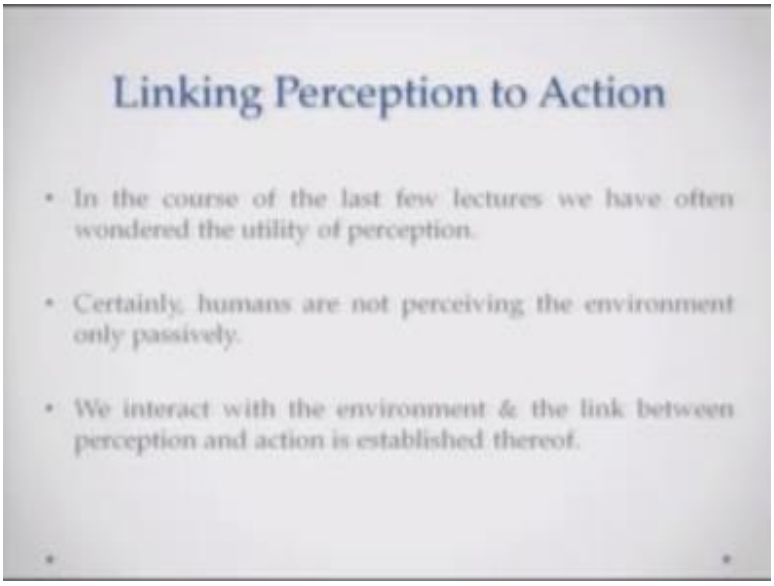

And that is basically the approach what JJ Gibson took if you remember that we talked about the ecological approach to perception and that ecological approach to perception was basically about the fact that perception is not a passive process perception is about inter acting with the environment and the influence of perception and action is something that is of interest to people who study perception. Now the theoretical background as I said is of JJ Gibson's ecological approach.

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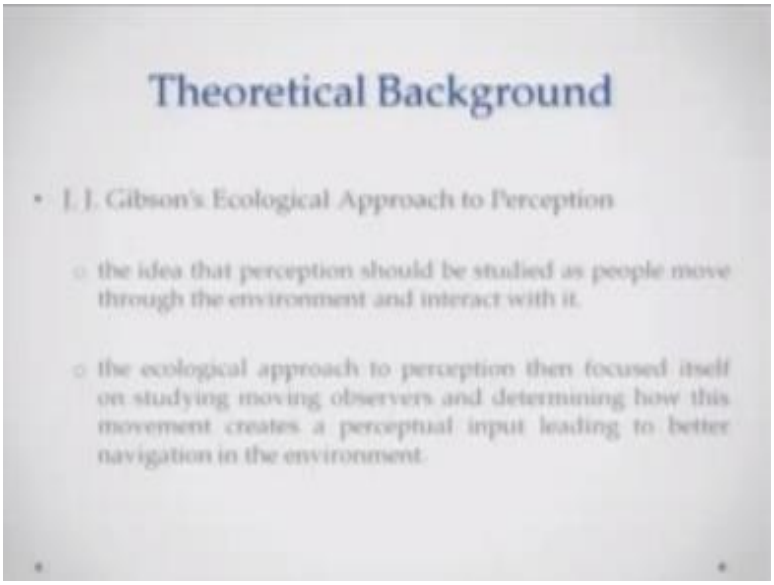

To perception he believed that perceptions too should be studied as people move through the environment and interact with it so his idea was that perception is not really a static thing you're not sitting or standing it is somewhere in a stationary manner and then looking and interacting with and then looking at the environment around you are more often than not moving around in the environment you are changing your position with respect you're changing your head position you're changing your body position and with that change with that aspect of dynamic city the perception that you are receiving the century input that you receiving is also changing accordingly.

So that is a brief background with which JJ Gibson's approach to perception was stuns and we have studied that in enough detail just to add to whatever we know already or this to remind you I just say that the ecological approach to perception is basically focus itself on moving observers so if it is designed in such a way that it is about not stationary observers and how they look at the environment but moving ourselves and how that movement information influences their perception of the environment.

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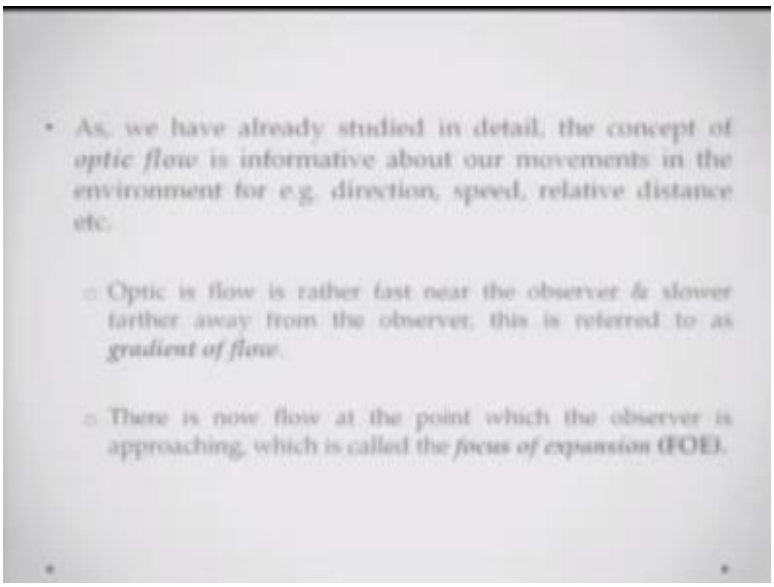

This was basically a very important concept in Gibson approach to perception was the concept of optic flow if you remember optic flow is basically the information about our movements in the environment and the aspects in the environment say for example if you remember I talked about the moving train example and how a driver looks out of the train and he sees cows grazing in the field how the movement of the train affects the perception of those cows which are grazing next to you know the train in the field.

So those kinds of things about direction of movement speed of movement relative distance between the two moving objects these kinds of things figured as very prominent you know sources of information in Gibson's approach to perception and that is what we will be building upon in today's lecture in trying to make a link between perception and action.

Optic flow basically is supposed to be rather fast near the observer who is moving and it becomes slower as you move further away from this observer. So this difference in the intensity of optic flow is referred to as gradient of flow this is a very important source of information the other important source of information is basically the focus of expansion if you remember I took an example of a person you know standing in front of the train and it is moving with the

direction of the Train in that sense there will be a small point in much further away from the moving train in the direction that the Train is moving and that point will be the point which is called the focus of expansion.

So it seems that the flow is emanating from that point but that point itself has no optic flow at all so that is the point where there is no optic flow but all the optic flow is emanating from that direction that point is called the focus of expansion I have a figure here to show you that the figure is from Goldstein's book of sensation in perception.

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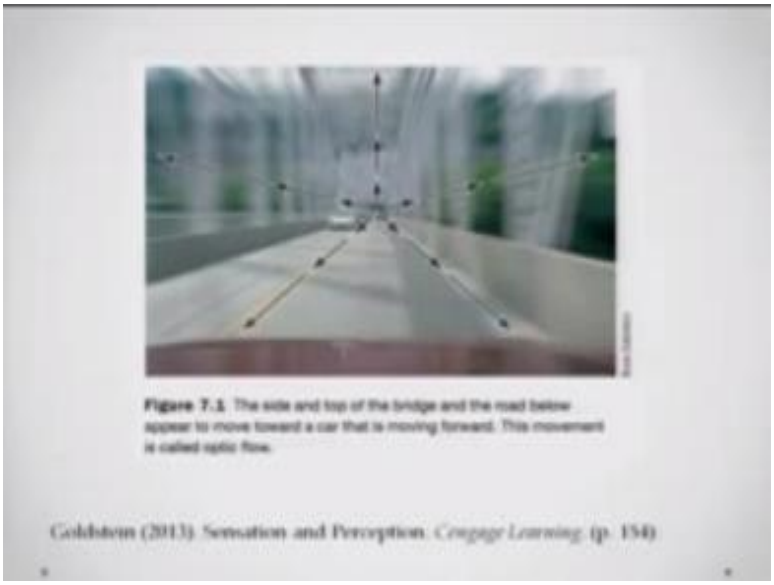

You can see that if you are moving in a particular direction you can see that you know at that point in the center there is no flow but flow is actually emanating from that direction, so this is what the focus of expansion is.

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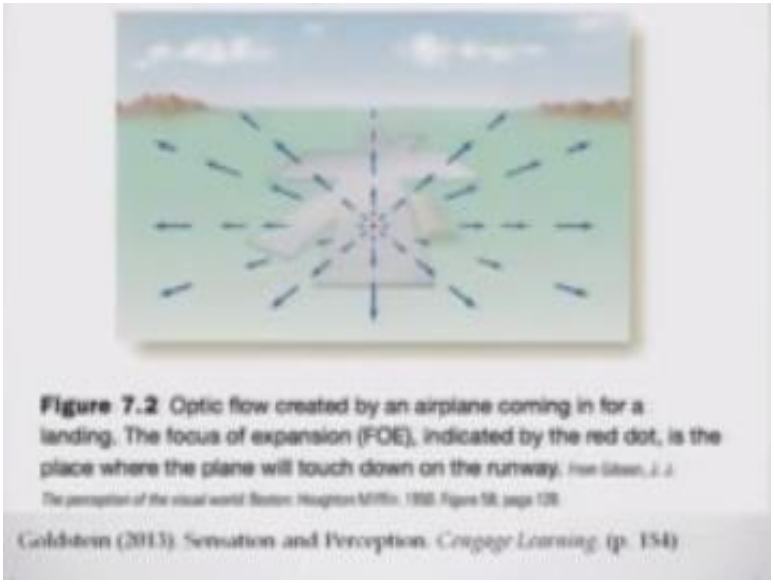

Hear you can see the focus of expansion or in the reference to a plane which is landing on an airship and you can see again a center point where there is no flow present at all but all the flow is emanating from the sides of those points.

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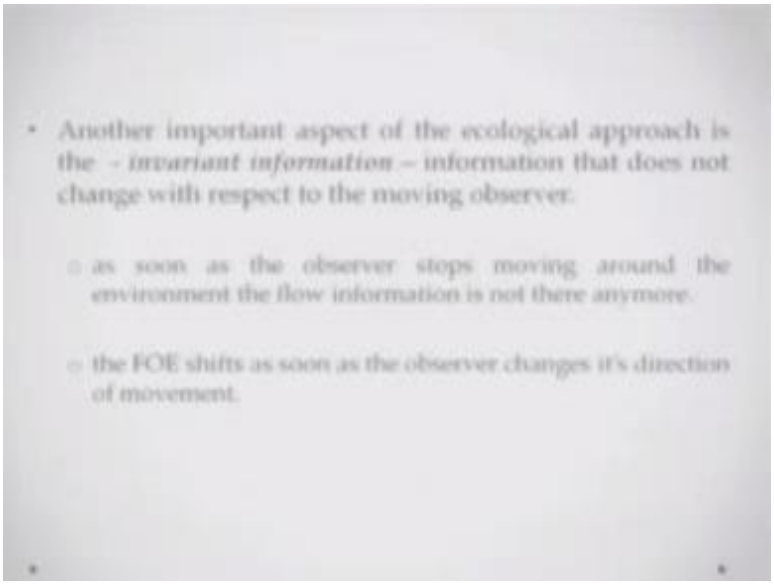

Now another important aspect of the ecological approach to perception is the aspect of invariant information now what is the invariant information invariant information is that information which does not change with respect to the movement of the observer, till now we have been talking about that the observer moves around in the environment this causes changes in the perception and that information that changes in perception in terms of optic flow or focus of expansion gives some very useful information to the observer in order to continue his movement or in order to continue this exploration of the environment.

There is however part of information that does not really change whether the observer is moving or not and this information is referred to as invariant information as soon as the observer stops moving around the environment there is no flow information there because flow is continuing to movement the focus of expansion also shifts as soon as the observer change its direction or it stops moving.

So these are the two sources of information you will see that the observers use in order to interact successfully with the environment so how does this work if you are moving in the environment.

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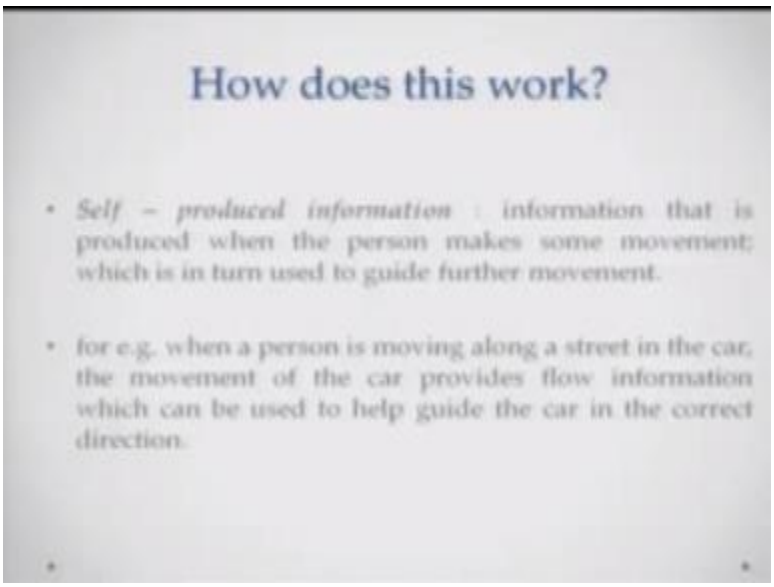

I will be creating something called self-produced information my movement in the environment will create some perceptual information that will help me continue moving and interacting with the environment if a person is moving along the street you know say for example imagine yourself driving a car in a particular busy street while you are driving the relative distance the direction of your movement and the speed with which you are moving we change a lot of information about say for example if there is a food stall somewhere nearby to your left or to right.

If you are you know the kind of turn that you are going to approach or with respect you are the relative size of the people that are in a particular distance those kind of in formations do change when you are moving okay so what you are doing here is you are actually producing some information some new information that is being used by the perceptual system.

But this new information is actually being produced by your movement itself and as you change the direction of movement speed of movement say for example you are stopping altogether at all now these kinds of things will basically you know be useful for you to plan how you are going to

move further. So this information is very important here and you can see a demonstration again from gold stein sensation perception.

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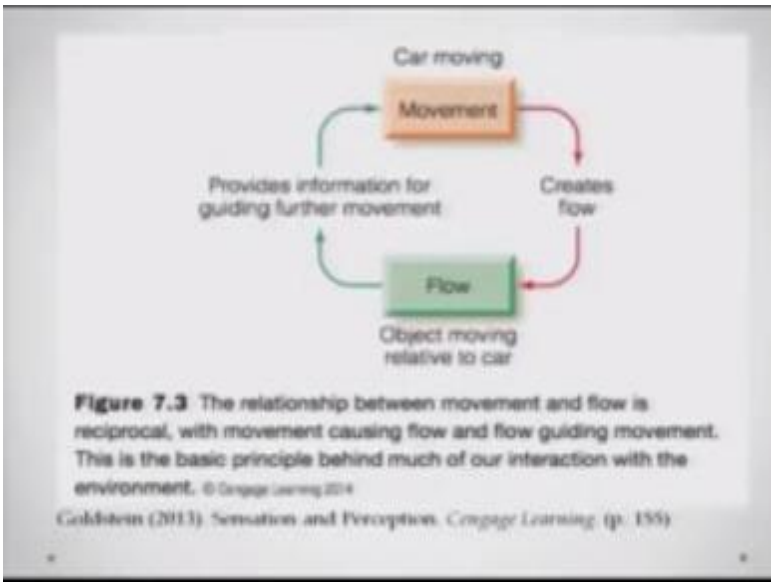

The movement of the car creates flow information the flow information provides information for guiding further movement if say for example you are moving very fast towards a particular obstacle or say for example there is a person crossing the road and you also immediately turned on the road you will see that the size of the person on your retina simply kind of is changing with the distance it is changing very fast with respect to whatever speed with you which you are approaching that person.

So these are some of the kinds of information that people have reasoned are dynamically and almost always used by our perceptual systems you can see that in that sense perception is not really a static process it is something that is changing every moment and whatever new information is produced by this change that is happening every moment also is already taken into account before you plan your next movement, also give some said one of the things that the senses working in communion with each other.

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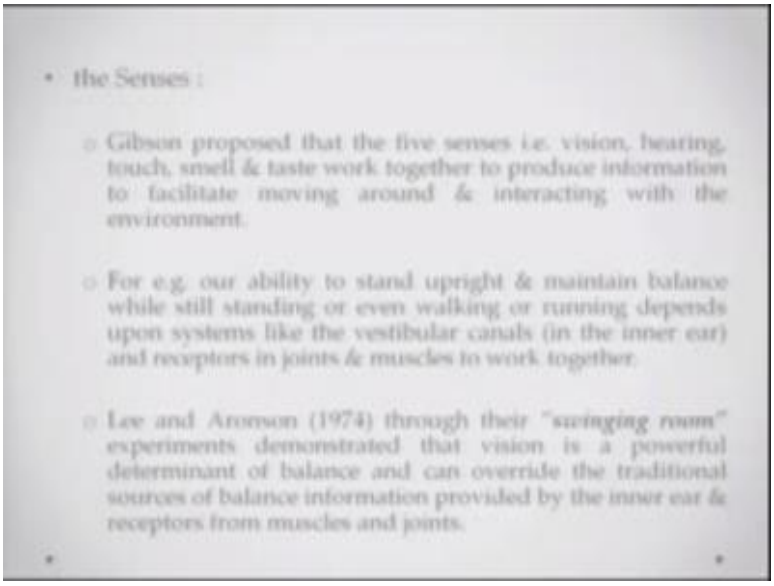

The senses work together to create this new perceptual information that you would use in order to move successfully imagine an animal who is hunting in the vague he is basically moving he is also using the sense of smell he is also using his sense of hearing all of that to plan his movement in order to you know chase the prey successfully Gibson actually produced that the five senses of vision hearing taste smell and touch we work together to produce information that actually facilitate moving around and interacting with the environment.

Another nice example that one can take a say for example our ability to stand upright and maintain balance of posture is basically dependent on you know these organs in the ear called the vestibular canals in the inner ear we will talk about these when you are talking about auditory perception these vestibular canals are is a kind of a canal like structure they are in some liquid is filled the position of this liquid tells you that the head is in balance or it is not in balance.

So this whole ability offer you know standing is not really only dependent on your touch or on your vision it is also dependent on something that is going on in your ears. So in that sense you can already see that we are using multiple sources of information to maintain our balance a very interesting experiment on this account was done by Lee and Aronson in 1974 they actually

designed what was called the swinging room experiment so they had a false room where in toddlers and young very young children could stand and the walls of this room could sometimes move closer to these people or sometimes move further away or sometimes the room would swing and this kind of created a perception of movement.

And what was observed that the fight of vision is actually found to be the more powerful source of information in order to maintain somebody's balance and the sight of and this information from vision that is getting that the people who are getting can also sometimes override other traditional sources of information like this rescue bill eternal.

So what was happening was that when people saw the walls coming toward themselves they tried to move backwards or they try to compensate for that movement of the wall even though there was no signal that they are going off balance from the vestibular canal system. So in that sense it was adequately established that you know the sense of vision has to do a lot with function like standing upright and they're you know standing straight and maintaining a particular body balance.

Now we will take up some examples which can be examples about how people you know how people's perceptual systems help them interact with the environment around them we will take some naturalistic settings say for example the setting of driving a car.

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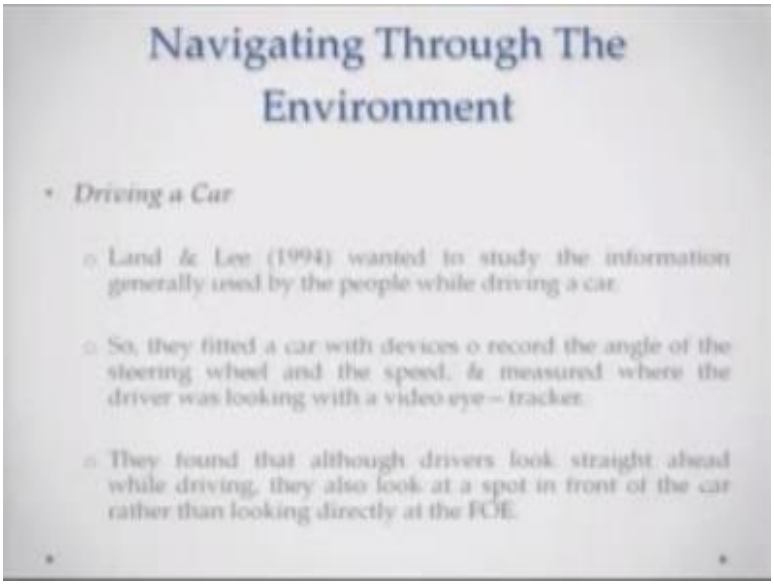

So Land and Lee in 1994 they wanted to study the information that people use while they are driving a car. So and what they did is they fitted the car with devices to record the angle of the steering wheel and also the speed and they also measured where this driver was looking while you know he is driving, so with the help of a video eye tracker they actually fitted a particular car with all of these gadgets and ask somebody to drive this car.

And when they did this experiment when some trials were done they actually found out that all the drivers do look straight ahead while driving they are not really looking at the exact spot of the focus of expansion that you know Gibson kind of talks about they are looking not directly at the F way they are looking at the point just adjusting to the F we still in front of the car.

So in that sense they are not really using optic flow information perceive but they are using some information from the outside environment to drive the car better.

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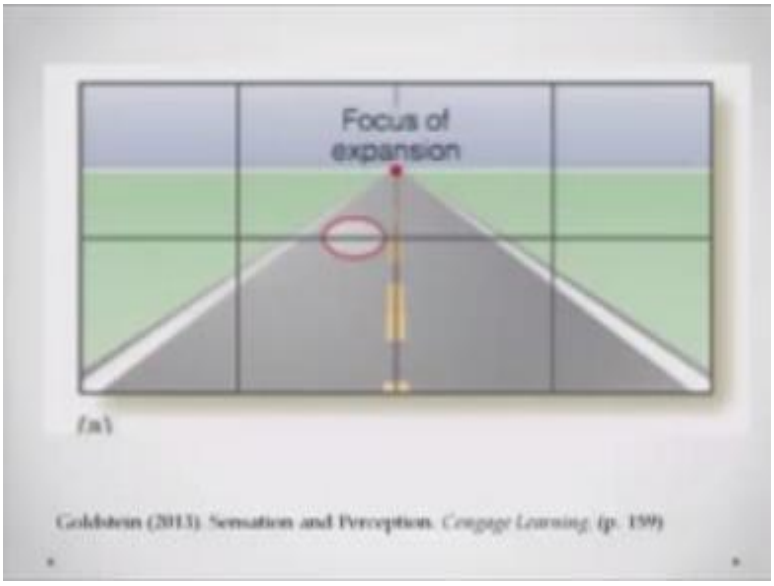

Let us say here you can see one of the demonstrations from Goldstein, so they are not really see looking at the focus of expansion they are looking at a point adjusting to the focus of expansion.

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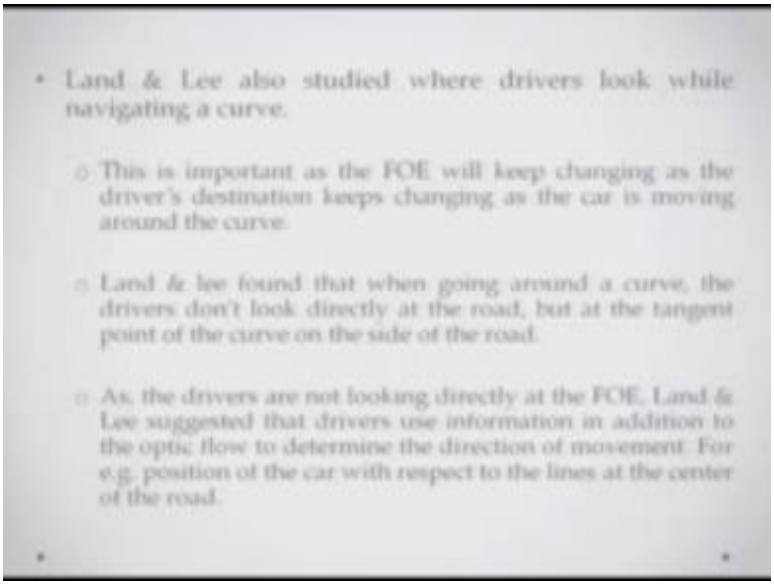

Now Land and Lee also wanted to study where drivers were looking while they were navigating a curved road so this was important because when you are actually navigating a curved road the focus of expansion is continuously changing. So it has to be directly right in front of you but as you are changing your direction by navigating a curve the focus of expansion is also changing and so flow information is also changing.

So Land and Lee you are interested in this and they found out that when going around the curve the drivers are not really looking directly at the road but they are actually focusing at the tangent point on the curve of the cider. So they basically want to you know stay on the road by looking at the tangent point and not really directly at the road okay. So as the drivers were not really looking directly at the focus of expansion land and lease it is the drivers are using information in addition to the optic flow information that gives in had specified in order to determine the direction of movement.

And this information could be anything you know something very simple like for example the position of the car with respect to the lines on the center or the side of the road so this is again you know something that tells us that you know people are actively engaging with the

environment in order to successfully move around and navigate with the environment we are taking up new sources of information in addition to obviously the traditional source of information in order to you know maintain this dynamic city of interaction.

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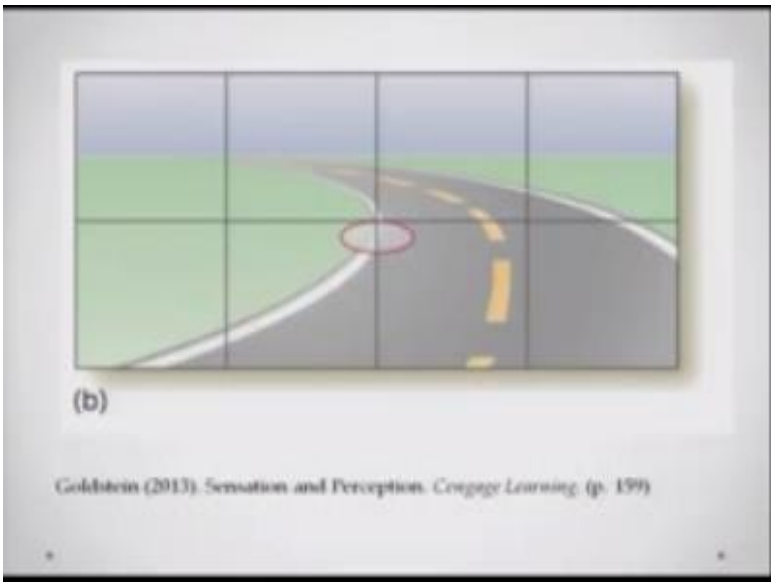

So here you can see that you know people are actually looking at the tangent point of the curve and not really the, you know the line at the center of the road okay.

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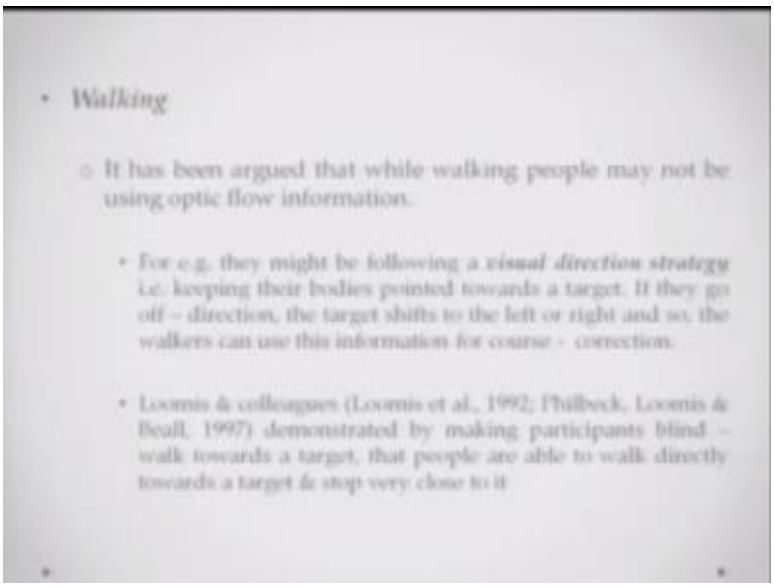

Now another aspect that we use perception in is in walking. So people walk and they navigate the environment successfully what is the kind of information they might be using here, so it is believed that they are probably following something called a visual Direction strategy. So what they are doing is they are keeping their bodies pointed towards a particular target see for example if you are walking on a straight road you might you know kind of position your body such that end of the road is your target and you are kind of walking in reference to that target.

So if they would go off in direction say for example some things while walking if you are talking to somebody or if you are kind of thinking about something else or maybe texting nowadays you might kind of go off direction and so the target would shift to the left or the right of where it was originally and this information helps us to do what is called course correction.

So we think assure now we have got off road we have to come back and then you know maintain that position with respect to the target that we have set up, so Loomis and colleagues they basically wanted to test in a you know series of experiments and they demonstrated this by making partisans blind walk towards a target that people are able to walk directly towards a target and they kind of reach very close towards it.

So for example if you kind of tell somebody that they are this is your target and you have to walk towards this target and then kind of blindfold them they will still reach rather close very close to the target without even using the visual information because they have oriented themselves related to that, so you can see a demonstration from Goldstein's book.

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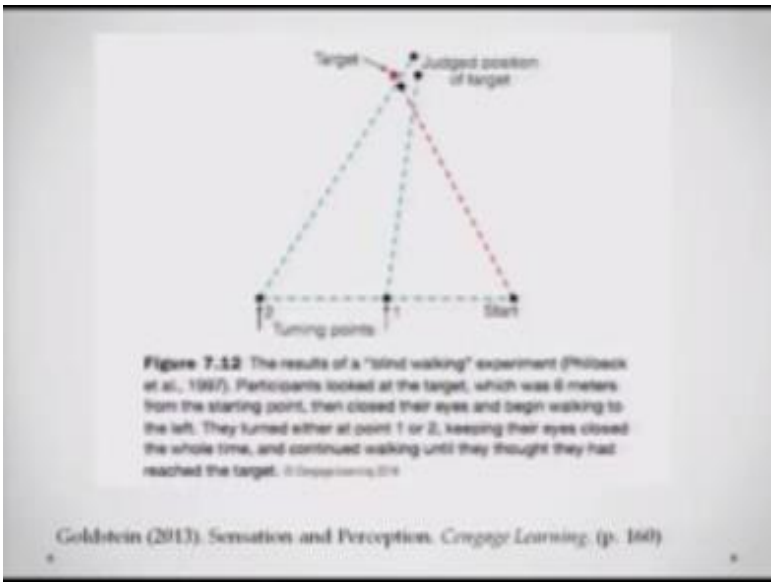

That the target is this square green square in the top and the person starts at a point slightly diagonal to that and they start walking towards points one or two and they can turn towards the right at either 0.1 or 0.2 and the kind of you see in both those in places land somewhere very close to the target they are not really off target by a lot. So these set of experiments actually demonstrated that people can orient themselves while walking to a particular target and then might not be actively using a lot of visual information they might kind of orient themselves in a different way.

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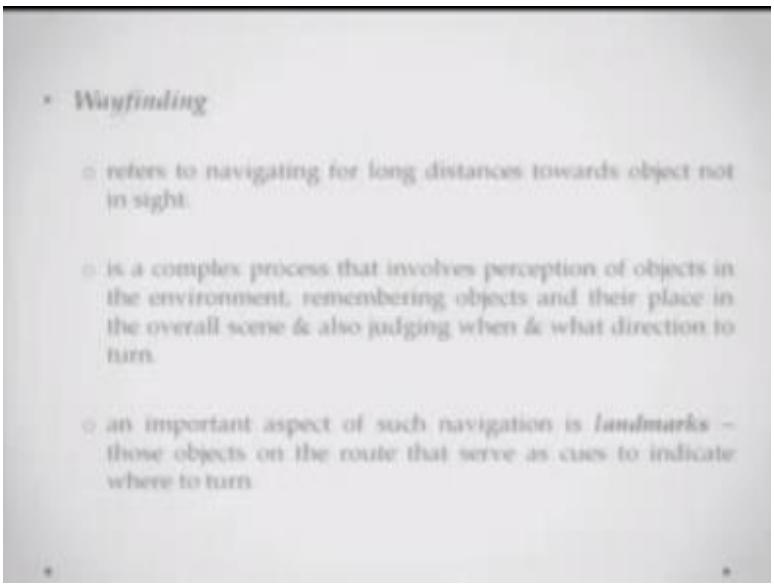

Way finding is also a very important somebody tells you that you know you have to reach there and meet me at this particular point and if you do not know the place you will be navigating for a long distance towards the object that is not already in sight the last example was when you already have an object insight and you are kind of preparing to walk towards it the other thing could be that you do not have an object in sight and you are kind of navigating making mental maps and moving towards that.

Way finding in that sense is a slightly complex process that involves perception of objects in the environment remembering those objects and their place in the overall scene and also judging when what direction to turn say for example if you are remembering you know how to reach you know a particular theatre or a particular coffee place from your home and it is a place you are where you going for the first time you might want to remember what all shops that you found in between if there was a park or if there is an important building what we do generally is we kind of tell people that that was that you know there you will find this building and you can take a left or right from that particular building and then reach this place.

If you are going alone as well you might use these strategies almost subconsciously but automatically that you remember that I said these are the pointers in the way of you know my target and I will remember them so that next time I can orient myself according to these points an important aspect of such navigation is these points and these points are refer to as land marks. So we remember these landmarks say for example from this particular building you have to turn you know turn left or turn right.

So that particular building becomes a source of important information it is associated with that you have to turn left or right during value of reaching a particular target so these are the objects on the road that service cues to indicate where you have to turn where you have to get off the road.

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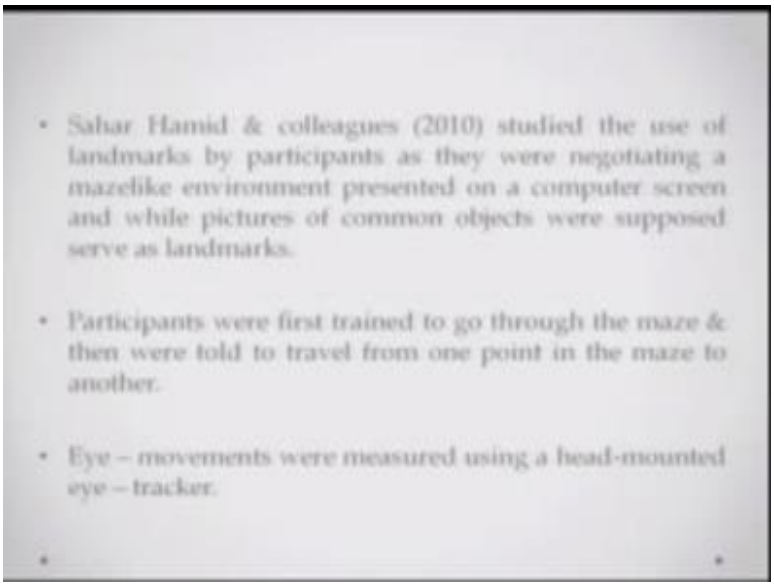

So Sahar Hamid & colleagues in 2001 they studied the use of landmarks by participants as they were negotiating a maze-like environment presented on a computer screen and why pictures of common objects were used as landmarks so they are actually in a simulated maze they basically taught to reach from point A to point B in the maze and at different points in the maze they use

these pictures of common objects as landmarks so they will know that except from this object I have to take a left to reach the end of the maze.

So there are two faces partisans were first trained to go through the maze and they were told to travel from point A to point B in the maze there in the second part they also monitored eye movement using what is called a head-mounted eye tracker.

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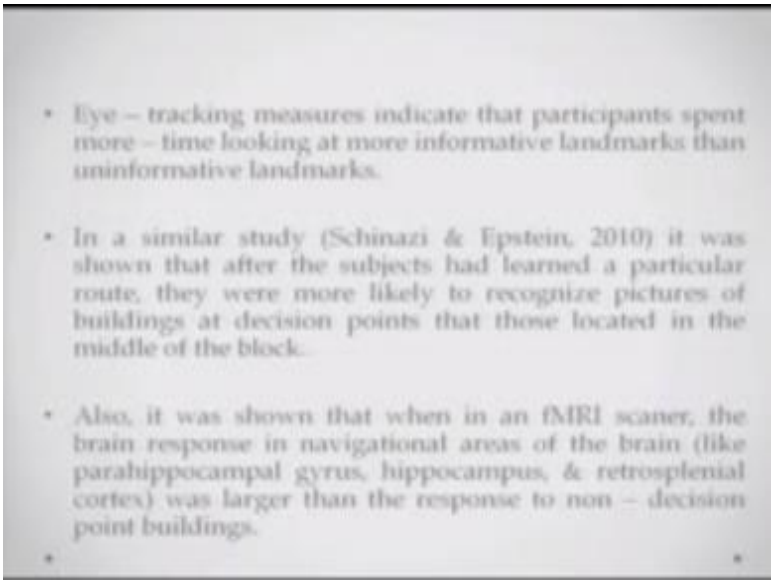

So I tracking measures indicated that participants spent more time looking at informative landmarks then uninformative landmarks, so those landmarks that actually provided useful information about turning and reaching the target successfully were looked at much more they were given much more importance in a similar study by Schinazi and Epstein it was shown that when subjects had learned a particular route they were more likely to recognize pictures of buildings at those decision points.

So you might say for example remember that that is a particular processing from which I have to take her turn so you will remember how that crossing looks what are the important shops or posters on that crossing similarly the participants in this study also remembered pictures of

landmarks at those particular pictures at those particular landmarks that were informative for reaching towards a particular target.

Also when these partitions were taken in an fMRI scanner it was found that the brain responses in the navigational areas of the brain which are like the parahippocampal gyrus hippocampal gyrus in the retrospelenial cortex the responses of these particular brain areas was much to these informative landmarks then to non informative landmarks or non-decision building points. So this kind of tells us that the brain is constantly keeping track of varying we are interacting with the environment what are the sources of pertinent information.

So that it can plan and it can be prepared for action for navigation for moving around the environment, you are seeing that you know we are not just following instructions even if somebody gives you a map and says that you reach from point A to point B and you are kind of you know follow these steps you are obviously all the time gaining much more information by really taking the car or your cycle or walking around that road here is this example of the brain.

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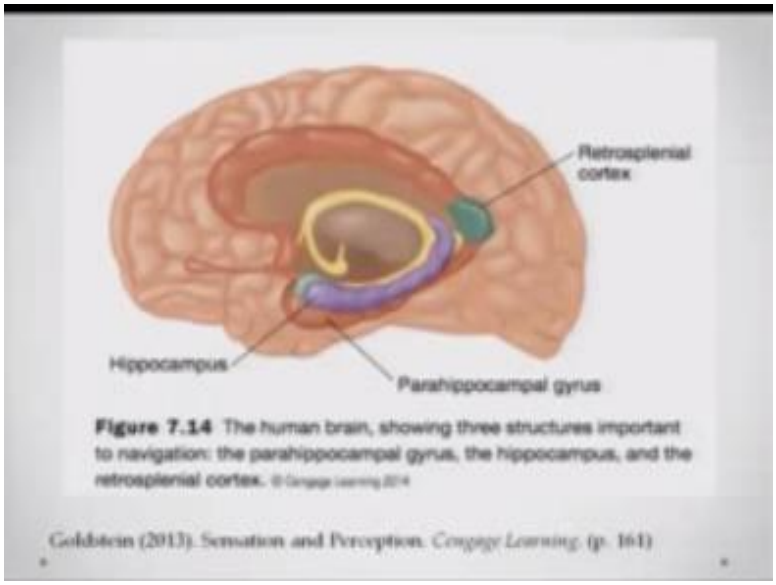

You can see the hippocampus the parahippocampal gyrus and the retro spinal cortex

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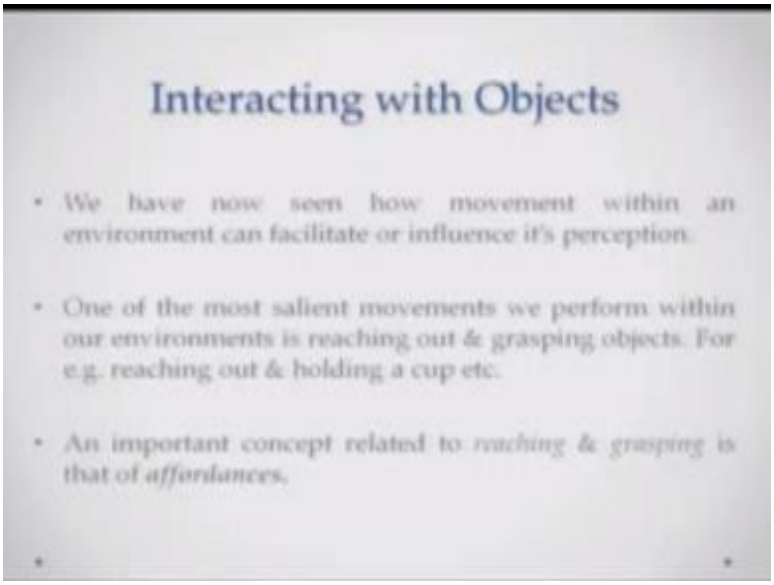

Now let us talk about interacting with objects now we have seen how movement actually within an environment can facilitate or influence perception one of the most salient movements we actually perform is when we reach out and grasp objects you know say for example if there is a cup here reach out to the curb and I pick up the cup to drink from it an important aspect about reaching and grasping behavior is this concept of affordances again you might want to revise the lecture on Gibson's ecological approach of perception because that is what Gibson had already talked about.

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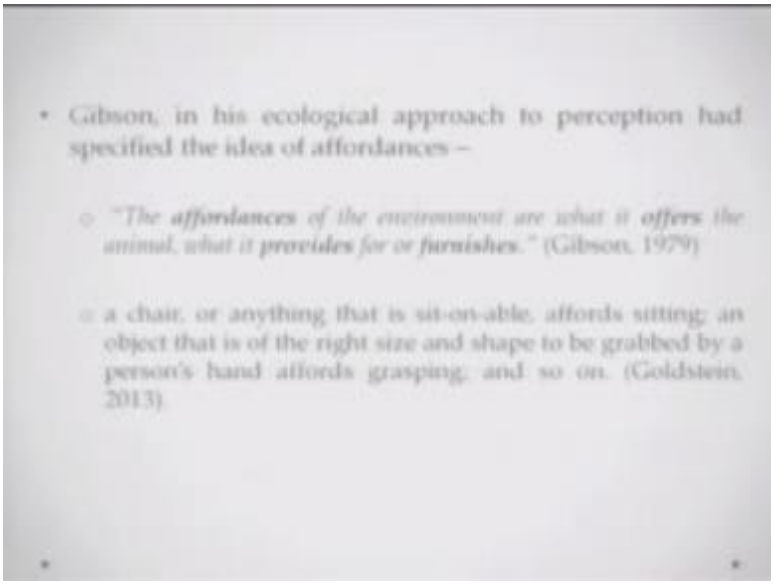

So what are affordances are basically things that a particular object renders or offers you say for example if there is a ball which does not have any edges you might want to pick the ball itself if there is an object which has a handle you might want to pick that object by that handle or say for example if there is an object which is which has a plain surface and a force hitting you might sit on that desert you see people doing this kind of behavior all around yourself why are they able to do that because they understand that this object are foods this kind of actions.

A lot of times you see that if you do not find a hammer or if you do not find a screwdriver you might use unconventional tools to hammer in a nail or to open and try and try and open a particular screw so why are we able to do this because we understand that objects have particular afford that objects can be interacted with in a particular manner and in that sense we are kind of always prepared to use this information in our interaction with these objects.

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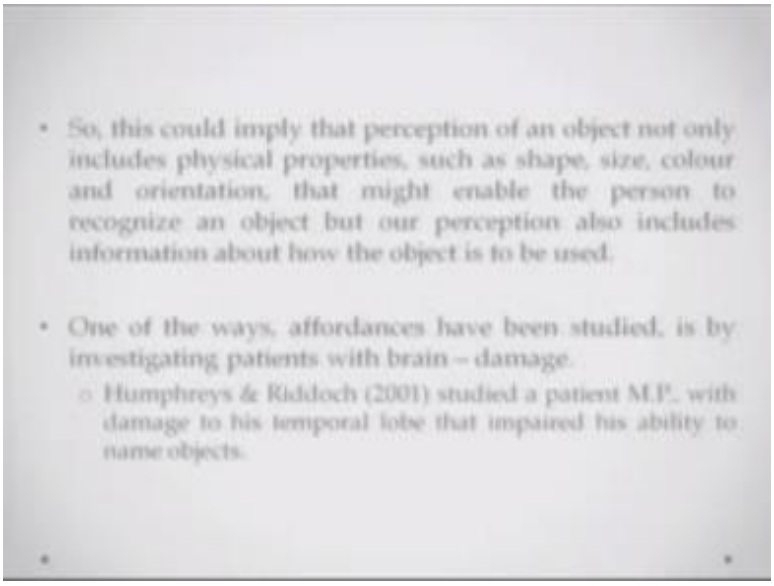

So this basically could imply the perception of an object then not only includes the information about physical properties such as shape size color and orientation it also might enable the person to recognize the object but our perception also includes information about how this object has to be interacted with or how this object has to be used one of the very interesting studies about affordances was done by Glenn Humphries and Jayne Riddick and they basically sir was studying a patient named MP and this patient MP had a damage to his temporal lobe and this damage to the temporal lobe had led to his you know led to an impaired ability to remember you know to name objects.

So this person would not be able to name an object if you show him okay, so MPI was during this course of this study it was given two kinds of cues.

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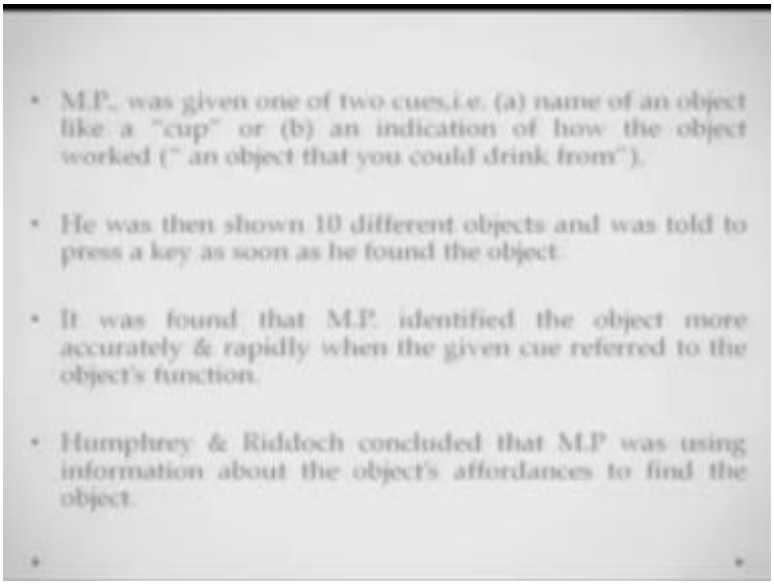

One of the cues will be the name of the object and the other cue would be the use of the objects say for example I could tell him that this is a cup or I could tell him that this is an object that I can drink from okay and then what will be done is he will be shown ten or fifteen different kinds of objects and it was told to press the key as soon as one of the already shown object is presented it was found that MP identified the object more accurately and more rapidly when the cue given would refer to the function of the object.

So it seems that they basically concluded that MP was using the information about use of that particular object or affordance of that particular object in recognizing the object and not really just the name of the object itself you something important it tells you that you know there are there is a very specific ways in which we interact with these objects in these specific ways help us store these objects in a much better way in our you know semantic memory in our knowledge of the world you know so to speak.

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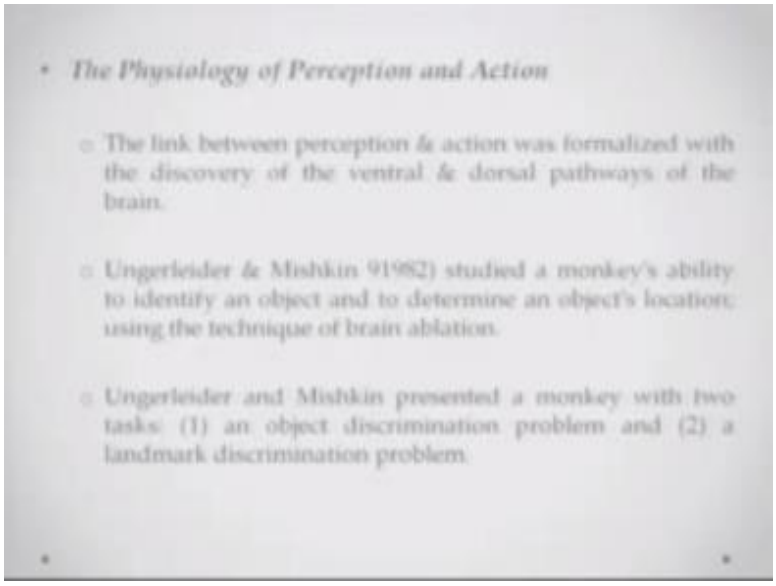

Now how is I mean we will kind link this to how the brain helps us in inter acting with the environment and this basically was explored in a very interesting study by Ungerleider and Mishkin what they did was they wanted to study a monkey's ability to identify a particular object or to determine a particular objects location. So angle Ungerleider and Mishkin presented a monkey with their two tasks one of the tasks was an object discrimination problem and the other tasks was a landmark discrimination problem.

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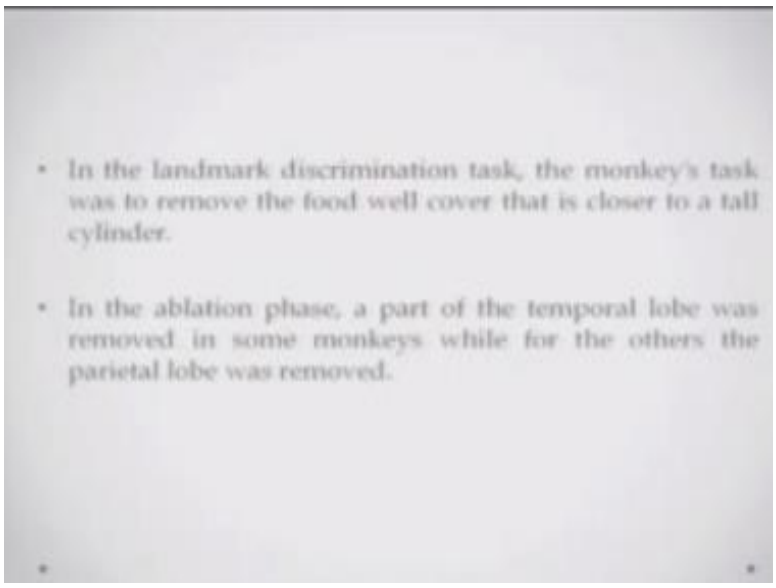

Now in the object discrimination problem the monkey was shown one object say for example a rectangular solid and then was presented with two choices so he was represented with the object that the monkey has already been shown and another stimulus that he had to differentiate this object from the monkey was supposed to push aside the target object and then he would get some reward that was placed under this target object so you can see the setup was something like this so the target object could be rectangle and stimulus object could be the triangle and as a monkey successfully you know moves aside that the rectangle which is a target object then the monkey will you know get the food as the reward.

The other kind of task was that the monkeys basically had to move the food well cover that is closer to a tall cylinder so you see here there are two kinds of covers one of them contains food but the monkey has to identify the cover that is closer to the cylinder because that is where the food will be filled in so the monkey has to what basically do is there determine the position of the object was the identity of the two objects is pretty much the same.

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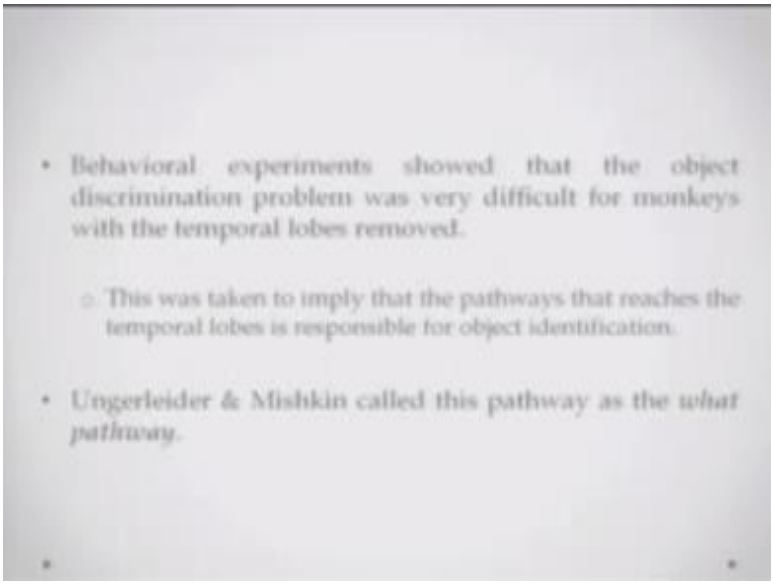

Behavioral experiments with these monkeys basically showed that object discrimination problem was particularly difficult for monkeys now the second so I will just kind of go back and I will tell you that the second phase of this experiment was the ablation of the monkey's brain and the ablation of monkey's brain was basically in one set of the monkeys the temporal lobes were removed in other side of the monkeys the parietal lobes were removed so this was the second important part and then when the behavioral testing was done it was found that object discrimination became unimportant became a very difficult task for monkeys who had got their temporal removed.

Now on the basis of this result it was implied that the pathway that reaches the temporal lobes is basically the pathway that is responsible for object identification so the temporal lobes in that sense can be implicated in identification of objects on the Ungerleider and Mishkin basically called this pathway starting from the 3/8 cortex in the occipital lobes as the what pathway.

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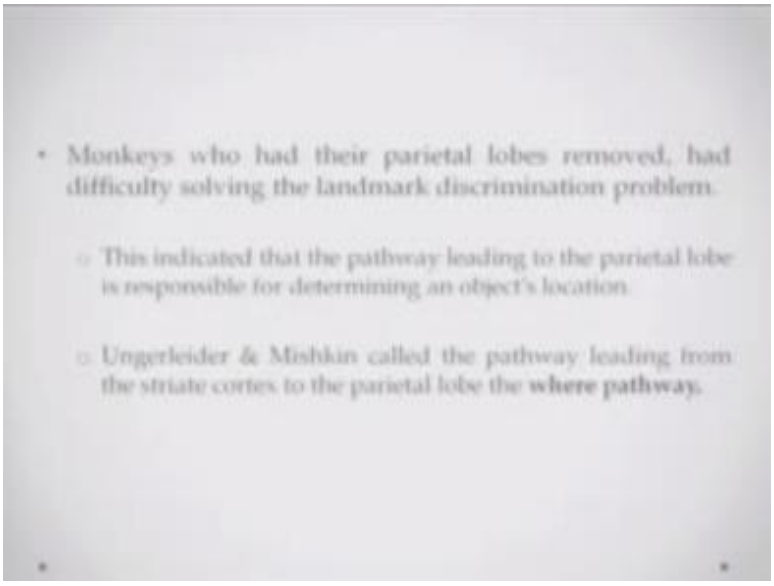

Monkeys who had their parietal lobes removed had difficulty solving the landmark discrimination problem now this indicated that the pathway leading to the parietal lobe is responsible for determining an object's location Ungerleide and Mishkin calls this pathway leading from the street cortex to the parietal lobe as they were pathway. So this is the pathway which is telling them the spatial location of objects the other pathway what pathway is basically telling them what these objects are remember that you will need both these kinds of information if you really want to navigate successfully with the environment.

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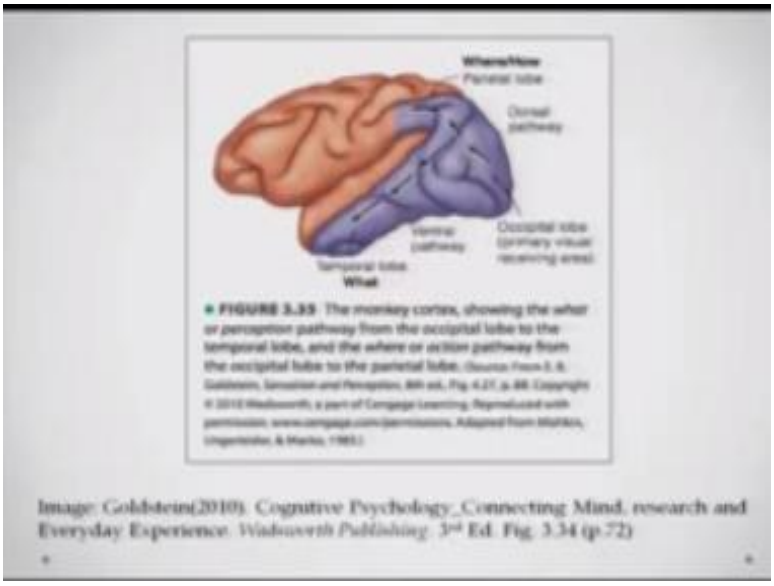

Here you can see the dorsal and the ventral pathway is the where path way is the dorsal pathway and the ventral pathway is the Vaught pathway okay.

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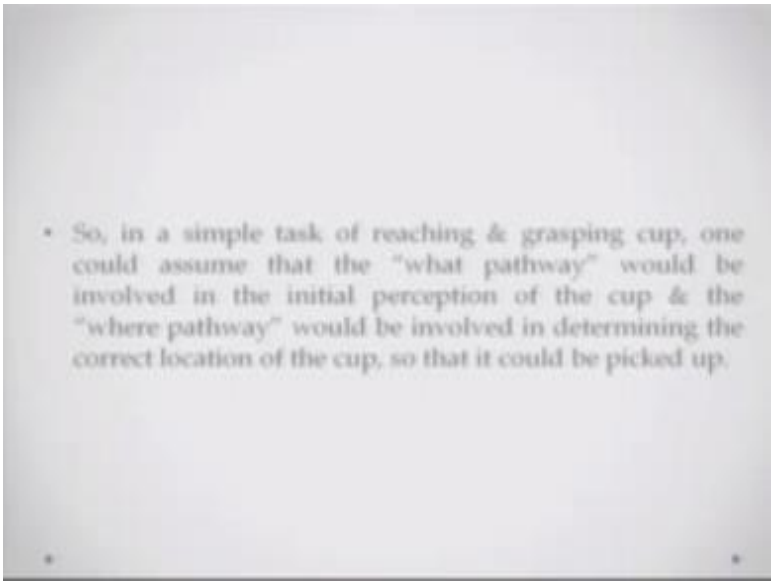

So in a simple task of actually reaching in grasping a cup one could assume that the where pathway would be involved in the initial perception of the cup and the where pathway will tell you that where the cup is and how much my hand should move away from my body in order to be able to grasp the cup and drink from it so in that sense we were kind of using information from both these sources and we are kind of integrating this information in order to successfully interact with this object that is the cup on my coffee table. Now we kind of try and summarize whatever we have learnt with respect to these approaches so we have seen that Gibson's approach was basically pushing for perception for action.

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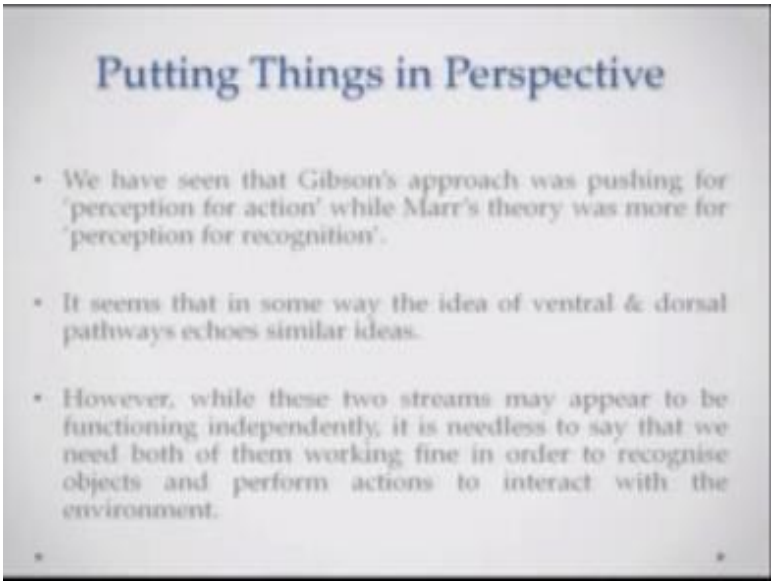

While David Marr was more concerned about perception for recognition both of these approaches are you know more or less correct in their own way but you have to try and integrate both of these approaches the findings and the perspectives from both of these approaches to understand perception as a whole cognitive function it seems that in some way the idea of both these ventral and dorsal pathways can echo the similar idea so the dorsal pathway is the perception for action kind of party and while the ventral pathway is the perception for recognition kind of fun say that David Marr was talking about.

So while these two streams may seem a slight different from each other and independent from each other I am sure you would appreciate that if you have only one of these information's you will not be able to successfully interact with the environment so we necessarily and you know definitely needs information from both of these pathways in order to understand and navigate the environment successfully.

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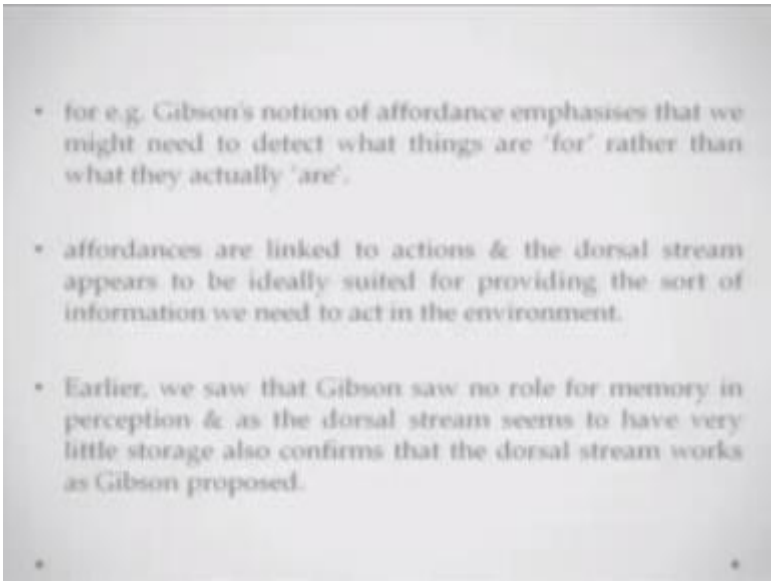

So gives us approach of affordance emphasizes that we might need to detect what things are for rather than what they actually are so affordances are linked to actions and to the dorsal stream basically that appears to be ideally suited for providing that kind of information also if you remember we saw that Gibson said that there is no rule of memory in perception and I searched the dorsal stream anyways has very little true storage and so this also confirms that the dorsal pathway works pretty much as Gibson was assuming.

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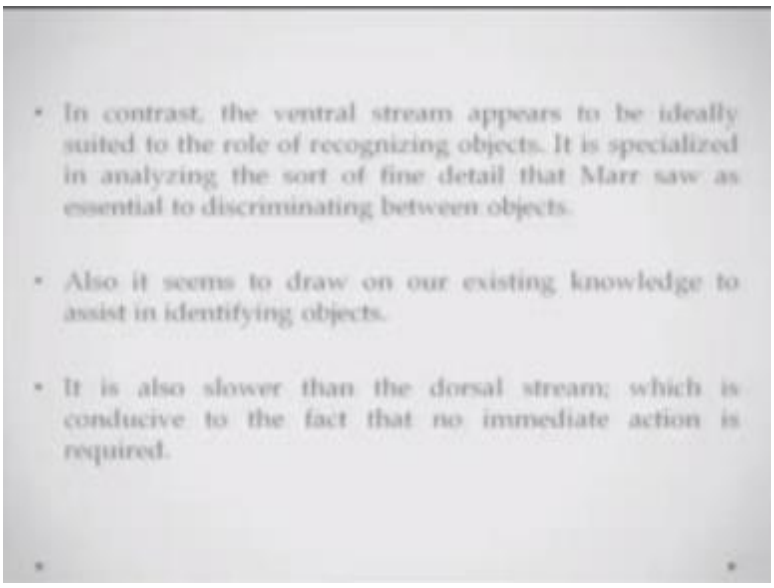

In contrast if you see the ventral stream appears to be ideally suited to the role of organ recognizing objects so it is specialized in analyzing the kind of fine detail that David Marr was concerned with the textures and the gradients in those kind of things and this information will be used in discriminating between objects also as it seems that you know we draw on our existing knowledge to understand and identify objects and so the dorsal the ventral seemed basically kind of is drawing from that source as well it is also the ventral stream is also slower than the dorsal stream which is conducive to the fact that the immediate action is required.

So if I say for example through a you know chalk towards somebody who is not really looking at me the first thing that you will do is you kind of grasp the chalk irrespective of recognizing whether it is a chalk or you know a pointed object or something very light okay because that information will automatically require immediate action and in that sense the dorsal pathway will be the one which will be required to act.

So to address these different kind of concerns and these two slightly you know different sources of information normally nicer in 1994 suggested what is called the dual processing approach.

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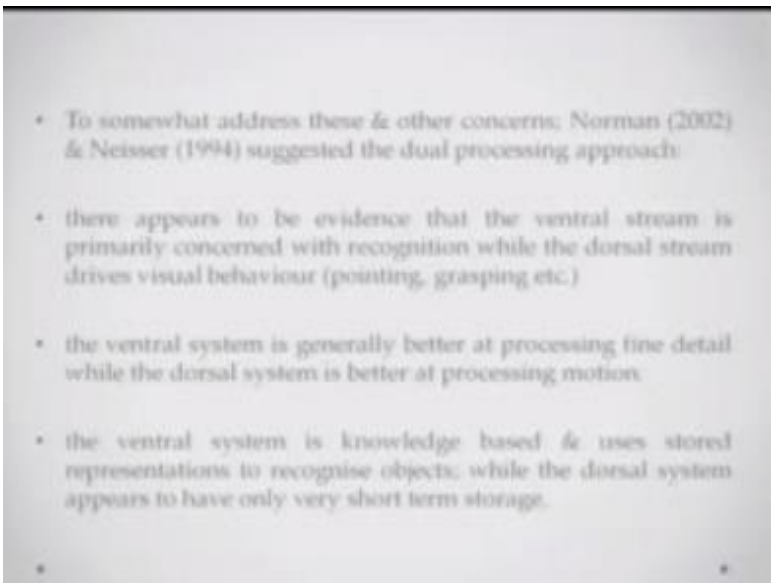

So they said the reappears to be evidence that ventral stream is primarily with recognition while the dorsal stream is primarily concerned with visual behavior the ventral stream as it said and as it is being found has been found to be generally better at processing fine detail while the dorsal system is more suited to processing motion the ventral system is knowledgebase and uses stored representations from memory while the dorsal system appears we have only very short-term storage that is required to add 10 no finish a particular task.

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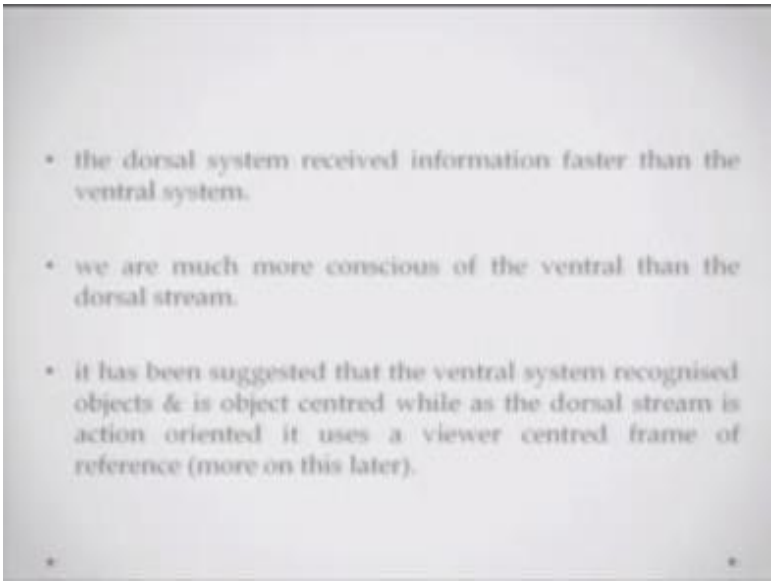

Also the dorsal system receives information much faster than the ventral system and we are much more conscious of the ventral than the dorsal system again if you take the example of somebody throwing a chalk at you or something and that you have not seen you will see that the ventral system does not require that kind of crossing it first needs to take evasive action. So it has been suggested on the basis of these things that the ventral stream recognizes objects and it is object centered in its approach while the dorsal stream is action oriented and it receives a viewer centered frame of reference okay.

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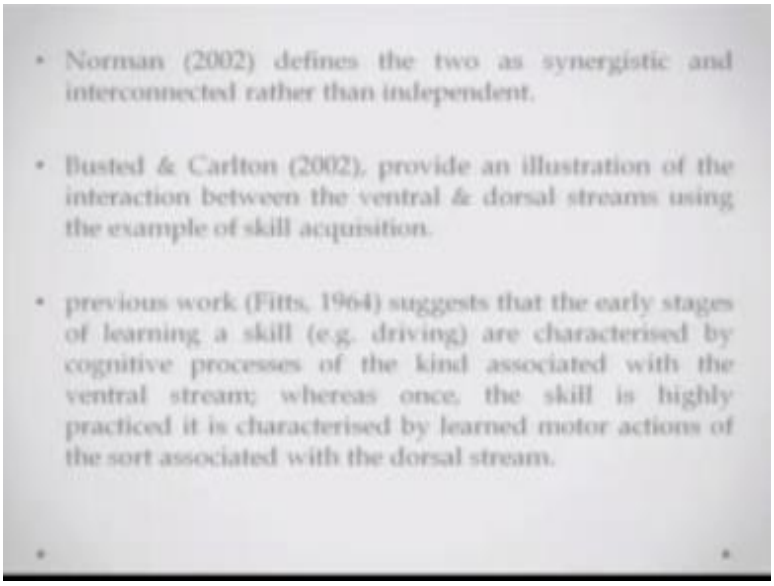

So a moving slightly further so Norman kind of tries and you know defines the to a synergistic systems basically working in an interconnected rather than an independent fashion first aid and Carlton they provided an illustration of the interaction between ventral and dorsal strings when people are learning you know a new tasks so the work of Fitz shows that in the early stages of learning a skill when you are not really aware of what has to happen if for example if you are just learning driving of a car you just first get you know very familiar with the consoles of the car the gear and you know other pedals and those kinds of things in that part you are kind of you know using the Ventral system a bit more.

Once the skill is formalized once you get you know acquainted with the particular skill then what you might shift onto is a highly practiced skill wearing the dorsal stream might be more useful so we are kind of just doing things for action say for example after you have learned driving a car you know for a particular amount of time then you are not really always looking at what the gear is and where the pedals are you already know that they are there and they have to serve this function and whenever you need to change the gas you are an automatically goes onto the gas and you can change the gas in order to move forward okay.

So this is the end of this link between perception and action we tried it look at the different aspects of how our movement in the environment you know facilitates or helps out our action and also how say for example information from the objects can help us a modulate or influence our interaction with the environment, thank you.

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