Cognition and its Computation
Prof. Rajlakshmi Guha
Prof. Sharba Bandyopadhyay
Biotechnology and Bioengineering
Indian Institute of Technology, Kharagpur

Lecture - 29
Basics of Perception - Object, Depth and Movement

Hello everybody, welcome back. In this the 4th and 5th lecture of a week 6 we are going to talk about Perceptual constancy and illusions. So, we have in this week we have spoken in details about attention and perception and we spoken about types of attention, we discussed about the different kinds of theories, we spoke about alerting orientation and executive network by poster and moved on with the disorders of tension.

And finally, we got into basics of perception and we spoke about form perception, movement perception, depth perception, distance perception and in today and in the next talk we are going to talk we are going to focus more on illusions and perceptual constancy. So, what are the errors in perception that we have and in this context we are going to talk about illusions and perceptual constancies. In today's talk and the next you will find that there are a lot of overlaps.

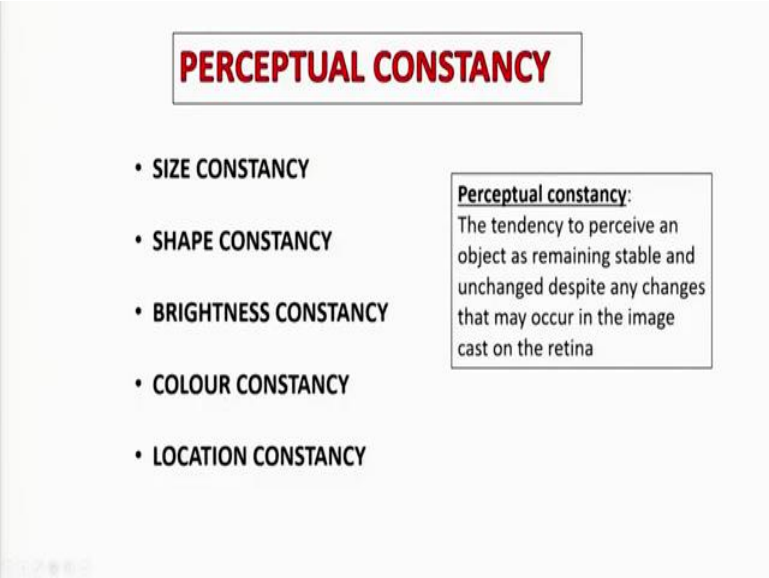
So, today's talk it will be focused more on perceptual constancy, but I will mention a couple of illusions in it as well and in the next one next that is the final talk of the you know of week 6 we are going to focus more on illusions specifically. So, what are illusions and perceptual constancies?

(Refer Slide Time: 01:53)

So, when we illusions are something that we frequently come across when we are talking when we move on with our life every day. And the funny thing is that for most of the things when we perceive an illusion our brain knows that this is not true. So, imagine yourself looking at a trained track and when you see the lines the two parallel tracks converging one of we do not think that they actually converge in reality, but somehow over the years over experience our brain knows that it is just what we are perceiving to be, but its not true. Now why do we have these illusions?

So, we are going to discuss that today, but before we move on to illusions I will be talking a little about perceptual constancy. So, what is perceptual constancy?

(Refer Slide Time: 02:55)



So, perceptual constancy is the tendency to perceive an object as remaining stable and unchanged despite any changes that may occur in the image cast on the retina. So, in simple terms when even when the image on the retina may be different in size we tend to consider it object as stable. So, just to give you an example, if you are looking at a human being from the ground floor.

So, that is if you are sitting on if you are sitting on a chair and looking at an individual standing in front of you and you are looking at that same individual from the terrace of the of tenth floor building, you still are aware of the constant size of the approximate size of the individual. Now how do we know that well this person is a 5.5 5 feet 5 inches or a 6 feeter.

How do we know that? Why do not we look at that individual as his he suddenly shrink when you are looking from the top of terrace? Similarly, when we are looking at objects like cars, vehicles from the terrace of a high rise building we still have a more or less approximate idea about the shape and size and along with it the volume of the object ok. So, how do we know this? Surprisingly, this is a concept this concept of perceptual constancy is picked up way earlier by the human brain. So, even children who are very young have an idea about constancy.

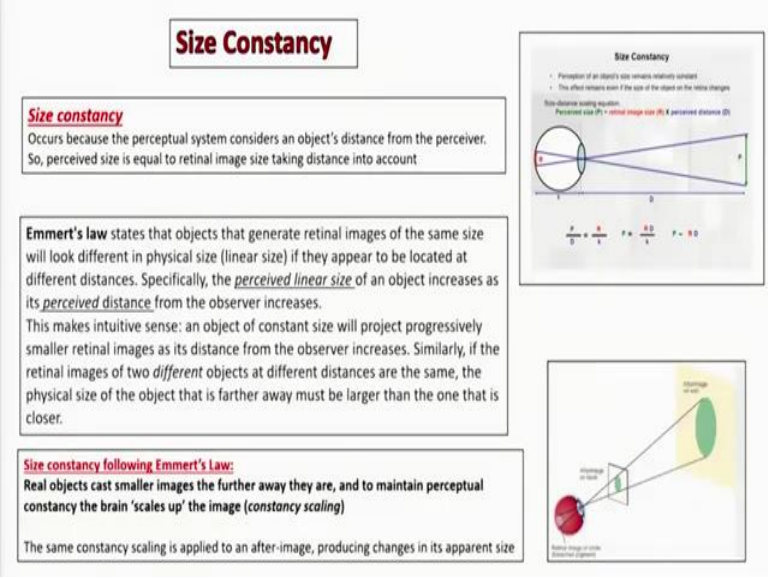
So, if you ask them to look at a leaf in the dark and ask them what is the color of the leaf? Even though the same leaf you know has a different hue in sunlight and when it is

seen in a dark room, the child will mention it as green or say you know a brown leaf or whatever, but irrespective of the change in brightness irrespective of the change in hue, the child can perceive that the color has not changed.

This is one excellent you know feature that humans in fact, many animals also do we pick it up as we grow. Now this is its a constant debate whether its a part of our learning that is our environment having an effect or it is it because of something that is inherent. One very interesting phenomena is people who studied primitive populations anthropologists and psychology social psychologists they have seen that primitive tribes who have not been familiar with moving objects from a distance perceives them to be growing larger in size as the animals come nearer.

So, there are wonderful interesting studies on this maybe we will discuss this in the forum. So, talking coming back to perceptual constancy again, the primary types of perceptual constancy that we see are size constancy, shape constancy, brightness constancy, color constancy and location constancy. Brightness and color constancy are very related to each other as you can well understand.

(Refer Slide Time: 06:55)



So, let us see what happens. So, what is size constancy? So, size constancy is the as we were just talking right now is the concept that no matter how far an object is we perceive it of a an approximately same size. Now how do we do that? Our brain somehow and that is how that is very important because that is how we try and evaluate or assess

distance. So, this was first identified by Emmert in 1881 he published his work and in his he gave this law as Emmert's law that states that objects that generate retinal images of the same size will look different in physical size if they appear to be located at different distances.

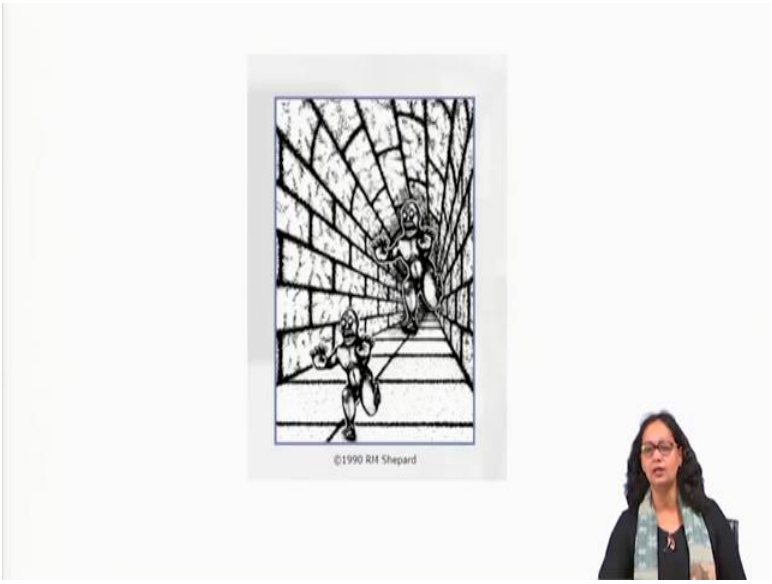
So, irrespective of the size irrespective of the size it the object is. So, it will when they appear at different locations you know their size is different. Now he worked on Emmert's work was primarily on after images and if you look at the image figure at the right side of the slide you will see that when you know he showed that real objects cast smaller images the further away they are and to maintain perceptual constancy the brain scales up.

So, what he showed is that in an after image you look at this image you will see that if it is on a book if the after image of a circle is on a book it is way smaller than when it is on a wall so on at a distance. Now, how does the brain scale this up? The brain understands that if the size looks larger then it must be at a distance if the same object looks closer. So, this. So, if. So, there is an input from the image that we are seeing or the real time visual image and a constant evaluation we will discuss this a little later from the past experiences and memory that you know considering the other inputs into view.

So, we will also be talking about this a little later. So, if you look at what happens in when we perceive an image. So, perceived size is actually retinal image size plus perceived distance ok into perceived distance. So, the now if you are if it is looking larger or if it is looking similar then the actual size must be way larger just to show you an example.

(Refer Slide Time: 10:09)

(Refer Slide Time: 10:13)



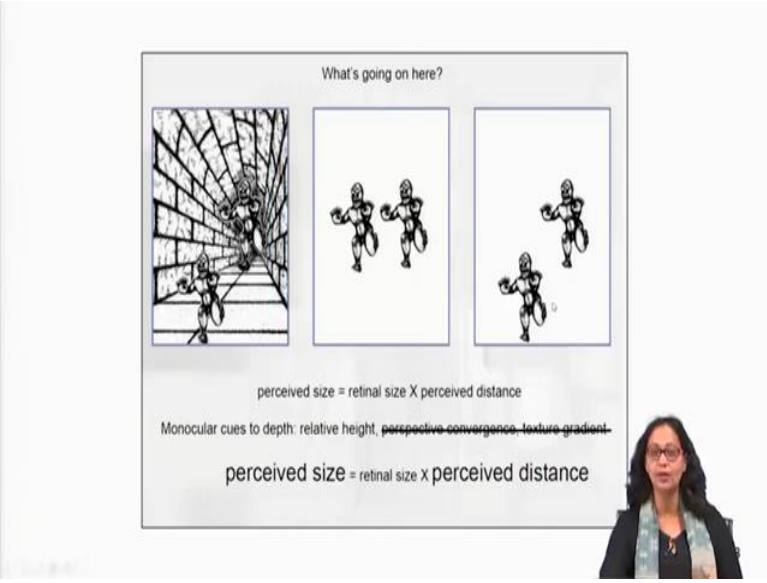
Now, many visual. So, think about before we get to the illusion part of it, many times what happens is we this input helps us to understand the world better. So, this concept of size constancy, we know that all of us we are aware that the individual has not shrunk in size if he is you know if we are looking at him from a tenth floor terrace. On the other hand, if we as we are gradually coming down from the terrace the person is not growing in size. So, its so, because we have this idea about size constancy.

But size constancy can be this ingrained knowledge of size constancy can also lead to multiple illusions. Now let us look at an illusion that happens because of size constancy. So, if you look at this monster chasing you know this is a very famous solution apparently the child in front looks smaller in size as compared to the monster at the back right. Now how do we why do we say that this guy at the monster at the back is larger in size?

If you look at this what are the inputs that we have we have talked about binocular and monocular cues in the previous sections and if you look at this environmental cues. So, this texture this change in texture this narrow down of these parallel lines emerging at a distance, this gives us a an idea or this gives us the concept of distance. Now how have we gathered this input? We have gathered this input from our environment that these are cues that we have picked up from our experiences in the visual world.

So, that there are is if you are looking at the distance the texture is more smoother, the gradients are more refined when it is nearer. The lines seem to converge when you are moving further down that is also a reason for one of the other illusions that we will discuss.

(Refer Slide Time: 12:50)



Now, actually what is the real size? So, this if you look at this image now, this is the size its the same size now of both the child and the monster. Now let us look at this picture now if you look at this third picture ok. So, here because this second the monster the

second individual in this case has been put on a higher plane even if you look at this third picture.

He seems apparently, he seems to be of the same size as the individual in front, but because of the additional cues its just that he seems a little behind because our idea is that this must be a plane. So, if this is a plane ok where they are. So, if both these individuals are grounded on a plane, then this must be further down or you know at a distance. So, in this second and the third image the other cues are absent, but the only cue is the relative height right now if you look at.

So, it looks at it seems as if this third image here the second person is at a distance from the first one, but that is about it, but if we look at the first image if we come back to the first image. Now the perspective convergence the convergence of these walls the lines that the bricks on the walls and the texture gradient these are additional cues that give us this idea that the second person must be larger in size.

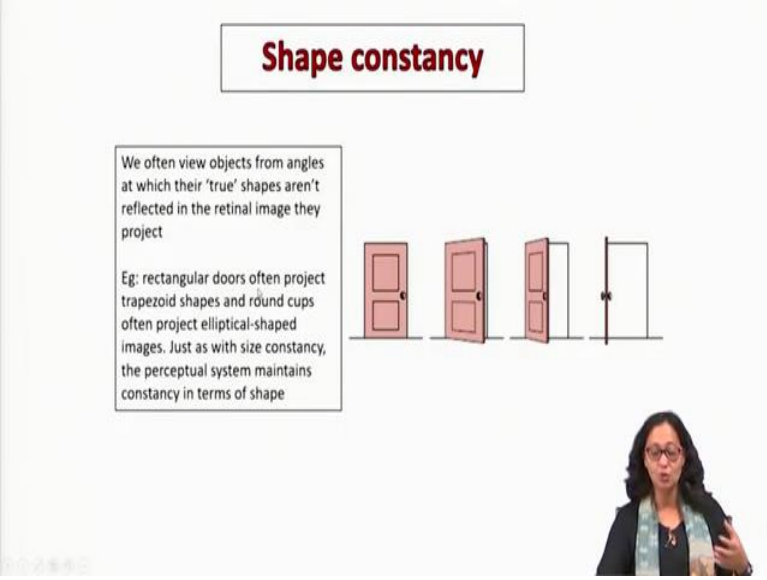
So, far Sso, the if you. So, now, the next question that may arise is, if you are looking at this q with if you looking at this image with one eye would it give you the similar input?

It would because at the end of the day these environmental cues would be provided even if you are looking at it with a single eye now. So, these texture gradients and the as I said the convergence this adds to the size if. So, how do we; how do we perceive? Now you look at how size constancy works. So, we know that the size if the size are similar if the size are the same of both these images both these individuals.

And their from the third image we know that this must be at a distance if they are at the same plane now these converging lines they add to increasing the size because if the size is the same and there is a distance between the two then definitely the perception is that the individual must be larger in size. So, just to give you another example. If you look at an individual of a 6 feet individual from the tenth floor and he still looks 6 feet then you know in real time then your idea is that must be he must be much taller if I see him from the same plane.

Now, this see the size constancy helps us understand the world better, but it also adds you know to our other inputs about the world and similarly it adds to us having illusions.

(Refer Slide Time: 16:52)



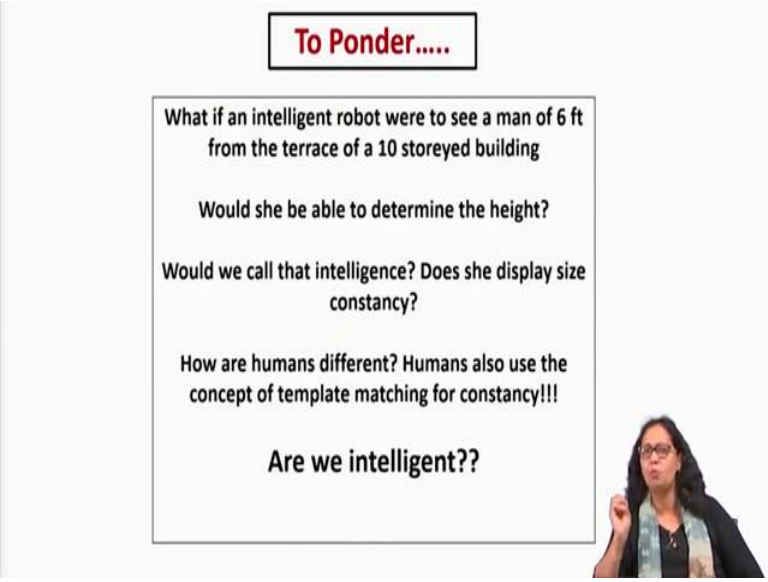
Now, let us get on to shape constancy shape constancy what does it mean? As I mentioned earlier that if we do not have an apparent idea about the world then it would be really chaotic for the brain to process information why? Because at every time every moment in time when I am shaking my head like this the image of the world in front of me is changing. So, at it becomes it comes at different angles.

And then if our brain was not able to process this change in the apparent world in the real world as because of my head movements and eye movements then I would think of everything around me as different as something new and then it would be a chaotic clutter for all of us to perceive information in continuity. So, shape constancy is one example of the brain trying to optimize this. So, if you look at this image of the door.

And if you ask even a child what is the size of the door the what is the shape of the dough, he will say he or she will say that it is rectangular in shape, but if you look at a partially open door or a half open door or you look at a full open door straight perpendicularly, then it may seem like a single line as in if you look at this image here, but that does not make us think that this has as you as one gradually opens the door, it does not make us think that the shape has changed and it has reduced to a single line.

To form or to formulate this continuity of information the shape constancy helps us ok. So, if we did not have that as I said everything would be seen as individualistic images and unique images and then we would not have any continuity in our perception.

(Refer Slide Time: 19:06)



Now, let us just ponder this question there is a lot of discussion about artificial intelligence you know and natural intelligence and we speak about you know intelligent robots these days who can perceive information like a human and in fact, in many ways better than the human.

So, say think about an intelligent robot if the robot I am sure many of you are familiar with Sophia. So, Sophia is a humanoid. So, if an intelligent robot were to see a man of 6 feet from this terrace of a ten storeyed building would she be able to determine the height and what would we call that? Would we call that intelligence or you know somehow she displays a size constancy or is it that she has calculated the distance between her on the top floor on the terrace of the tenth floor building and down and that is how she has you know assumed approximated the height.

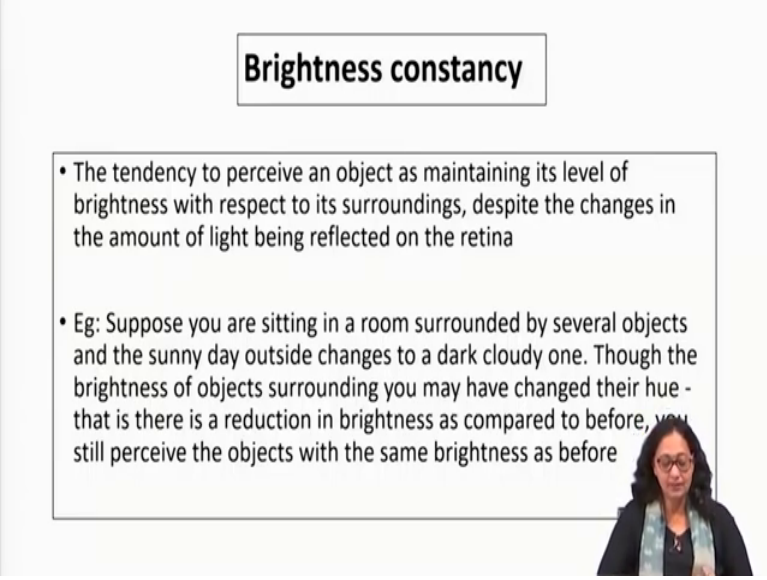
So, would we or you know are we doing the same thing like the robot does? So, are we also making templates in our brain and are we matching the templates you know and identifying it? So, are we intelligent or I should rather say that you know is this a difference is there a difference between how the robot would see it and how we would see it and you know how in what ways would our intelligence be different than the robots well.

The question and the argument may continue on different perspectives about emotions and you know memory and things like that where and the efficiency of a machine is way

better while our perception of a social situation may be much better in certain cases as compared to the, but were not going into that, but just to ponder this how a robot would look at information and are we actually doing it the same way.

So, at you know another interesting feature is, how many examples do we actually require to have to build up the constancy to build up perceptual constancy? If there were many examples that were required then a child would need a couple of years in his life to actually understand constancy, but if you look at very young children too they develop this idea about depth and distance and they developed this idea about constancy.

(Refer Slide Time: 21:59)



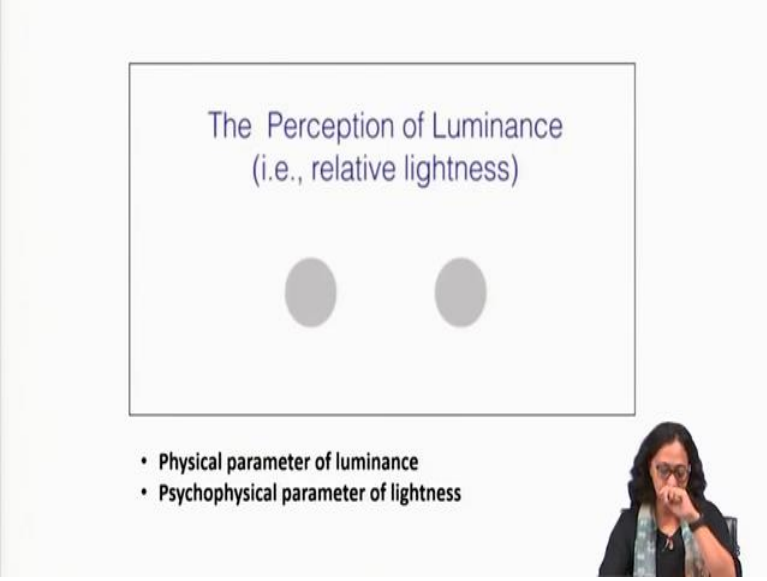
Coming to brightness constancy. So, what is brightness constancy? That is the tendency to perceive an object as maintaining its level of brightness with respect to its surroundings despite the changes in the amount of light being reflected on the retina. So, irrespective of the color the change in hue the change in brightness of the object that is on the retina we see it as the same you know irrespective of the changes.

Now actually what is very important here is we the environment around it is very important. So, the features in the environment that add to our concept of brightness as you will see also in color. So, just to give you an example suppose you are sitting in a room surrounded by several objects on a sunny day and suddenly it changes into a dark and gloomy one.

So, the light from outside has reduced and the brightness of the objects in your living room has also changed; obviously, if you have not switched on the light on the artificial light at home. This reduction is. So, there is a reduction in brightness as compared to what you were perceiving before, but this reduction in brightness does not change your perception of brightness of the object surrounding one of the primary reasons for this is because the other the change in brightness outside has also impacted the other objects in the room.

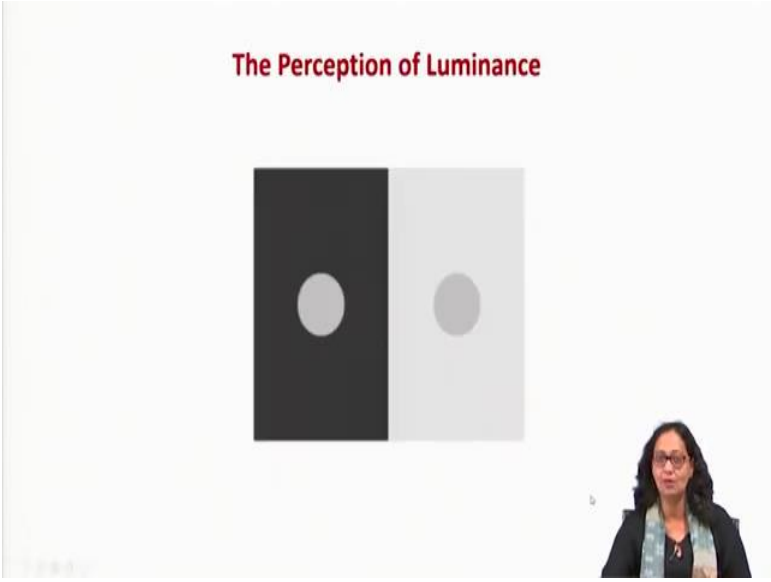
So, we use a constant comparison with other objects. As I was mentioning about the monster and the child you saw that there is a there is the inputs from the environment add to our perception. So, it is not only the object in space, but the object with other surrounding objects in space that give us our idea about the qualities of the object.

(Refer Slide Time: 24:28)



So, now let us look at certain examples. So, you if you look at these two circles ok. Well they are of the same hue they are of the same hue there is the same lightness.

(Refer Slide Time: 24:53)

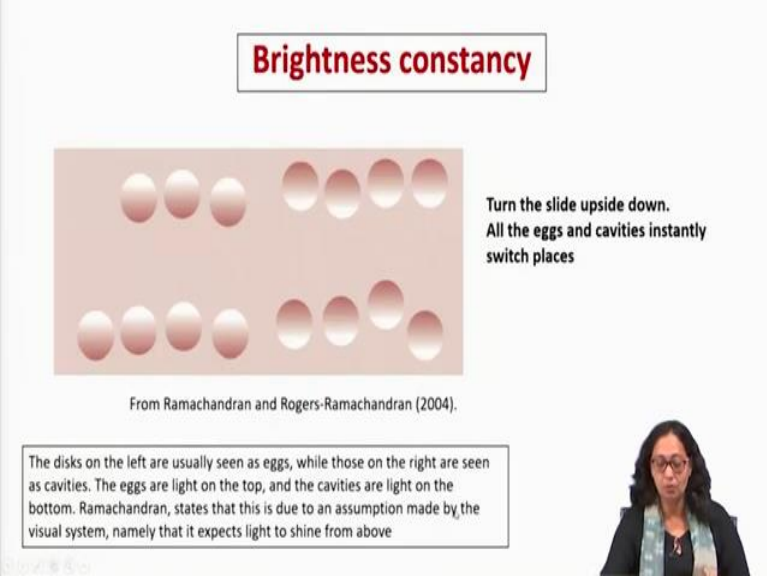


And now if we look at this image on a different plane. So, let us look at the image its the same two circles on a background of dark gray or black and with a lighter one. Now which one look at this and see for yourself which one looks lighter? You will see that its the same two images I will go back ok its the same two circles ok and if you now go back look at these two you will see that this looks lighter a lighter gray than this one now why is that so?

Just as I was discussing its because of the environment its the background that gives it the contrast. The contrast is here a contrast here is much more as compared to the contrast here. So, or rather I should say that here because the background is dark this seems lighter in comparison and because the background is light here this seems darker. So, this is one classical example that is used by image professionals.

So, if you are looking at actors and actresses and the way they dress or at photographers, they use this idea about luminance they use this idea about you know these contrasts to project an image better. So, actresses may be wearing dark colored clothes to look fairer. So, as compared if their complexion is more on the duller side.

(Refer Slide Time: 26:59)



So, now this is the most important part of this is the you know contrast phenomena. Now let us look at this figure this is very interesting this is known as the eggs and cavities. So, if you look at the left side of the image if you look at this, these look as if the they are the egg shells. So, they are like the eggs.

So, its outside and these look as the look at the look like the cavities. So, as if this is the inside of the shell. Now if you turn this figure if you turn this figure upside down you will see try it for yourself look at the slides and try it for yourself you will see that these on the right if you turn the image these apparently look like the eggs and these look like the cavities. So, as if they have switched places now why does that happen? As I was mentioning earlier it is information that we have gathered from the environment over time.

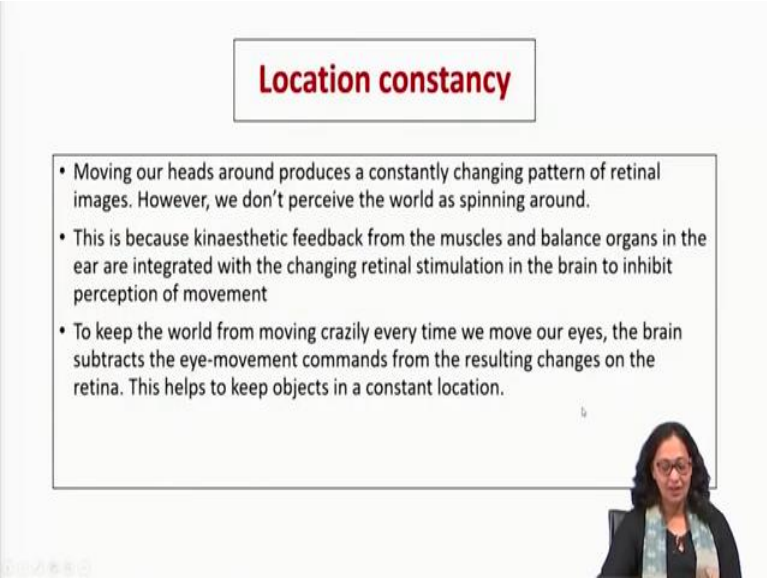
Now, this is a very challenging question that whether it is something that we pick up after we are born or is it more of a collective intelligence that we have inherited from humans per se our of our species from our you know primates other prehistoric ancestors. So, because you know in this image why do we; why do we do the change positions?

Why do we see these as actions? Its because we have an idea that light comes from above now this information how did we how do we have this idea it is from? Our perception of the sun as being above us ok on the sky. Now, that is why so, this input

that we have gathered across time over our years of experience is implemented here in this and we that is why if it is from above it seems like a convex shape ok and on the other hand if it is from below its like a cavity.

So, irrespective. So, this in irrespective of knowing that they are the same and you have just switched the image if you have turned that you have turned the image upside down the perception changes ok.

(Refer Slide Time: 29:47)



This was worked on by B.S Ramachandran and Rogers location constancy. As I was mentioning this is you know if we do not have a concept of constancy perceptual constancy if we did not did not have the input to the brain challenging the you know or you know optimizing the multiple number of images, we would see every single image with head movement and with eye movement that is with a different angle as separate now this.

So, you know there are constant number of images that are being produced you know when we are changing our positions and this input is going to our brain and the brain is considering that movement as a part as responsible for the change in the perception perceptual angle ok. So, this is actually what I should say is that the brain nullifies this movement unless it is too much.

So, if you if I just turn my head like this and move around and come back again to the same position, I know that things around me has not changed, but I have turned or if I just turn a little move a little and you know the objects seem to be moving ok we the brain takes it into account that this object movement is because of my movement. So, that should be nullified.

Now, this is used as a part of an illusion creating movement illusion in movies ok. So, many times you know I may be sitting here and the background if the background is moved constantly. So, if there is a sweeping screen of roads and you know the image of moving fields and traffic lights and lampposts and things like that it will seem that I am on a moving vehicle. Now this is used in movies many times this illusory effect of creating movement is used in movies.

Now this is a little of course a little different from location constancy, but location constancy primarily focuses on our idea of the continuity of form and shape ok. So, that we do not think of each separate unit each unit as separate.

(Refer Slide Time: 32:46)

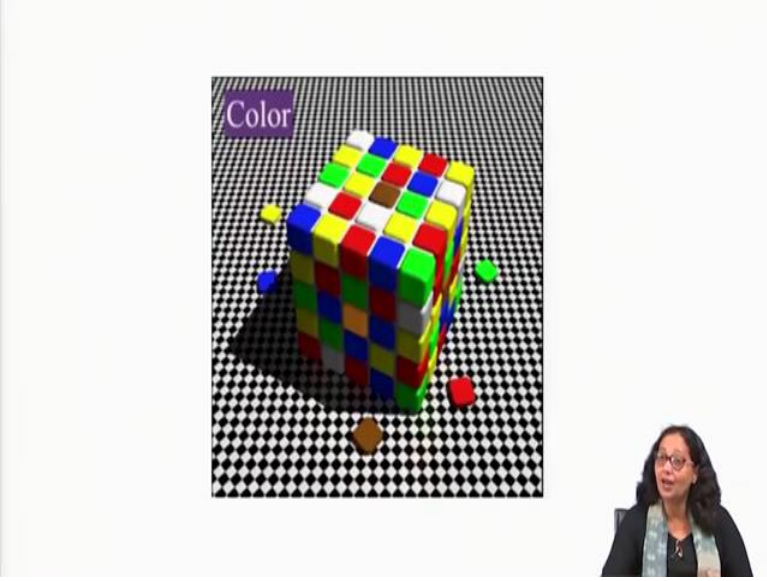
Now, color constancy as I mentioned earlier with brightness is very similar and you will often see that color constancy you know if you look at an object at in bright light and if you look at it in dull light irrespective of the change in hue you know the color it will seem the same and as I mentioned at the beginning of this talk children will perceive a

leaf as green its not because they have learned that the color of the leaf is green, but irrespective of the change in hue and change in color because of the brightness.

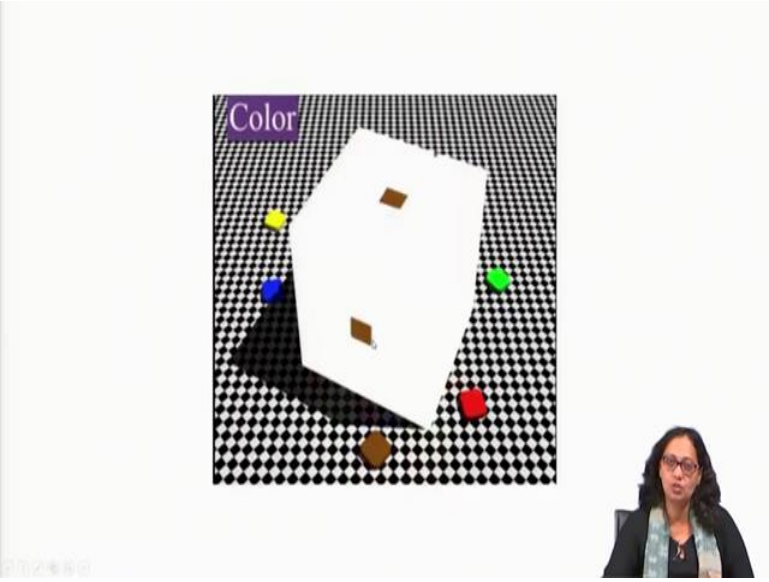
Now this is not always true if you are looking at something new. So, that just implies that learning plays an important part for example, if you are looking at if you bought something in some you know dress material in bright light and you come home bright light of the shops with fluorescent yellow lights and if you come home and you see it on your regular lighting at home, it may seem very very different.

Now it seems different in this case because you this is new input to you this color of the dress material is new input to you it is not a constant like the color of the leaf or you know the sky and things like that ok.

(Refer Slide Time: 34:21)



(Refer Slide Time: 34:52)



So, now let us again its a very important factor that the surrounding environment also adds to how we perceive color. So, let us look at this illusion ok. If you look at this brown here ok this center dice and this one ok they seem to be of two different colors. So, this is brown and this is orange. Now if I change if I remove all the other colors they are actually of the same color now let us go back.

So, this is the brown which is here and which is here in the that we actually are perceiving as orange then what has happened? Why are we seeing this as orange or saffron? The reason is because of the surrounding colors. So, they give they are much darker colors that give the perception of a lighter saffron as compared to the colors here you can check this out for yourself ok. So, try it out for yourself and see.