Multimodal Interaction
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Lecture 1.3.1
The Human Eye

In this video I will present you the mechanical set up of the eye.

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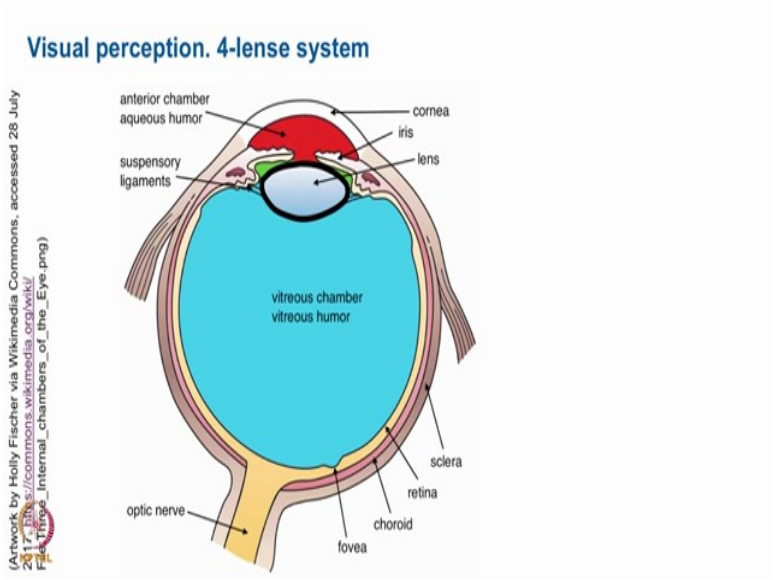

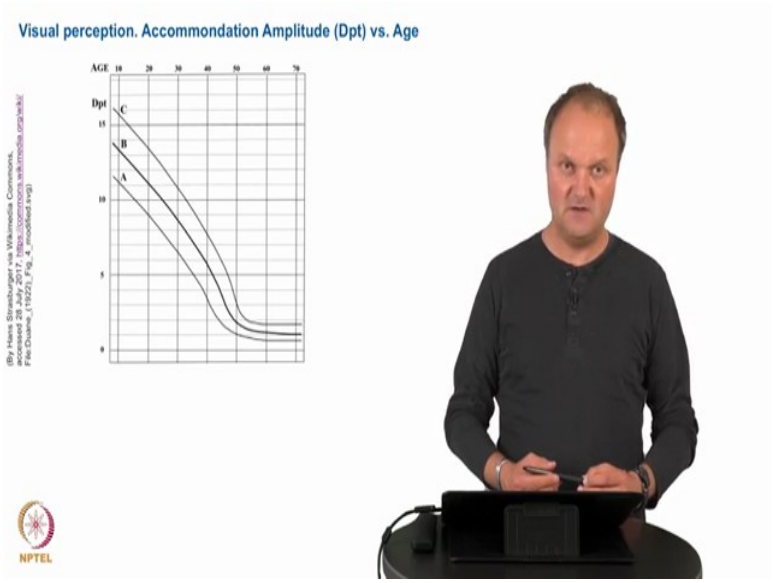

As you might know, the eye is a four lens system which helps focus the light beam falling into the eye, on to the sensitive cells of the eye. These are located on the retina. The four lenses you can see in the lenses behind me. There is first the transition of the air surrounding the eye and the so called cornea which is the outer skin of it, then the interior chamber that is

the middle part here, then the lens which is here and then the vitreous chamber which you can see here in this area.

So, these four lenses together have reflective power which helps to focus light beams on to particular points on the retina. The reflective power of the entire system is approximately 60 dioptres where 43 dioptres approximately come from the transition between the air and the cornea and approximately 20 from the lens. The reflective power of the lens can actually be changed by tearing the lens to the outer side making it flatter and making it less reflective.

This process is called accommodation and this accommodation changes also on the long run. If you get older, the reflective power of the lens will diminish and that is what you see in the picture behind me. You see the reflective power in terms of dioptres for an average test participant, that is curve B, and the standard deviation, these are curve A and C and you see that it decreases significantly with age.

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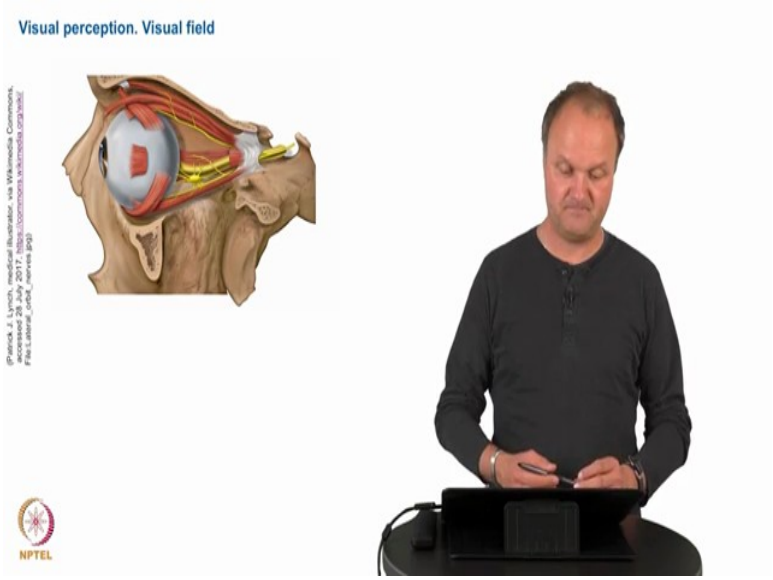

Now if you want to look at a particular point in the room, we have to move our eyes. And this focusing is done with the help of a couple of muscles. Actually three pairs of muscles which help to move the eyes. This movement is usually not done continuously, but in terms of fixations which are separated by saccades. These fixation have a duration of approximately 2 to 3 seconds and they help us in scanning the environment so what we are continuously doing is we scan the environment with our eyes. We have to do it in such a way that both eyes produce a sharp picture on their respective retina that is there is some inside movement in both eyes which helps to make both pictures of both eyes to get sharp. We will come back to

this process a little bit later when we talk about depth perception. This process is called convergence or vergence.

But there is of course other movement of the eyes, for example if we follow moving objects, these are called slow pursuits or if we have to compensate for our head movement so if we move our head but we are still looking at the same position then these are called fast faces.

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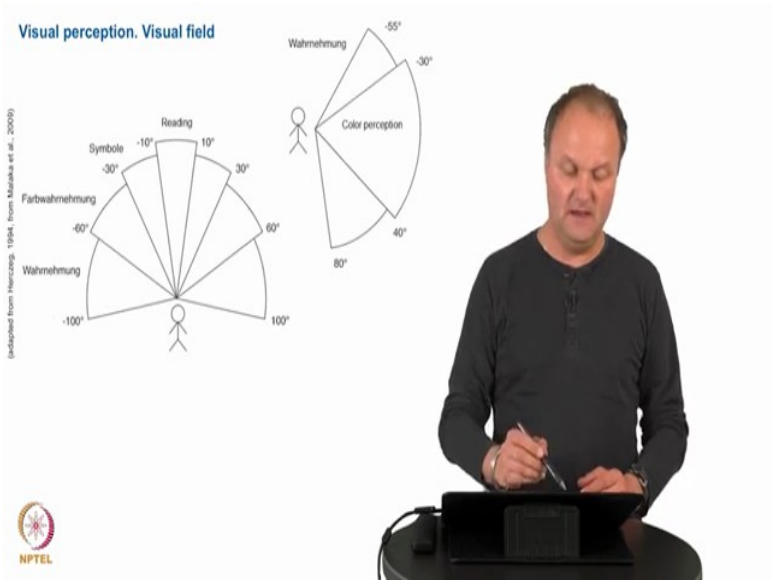

These movements of the eye help us see different areas around us and this is done with different degrees of precision and we call that the visual field. The visual field is most precise in the middle up to a degree of approximately plus or minus 10 degrees from the central point. This is the area where we can for example read. Then an area a little bit outside, plus minus 30 degrees, where we can still recognize symbols, and an area even more outside where we can recognize colours and then a general outside area where we can recognize that something is happening, for example someone is approaching us but we cannot see that sharply and the same by the way same happens also in the medium plane that is the plane transversing our head vertically.

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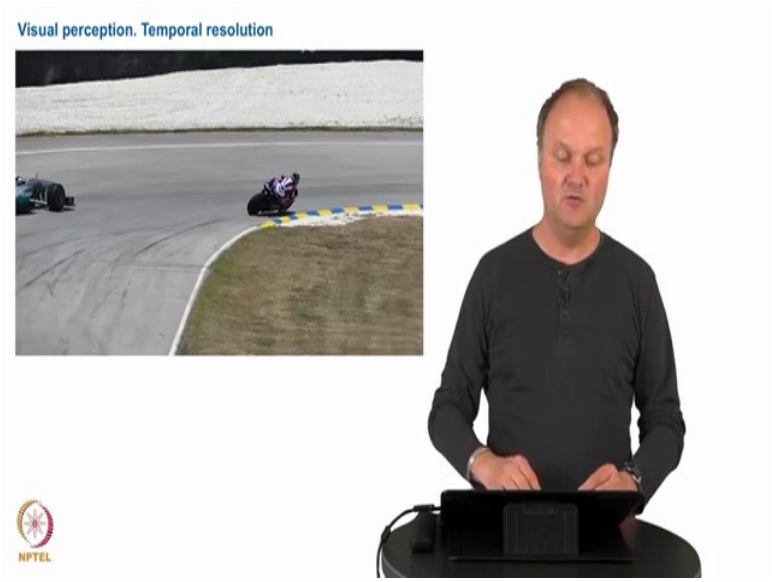

This is linked to the spatial flexibility and spatial resolution of our eye, but our eye, of course has some timing characteristics, dynamic characteristics. The time resolution or the temporal resolution is something which is particularly important for perceiving movements, movements or things around us. You know that from television that for example if we have a film which is played back with a relatively low frame rate, then what happens is that objects in this film are jumping. They are jumping from one picture to the other.

Actually, in order to be perceivable a picture needs to be available, a visual stimulus needs to be available, for approximately from 15 to 50 milliseconds. But we can actually start to perceive movements when we have three to five pictures per second. These pictures are of course not fluid, they are jumping as we have seen in the film. Fluid movements can be perceived from approximately 20 to 25 pictures per second and that is actually the rate which you have in standard cinema films.

Below the rates of approximately 20 to 70 hertz, we can perceive some flickering and this is why high definition television sets try to repeat pictures a little bit with a higher rate for example, 100 hertz in order to avoid this flickering.

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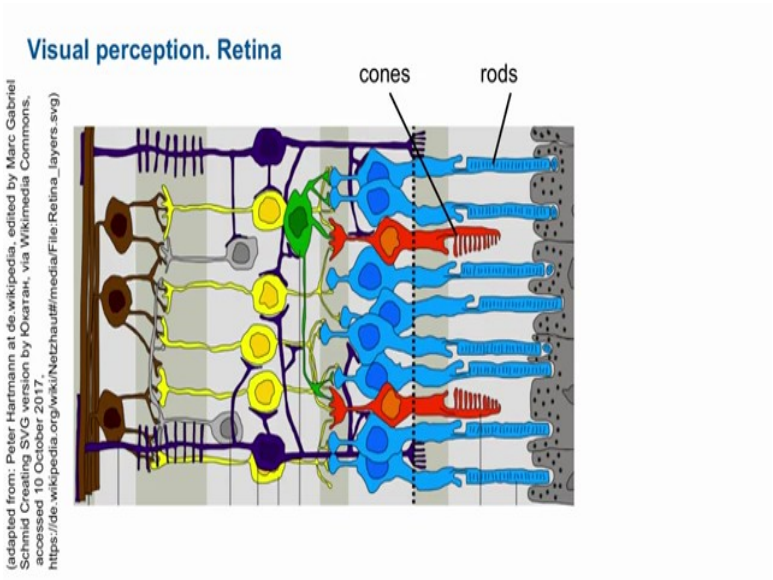

As mentioned before the sensitive cells are located on the retina and here you see cross section of the retina. The cells actually located at the low end at the end of the retina and there are two type of sensitive cells the Rods and the Cones. There are many more rods than cone. We have approximately 100 million rods and only about 5 million cones. The rods are very light sensitive upto one photon is enough to excite them but they are mono chromatic that is they only react in an on-off way with black or white light distinction. Instead the cones are less light sensitive but there are three different types of cones in three different colours and these help us to perceive colour.