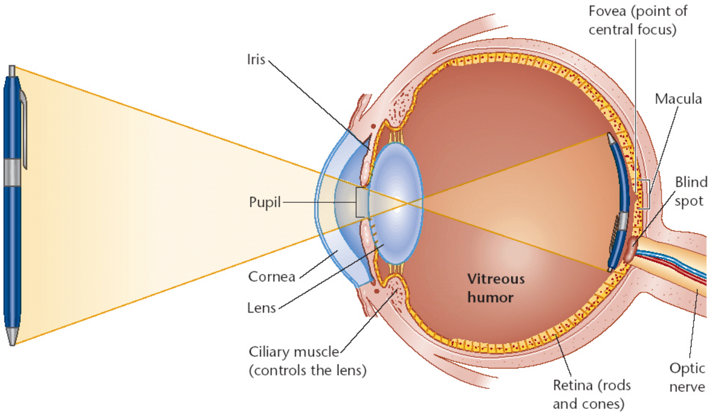
HPS310

BRAIN, BIOLOGY AND BEHAVIOUR

Table of Contents

TOPIC 6: VISION AND HEARING

They Eye



Sensory transduction is the conversion of energy of some form into neural activity. There needs to be a functional bridge between the real world and the neurological information.

You need to collect and focus in the energy so it can be used and turned into action potentials.

The rest is about turning light into an image. You can see an image because there is an image at the back of your eye.

The first step is to refract the light, the lenses pull the light in and bring it to the back of the eye. As an object gets closer you need to increase the refractive power to pull it closer. The light gets focused in. Secondly, you get a focused image at the back of the eye.

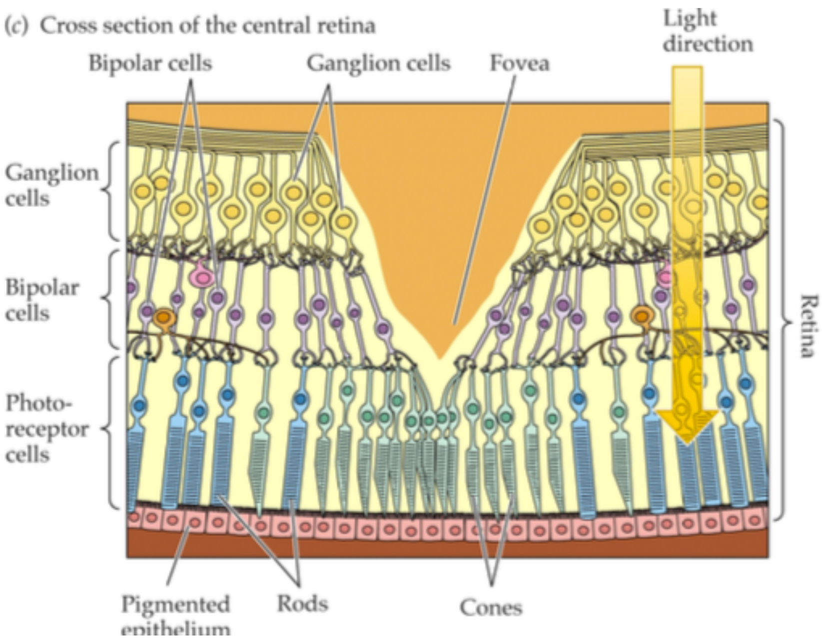


Figure 1: The Retina

This is full of complex neural circuitry. At the very bottom/deepest layer is the layer you have the photo sensitive cells – rods and cones, which do the act of sensory transduction. These are chemicals that change when they are struck by light. Causing a domino effect of chemical events. Here, energy of the world is transformed into neural activity. That is **sensory transduction.** This means that the light has to go through all of this other junk before it can get to the cells that transform the light.

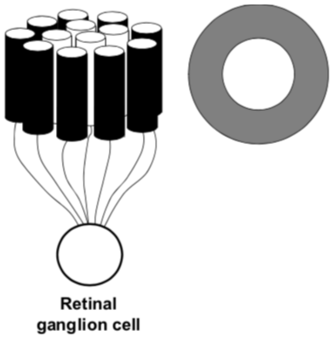
Photoreceptors

Rods and cones. They have a different shape, their distribution is quite different in the back of your eye (retina) the cones are mainly in the centre, they aren't as good at responding to light, but they have higher resolution. They generally connect with other ell types. The rods are the opposite, there aren't as many in the centre, more outward, but they are good at responding to light, but they do not have 1-to-1 connections.

The rods and cones are short, they are sensory cells that don't go far, they don't tell the brain what is happening in the eye.

They do not tell the brain what is going on, information is being contrasted and combined.

Ganglion Cells



They send their axons to the brain.

Here is a ganglion cell that is connected to rods and cones (not directly connected)

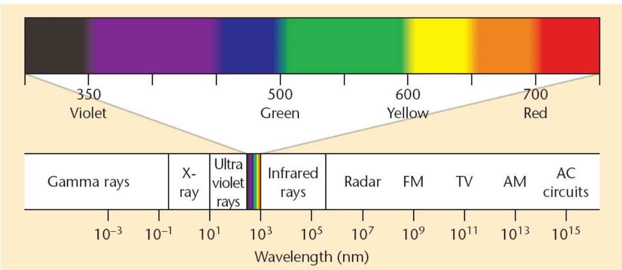
They get their inputs from a whole bunch of rods and cones. There is an area over the retina over which the ganglion is active, its receptive field. That area is complex, it doesn't just collect, it compares and contrasts.

The doughnut shape is the receptive field, if you shine light over the whole area, the ganglion cell wouldn't respond. Because it tells the brain about contrast and shape of the light.

Herman Grid (a 5x5 black square grid)– you see black spots in the intersections of the squares. There is the same amount of light, but it is about the inhibitory areas.

If you have a grey dot and one is on the black background and the other is on the white, the grey colour will look different because of the contrast, it makes comparisons over space.

Cone Photoreceptors and colour vision



The colour scale is a part of the one on the bottom, so humans can only see a tiny portion in the grand scheme of things.

Trichromatic (Young-Helmholtz) theory

Trichromatic (Young-Helmholtz) theory

There are three cone types – one tuned to red, then blue and green but they can discriminate 16 million colours based on the relative activity on the red, blue and green cones.

Opponent-Process (Herring's) Theory

Developed by Ewald Hering, the opponent-process theory states that the cone photoreceptors are linked together to form three opposing colour pairs: blue/yellow, red/green, and black/white. Activation of one member of the pair inhibits activity in the other. Consistent with this theory, no two members of a pair can be seen at the same location, which explains why we don't experience such colours as "bluish yellow" or "reddish green". This theory also helps to explain some types of colour vision deficiency. For example, people with dichromatic deficiencies are able to match a test field using only two primaries. Depending on the deficiency they will confuse either red and green or blue and yellow.

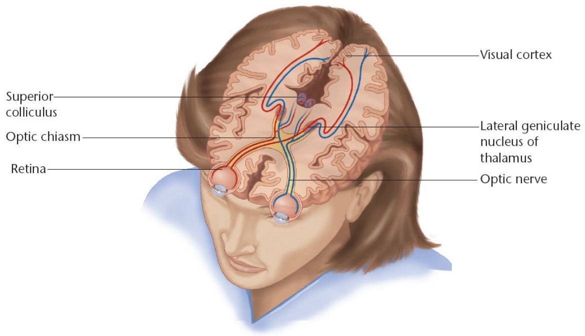
The opponent-process theory explains how we see yellow though there is no yellow cone. It results from the excitatory and inhibitory connections between the three cone types. Specifically, the simultaneous stimulation of red (L cones) and green (M cones) is summed and in turn inhibits B+Y-, which results in the perception of yellow. However, when blue light is present, the S cone is activated, the B+Y- cell receives excitatory input and blue is perceived.

(pink dot going around and you see green that isn't even there)

Constancy

Colour constancy is an example of subjective constancy and a feature of the human colour perception system which ensures that the perceived colour of objects remains relatively constant under varying illumination conditions. A green apple for instance looks green to us at midday, when the main illumination is white sunlight, and also at sunset, when the main illumination is red. This helps us identify objects.

Visual Pathways



Information still needs to go from the eye to the brain

The superior colliculus is about detecting sudden oriental change – a fly buzzing pass, you're alerted.

Most of the information from the eye doesn't go straight to the back/occipital lob here vision is processed, it stops at the **lateral geniculate nucleus.** They have thick axons and are fast processors. They don't care about colour etc. just motion detection.

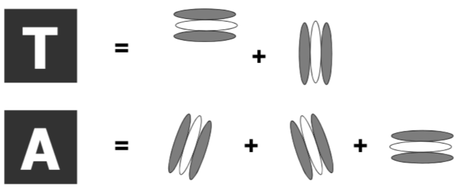
Neurons of Primary Visual Cortex

These are **simple cells**.

These are like the doughnuts before, they are instead elongated, the white area is excitation, the dark areas are inhibition. These are stretched out visual fields. There are receptive fields arranged in a column one on top of another.

It responds to spots of lines/bars/edges. This is the reason you can see light.

Complex cells are harder to depict, as to what types of bar of lights are preferred. These are about motion.



How is this information by simple cells used?
When you show a letter T you get the horizontal and vertical inputs and see something firing at the same time.

These are visual frequencies, as opposed to audio ones.
High frequency at the top, then medium then low.