The Human Eye

Seeing, like all our other senses, appears effortless and direct; but the more we learn about it, the more we appreciate that seeing is anything but a simple process. Over 32 areas of the brain have been shown to take part in the process of vision.

The human eye is a complex organ. Its main function is to transform light into the electrical signals that the brain uses, but also to begin their analysis, and this is why the eye is considered as the beginning of the brain. Another function of the eye is to feed information to the system that coordinates our periods of sleep and wakefulness called *circadian rhythms* as well as the control of other reflexes such as the *pupillary light reflex*. What follows is a brief description of the most important structure of the eye.

Cornea

Starting from the front, we first encounter the ***cornea***, a transparent layer that is better appreciated from the side, as in Figure 1. The cornea is the most powerful lens of the eye which means that light is more bent by it than by any other structure. Figure 2 shows the same structures of the eye as viewed from the front.

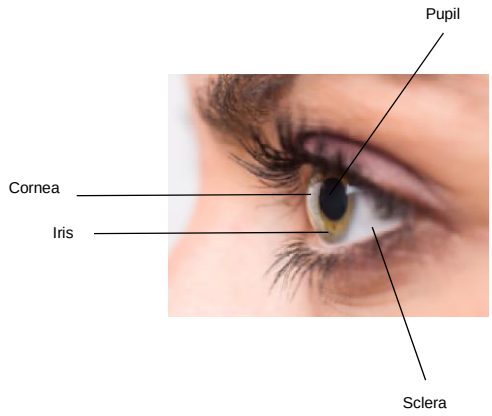

Figure 1. Side view of the eye.

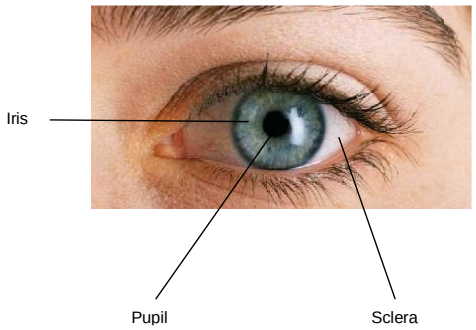

Figure 2. Front view of the eye.

Iris

The ***iris*** is the coloured part of the eye. Its tissue is pleated like the bellows of an accordion with an aperture in the centre called the ***pupil***.

Pupil

The pupil's size changes with the amount of light that enters the eye, like the diaphragm of a camera. A small or contracted pupil protects the rest of the eye in bright light, and a large or dilated pupil allows as much light as possible in darkness. These reflexive responses are known as the *pupillary light reflex*.

Figure 3. Leukocoria in the left eye and "red eye" in the right.

When seen straight ahead, the colour of the pupil is black, but under certain conditions it can also be red. This "red eye" is produced by the camera's flashlight reflecting the colour of the retina and it is easily corrected by most smart phones and electronic cameras. A white pupillary reflex or Leukocoria, on the other hand, is an abnormal white reflection from the retina and is an indication of a serious medical condition such as retinoblastoma. Leukocoria may appear also in low indirect light (Figure 3).

A cross section diagram of the most important structures of the human eye can be seen in Figure 4. Note the location of the optic nerve and two of the six extraocular muscles.

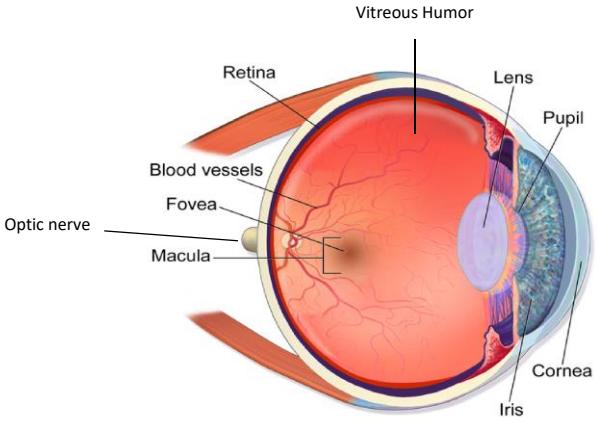

Figure 4. Cross section of the eye.

Lens

After the iris comes the ***lens*** whose shape changes when we focus near or far. The lens helps to focus light on the retina which is the innermost layer at the back of the eye. With age or disease, the lens can become hard and opaque reducing the quality of vision. This "cataract" can be removed by surgery and a new plastic lens inserted in its place.

Vitreous Humor

The ***vitreous humor*** is a transparent, colourless, gelatinous mass that fills the space between the lens and the retina.

Retina

The ***retina*** is the innermost layer of the eye on which the optics create a two-dimensional image of the world (see Figure 5). The retina translates that image into electrical neural impulses that are sent to the brain in order to create visual perception, but the job of the retina is more that that of the film or the image sensor of a camera because visual processing begins here.

There are two kinds of light-sensing cells or photoreceptors in the retina: rods and cones. Rods function mainly in dim light and provide mostly black-and-white vision. Cones function in well-lit conditions and are responsible for the perception of colour, as well as the high-acuity vision we need for tasks such as reading. Cones are tightly packed in the central area of the retina which is called the ***macula*** and in its centre, the ***fovea***, rods are virtually absent. The peripheral area surrounding the macula provides progressively lower resolution information.

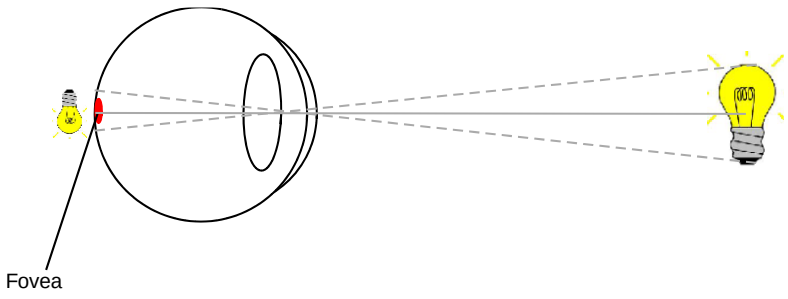

Figure 5. Image of an object on the retina. Note the inversion of the visual target.

A third type of light-sensing cell, the photosensitive ganglion cell, is important for the control of *circadian rhythms* and of reflexes such as the *pupillary light reflex*. The neural signals from the rods and cones are processed by other neurons and converge in retinal ganglion cells whose axons, like a fiber optic cable, form the optic nerve that conducts the visual impulses from the retina to the brain. Approximately half of the nerve fibers in the optic nerve carry information from the fovea, while the remaining half carry information from the periphery of the retina.

Optic Disc

The *optic disc* is the point where the ganglion cell's axons exit the eye. There are no rods or cones in this area which creates a small blind area in each eye. Normally we are not aware of this blind spot because the brain has a mechanism by which the missing information is filled-in with the visual information surrounding it. Various kinds of treatments damage some photoreceptors create blind spots on the retina. Just like at the optic disc, the brain fills-in the missing information. Figure 8 is a demonstration of the normal blind spot.

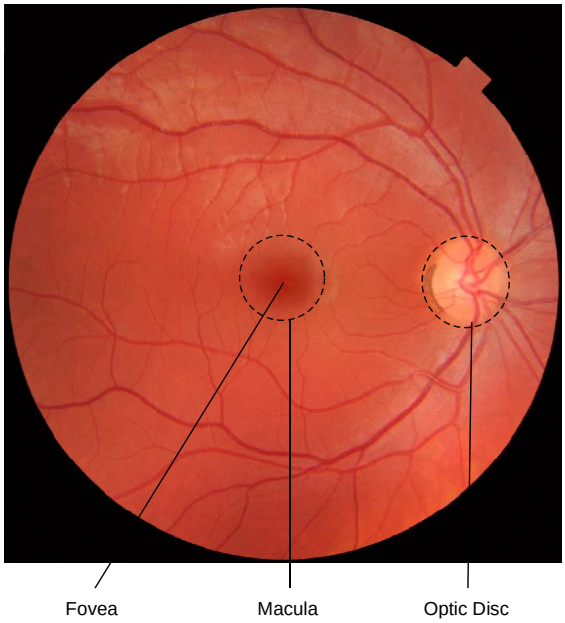

Figure 6. The retina of the right eye as seen straight ahead.

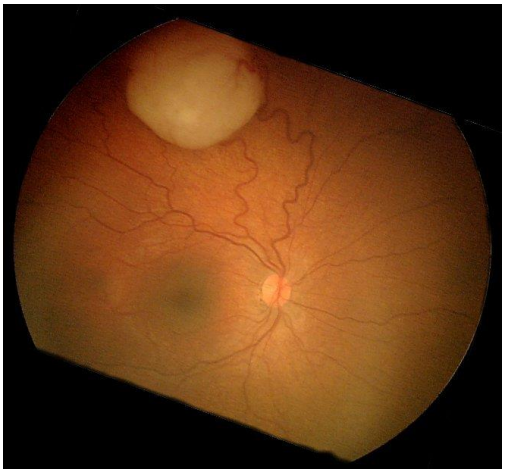

Figure 7. Retina of a right eye with a retinoblastoma tumor in the periphery.

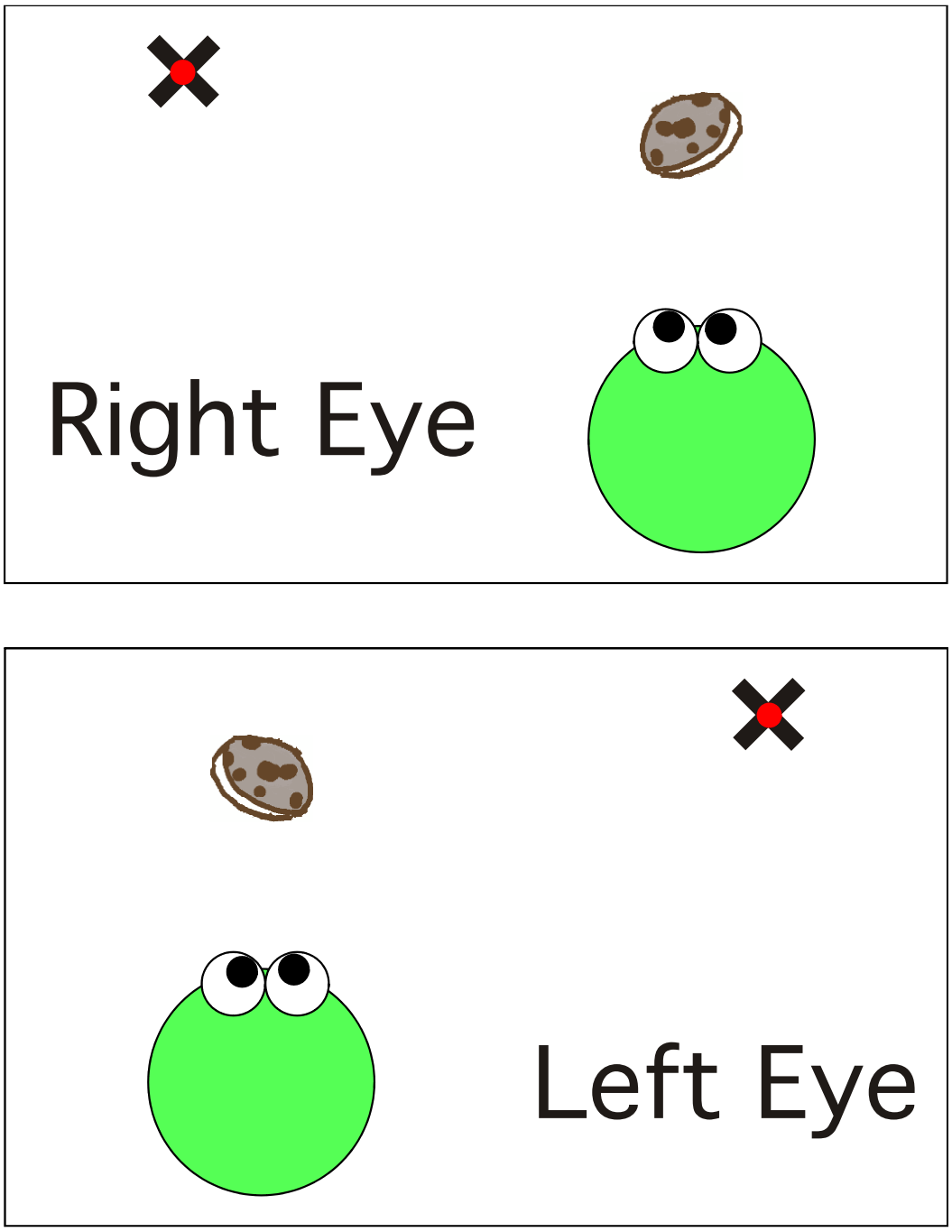

Figure 8. Demonstration of the blind spot.

First, select the panel corresponding to the eye that you will be using, then cover the other with a piece of paper. Look at the panel from a distance of about 20 cm and fixate on the red dot inside the cross. Then slowly move away from the picture and you will notice that the cookie will disappear, and then reappear as you keep moving away. The green character and the name of the eye will not disappear. Moving back and forth makes the cookie disappear when its image falls on you blind spot and reappear when it falls away from the blind spot.

Credits

Figure 1: https://yoursightmatters.com/women-eye-side-view/

Figure 2: https://www.thehealthsite.com/diseases-conditions/top-8-interesting-facts-about-the-human-eye-179180/

Figure 3: Leucokoria: By J Morley-Smith (talk) - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=6463697

Figure 4: Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436., CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=29025015

Figure 6: By Mikael Häggström, used with permission. - Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=18776091

Figure 7: By Tero Kivelä - Meilahti Hospital, Department of Ophthalmology, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=3187806