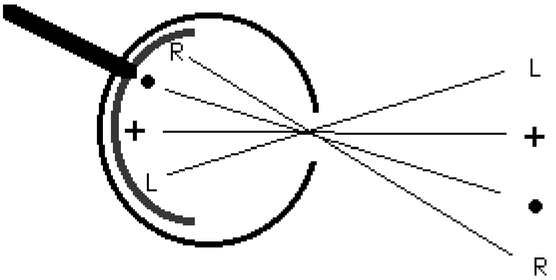
Binocular Vision

NAME ____ DATE ______________________

The blind spot

Most people (even many who work on the brain) assume that what you see is pretty much what your eye sees and reports to your brain. In fact, your brain adds very substantially to the report it gets from your eye, so that a lot of what you see is actually "made up" by the brain.

Some special features of the anatomy of the eyeball make it possible to demonstrate this to yourself. The front of the eye acts like a camera lens, differently directing light rays from each point in space so as to create on the back of the eye a picture of the world. The picture falls on a sheet of photoreceptors (red in the diagram), specialized brain cells (neurons) which are excited by light.



The sheet of photoreceptors is much like a sheet of film at the back of a camera. But it has a hole in it. At one location, called the optic nerve head, processes of neurons collect together and pass as a bundle through the photoreceptor sheet to form the optic nerve (the thick black line extending up and to the left in the diagram), which carries information from the eye to the rest of the brain. At this location, there are no photoreceptors, and hence the brain gets no information from the eye about this particular part of the picture of the world. Because of this, you should have a "blind spot" (actually two, one for each eye), a place pretty much in the middle of what you can see where you can't see.

Look around. Do you see a blind spot anywhere? Maybe the blind spot for one eye is at a different place than the blind spot for the other (this is actually true), so you don't notice it because each eye sees what the other doesn't. **Close one eye and look around again.** Now do you see a blind spot? Hmm. Maybe it’s just a little TINY blind spot, so small that you (and your brain) just ignore it. Nope, it’s actually a pretty BIG blind spot, as you'll see if you look at the diagram below and follow the instructions.

Experiment 1

(a) Close your left eye.

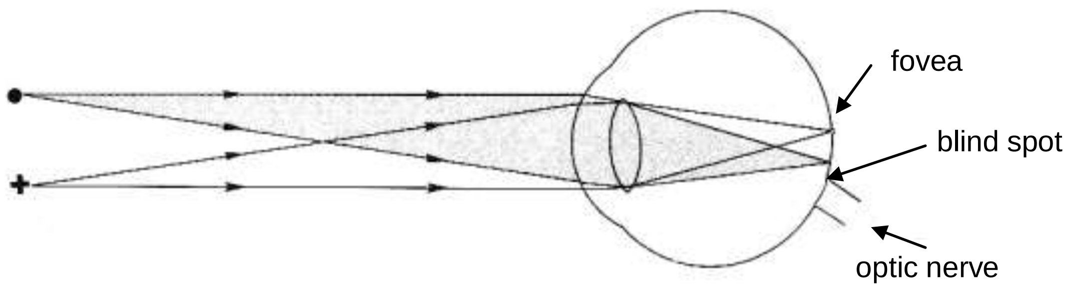
(b) Hold this page about 60 cm away from your face.

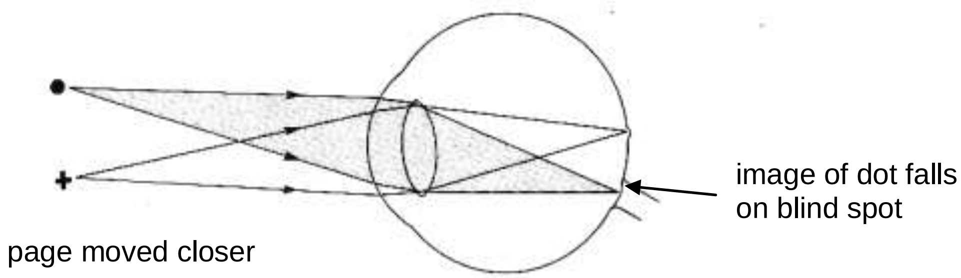
(c) Concentrate on the cross with the right eye and slowly bring the page closer to the face, still concentrating on the cross.

(d) Repeat the experiment with the page held sideways so that the dot is above the cross; and also with the page upside down with the dot on the left of the cross.

(e) Describe what you see in each case and explain it as far as possible.

The act of concentrating attention on the cross throws its image on to the fovea and the image of the dot on to the periphery of the retina to the left of the fovea. As the book approaches the face, the distance between the images of the cross and dot increases until that of the dot falls on the blind spot, whereupon the dot disappears (Figs. 1a and b).
These results can be used to establish the relative positions of the blind spot and fovea since the dot cannot be made to disappear when the experiment is repeated with the dot and cross in other positions.
One is not usually aware of the blind spot because (a) both eyes are used, (b) the eyes make constant scanning movements (c) the gap in the visual field never coincides with the image of the object on which we are concentrating and (d) the brain 'fills in' the gap





Experiment 2

(a) Close the left eye and hold the page at arm's length.

(b) With the right eye, concentrate on the cross and bring the page slowly nearer your face. At first, the short line on the right will disappear because its image falls on the blind spot.

(c) When the short line reappears, the image of the gap will be on the blind spot. Describe what you see at this point.

When the image of the gap falls on the blind spot, the line appears to be continuous. It is as if the brain does not normally recognize the absence of sensory information from the blind spot

So, as you can see, you have a pretty big blind spot, at least as big as the spot in the diagram. What's particularly interesting though is that you don't SEE it. When the spot disappears you still don't SEE a hole. What you see instead is a continuous white field (remember not to LOOK at it; if you do you'll see the spot instead). What you see is something the brain is making up, since the eye isn't actually telling the brain anything at all about that particular part of the picture

Binocular vision: eye dominance

Binocular vision is vision in which both eyes are used together. Having two eyes confers at least four advantages over having one. First, it gives you a spare eye in case one is damaged. Second, it gives a wider field of view. For example, a human has a horizontal field of view of approximately 180 degrees with two eyes but only 150 degrees with one. Third, it gives binocular summation in which the ability to detect faint objects is enhanced. Fourth it can give stereopsis in which parallax provided by the two eyes' different positions on the head give precise depth perception. Such binocular vision is usually accompanied by singleness of vision or binocular fusion, in which a single image is seen despite each eye's having its own image of any object.

Eye dominance is the tendency to prefer visual input from one eye to the other. It is somewhat similar to being right or left handed; however, the side of the dominant eye and the dominant hand do not always match. This is because both hemispheres control both eyes, but each one takes charge of a different half of the field of vision, and therefore a different half of both retinas. There is thus no direct correlation between "handedness" and "eyedness".

Approximately two thirds of the population is right-eye dominant and one third left-eye dominant; however in a small portion of the population neither eye is dominant. Dominance does appear to change depending upon direction of gaze due to image size changes on the retinas.

Experiment 3

(a) Keep both eyes open and hold a pen or pencil upright at arm's length.

(b) Quickly move the pencil to come exactly in line with a more distant vertical object, such as a window frame or lamp-post.

(c) Close and open the left eye.

(d) Close and open the right eye.

(e) Note any change in the apparent position of the pencil and whether it was the closure of the left or right eye which produced it.

(f) Which eye did you use in lining up the two objects?

Although both eyes are kept open to line up the pencil and the distant object, only one eye, the dominant eye, is used to determine the alignment. When this eye is closed, the pencil will appear to 'jump' sideways. It is closure of the dominant eye which produces the jump because, according to the eye now remaining open, the pencil and distant object are not in line. If you are slow to line up the two objects you may be aware of a double image of the near object.

Binocular vision: double vision

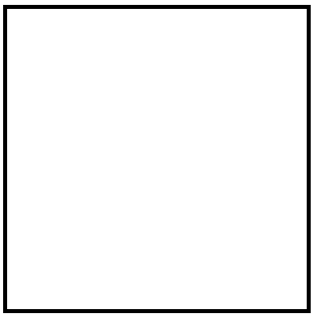
Diplopia or double vision, is the simultaneous perception of two images of a single object. These images may be displaced horizontally, vertically, or diagonally (i.e. both vertically and horizontally) in relation to each other. When a person experiences double vision it means that the visual information that the right eye sends to the retina is not being combined, or fused, adequately with the visual information that the left eye contributes. There are many reasons for someone to have diplopia, including poor control of the eye muscles, convergence insufficiency, convergence excess and an assortment of diseases. Binocular diplopia happens when the eyes don't team together accurately to point to the same location in space at the same exact time

Experiment 4

(a) Keep both eyes open and concentrate on the square drawn below.

(b) Rest a finger lightly against the upper eyelid at the outer corner of your less dominant eye (Experiment 6a) and press very gently.

(c) The two images formed by the eyes cannot now be properly correlated by the brain, and double vision results.



This experiment illustrates the fact that each eye sends a distinct stream of impulses to the brain. The ability of the brain to blend the two images into one impression must depend to some extent on information from the stretch receptors of the external eye muscles, since disturbing the normal alignment of the eyes seems to prevent the 'fusion' of the two images.