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Pupil

Your pupil changes size to control how much light enters your eye.

You can observe that the pupil of your eye changes size in response to changes in lighting. You can also experiment to determine how light shining in one eye affects the size of the pupil in your other eye.



materials

- A magnifying glass (at least 1 inch [2.5 cm] in diameter).
- A mirror (a small, flat, compact mirror, a plastic mirror 4 x 4 inches [10 x 10 cm] or larger, or a wall mirror). Plastic mirrors are safer than glass and are available at plastics stores.
- A flashlight.



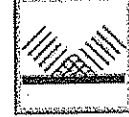
Life Science



Perception



Light



Reflection

assembly

No assembly needed.

to do and notice

(15 minutes or more) Place the magnifying glass on the surface of the mirror. Look into the center of the magnifying glass with one eye. If you wear contact lenses or glasses, you may either leave them on or remove them. Adjust your distance from the mirror until you see a sharply focused and enlarged image of your eye.

Notice the white of your eye, the colored disk of your iris, and your pupil, the black hole in the center of your iris.

Shine a light into the pupil of one eye. If you are using a small mirror, hold the flashlight behind the mirror and shine the light around the edge of the mirror into your eye. If you are using a large mirror, bounce the flashlight beam off the mirror into your eye. Observe how your pupil changes size.

Notice that it takes longer for your pupil to dilate than it does to contract. Notice also that the pupil sometimes overshoots its mark. You can see it shrink down too far, and then reopen slightly.

Observe changes in the size of one pupil while you, or an assistant, shine a light into and away from the other eye.

In a dimly lit room, open and close one eye while observing the pupil of the other eye in the mirror.

what's going on?

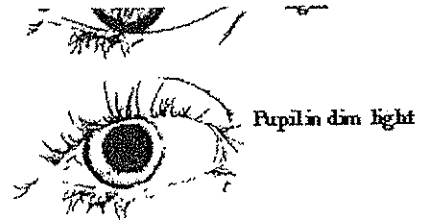
The pupil is an opening that lets light into your eye. Since most of the light entering your eye does not escape, your pupil appears black. In dim light, your pupil expands to allow more light to enter your eye. In



Pupil in bright light

bright light, it contracts. Your pupil can range in diameter from 1.5 millimeters (1/16th of an inch) to more than 8 millimeters (1/3 of an inch).

Light detected by the retina of your eye is converted to nerve impulses that travel down the optic nerve. Some of these nerve impulses go from the optic nerve to the muscles that control the size of the pupil. More light creates more impulses, causing the muscles to close the pupil. Part of the optic nerve from one eye crosses over and couples to the muscles that control the pupil size of the other eye. That's why the pupil of one eye can change when you shine the light into your other eye.



In this experiment, the light reflecting from your eye passes through the magnifying lens twice - once on its way to the mirror and once on its way back. Therefore, the image of your eye is magnified twice by the magnifying glass.

etcetera

The size of your pupils actually reflects the state of your body and mind. Pupil size can change because you are fearful, angry, in pain, in love, or under the influence of drugs. Not only does the pupil react to emotional stimuli; it is itself an emotional stimulus. The size of a person's pupils can give another person a strong impression of sympathy or hostility.

The response of the pupil is an involuntary reflex. Like the kneejerk reflex, the pupillary response is used to test the functions of people who might be ill or injured.

The pupil of your eye is also the source of the red eyes you sometimes see in flash photographs. When the bright light of a camera flash shines directly through the pupil, it can reflect off the red blood of the retina (the light-sensitive lining at the back of your eye), and bounce right back out through the pupil. If this happens, the person in the photograph will appear to have glowing red eyes. To avoid this, photographers move the flash away from the camera lens. With this arrangement, the light from the flash goes through the pupil and illuminates a part of the retina not captured by the camera lens.

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Proprioception

Wiggle where you're at

Even with our eyes closed, we have a sense of body position - where our arms and legs are, for example, and that we are moving them. Muscles, tendons, joints and the inner ear contain proprioceptors, also known as stretch receptors, which relay positional information to our brains. Our brains then analyze this information and provide us with a sense of body orientation and movement.

materials

- Paper with lines
- Pencil

assembly

No assembly needed.

to do and notice

Activity one: Finding Fingertips

Close your eyes and raise both hands above your head. Keep the fingers of your left hand totally still (no wiggling!). With your right hand, quickly touch your index fingertip to your nose, then quickly touch the tip of your thumb of your left hand with the tip of your right index finger. Quickly repeat the entire process while attempting to touch each fingertip (always return to your nose in between fingertip attempts).

Switch hands and try again.

How successfully do you find each fingertip? Do you improve with time? Is there a difference when the different hands are used?

Activity Two: "X" marks the spot

Mark an "X" on a piece of paper. Pencil in hand, raise your hand above your head, close your eyes and make a dot as near as possible to the X. Open your eyes and check your success. Raise your hand above your head, close your eyes, and attempt to make a dot closer to the X. Do this several times. Repeat with your eyes open.

Handwriting analysis

On a lined sheet of paper, write the word "proprioception" or some other vocabulary word of the day. Place your pencil on the same line next to the written word, close your eyes, and write "proprioception" again. Is



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there a difference in the appearance of the two written words?

what's going on? _____

You are using proprioceptors in your muscles, tendons and joints to judge your body positions in all of these activities. Since most of us are highly dependent on visual cues for judging distance, position, etc. proprioception alone is not enough to give us the fine detail of position, such as needed to complete these activities accurately. Wiggling your fingers in the first activity provides additional information to your brain which helps us correctly locate our fingers in space.

You may notice that with repeated trials one can learn to complete the activities more successfully, and visual cues, such as looking at the position of the X between trials, help us to adjust our movements to complete the task. Most people find that vision is not an important cue in reproducing written words, because we are used to the "feel" of writing provided by proprioceptors in our hands and fingers.

etcetera _____

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Blind Spot

To see, or not to see

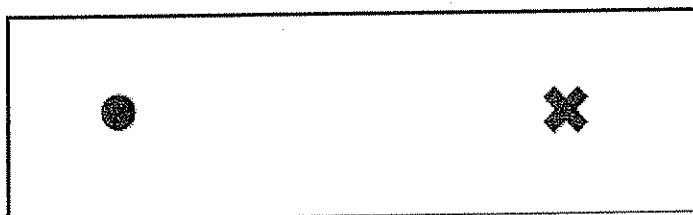
The eye's retina receives and reacts to incoming light and sends signals to the brain, allowing you to see. There is, however, a part of the retina that doesn't give you visual information. This is your eye's blind spot.

materials _____

- One 3 X 5 inch (8 x 13 cm) card or other stiff paper
- A meterstick

assembly _____

(5 minutes or less) Mark a dot and a cross on a card as shown.



to do and notice _____

(5 minutes or more)

Hold the card at eye level about an arm's length away. Make sure that the cross is on the right.

Close your right eye and look directly at the cross with your left eye. Notice that you can also see the dot. Focus on the cross but be aware of the dot as you slowly bring the card toward your face. The dot will disappear, and then reappear, as you bring the card toward your face.

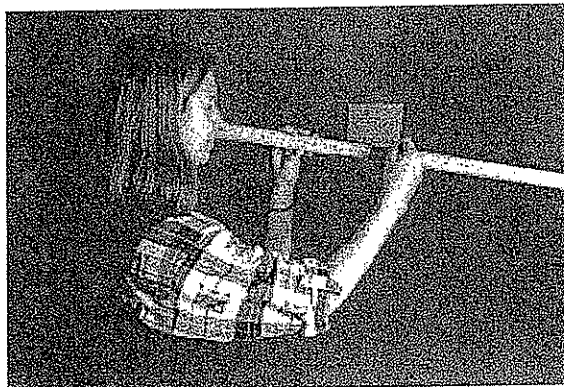
Now close your left eye and look directly at the dot with your right eye. This time the cross will disappear and reappear as you bring the card slowly toward your face.

Try the activity again, this time rotating the card so that the dot and cross are not directly across from each other. Are the results the same?

what's going on? _____

The optic nerve carries messages from your eye to your brain. This bundle of nerve fibers passes through one spot on the light sensitive lining, or retina, of your eye. In this spot, your eye's retina has no light receptors. When you hold the card so that the light from the dot falls on this spot, you cannot see the dot.

As a variation on this blind spot activity, draw a straight line across the card, from one edge to the other, through the center of the cross and the dot. Notice that when the dot disappears, the line appears to be continuous, without a gap where the dot used to be. Your brain automatically "fills in" the blind spot with a simple extrapolation of the image surrounding the blind spot. This is why you do not notice the blind spot in your day-to-day observations of the world.



etcetera _____

Using a simple model for the eye, you can find the approximate size of the blind spot on the retina.

Mark a cross on the left edge of a 3 x 5 inch (8 x 13 cm) card. Hold the card 9.75 inches (25 cm) from your eye. (You will need to measure this distance; your distance from the card is important in determining the size of your blind spot.)

Close your left eye and look directly at the cross with your right eye. Move a pen on the card until the point of the pen disappears in your blind spot. Mark the places where the penpoint disappears. Use the pen to trace the shape and size of your blind spot on the card. Measure the diameter of the blind spot on the card.

In our simple model, we are assuming that the eye behaves like a pinhole camera, with the pupil as the pinhole. In such a model, the pupil is 0.78 inches (2 cm) from the retina. Light travels in a straight line through the pupil to the retina. Similar triangles can then be used to calculate the size of the blind spot on your retina. The simple equation for this calculation is $s/2 = d/D$, where s is the diameter of the blind spot on your retina, d is the size of the blind spot on the card, and D is the distance from your eye to the card (in this case, 9.75 inches [25 cm]).

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