



Experiments in Human Vision

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Topic

Limitations of human vision



Time

2 hours



Safety

Please click on the safety icon to view the safety precautions. Do not expose your eyes to excessively bright light or allow sharp objects to touch your eyes.

Materials

strip of paper 14 in. 2 1 in.	white paper, 8½ in. 2 11 in.
ruler	Ping-Pong™ ball
tape measure	bright red, yellow, and blue paint
black construction paper, 8½ in. 2 11 in.	small object (a stuffed animal, for example) or picture
scissors	marker pens
three 5-cm 2 5-cm paper squares	
pencil	

Procedure

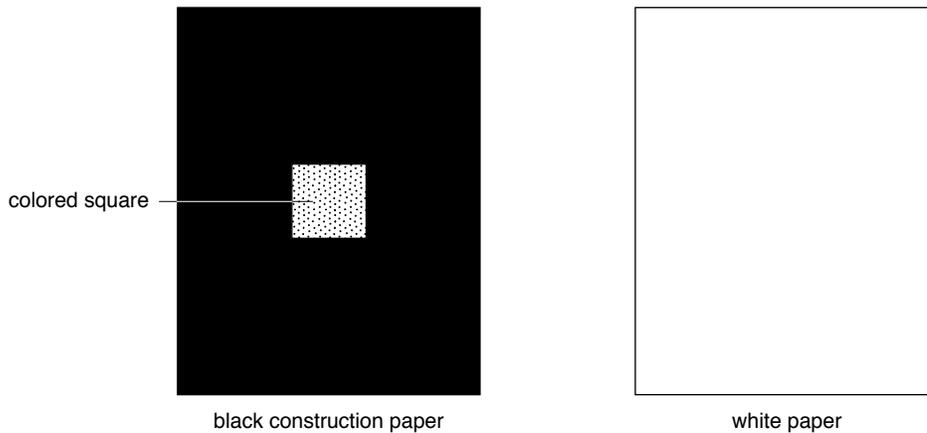
A test group of 20 people is necessary to perform Parts B to D of this experiment. The group should be mixed in age, sex, and right- and left-handedness. Make sure that all subjects are tested privately, one at a time.

PART A: RETINAL AFTERIMAGE

Chemicals produced in the cone cells of the retina cause us to perceive colors. The different wavelengths (colors) of light stimulate the cells to produce different chemicals.

1. Using paint or magic marker, color each of the 5-cm 2 5-cm squares a different color.
2. Place the black construction paper on a table with the white sheet of paper 10 cm or more away.
3. Place one of the colored squares in the center of the black paper (see figure 1).
4. Stare at the colored square for 30 sec, and then immediately look at the white paper. Observe what happens.

Figure 1



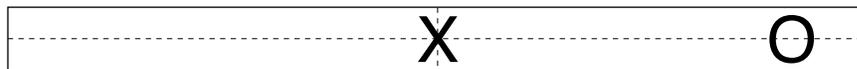
- Repeat steps 3 and 4 with the other colored squares.

PART B: TESTING FOR THE BLIND SPOT

The point where the *retina* meets the *optic nerve* is not covered with any of the visual receptors called *rods* and *cones*. The following procedure will show what effect this has on sight.

- Cut a strip of paper 14 in. \times 2 in. Find the center of the length and draw an X at this point on the paper strip.
- Measure 5 in. to the right of the X on the paper, and draw a circle there, as shown in figure 2.

Figure 2



- Have the first subject hold the strip at arm's length in her or his right hand, with the X in front of, or over to the right of, his or her right eye.
- Have the subject stare at the X with the right eye while the left eye is shut.
- Tell the subject to slowly move the strip toward her or his face and to stop when the circle disappears. If the circle does not disappear the first time, repeat this step slowly until it does.
- While the subject holds the strip, use the tape measure to measure the distance from his or her eye to the strip. Enter this distance on the data table.
- Continue through Parts C and D before testing another subject.
- Test yourself.

PART C: FINDING THE DOMINANT EYE

Each eye presents the brain with a different image and a different portion of the visual stimulus being observed. This information is then combined by the brain into the single consistent image we perceive. One eye is usually stronger than the other and provides more information.

- Place an object at one end of the room approximately 9 m from where the subject will stand.

2. Ask the subject to look at the object with both eyes and to point to it with one finger.
3. Ask the subject to close the left eye and observe the spatial relationship of the finger to the object. Make sure that the subject does not move her or his hand or eyes.
4. Instruct the subject to open the left eye and close the right. Again, observe the finger relative to the object.
5. Ask which eye showed the finger pointing at the object. This is the subject's dominant eye. Record this information on the data table.
6. Find out if the subject is left- or right-handed and record this information on the data table.
7. Test yourself.

PART D: DEPTH PERCEPTION

1. Stand 2 to 3 m from your subject. Have your subject keep both eyes open.

DATA TABLE						
Trial	Distance of blind spot (cm)	Left- or right-handed	Dominant eye	No. of successful catches with both eyes open	No. of successful catches with left eye open	No. of successful catches with right eye open
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

2. Toss a Ping-Pong™ ball back and forth 20 times. Record the number of successful catches.
3. Have your subject close his or her dominant eye, and toss the ball to the subject 10 more times. Record the number of successful catches.
4. Repeat 10 tosses, this time with the subject's dominant eye open and the other eye closed. Record the number of successful catches.
5. Have one of your subjects toss the ball to you for 10 tosses as you close one eye, and then close the other eye for 10 more tosses.

A: RETINAL AFTERIMAGE

6. What happened when you looked at the white paper after 30 sec of staring at each colored square?
7. Can you think of a time when you have had this afterimage experience before?

B: TESTING FOR THE BLIND SPOT

8. What was the average measure of your subjects' blind spots?
9. Explain why the blind spot occurs.
10. Why are we not constantly aware of our blind spot?

C: FINDING THE DOMINANT EYE

11. Which eye appeared most as the dominant eye? What were your totals?
12. Did you find any correlation between the dominant eye and handedness?

D: DEPTH PERCEPTION

13. Were there more successful catches with both eyes open or with one eye closed?
14. When testing subjects with one eye closed, was there any difference between the results with the dominant eye open and when the dominant eye was closed?
15. What difference does closing one eye make? Explain.

What's Going On**A: RETINAL AFTERIMAGE**

When you look at the colored square, the cones in the retina of your eye are stimulated to produce a chemical that corresponds to that color. When you look at the white paper, you see an afterimage, which is usually of the complimentary color of the color at which you were staring. What you are actually seeing are the stimulated cones and the residue of chemical. After you glance at the sun and then turn away, you may have noticed that you see its image. The brighter the object or color causing the afterimage, the more of the requisite chemical produced and the longer the afterimage.

B: TESTING FOR THE BLIND SPOT

Results will vary. We found an average measurement around 45 cm. This is based on a range of 30 to 53 cm. There is a point in the eye where the blood vessels and optic nerve meet the retina. At this point, there are no rods or cones, and therefore no visual reception. Because we have stereoscopic vision (as a result of both eyes covering much of the same field of vision), each eye can cover the blind spot of the other eye. We become aware of our blind spot only when things are on one side or the other, so that one eye must work alone. Also, the blind spot is not at the point of strongest vision, where most images are received.

C: FINDING THE DOMINANT EYE

In our sample, the right eye seemed to be dominant in more people than the left. Results will vary. There is no clear correlation to handedness, although more people are right-handed as well as right-eye dominant.

D: DEPTH PERCEPTION

People are much more successful with both eyes open than with either eye closed. Results will vary. Many people tend to catch more balls with the weak eye closed and the dominant eye open. This is because the dominant eye covers a larger field than the weaker eye and provides more spatial information. When one eye is closed,

we lose the ability to perceive depth. Both eyes receive a flow of information that gives a more three-dimensional picture than one eye alone.

Connections

In this experiment, you tested some of the limits and strengths of human vision by sampling a group of people. Vision is the sense that enables animals to receive and interpret light stimuli allowing the recognition of shapes, colors, distance, and shadow. The *retina* is the part of the eye responsible for the conversion of light into nerve impulses, which travel to the brain. The eye is actually like a camera. The smooth muscles of the iris open and close the pupil so that light enters through the lens to the retina. The retina contains a series of rods and cones, which are responsive to light and dark, and to color, respectively. The coordination of information from both eyes is necessary for *depth perception*.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say “be careful with hot liquids” or “don’t cut yourself with the knife” does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don’t use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES