

Bird in the Cage

Stare at color and see it change.

You see color when receptor cells (called cones) on your eye's retina are stimulated by light. There are three types of cones, each sensitive to a particular color range. If one or more of the three types of cones becomes fatigued to the point where it responds less strongly than it normally would, the color you perceive from a given object will change.

materials

- 4 white posterboards or pieces of paper
- Bright red, green, and blue construction or contact paper
- Small piece of black construction or contact paper, or black marking pen
- Scissors
- Glue or glue stick (if you are using construction paper)
- Adult help

assembly

(30 minutes or less)

Cut the same simple shape, such a bird or a fish, from each of the three colored papers. Glue each shape on its own white board. Leave one white board blank. Cut a small black eye for each bird or fish or draw one in with the marking pen. If you choose a bird as the shape, draw the outline of a birdcage on the blank board; if you choose a fish, draw a fishbowl, etc. (Be creative!)

to do and notice

(15 minutes or more)

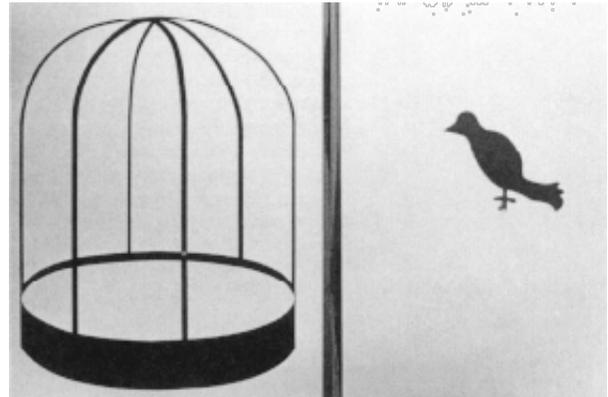
Place the boards in a well-lit area. (Bright lighting is a significant factor in making this Snack work well.)

Stare at the eye of the red bird for 15 to 20 seconds and then quickly stare at the birdcage. You should see a bluish-green (cyan) bird in the cage. Now repeat the process, staring at the green bird. You should see a reddish-blue (magenta) bird in the cage. Finally, stare at the blue bird. You should see a yellow bird in the cage. (If you used a fish, try the same procedure with the fish and the bowl.)

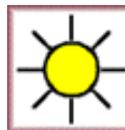
what's going on?

The ghostly fishes and birds that you see here are called afterimages. An afterimage is an image that stays with you even after you have stopped looking at the object.

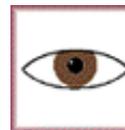
The back of your eye is lined with light-sensitive cells called rods and cones. Cones are sensitive to colored light, and each of the three types of cones is sensitive to a particular range of color.



Color



Light



Perception



Reflection

When you stare at the red bird, the image falls on one region of your retina. The red-sensitive cells in that region start to grow tired and stop responding strongly to red light. The white board reflects red, blue, and green light to your eyes (since white light is made up of all these colors). When you suddenly shift your gaze to the blank white board, the fatigued red-sensitive cells don't respond to the reflected red light, but the blue-sensitive and green-sensitive cones respond strongly to the reflected blue and green light. As a result, where the red-sensitive cells don't respond you see a bluish-green bird. This bluish-green color is called cyan.

When you stare at the green bird, your green-sensitive cones become fatigued. Then, when you look at the white board, your eyes respond only to the reflected red and blue light, and you see a red-blue, or magenta, bird. Similarly, when you stare at a blue object, the blue-sensitive cones become fatigued, and the reflected red and green light combine to form yellow.

etcetera

You can design other objects with different colored paper and predict the results. Try a blue banana! For smaller versions, you can use brightly colored stickers (from stationery, card, or gift stores) on index cards.

One classic variation of this experiment uses an afterimage to make the American flag. Draw a flag, but substitute alternating green and black stripes for the familiar red and white stripes, and black stars on a yellow field for the white stars on a blue field. For simplicity, you can idealize the flag with a few thick stripes and a few large stars. When you stare at the flag and then stare at a blank white background, the flag's afterimage will appear in the correct colors.

You may also want to experiment with changing the distance between your eyes and the completely white board while you are observing the afterimage. Notice that the perceived size of the image changes, even though the size of the fatigued region on your retina remains the same. The perceived size of an image depends on both the size of the image on your retina and the perceived distance to the object.