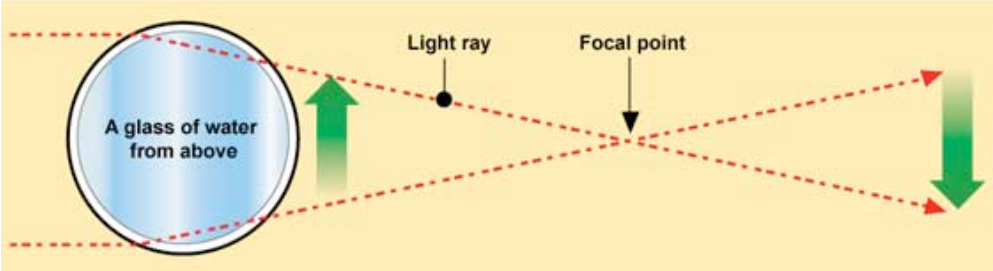
The Reversing Arrow

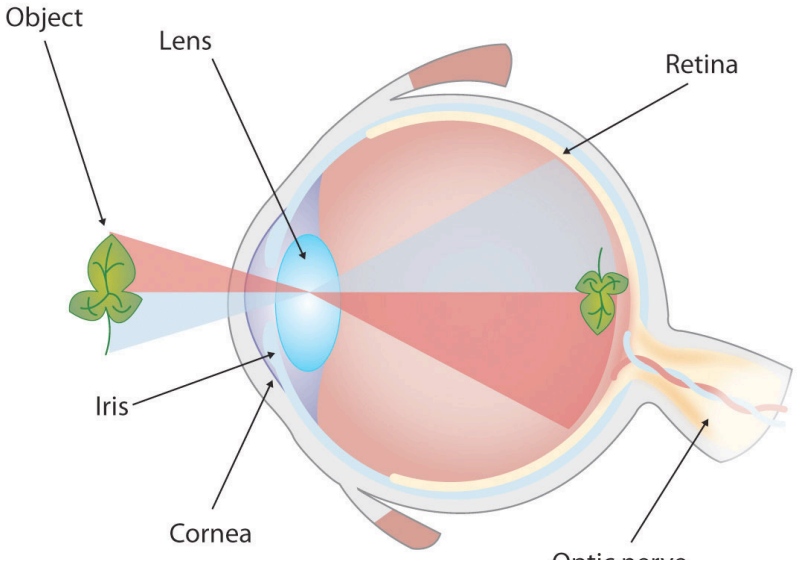
What's Happening?

The arrow reverses when you put it behind a glass full of water at a certain distance. This is called refraction, the bending of light. Anytime that light passes from one medium, or material, into another, it refracts. BUT: Just because light bends when it travels through different materials, doesn't explain why the arrow reverses itself. To explain this, you must think about the glass of water as if it is a magnifying glass. When light goes through a magnifying glass the light bends toward the center. Where the light all comes together is called **the focal point**, but beyond the focal point the image appears to reverse because the light rays that were bent pass each other and the light that was on the right side is now on the left and the left on the right, which makes the arrow appear to be reversed.



How Your Eyes Work: Upside Down Vision:

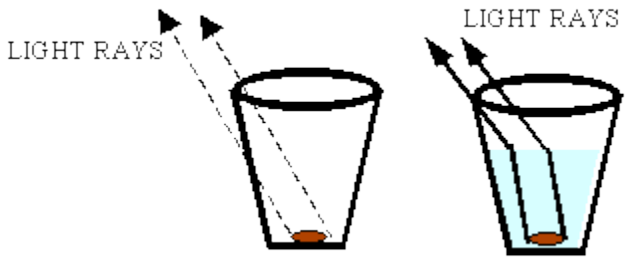
The images formed on your retina are upside-down but your brain is so USED to seeing things upside-down that it eventually adjusts to it. For the first few days of life babies see everything upside-down! But after awhile the brain adjusts!



The Vanishing Coin

What's Happening?

The trick behind the Vanishing Coin experiment is the refraction of light. Images that we see are all light rays that reach our eyes. When these light rays travel through air, they experience little or no refraction. That's why you can still see the penny through the side of the empty glass. BUT when there is water in the glass, it was as though the penny had disappeared, but it was really just some bending light rays. After traveling through the water and the side of the glass, none of the rays were able to reach your eyes. Refraction occurs because of the molecules in the substance that the light rays are passing through. Gas molecules are spread out. This is why little to no refraction occurs. However, when light rays pass through a substance such as water, the refraction is greater because the molecules are closer together. You would be able to see it if the saucer was not on top the glass.

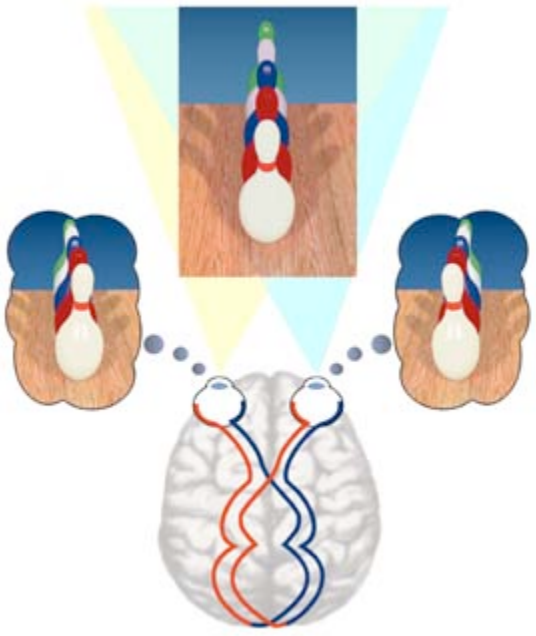


Putting a Hole in Your Hand

What's happening?

Normally, both of your eyes see the same thing, just from slightly different angles. Your brain combines these two slightly different views to let you see in three dimensions and judge distances. We have changed that. We are giving your brain two different images. One eye is seeing the palm of your left hand. The other eye is seeing the other side of the room, viewed through the tube. In combining the two images, your brain has to decide what is more important to see. Most of the view from your right eye is blocked by the sides of the tube, so you mostly see the view from your left eye. The one exception is the bright circle of image that your right eye sees through the tube. Since this is the one bright spot from your right eye, your brain pays extra attention to it. As your brain combines the two images, you wind up seeing your hand with a hole through it!

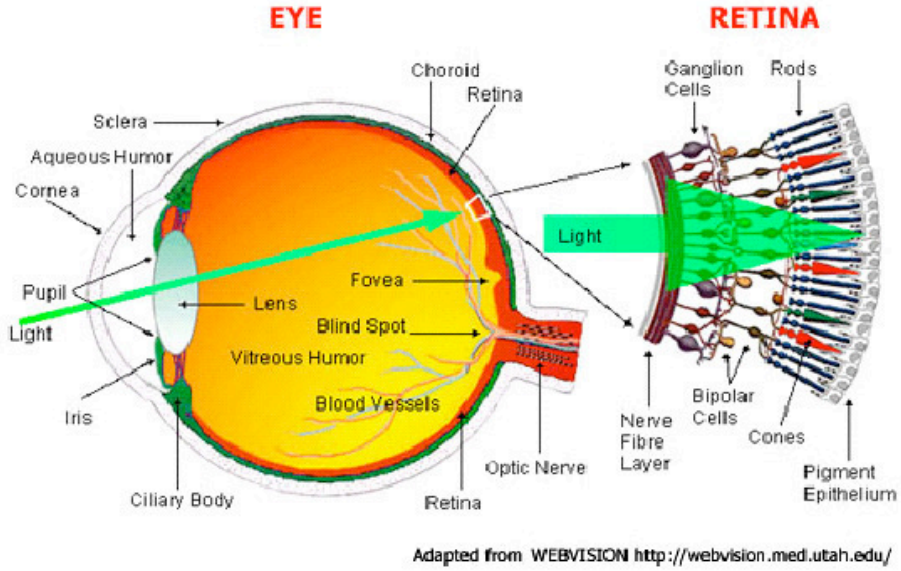
How Your Eyes Work:
Two Eyes = Three Dimensions (3D)!
Each eye captures its own view and the two separate images are sent on to the brain for processing. When the two images arrive simultaneously in the back of the brain, they are united into one picture. The mind combines the two images by matching up the similarities and adding in the small differences. The small differences between the two images add up to a big difference in the final picture! The combined image is more than the sum of its parts. It is a three-dimensional *stereo* picture.



Put the Fish in the Bowl

What's Happening?

In the retina of your eyes, there are three types of color receptors (cones) that are most sensitive to either red, blue or green. When you stare at a particular color for too long, these receptors get "tired". When you then look at the white background, the receptors that are tired do not work as well. Therefore, the information from all of the different color receptors is not in balance and you see the color "afterimages." You can see that you vision quickly returns to normal.

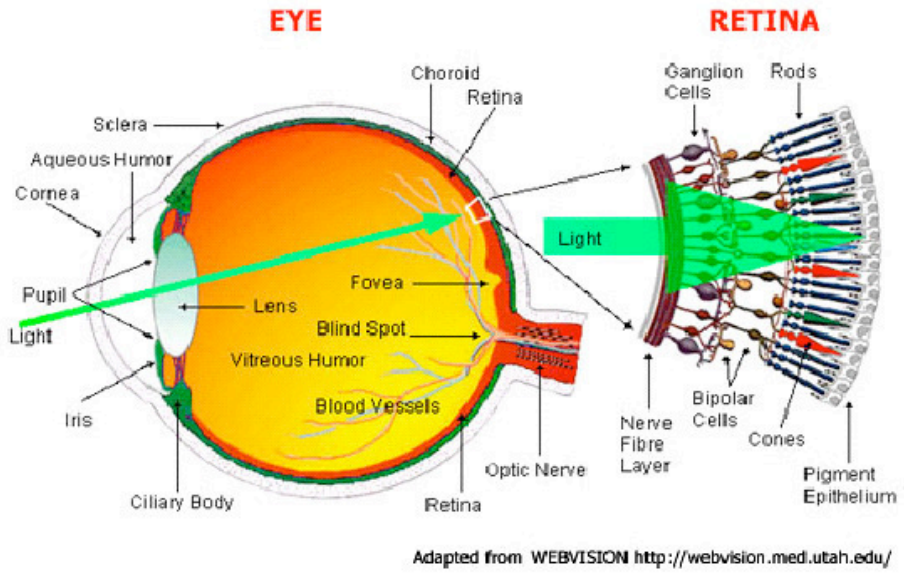


Rods and Cones: Cones are sensitive to color and are good for seeing in bright light. Rods are more sensitive to light and are good for seeing in low light but not colors. There are more rods than cones in our eyes.

Make Colors from Black and White: Benham's Disk

What's Happening? What Causes the Colors?

The retina of the eye is composed of two types of receptors sensitive to light: cones and rods. Cones are important for color vision and for seeing in bright light. There are three types of cones, each of which is most sensitive to a particular wavelength of light. Rods are important for seeing in low light. We are not sure why we see colors in the spinning disk but one theory is that different types of cones take different times to respond and that they stay activated for different amounts of time. Therefore, when you spin the disk, the white color activates all three types of cones, but then the black deactivates them. The activation/deactivation sequence causes an imbalance because the different types of cones take different times to respond and stay on for different times. This imbalance in information going to the brain results in colors. However the full reason behind the illusion remains unsolved! Maybe you can make an experiment that will one day explain it!



Rods and Cones: Cones are sensitive to color and are good for seeing in bright light. Rods are more sensitive to light and are good for seeing in low light but not colors. There are more rods than cones in our eyes.

Problem 1:

Reverse the Arrow

Change the arrow's direction without redrawing it!

Can you arrange the glass and the card in a way that changes the direction of the arrow?

Why does this happen?

Write it down on the blank paper.

Give it to a teacher to exchange it to get the answer to see if you were right!

Problem 2:

The Vanishing Coin

Can you arrange the glass, the saucer and the coin in a way that makes the coin look like it disappears?

Why does this happen?

Write it down on the blank paper.

Give it to a teacher to exchange it to get the answer to see if you were right!

Problem 3:

Put A Hole in Your Hand!

Can you arrange the paper in a way that you see a hole in your hand?

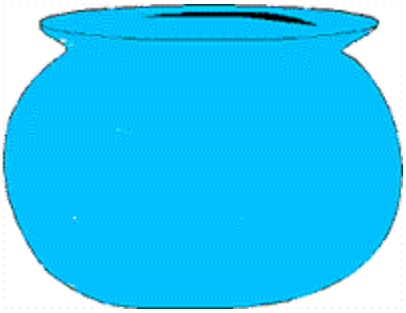
Why does this happen?

Write it down on the blank paper.

Give it to a teacher to exchange it to get the answer to see if you were right!

Problem 4:

Put the Fish in the Fishbowl



Can you put the fish in the fish bowl without moving it or cutting it out?

Why does this happen?

Write it down on the blank paper.

Give it to a teacher to exchange it to get the answer to see if you were right!

Problem 5:

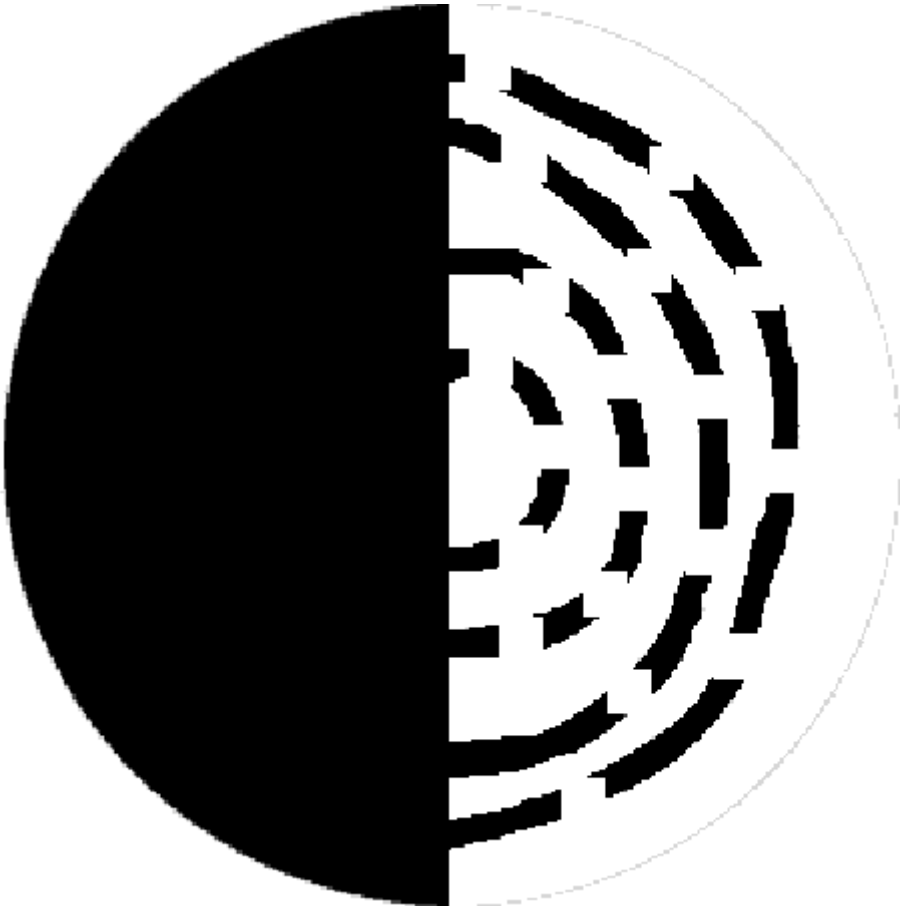
Make Colors from Black and White: Benham's Disk

Can you do something to the black and white disk to make it look like it has colors?

Why does this happen?

Write it down on the blank paper.

Give it to a teacher to exchange it to get the answer to see if you were right!



What Do You Think about Vision & Light?

Circle Yes or No:

1) We see equally with both eyes.
Yes.
No, our vision overlaps and partially cancels out.

2) We see through something like a camera lens in our eyes.
Yes.
No, we see through a little black empty hole in the center of our eyes.

3) We see things exactly as they are in front of us.
Yes.
No, the image is upside down at the back of our eyes and that image goes to our brain.

4) Light moves in straight lines everywhere, in air, water or other materials.
Yes.
No, it bends and scatters like a wave.

5) Light comes from our eyes to see the object.
Yes.
No, light bounces off the object and into our eyes to see.

6) There are little sensors in the back of our eyes that are sensitive to only three colors.
Yes.
No, we see all the colors of the rainbow directly in our eyes.