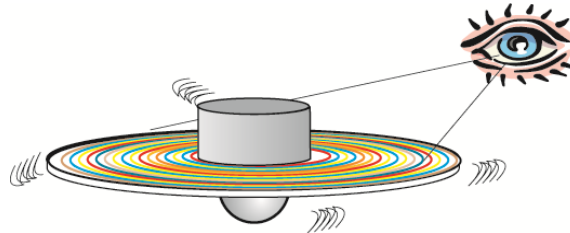


Black & White Makes Color?

The Mystery of Benham's Disc!



Spin a CD with a Benham's Disc pattern on top and observe an interesting optical effect. The black and white pattern on the disk creates a mysterious illusion of color! This illusion provides valuable insights into how our eyes and brain perceive color.

Curriculum topics

- Vision
- Color
- Light
- Perception/Senses

Subjects

- Life Science
- Physical Science

Grade range: 3 – 12

Serves: Each kit can be used by 1-4 students at a time, individually or in small group collaboration depending on the intended outcomes.

Who we are: Resource Area for Teaching (RAFT) helps educators transform the learning experience by inspiring joy through hands-on learning.



Share Your feedback!

<http://bit.ly/RAFTkitsurvey>

Materials

Materials in the kit may vary but generally, this kit contains the following:

- CD
- Foam cylinder w/ self-adhesive
- Marble
- Benham's Disc pattern

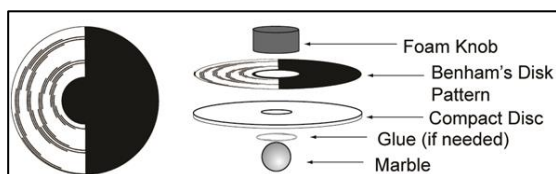
Facilitation

Students are often fascinated to learn that the perception of color is a light-based phenomenon, and they may already know a little about it. What is not always obvious to students is how our brain plays a role in what we see, especially in terms of perceiving colors. This activity provides a great way to discuss and demonstrate how we “see” objects with our brains based on light received by sensory receptors in the eyes.

A few suggestions for getting started:

- **Think-Pair-Share:** Have students think about how their eyes work (1 min). Let them pair up and discuss their ideas (2-3 min). Call on student pairs to share their thinking with the whole group.
- Let students explore this Wonderopolis article (<https://bit.ly/3BvecXy>) on how our eyes work (individual, team, or whole group). Have students record their ideas in a science notebook/STEAM journal.

Provide time for students to explore and ask questions about the materials in this kit. Below is an image that can be used to highlight the function of each material and help student visualize the assembly steps listed below in the **To Do and Notice** section below.



To Do and Notice

- 1** Place the marble on a flat surface. Position the center hole of the CD over the marble with the Benham's Disk pattern facing up.
- 2** Peel off the backing paper from the self-adhesive foam knob while squeezing the sides of the foam between your thumb and index finger. Press the foam knob, with adhesive side down, firmly over the center of the CD, securely connecting to the exposed marble and the CD surface.
- 3** Spin the Benham's Disk and carefully observe the pattern. Look for narrow arcs of color at different distances from the center of the circle. Different people may see different colors, and some people will not notice any effect (this is normal). Do the colors observed change as the disk slows down? Reverse the direction of the spinning and see what happens!
- 4** Record your observations in a science/STEAM notebook. What claims can you make about how we perceive color based on your observations? What is your evidence?
- 5** **Share** student learning with RAFT! Submit photos/video via email at education@raft.net or on social media ([Facebook](#), [Twitter](#), [Instagram](#)).

Core Content Skills:

Science & Engineering (NGSS)

Using Models to Test Interactions Concerning the Functioning of Natural Systems, Information Processing – Senses, Engaging in Argument from Evidence, Structure and Function

Social Emotional Learning

- Self-awareness
- Self-management
- Responsible decision-making

The Content Behind the Activity

Color sensing nerves, called **cones**, are located on the retina in the back of the eye. Cones come in 3 types: red-sensitive, green-sensitive, and blue-sensitive.

White light is a mix of all the colors in the visible spectrum. White light causes all three cones to fire, and our brain tells us we are seeing white. Black is the absence of color. Black causes no cones to fire, and our brain tells us we are seeing black.

It takes a small amount of time for each cone to fire. This is called “latency.” After a cone fires, it takes a brief time to shut off even after the color is removed. This is known as “persistence.” Each of the different types of cones (red, green, and blue) may have a slightly different latency and persistence.

Notice the pattern of curved black and white lines on the Benham’s Disk. Recall that white causes all 3 cones to fire, and black causes them to turn off. As you watch the pattern spin, each transition from black to white should trigger all 3 cones to fire at the same time. However, as the different cones turn on and off rapidly, their different **latency** and persistence responses cause them to get “out of sync.” So, instead of firing together when your eye sees a transition from black to white, the cones may fire at different times. As a result, your brain interprets the information as color!

Interestingly, scientists cannot explain why only certain patterns generate the effect. Random black and white patterns do not tend to produce the illusion of color. Somehow, the length of the arcs of black and their locations around the disk are important – but the details continue to elude explanation.

Reuse

This kit uses 100% reusable materials designed for other uses. To continue making a positive impact in reducing waste, reuse these materials in other projects. Additionally, any unused materials can be collected and delivered back to RAFT.

Feedback

Please comment on this kit by taking this short survey: <http://bit.ly/RAFTkitsurvey>. Let us know of any material concerns such as missing, broken, or poorly fitting parts as well as improvements or other suggestions.

Visit <https://raft.net> to view related activities!

The Colors of Light
Colors in the Mind
Eye See It!
The Light Color Wheel
Kaleidoscope Explorations

Resources

- Color blindness simulator - <https://bit.ly/31cMlcl>
- RAFT Benham’s Disk assembly video - <https://bit.ly/3BN6J6x>