CD Spinner

No audio, but lots of visual.

Rotating patterns can fool the human visual system and create interesting illusions. In this snack, you create a simple "top" from a CD, marble and bottle cap, and use it as a spinning platform for a variety of illusion-generating patterns.

Materials

- CD
- marble
- plastic cap from soda or water bottle **AND / OR** golf tee
- hot glue gun and hot glue sticks
- scissors

NOTE: For the Benham's disk, the central part of the spinner is not essential to the effect, and the cap and tee work equally well. For the Spiral, the central part of the pattern is important, and the tee works better, since less of the central part of the pattern needs to be cut out to get it onto the CD.

Assembly

1. Hot glue the marble into the hole on one side of the CD. See Figure 1.
2. (a) Center a plastic cap on the other side of the CD and hot-glue it in place. See Figure 2.

   AND / OR

   (b) Center a golf tee on the marble on the other side of the CD and hot-glue it into place. See Figure 3.
3. Make a photocopy of the Benham's Disk in Figure 4 and the Spiral in Figure 5 (or use the originals if you wish). For each pattern, cut out the disk, and then cut out a center hole large enough to fit over either the bottle cap or the golf tee (see note above in Materials section).

Figure 1

Figure 2

Figure 3

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To Do and Notice

Place the Benham's Disk pattern on the CD so that the cap or tee sticks up through the center of the pattern.

Place the CD spinner on a smooth table top. Grab the cap or tee with your thumb and forefinger, and give the CD spinner a spin. What do you notice?

Replace the Benham's Disk pattern with the Spiral pattern, and spin the CD in the direction that makes the spiral seem to be going inward.

Stare at the center of the spiral for about 20 seconds or longer. Then shift your gaze to the open palm of your hand. What seems to happen?

Wait a minute or so. Again spin the CD spinner and stare at the spinning spiral for 20 seconds or longer. Then shift your gaze to someone's face, or a picture on a wall, or any interesting object. What seems to happen?

Wait another minute or so to give your brain time to recover. Then spin the CD in the opposite direction, so that the spiral moves outward. Again, stare for 20 seconds or longer, and then look at your palm or other objects. What seems to happen?

What's Going On?

Benham's Disk With the Benham's disk, people see different intensities of color, even though the pattern is only black and white. Just why people see color when they view a spinning Benham's disk is not fully understood, but the illusion involves the color vision cells of your retina called cones. There are three types of cones. One is most sensitive to red light, another to green light, and the third to blue light. Each type of cone has a different *latency* time, the time it takes to respond to a color, and a different *persistence of response* time, the time it keeps responding after the stimulus has been removed. Blue cones, for example, are the slowest to respond (have the longest latency time), and keep responding the longest (have the longest persistence time). Normally, you don't notice these differences. For example, the color white causes each type of cone to respond the same way, and your brain combines their responses to perceive white.

When you gaze at one place on the spinning disk, you are looking at alternating flashes of black and white. When a white flash goes by, all three types of cones respond. But your eye and brain see the color white only when all three types of cones are responding equally, and in this case each flash of white goes by too quickly for the different cones, with their different latency times and persistence times, to respond in the same way. The resulting imbalance causes a perception of color.

The colors vary across the disk because at different radial positions on the disk the black arcs have different lengths and produce different flashing rates on the retina.

The Benham's disk illusion is more complicated than suggested by the explanation given to the above. For example, the short black arcs that are on all Benham's disks must also be thin, or no colors will appear.

Benham's disk was invented by a nineteenth-century toy maker who noticed colors in a black-and-white pattern he had mounted on a top.

Spiral This pattern exploits the fact that your visual system is sensitive to inward and outward motion. Some nerve cells in your visual cortex fire more when objects move outward from the center of your field of view, and others fire more when objects move inward. When you are looking at something that is standing still, the inward and outward channels are in balance with one another and send equally strong signals to your brain. When you stare at the moving spiral, however, one detector channel gets tired. Then, when you stare at something that isn't moving, the detector channel that hasn't been working sends a stronger signal to your brain than the tired one. Therefore, if the spiral was spinning inward, your palm will seem to move outward, or expand. If it was spinning outward, your palm will seem to be move inward, or contract. You may also experience the illusion as your palm moving toward you or away from you.
Next time you are near a waterfall, try staring at one point on the waterfall for a minute. Then look at a rock or another stationary object to the side of the waterfall. The solid object should seem to flow upward. This apparent motion is due to fatigue of the channels in your visual system that detect linear upward and downward motion.

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Going Further

The book *Turntable Illusions* (see References) contains many patterns that can be used with the CD spinner.

References

Kremer, John. *Turntable Illusions*. Open Horizons Publishing Company, Fairfield, Iowa, 1992. A great collection of spinner illusions with discussion and explanation.

Falk, David, Dieter Brill, and David Stork. *Seeing the Light*., Harper and Row, New York, 1986. A unique and outstanding text with a largely qualitative treatment of virtually all aspects of light, vision, and color. See in particular pp. 284-285 for Benham's disk and pp. 201-203 for the spiral aftereffect, or waterfall illusion.

Credit

The CD spinner was originally brought to our attention by Professor Ron Bonstetter of the University of Nebraska, Coral Clark contributed the bottle cap and marble mechanism, and Paul Doherty came up with the use of the golf tee.

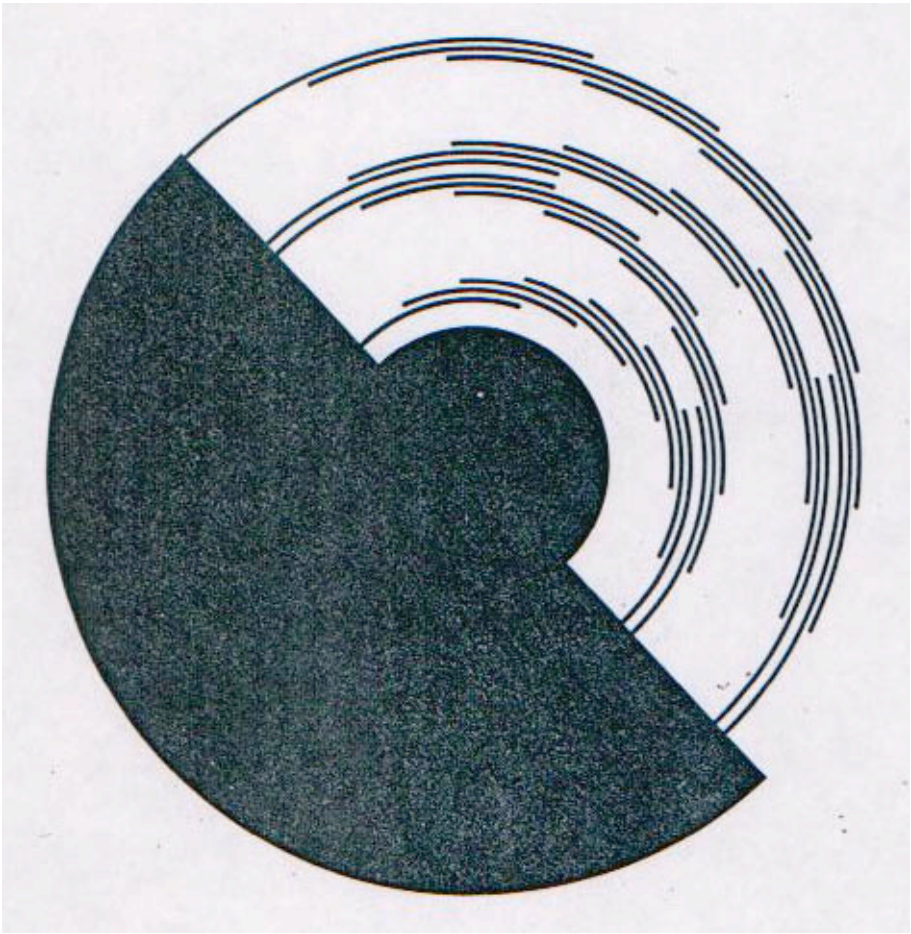

Figure 4

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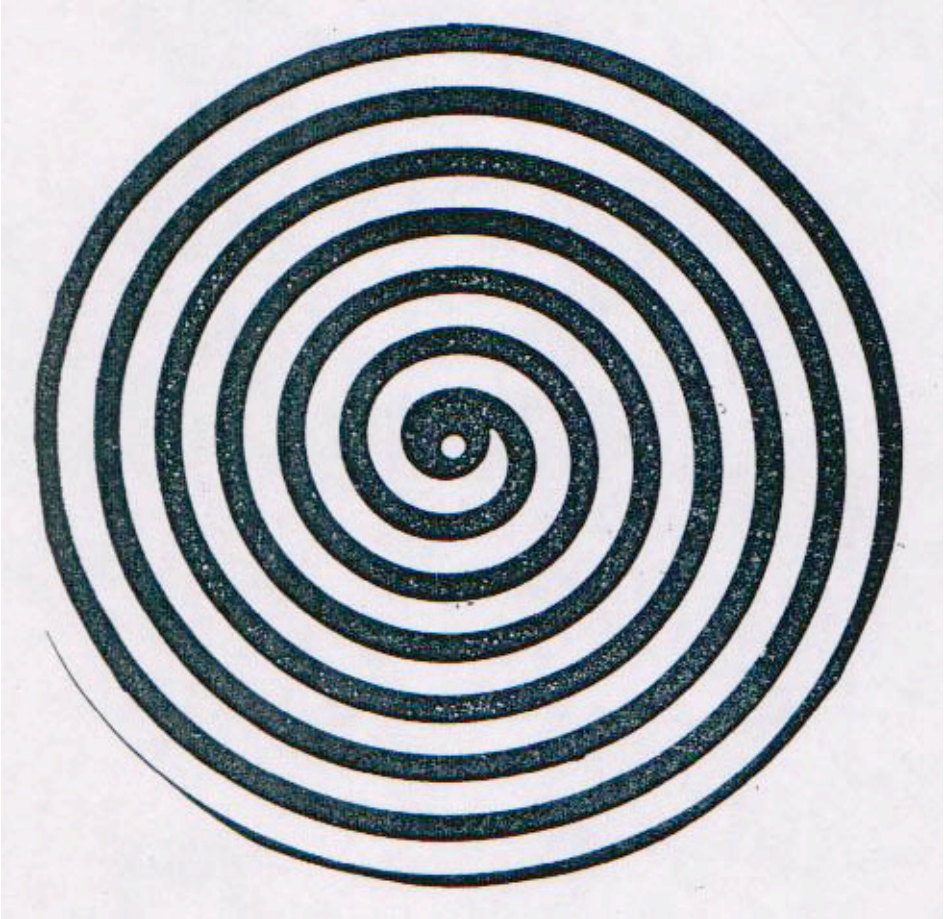

Figure 5

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