# Reverse Masks

**Eye'll be seeing you.**

One mask protrudes from the black surface like an ordinary face, and the other is indented into the surface. When you close one eye and view the two masks, they both look like they are protruding, and when you move sideways, the indented mask seems to turn to follow your movement!

## Materials

• 2 identical masks (Craft stores have blank relatively inexpensive blank masks that are white on both sides; Halloween masks also work well. If you can't get two identical masks, you can use two different masks.
• masking tape (only necessary if you want to cover the eye and mouth holes of the masks)
• black poster board
• ruler
• pencil
• utility knife or sharp scissors
• hot glue gun and glue sticks
• movable light source (e.g., adjustable desk lamp)

If the masks you choose are not already white on both sides, you may need these materials as well:
• white spray paint, or white paint and a brush

## Assembly

1. You may first need to make some decisions about whether or not to modify your masks. If the masks aren't white on both sides, you may want to paint them so that both sides are white. If the masks have holes for the eyes, nostrils, and mouth, you may want to cover the holes with masking tape. (Put the tape on the "back" side of the mask, relative to the side you will be looking at). Masks with holes and masks with colored outside surfaces will both work, but may distract from the main effect of the snack.


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2. Cut a sheet of black poster board on which you can place both masks side by side, with at least 2½ inches (6 cm) between the masks, and a border of at least 1½ inches (4 cm) around the edge.
3. Draw a vertical line dividing the poster board in half.
4. Place one of the masks in the middle of the left half of the poster board, and carefully draw its outline.
5. Using the scissors or utility knife, carefully cut along the mask outline to make a hole in the poster board that is exactly the shape of the outline of the mask.
6. Place the mask right-side up on a table. Place the poster board over the mask so that the hole in the poster board fits over the mask. Press down on the poster board until it is flat on the table, with the mask protruding upward. If you have drawn and cut accurately, the edge of the hole should fit fairly closely around the edge of the mask.
7. Run a small bead of hot glue completely around the edge of the mask to glue it to the poster board.
8. Turn the poster board over, so that the mask is now on the right side, and is concave (or "inside out").
9. Lay the second mask in the middle of the left side of the poster board, and run a small bead of hot glue completely around the edge of the mask to glue it to the poster board. You should now have a convex mask protruding from the left side of the poster board and a concave mask indented into the right side, as shown in figure 1.

***Figure 1***

***Mounting tilted to show front and back***

## To Do and Notice

Stand the mask board up on a table by propping it against a box, a stack of books, or anything convenient. Place the light source a little less than a 3 feet (1 m) from the concave mask, and a little off to the side.

With your head about 3 feet (1 m) away from the masks, close one eye and look at the masks. Move your head to the left and right, or walk to the left and right.

Both masks should look like they are protruding out from the poster board -- even though the one on the right is hollow, or concave.


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Additionally, the hollow mask should seem to follow you as you move.

Keeping one eye closed, try moving your head up or down while looking at the hollow mask. It should still follow you.

Try moving the light to illuminate the masks from different angles, and try adjusting the intensity of the light.

## What's Going On?

It's hard to judge depth with only one eye. When you see the masks with one eye closed and from some distance away, your brain assumes that both masks protrude outward, as ordinary faces do.

But why does the concave mask seem to follow you when you move? This illusion is your brain's attempt to make sense of two conflicting sources of information. First, your visual system notices that the nose of the concave mask moves less than the rest of the face when you move your head. This information suggests that the nose is the most distant feature on the face (and the face is therefore concave), because to a moving observer, distant objects appear to move less than nearby objects. (Think of how highway signs whiz by when you are in car, while the distant scenery seems to barely move at all). But based on its experience in the world, your brain can't accept the existence of a concave face. So, it concludes that the hollow mask is instead an ordinary protruding face that turns to watch you walk past, its nose following your gaze and therefore having little apparent motion.

The intensity and angle of illumination can influence the effectiveness of the illusion. The areas of shadow and bright reflection can either enhance or detract from the illusion, depending on their location.

Researchers in visual perception have traditionally concluded that, in the absence of other cues, we normally assume objects are illuminated from above (based on the fact that the sun is such a basic source of illumination). We therefore perceive objects with shadows at the bottom as convex and those with shadows at the top as concave. See Figures 2 and 3 below.

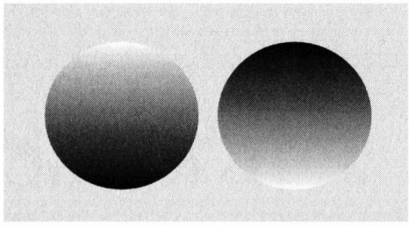

***Figure 2***
***Does one of these two circles appear to protrude from the page like a bump? Does the other look more like a crater? Turn your computer screen upside down, or tilt your head so you're looking at the figure upside down, or print this figure on paper and hold the paper upside down, and the situation will probably reverse. This is a version of a classic illusion known as Dome/Crater, or Mountain/Crater or Hill/Crater.***


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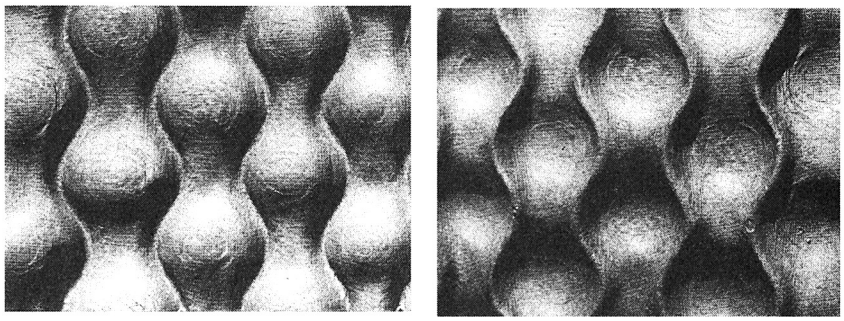

***Figure 3***
***The left image shows an egg crate, illuminated from above. The right image shows the same egg crate illuminated from below. Most people see protrusions in the left image and indentations in the right image. Turn your computer screen upside down, or tilt your head so you're looking at the figure upside down, or print this figure on paper and hold the paper upside down, and look again. The photo that looked concave should change to convex, and vice-versa.***

Nonetheless, we tend to perceive all human faces as convex -- even hollow masks that have shadows at the top. Our perception of faces seemed to be an exception to our usual interpretation of shape based on light and shadow and was ascribed to the special importance faces have for us.

However, neuropsychologist V. S. Ramachandran has found that this propensity to view hollow masks as projecting outward actually extends to many complex inward-curving objects. His work generalizes this tendency, rather than attributing it to a unique perception of the human face by the brain.

Disneyland's Haunted Mansion uses hollow masks to create eerie illusions of faces that seem to rotate and follow you as you move. The placement of the masks and the lighting are carefully adjusted to maximize the illusion.

## Going Further

### *Painted Faces*

Try painting the features on the inside of a mask to create your own realistic Haunted Mansion-type mask. Or, just try looking at the inside of a Halloween mask with a reasonably bright light source behind it, so that the painted features become visible through the mask.

## Credits & References

This snack is based on the Exploratorium exhibit of the same name.

Brand, Judith. "How We Learn by Being Fooled: The Lessons in Illusions." Exploring (Visual Illusions Issue), Vol. 20, No. 2, Summer 1996**.** This article is an outstanding discussion of visual illusions in general, with examples of several types. The work of V.S. Ramachandran in exploring our tendency to perceive complex concave objects as convex is discussed on page 11.


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Gregory, Richard. *Eye and Brain: The Psychology of Seeing*. 4th ed. Princeton, N.J.: Princeton University Press, 1990. See pages 190-195 for a discussion of the role of shading and shadow in the perception of concavity and convexity, including the egg-crate illusion shown in figure 3.

Gregory, Richard, *The Intelligent Eye*. New York: McGraw-Hill, 1970. A discussion of the hollow mask illusion appears on pages 126–131.

Yellott, John, "Binocular Depth Inversion." *Scientific American*, July 1981, pages 147–159. Although this article deals primarily with binocular (viewing with two eyes) inversion, monocular inversion with a hollow mask is discussed, and the hollow mask is part of an interesting experiment described in the article.


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