

The Hole Story

Fun with the Exploratorium business card

Written by Stephanie Chasteen, and credited to the person who sent me the activity

Pie in your face

Offer your card and a piece of string. The recipient can use it to find pi. First, they circumnavigate the hole with the string, to measure its circumference. How many diameters of the hole can they fit within this length of string? The answer is 3 and a little bit, since π (3.14) is the ratio of the circumference of a circle to its diameter. *Larry Shaw*

A quarter, not a half

Offer your card and ask for a quarter (are budgets that tight?) Tell them they can push a quarter through the hole without tearing or cutting the card. Most people try folding the card in half first, and quickly recognize that the diameter of the hole doesn't change when you make it into a semicircle. This is a topology problem. The trick is to fold the card so it's three dimensional, not two. Crease the card across the middle of the hole by folding it lengthwise and re-opening it, and then fold it in half the short way. Then pinch the card (pulling down the folded edges on either side) so the hole opens like a mouth, and the quarter will drop right through. This essentially takes some of the circumference of the hole and makes it into the diameter of the hole. *Paul Doherty*

Rose-colored glasses

You need two of your cards and some red filter. Cover the hole with a red filter to make rose colored glasses. Have fun with color adaptation. Greens will be especially brilliant since it is a complementary color to red. Similarly, the world will look a little greenish when taking off the glasses. *Paul Doherty*

3D glasses

You need two of your cards, a red filter, and a green filter. Cover each hole with a different color to make 3D glasses. *Paul Doherty*

Meet the stars

You need your a card and a diffraction grating. You can see the star-like patterns from diffracted light. *Paul Doherty*

Bracelet

You need your card and some scissors. Make radial cuts in the card outward from the hole (not reaching the edge of the card) and inward towards the hole (not quite reaching the hole itself), so that the two patterns interfinger. Then the card can be opened up to go around your wrist. *Paul Doherty*

Black & white

You need your card and a glass of water. Soak the card in water and it will split into a black card and a white card. *Paul Doherty*

Seeing the bigger picture

You need two cards and a piece of fresnel lens. Tape the lens across the hole on one card, turning it into a magnifier. Now you can read the information on the other card, which has been printed small because of the big hole in our card. *Karen Kalamuck*

A prime specimen

You need two cards and some cellophane tape. Put cellophane tape across one side of the hole of one card. Place a "specimen" on the tape (whatever -- hair, ant, tick, pollen, booger, etc.). Put tape across the hole of the other card and place it on top of the first one, sticky side down. You now have a specimen prepped on a slide, held in place with sticky tape. Use the business card magnifier to examine. *Karen Kalamuck*

Earth to Exploratorium... Angular size of the moon

You need your card and your arm. If you hold the business card at arms length, with elbows straight - the size of the hole will appear to be the same size as the earth would appear in the lunar sky (taking up 2 degrees). If you take the card outside and try this with the full moon, you will notice that the moon is only a

quarter of the diameter of the earth...or taking up 0.5 degrees of sky. *Linda Shore*

Bubbles

You need your card and some bubble solution. Put the "hole" end of the card in some bubble solution. Remove. Hold against black background, such as another card. Watch the colors swirl, change, and turn colorless -- a micro soap-film painting, good to show interference patterns. For those who'd like to use the card repeatedly - cover both sides with wide, clear, packaging tape. Use a razor blade or scissors to remove the tape from the hole. *Karen Kalamuck*

There's a hole in my hand (dear Liza)

You need your card and your hand. Hold your left arm straight out in front of you, bent upward at the elbow so that your palm is facing you. Hold the card with your right hand so that the card is a couple of inches in front of your face with the white side of the card facing you and long sides vertical. Look through the hole at the middle of your left palm, keeping both eyes open. Now slowly move the card to the right -- if all goes well, you may be able to get the "Hole in the Hand effect" from the Cardboard Tube Syllabus exhibit and snack. You may have to try adjusting your focus, and it's a little difficult to get the whole circle, but you should at least be able to get a semicircle cut out of the edge of your palm. *Don Rathjen*

Thread the card

You need your card and your hand. Hold the card at arms length with your left hand, so you are looking directly at the hole. Now angle the top of the card outward, so it's tilted at 45 degrees. Close your left eye. Hold a pencil by the writing end in your right hand, and try to put the eraser end through the hole while keeping the left eye closed. This is the "Thread the Needle" exhibit and snack. *Don Rathjen*

That's about the size of it

You need your card and a dime. Hold the card at arm's length with your left hand. Close your left eye. Hold a dime close to your face and gradually move it outward until it exactly covers the hole. When you close one eye, your depth perception is impaired, so you can't tell whether the dime or the card is farther

away. So the closer, smaller dime appears the same size as the farther, larger hole in the card. This is the Size and Distance exhibit and snack. *Don Rathjen*

Dominant eye

You need your card and your eye. Hold the card at arm's length and look through the hole at some object a foot or more away, so the object appears centered in the hole. Close each eye in succession. Is the object still centered, or does the card seem to jump to one side? The distant object will stay the most centered in the hole when your *dominant eye* is open. This activity highlights that we merge information from our two eyes, with slightly different views, to make a singular picture of the world.

Alternate methods:

- Bring the card to your face, while keeping the object centered in the hole. The eye the card is closest to when you finish is your dominant eye.
- Hold the card in the middle of your face and look through the hole – does the hole appear to be in the center, or slightly offset? If your right eye is dominant, it will appear to be offset to the left.

Stephanie Chasteen

Pinhole

You need two cards, a piece of white paper, and a bright sunny day. Tape the paper to a wall facing the sun – this works best if you can tilt the paper about 45 degrees so that its face is perpendicular to the sun's incoming rays. Overlap the holes in your card so you have a very thin slit. Hold the overlapped cards close to the paper screen so that you can see their shadow, which is elliptical. Slowly move away from the screen – you will see the shadow become fuzzy, and then gradually form a perfect circle. You are seeing a pinhole image of the sun. Experiment with sliding the cards to make larger and smaller holes, to find the point where you get this pinhole image. Notice that when you have the circular image of the sun, making the pinhole smaller doesn't make the circle smaller – just dimmer. This is even more convincing if a cloud passes in front of the sun, or there's an eclipse. This is from Bob Miller's Light Walk. *Stephanie Chasteen*

Blind Spot

You need your card and your arm. Hold the card at arm's length in front of you, at eye level. Close your right eye, and keep staring straight ahead while slowly moving the card to the left, until the hole disappears - it's now in your blind spot. Now bring it in slowly, adjusting to keep the hole invisible, until it's so

close you can't make it disappear - it's now coincident with your blind spot. Do the geometric calculation, and you should get about 5 degrees. Notice that when the hole becomes invisible, the brain guesses there's a solid business card there. If you're looking at the black side of the card, the place where the hole was appears black, but it appears white when you flip the card over to its white side.

Antihole

Make an antihole - simply color a transparency with a black sharpie through the hole. Now you have a nice complement, which can be used to supplement many of the hole demos. *Richard Brown*

Reading through the Hole

The visual field seen through the hole at arm's length is approximately coincident with the fovea, ~2 degrees. This covers less than 1 mm of your retina (<0.1% of the total area), but this tiny speck the only place we can see things at high acuity, such as reading fine print. A huge amount of the visual cortex is devoted just to processing foveal information. Also, there are no rods in the central 1.5 degrees or so of vision, so you're essentially night blind looking through the hole. Then hold the complementary "antihole" at arms length, and stare at the center of the black spot. Notice how hard it is to read anything behind the transparency, until you move your eyes. *Richard Brown*