Color plays “musical chairs” in brain

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Courtesy University of Chicago
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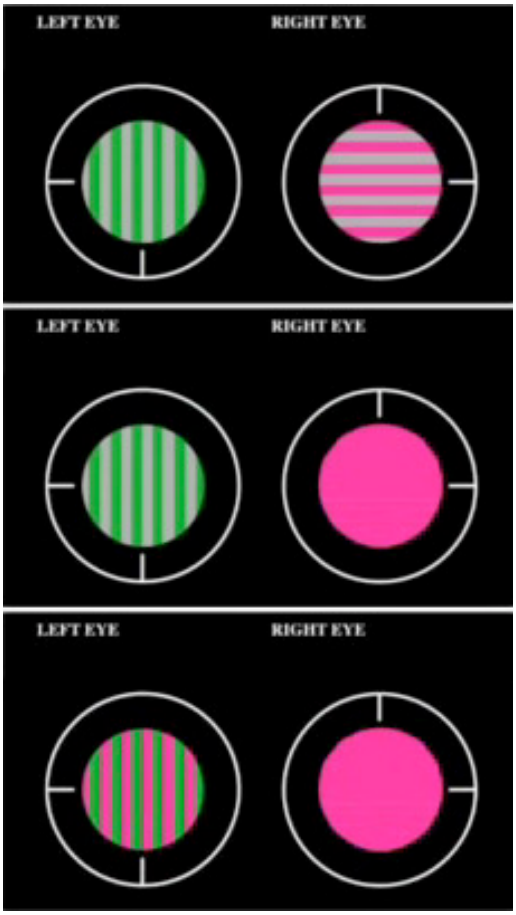
Scientists have managed to trick people’s eyes into losing sight of a shape while continuing to perceive its color.

The result: the color—divorced from the shape to which it “belongs”—seems to go into another shape, according to the researchers.

This finding, they say, reveals a new property of sight.



Color from one shape is transferred to another. Above, two patterns of stripes are incompatible to the eyes; when one pattern is shown to each eye, the brain only sees one. In the middle, the stripe pattern fades away at right, but its reddish hue remains. Below, the red reappears in half of the stripes on the left side when the vertical stripe pattern is perceived. (Images courtesy U. Chicago)

The brain processes an object's shape and color in two separate pathways. And although the shape and color normally are linked, the representation of color can survive alone, said Steven Shevell, a University of Chicago psychologist who specializes on color and vision. When that happens, he added, the brain establishes a new link that binds the color to another visible shape.

"Color is in the brain. It is constructed, just as the meanings of words are constructed. Without the neural processes of the brain, we wouldn't be able to understand colors of objects any more than we could understand words of a language we hear but don't know," said Shevell.

The new experiments, by Shevell and Wook Hong of Vanderbilt University in Tennessee, are described in the current issue of the research journal *Psychological Science.*

Color is normally thought of as a fundamental attribute of an object: a red Corvette, a blue lake, a pink flamingo. Yet despite this popular notion, new research suggests that our perception of color is malleable, and relies heavily on biological processes, Shevell said.

"An aspect of human vision that we normally don't appreciate is that different features of an object, including color and shape, can be represented in different parts of the brain," said Shevell.

If a person sees a basketball coming, it is perceived as having a particular color, shape and velocity. "The knitting together, or what can be called 'neural gluing,' of all those different features so we see a unified object is a complex function done by the brain. Our research focused on how the brain does that," Shevell explained.

To study how the brain represents the color of objects, the researchers used a technique called binocular rivalry. The technique presents a different image to each eye and thus pits signals from the right eye against signals from the left.

"The brain has difficulty integrating the two eyes' incompatible signals. When the signals from the two eyes are different enough, the brain resolves the conflicting information by suppressing the information from one of the eyes," Shevell said. "We exploited this feature of the brain with a method that caused the shape from one eye to be suppressed but not its color."

The researchers first showed subjects vertically oriented green stripes in the left eye and a horizontally oriented set of red stripes in the right eye. "The brain cannot fuse them in a way that makes sense. So the brain sees only horizontal or vertical," Shevell said.

For their study, the researchers developed a new form of the technique that allowed the horizontal pattern to be suppressed without eliminating its red color, which continued on to the brain. They did this by fading out the horizontal stripes while leaving their red hue intact.

At this point, the brain has a musical chairs problem. Both the red and green colors reach consciousness but with only the one vertical pattern—one object but two colors. The surprising result was that the "disembodied red, which originated from the unseen horizontal pattern in one eye, glued itself to parts of the consciously seen vertical pattern from the other eye. That proves the idea of neural binding or neural gluing, where the color is connected to the object in an active neural process," Shevell said.

"To us it seems automatic," Shevell added. "Every basketball has a color. Every shirt has a color, but the brain must link each object's color to its shape."