Colors Out of Space

Colors can change with their surroundings and spread beyond the lines

By Stephen L. Macknik and Susana Martinez-Conde

It was just a colour out of space—a frightful messenger from unformed realms of infinity beyond all Nature as we know it; from realms whose mere existence stuns the brain and numbs us with the black extra-cosmic gulfs it throws open before our frenzied eyes.

Science-fiction author H. P. Lovecraft considered *The Colour Out of Space* his best story. In this 1927 classic tale of cosmic horror, a small Massachusetts farming community faces unspeakable evil from the outer reaches of the universe. The extraterrestrial villain is not a face-hugging or chest-bursting alien but something far more terrifying: a weird color.

Slowly but surely the otherworldly color mutates and destroys crops, insects, wild animals and livestock. It impregnates the land and the water. The unfortunate farmers who encounter the bizarre hue fall prey to insanity and untimely death.

And you thought vision research was for wimps.

This article features some of the most spectacular color phenomena this side of the galaxy. You won't see any extraterrestrials, but many strange illusions arise from taking colors out of place and putting them in an unusual context. Use caution: the peculiar shades and tints you are about to experience could blow your mind.

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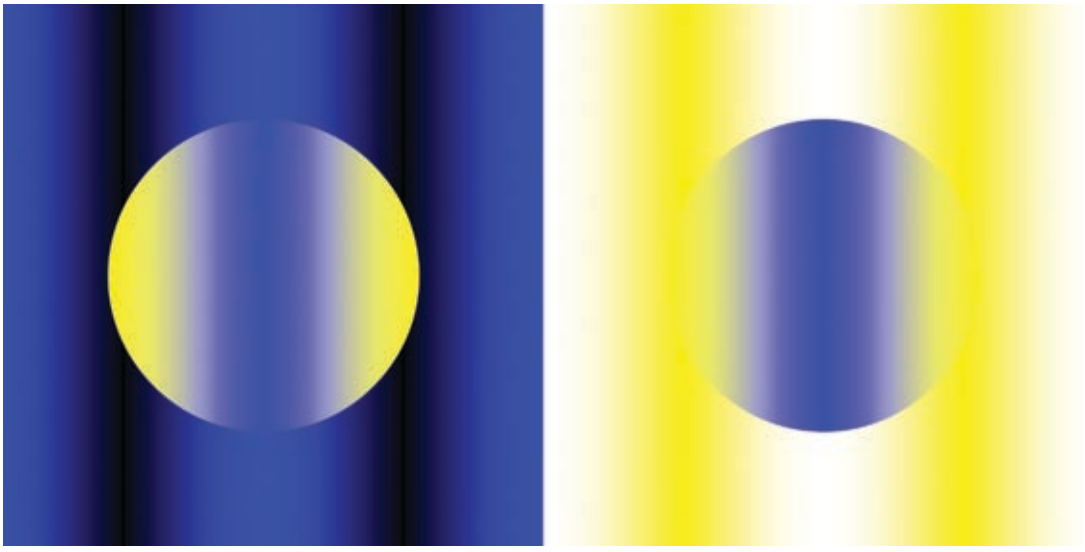
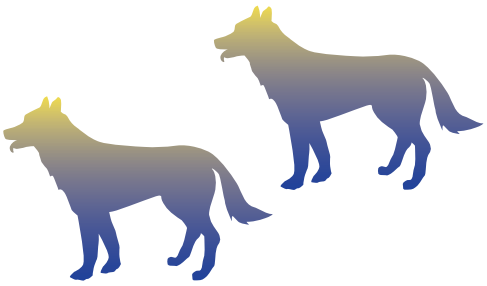


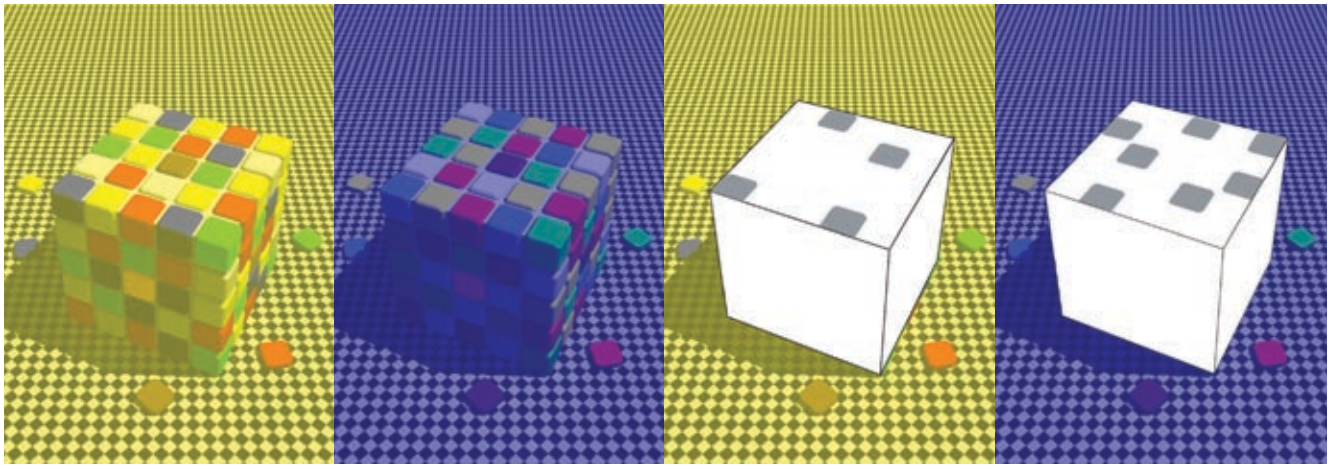
YELLOW MOON AND BLUE MOON Here we have two moons out of space. One yellow and one blue. Or are they? Actually both moons are exactly the same color in this illusion by psychologist Akiyoshi Kitaoka of Ritsumeikan University in Japan; only the surrounding colors are different. If you don't believe it, cut out the two moons—you'll find them to be identical. The appearance of colors is all about their context.

COURTESY OF AKIYOSHI KITAOKA *Ritsumeikan University*



REX AND FIDO

Legend has it that Rome was founded by warring twin brothers, Romulus and Remus, born to a vestal virgin named Rhea Silvia and fathered by Mars, the god of war. Vestal virgins, as it turns out, are not supposed to conceive children, even if the father is a god. The family shame was too much for Rhea's father, who killed her and then condemned the twin baby boys to die of exposure. The wolf Lupa found the boys and adopted them. But hey, what about Lupa's biological pups, Rex and Fido, younger brothers to the feral Romans? These nonidentical twins (*left*) become identical when the background is removed (*right*). Had this pair been born before their mother discovered Romulus and Remus, surely Rome would have gone to the dogs.



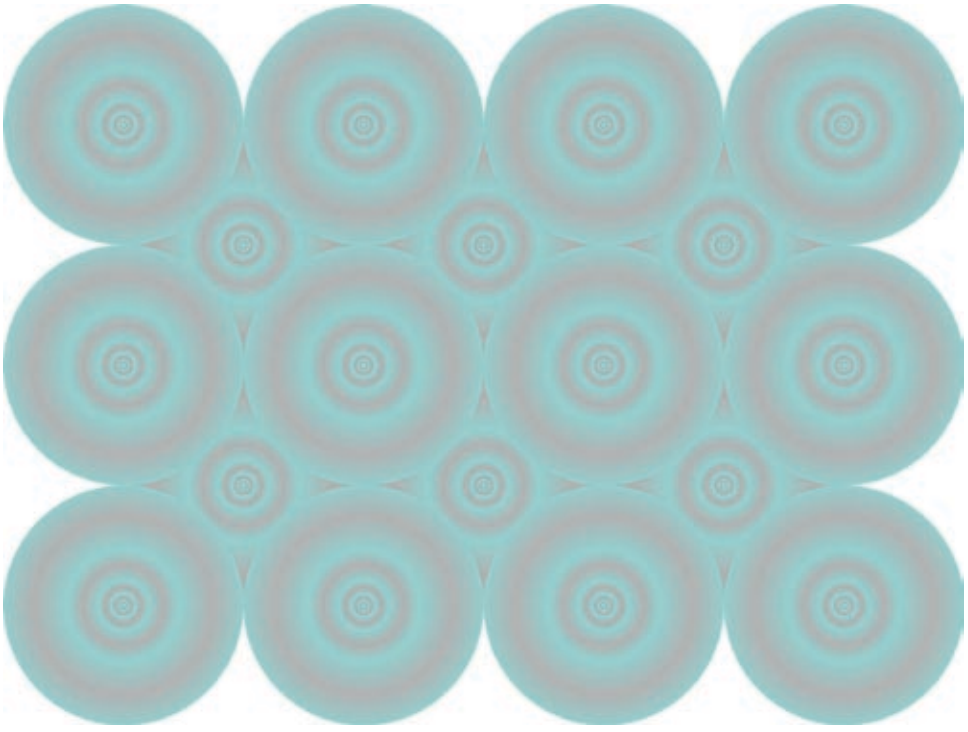
RUBIK'S FOLLY

Rubik's Cube is a three-dimensional puzzle in which the player rotates the tiled faces of a cube until each face shows the same color on all nine tiles. Sound easy? Only if the lighting conditions are stable. As this illusion by Beau Lotto and Dale Purves of Duke University shows, if the lighting changes, it can be hard to know which color is which. The masked version of the illusion (*above, right*) reveals that the blue squares on the left and the yellow squares on the right are actually all gray when viewed under white light. Color perception is not based strictly on the wavelengths of the light that strikes your retina; instead the brain assigns colors based on the lighting conditions and uses the wavelengths only as a guideline to determine which objects are redder or bluer than other objects in the same scene.

EYE SHADOW

It looks like this Japanese *manga* girl has one blue eye and one gray eye. In fact, both eyes are exactly the same shade of gray. The girl's right eye only looks the same as the turquoise hair clip because of the reddish context. Part of the process of seeing color is that three different kinds of photoreceptors in the eye are tuned to three overlapping families of color: red, green and blue (which are activated by visible light of long, medium and short wavelengths). These signals are then instantaneously compared with signals from nearby regions in the same scene. As the signals are passed along to higher and higher processing centers in the brain, they continue to be compared with larger and larger swaths of the surrounding scene. This "opponent process," as scientists call it, means that color and brightness are always relative.

ADAPTED FROM WWW.MOILLUSIONS.COM (*dogs*); DALE PURVES *Duke University* (*cubes*); COURTESY OF AKIYOSHI KITAOKA (*eye shadow*)



RED RINGS

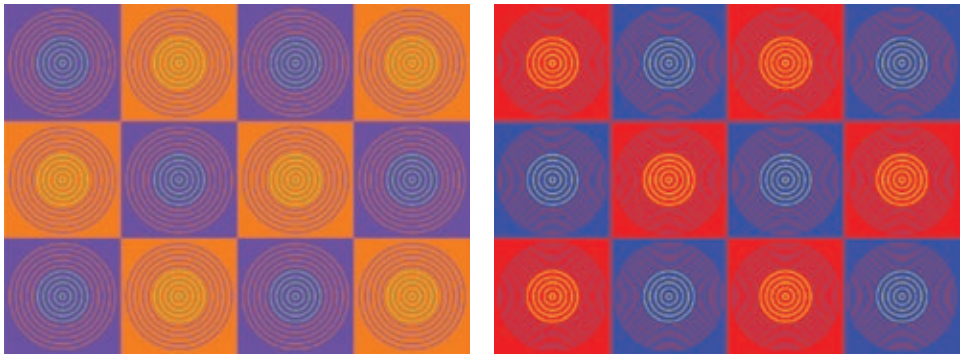
This image by Kitaoka contains a number of blue-green circular structures. The red rings are purely a creation of your brain.

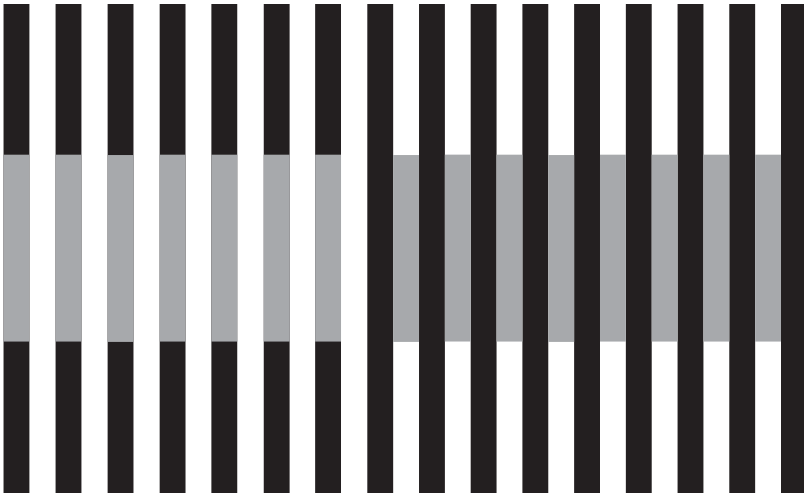
A process called color constancy makes an object look the same under different lighting conditions, even though the color of the light reflecting from the object is physically different. Color constancy is an incredibly important process that allows us to recognize objects, friends and family both in the firelight of the cave and in the bright sun of the savanna.

Because the rings here are drawn in shades of blue, the brain mistakenly assumes that the image is illuminated by blue light and that the physically gray rings inside the blue structures must therefore be reddish. The visual system subtracts the blue "ambient lighting" from the gray rings, and gray minus blue results in a pastel red color.

MULTICOLORED RINGS

Here is another example of how the brain determines color depending on the context. In the bull's-eye structures in the left checkerboard, the center rings look either green or blue, but they are all the same color (turquoise). The center rings in the right checkerboard are all the same shade of yellow. Unlike the previous images, this type of color illusion is difficult to explain by an opponent process because the apparent color of the rings is more similar than dissimilar to the background.





WHITE'S EFFECT

In 1979 Michael White of the Tasmanian College of Advanced Education described an illusion that changed everything in visual science. The gray bars on the left look brighter than the gray bars on the right. In fact, all the gray bars are physically identical. Before White discovered this effect, all brightness illusions were thought to result from opponent processes—that is, a gray object should look dark when surrounded by light and light when surrounded by dark. But in this illusion the lighter-looking gray bars are surrounded by white stimuli, and the darker-looking gray bars are surrounded by black. The brain mechanisms underlying White's effect remain unknown.

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