Misperceptions

Your perception may depend on your perspective.

BY SUSANA MARTINEZ-CONDE AND STEPHEN L. MACKNIK

Your brain creates a simulation of the world that may or may not match the real thing. The "reality" you experience is the result of your exclusive interaction with that simulation. We define "illusions" as the phenomena in which your perception differs from physical reality in a way that is readily evident. You may see something that is not there, or fail to see something that is there, or see something in a way that does not reflect its physical properties.

Some people think these illusions are simply mistakes made by the brain: erroneous computations, failures of perception that we would do well to overcome. But what if illusions are good things? Could it be that these peculiar mismatches between the inner and outer worlds are somehow desirable? Certainly, illusions are the product of evolution; we know that several illusions occur because of shortcuts that your brain takes to help you survive and thrive. Some of your misperceptions allow you to make lightning-fast assumptions that are technically wrong but helpful in practice. They can help you see the forest better—even if they make you discern the trees less precisely.

For example, you may underestimate or overestimate distances depending on various contextual cues. The psychologists Russell E. Jackson and Lawrence K. Cormack reported that when observers guessed the height of a cliff while looking down from the top, their estimates were 32 percent greater than when they were looking up from the cliff's base. This discrepancy appears related to the way we observe the same precipice from above versus below: a cliff edge against the sky versus a cliff face sloping into open land. Given that accidents are more likely to happen while climbing down rather than up, this height overestimation, when you look down from the top, may make you descend cliffs with greater care, reducing your chances of falling.

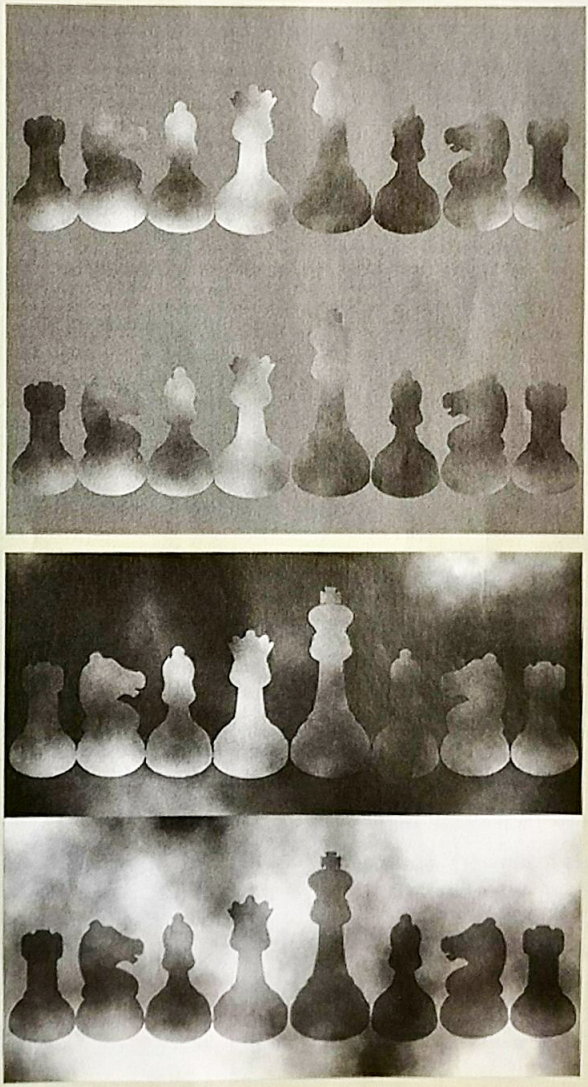
On the left, a young girl in a Venetian mask pines for love. On the right, it seems that she has moved on to kissing. This type of illusion is called "bistable" because, as in the classic face-vase illusion, you may see either a girl or a couple, but not both at once. Our visual system tends to see what it expects, and because only one mask is present, we assume at first glance that it surrounds a single face.

Illusions also offer a window into how our neural circuits create our subjective experience of the world. The simulated reality your brain creates—also known as your consciousness—becomes the universe in which you live. It is the only thing you have ever perceived. Your brain uses partial and flawed information to build this mental model and relies on quirky neural algorithms to alleviate those flaws.

Because illusions enable us to see objects and events that do not match physical reality, they are critically important to understanding the neural mechanisms of perception and cognition. To encourage the discovery and study of illusions, we created the Best Illusion of the Year Contest in 2005 to honor the best new illusions from the previous year and celebrate the inventiveness of illusion creators around the world: researchers, software engineers, mathematicians, magicians, graphic designers, sculptors, and painters fascinated with mapping the boundaries of human perception. The contest is playful, but for scientists it serves a deeper purpose. All the little perceptual hiccups that the contest showcases are opportunities to peer behind the neurological curtain and learn how the brain works.

Nothing is more fundamental to our vision than how we see the brightness of an object. But even so, our visual system plays fast and loose with reality and serves up monstrously bizarre and perplexingly inaccurate interpretations of the physical world. And this raises the question that constantly cycles through the brains of vision scientists: Why doesn't human vision faithfully represent the world we see? The answer is that illusions must help us survive (or at the very least not hinder our survival). If illusions were harmful, it is likely that they would have been weeded out of the gene pool by now.

But how can a visual illusion be useful? To illustrate,

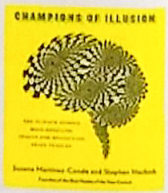


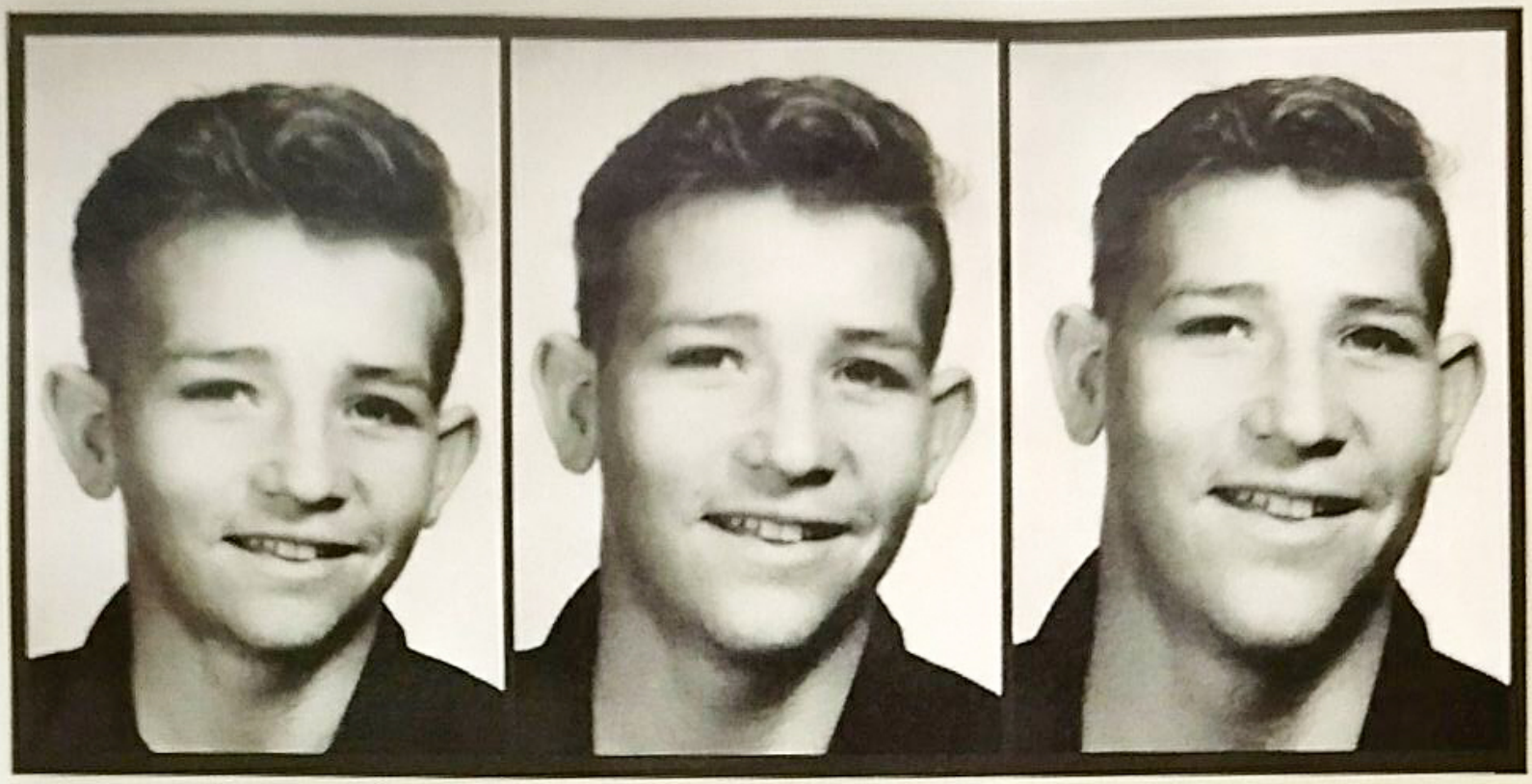
BARTON ANDERSON AND JONATHAN WINNICKER

The images above extend dramatically the concept of relative brightness and darkness to very large object displays. The four sets of chess pieces are identical. The backgrounds are the only things that change: the images on the right show the same chess pieces as the images on the left, only with the backgrounds removed. We perceive the upper pieces as white and the lower ones as black because of the variations in the clouds engulfing the pieces.

we'll do an experiment. Go to a dark room in your domicile with a cell phone and a book (an actual book, made of paper). Then dimly illuminate the pages of your book, using your phone, just enough to see the letters. White pages, black text—looks like a book, right? After you have completed this part of the experiment, head outside on a sunny day with the same book. Under direct sunlight, look at the same page; it looks identical, right? If you think it through, that's impossible, because the physical reality under the two lighting conditions is very different! When you read black text on a page lit by a dim cell phone, the amount of light reflected by the white paper is around 100,000 times lower than the amount of light reflected by the black letters in direct sunlight. So why don't the black letters seem super-white (100,000 times brighter than white) outside? The reason is that your brain doesn't care about light levels; it cares about the contrast between the lightness of objects. It interprets the letters as black because they are darker than the rest of the page, no matter the lighting conditions.

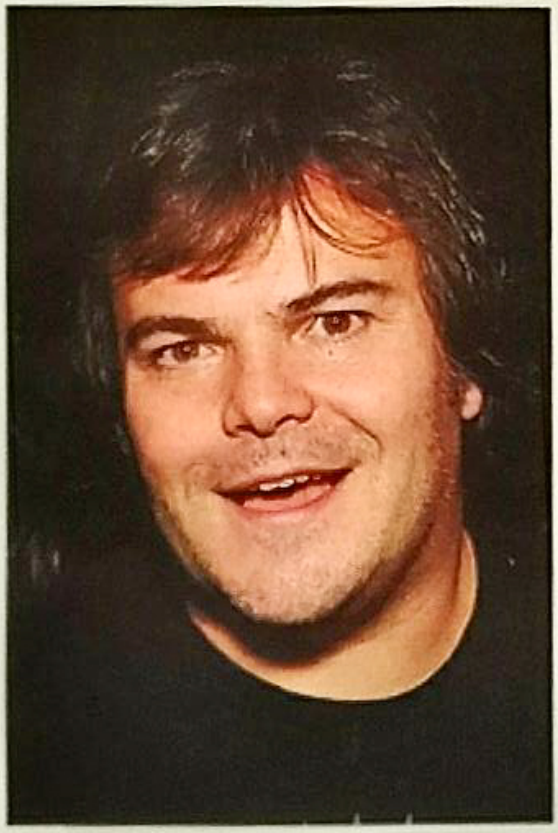
The illusion that allows us to identify an object as being the same under different lighting conditions is a very useful one. It helps us survive. Our brain does not perceive the true brightness of an object in the world (for instance, measured with a photometer), but instead compares it with that of other nearby objects. For instance, the same gray square will look lighter when surrounded by black than when it is surrounded by white.

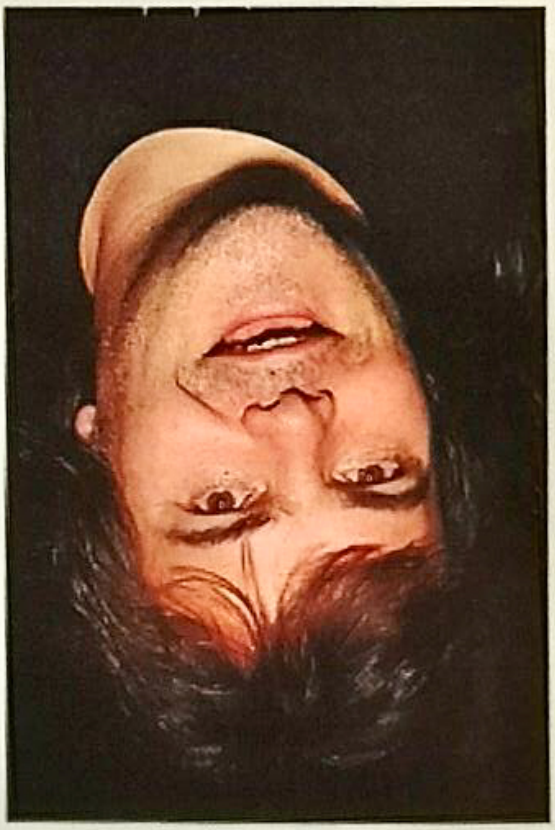




VICTORIA SKYE

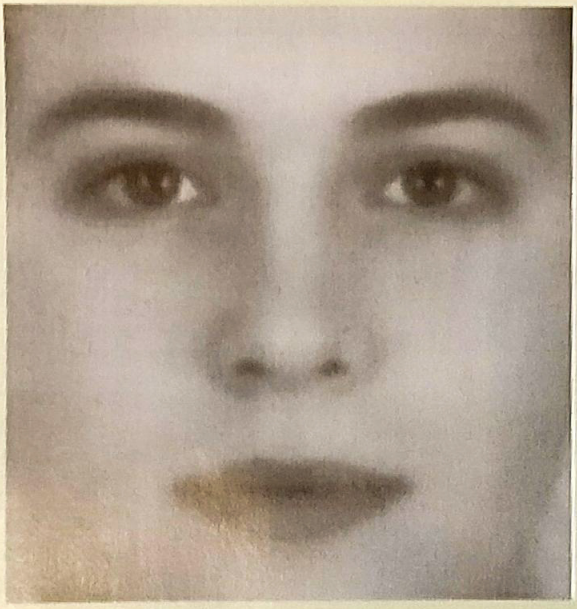
This illusion by magician, photographer, and illusion creator Victoria Skye is an example of anamorphic perspective. By tilting her camera, she created two opposite vanishing points, producing the illusion of age progression and regression. In the case of age progression, the top of the head narrows and the bottom half of the face expands, creating a stronger chin and a more mature look. In the case of age regression, the opposite happens: the forehead expands and the chin narrows, producing a childlike appearance.

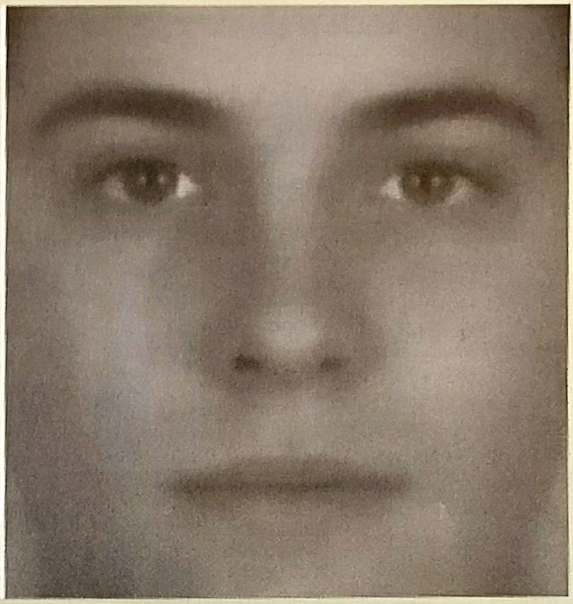




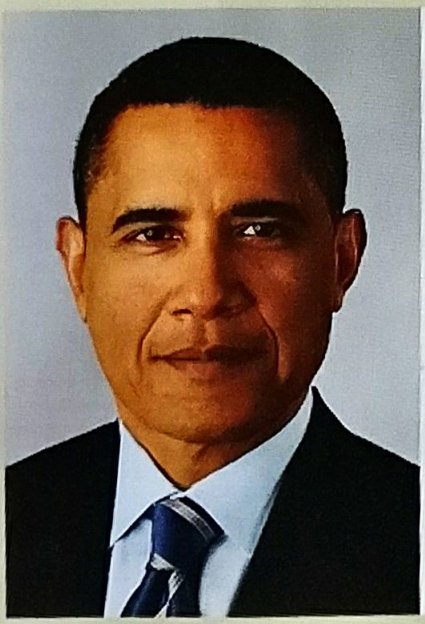
GLENN FRANCIS

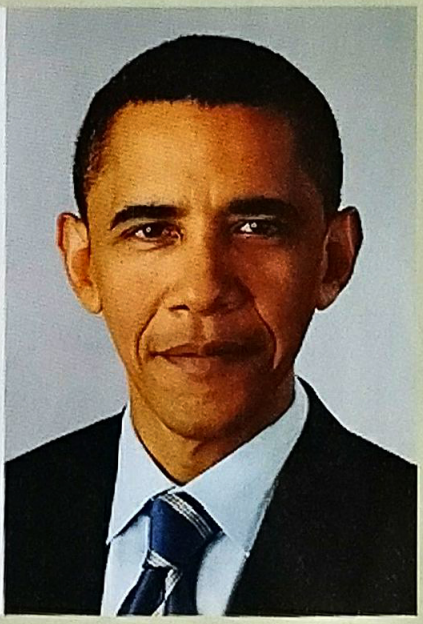
The Fat Face Thin Illusion shows two photographs that are identical, although the upside-down face appears strikingly slimmer than the right-side-up version. One possible explanation is that it is easier for the brain to recognize distinctive facial features, such as chubby cheeks, when they are viewed in the normal upright position. The neural mechanisms underlying this difference are not known, but research has shown that face-selective neurons of the human brain respond best to upright faces—probably because there has been no evolutionary pressure to recognize faces upside-down. These same neurons may encode various facial properties—like chubbiness—and be less capable of doing so accurately when faces are upside-down. If so, all upside-down faces could end up looking more similar to one another than if they were upright.



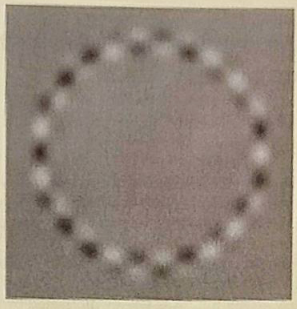


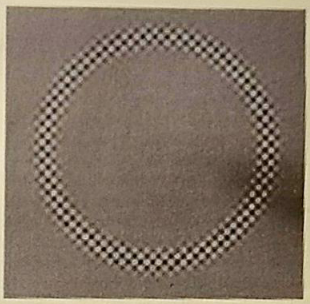
You may perceive these two side-by-side faces as female (left) and male (right). But both are versions of the same androgynous face. The two images are identical, except that the contrast between the eyes and mouth and the rest of the face is higher for the one on the left than for the one on the right. This illusion shows that contrast is an important cue for determining the gender of a face: low-contrast faces appear male, and high-contrast faces appear female. It may also explain why females in many cultures darken their eyes and mouths with cosmetics: a made-up face looks more feminine than a face without makeup.





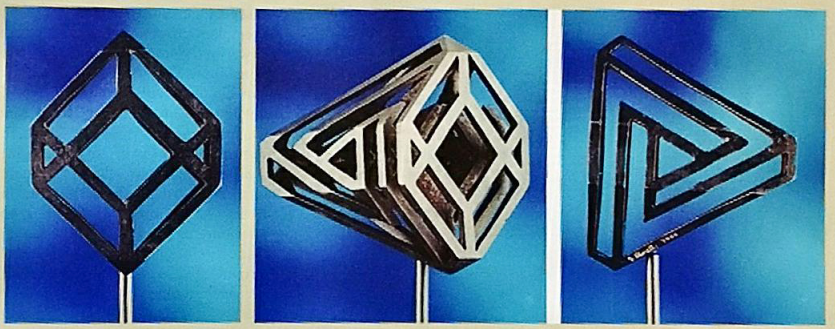
Cognitive scientists Kazunori Morikawa and Eri Ishii discovered a phenomenon they call the Head Size Illusion. The two faces shown here are identical except that the man on the left has a wider jaw and fuller face. The top of the head appears fatter, too, but it is not. The Head Size Illusion demonstrates that the brain does not determine the size of visual stimuli in isolation from one another; it compares objects and features with those nearby in the visual scene. The illusion occurs in everyday life, Morikawa said, and offers an opportunity for those who wish to alter their appearance. "If one part of your face or body appears wider or thinner than average, other parts appear wider or thinner, too," he explained."





DAVID WHITAKER

Subtle local effects can have major global consequences on how we perceive a shape, even one as simple as a circle. The circle on the left appears round only if you look directly at it. If you view it through your peripheral vision, it has corners! Visual neurons processing peripheral information have low spatial resolution, allowing them to "see" the gross details of objects only. When you see the circle on your left at the center of your vision—where your visual neurons have small, high-resolution windows on the world that scientists call "receptive fields"—you can see the curves that form the circle, and also the checkerboard pattern on the surface of the ring. In the periphery of your vision, however, visual neurons see the world through larger, low-resolution receptive fields that poorly appreciate the circle's subtle curves while favoring its high-contrast large checks. And because the checks form diagonal lines when blurred, you see a diamond shape instead of a circle out of the corner of your eye. In contrast, when you view the ring on the right through the center of your vision, you perceive it as roughly circular with a checkerboard surface. But when you view it peripherally, it looks much more rounded. That's because the smaller elements that form the circle smear out to gray in the larger peripheral receptive fields, and so the circular interpretation of the ring dominates your perception.



GUIDO MORETTI

Three-Bar Cube by Italian sculptor Guido Moretti appears to be a cube, a solid structure, or an impossible triangle. This specific vantage point is known to scientists as the accidental view, but there is nothing accidental about it. If the observer is to perceive the illusion, the view must be carefully staged and choreographed; otherwise, the audience will fail to see the "impossible" sculpture.

BOTH IMAGES: MARION LANEZ, COURTESY OF SUNY DOWNSTATE

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