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Crystal (Eye) Ball: Study Says Visual System Equipped With "Future Seeing Powers"

New research categorizes more than 50 types of illusions that help us perceive the present

Troy, N.Y. — Catching a football. Maneuvering through a room full of people. Jumping out of the way when a golfer yells "fore." Most would agree these seemingly simple actions require us to perceive and quickly respond to a situation. Assistant Professor of Cognitive Science at Rensselaer Polytechnic Institute Mark Changizi argues they require something more — our ability to foresee the future.

It takes our brain nearly one-tenth of a second to translate the light that hits our retina into a visual perception of the world around us. While a neural delay of that magnitude may seem minuscule, imagine trying to catch a ball or wade through a store full of people while always perceiving the very recent (one-tenth of a second prior) past. A ball passing within one meter of you and traveling at one meter per second in reality would be roughly six degrees displaced from where you perceive it, and even the slowest forward-moving person can travel at least ten centimeters in a tenth of a second.

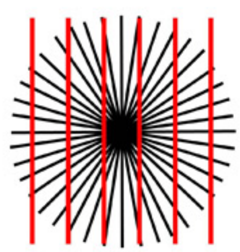
Changizi claims the visual system has evolved to compensate for neural delays, allowing it to generate perceptions of what will occur one-tenth of a second into the future, so that when an observer actually perceives something, it is the present rather than what happened one-tenth of a second ago. Using his hypothesis, called "perceiving-the-present," he was able to systematically organize and explain more than 50 types of visual illusions that occur because our brains are trying to perceive the near future. His findings are described in May-June issue of the journal *Cognitive Science.*

"Illusions occur when our brains attempt to perceive the future, and those perceptions don't match reality. There has been great success at discovering and documenting countless visual illusions. There has been considerably less success in organizing them," says Changizi, who is lead author on the paper. "My research focused on systematizing these known incidents of failed future seeing into a 'periodic table' of illusion classes that can predict a broad pattern of the illusions we might be subject to."

More than meets the eye

We experience countless illusions in our lifetime. The most famous being geometrical illusions — those with converging lines and a vanishing point we often see in *Psychology 101* classes or in entertaining optical illusion books.

To picture one, think of the Hering illusion, which looks like a bike spoke with two vertical lines drawn on either side of the center vanishing point. Although the lines are straight, they seem to bow out away from the vanishing point. The optical illusion occurs because our brains are predicting the way the underlying scene would project in the next moment if we were moving in the direction of the vanishing point.



The Hering illusion is exemplified by the perceived curvature of the straight lines near the vanishing point in the center of the drawing. The optical illusion occurs because our brains are predicting the way the underlying scene would project in the next moment if we were moving in the direction of the vanishing point.

"Evolution has seen to it that geometric drawings like this elicit in us premonitions of the near future," says Changizi. "The converging lines toward a vanishing point are cues that trick our brains into thinking we are moving forward — as we would in the real world, where the door frame seems to bow out as we move through it — and we try to perceive what that world will look like in the next instant."

Beyond geometric, Changizi was able to identify 27 other classes of illusions. He organized them into 28 predictable categories classified on a matrix that distributes them among four columns based on the type of visual feature that is misperceived (size, speed, luminance, and distance) and among seven rows based on the different optical features that occur when an observer is moving forward.

He then culled hundreds of previously documented illusions to test whether they would follow the appropriate prediction as determined by the table, and found that they did, indeed, follow the patterns he laid out in the matrix.

This new organization of illusions presents a range of potential applications, including more effective visual displays and enhanced visual arts. It especially may help constrain neuroscientists aiming to understand the mechanisms underlying vision, according to Changizi.

Changizi conducted his research during a fellowship in the Sloan-Swartz Center for Theoretical Neurobiology at the California Institute of Technology. Coauthors on the paper include: Caltech Biology Professor Shinsuke Shimojo, former Caltech undergraduate student Andrew Hsieh, and former Caltech postdoctoral researcher Ryota Kanai, as well as Romi Nijhawan, a psychologist at the University of Sussex in England.

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About Rensselaer

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