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## Art as Visual Research: 12 Examples of Kinetic Illusions in Op Art

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Art and neuroscience combine in creating fascinating examples of illusory motion  
By Susana Martinez-Conde and Stephen L. Macknik

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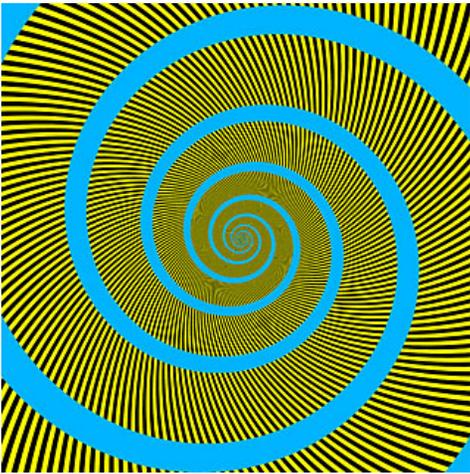
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Courtesy of Akiyoshi Kitaoka

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[Slide Shows: Op Art Illusions](#)

This is the fifth article in the [Mind Matters](#) series on the neuroscience behind visual illusions.

Scientists did not invent the vast majority of visual illusions. Rather, they are the work of visual artists, who have used their insights into the workings of the visual system to create visual illusions in their pieces of art. We have previously pointed out in our essays that, long before visual science existed as a formal discipline, artists had devised techniques to “trick” the brain into thinking that a flat canvas was three-dimensional, or that a series of brushstrokes in a still life was in fact a bowl of luscious fruit. Thus the visual arts have sometimes preceded the visual sciences in the discovery of fundamental vision principles, through the application of methodical—although perhaps more intuitive—research techniques. In this sense, art, illusions and visual science have always been implicitly linked.

It was only with the birth of the op art (for “optic art”) movement that visual illusions became a recognized art form. The movement arose simultaneously in Europe and the U.S. in the 1960s, and in 1964 Time magazine coined the term “op art.” This style became hugely popular after the Museum of Modern Art in 1965 held an exhibition called “The Responsive Eye.” In it, op artists explored many aspects of visual perception, such as the relations between geometrical shapes, variations on “impossible” figures that could not occur in reality, and illusions concerning

brightness, color and shape perception. But “kinetic,” or motion, illusions drew particular interest. In these eye trick, stationary patterns give rise to the powerful but subjective perception of (illusory) motion.

The accompanying slides illustrate several works of art in which objects that are perfectly still appear to move. Moreover, they demonstrate that research in the visual arts can result in important findings about the visual system. Victor Vasarely, the founder of the op art movement, once said, “In basic research, intellectual rigor and sentimental freedom necessarily alternate”. Some of the illusions in this month’s slide show have been created by op artists; some by vision scientists honoring the op art tradition. But all of them make it obvious that in op art, the link between art and illusory perception is an artistic style in and of itself.

### [Slide Shows: Op Art Illusions](#)

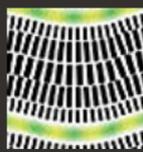
Are you a scientist? Have you recently read a peer-reviewed paper that you want to write about? Then contact Mind Matters editor [Jonah Lehrer](#), the science writer behind the blog [The Frontal Cortex](#) and the book [Proust Was a Neuroscientist](#).

### ABOUT THE AUTHOR(S)

Susana Martinez-Conde is director of the Laboratory of Visual Neuroscience at the Barrow Neurological Institute in Phoenix. She holds a Ph.D. in medicine and surgery from the University of Santiago de Compostela in Spain. Stephen L. Macknik is director of the Laboratory of Behavioral Neurophysiology at the Barrow Neurological Institute and earned a Ph.D. in neurobiology from Harvard University.

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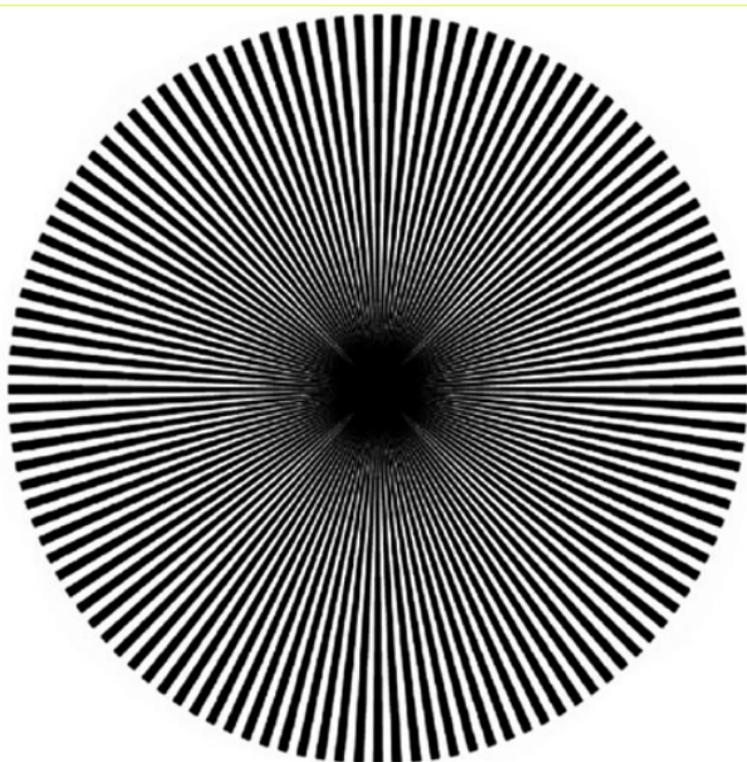
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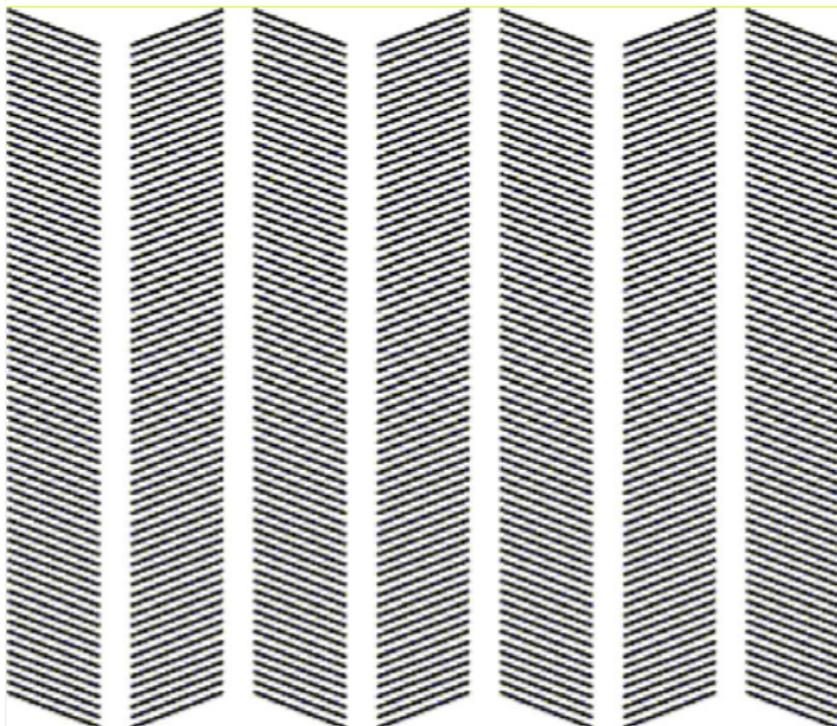
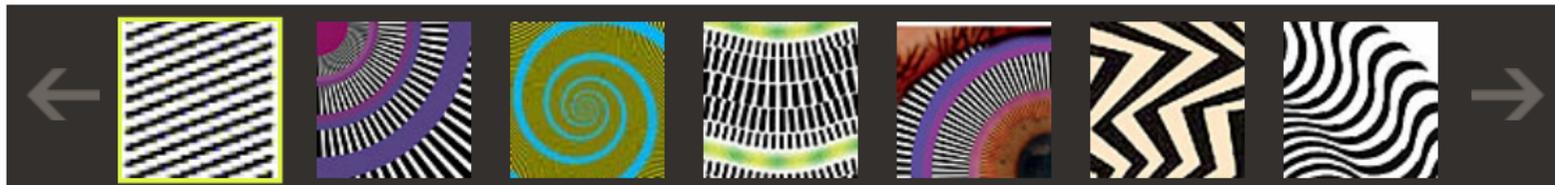
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### MacKay Rays

This illusion, created in 1957 by neuroscientist Donald M. MacKay (then at King's College London in England), shows that simple patterns of regular or repetitive stimuli, such as radial lines (called "MacKay rays") can induce the perception of shimmering or illusory motion at right angles to those of the pattern. To see the illusion, look at the center of the circle and notice the peripheral shimmering.



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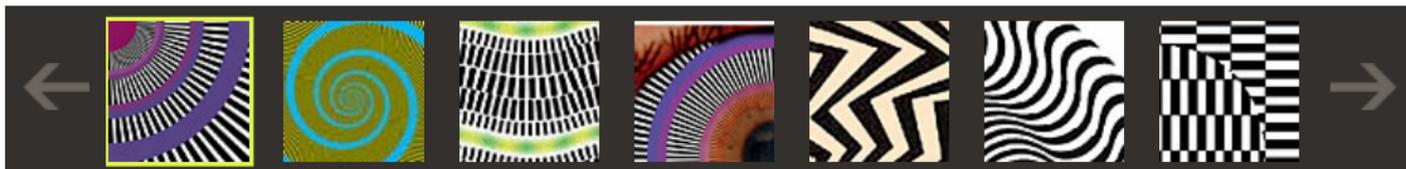


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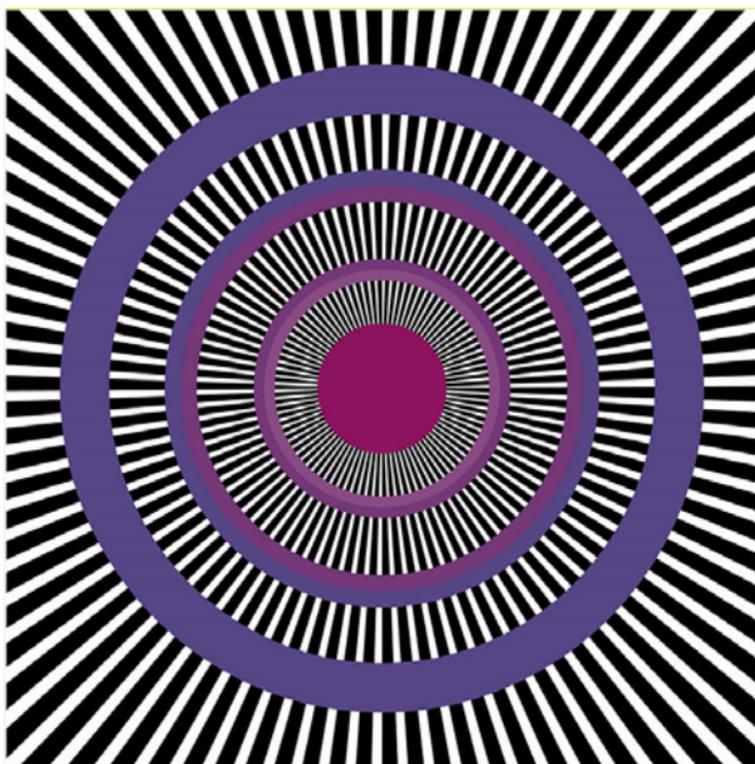
#### BBC Wallboard

This illusion has its origin as a chance observation. MacKay first observed this effect on the wallboard of a BBC studio: the broadcasting staff had been annoyed by illusory shadows running up and down blank strips between columns of parallel lines.

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### The Enigma Illusion

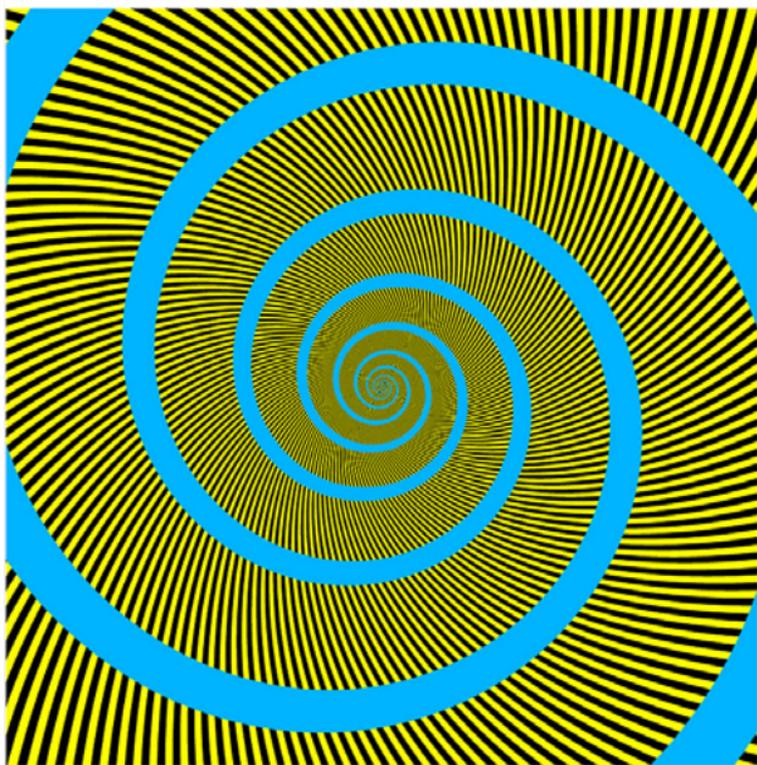
Op artist Isia Leviant unknowingly combined the MacKay Rays and the BBC wallboard illusion in the now classic Enigma illusion. Several original Leviant paintings illustrating this effect hang in the San Francisco Exploratorium, including its very first version (known as the Traffic Illusion). As you view the Enigma image, notice how the concentric purple rings appear to fill with rapid circular motion, as if millions of tiny and barely visible cars were driving hell-bent-for-leather around a track. But does the illusion originate in the mind or in the eye? The evidence was conflicting until we [found](#), in collaboration with our neuroscientist colleagues Xoana G. Troncoso and Jorge Otero-Millan, at the Barrow Neurological Institute in Phoenix, Arizona, that the illusory motion is driven by microsaccades: small, involuntary eye movements that occur during visual fixation. The precise brain mechanisms leading to the perception of the illusion are still unknown, however. One possibility is that microsaccades produce small shifts in the geometrical position of the peripheral portions of the image. The reversals in contrast that these shifts produce could then create the illusion of motion. Neuroscientist and artist Bevil Conway and his colleagues at Harvard Medical School recently [showed](#) that pairs of stimuli of different contrasts can generate motion signals in visual cortex neurons, and proposed that this neural mechanism may underlie the perception of illusory motion in certain static patterns.

The image is courtesy of Jorge Otero-Millan

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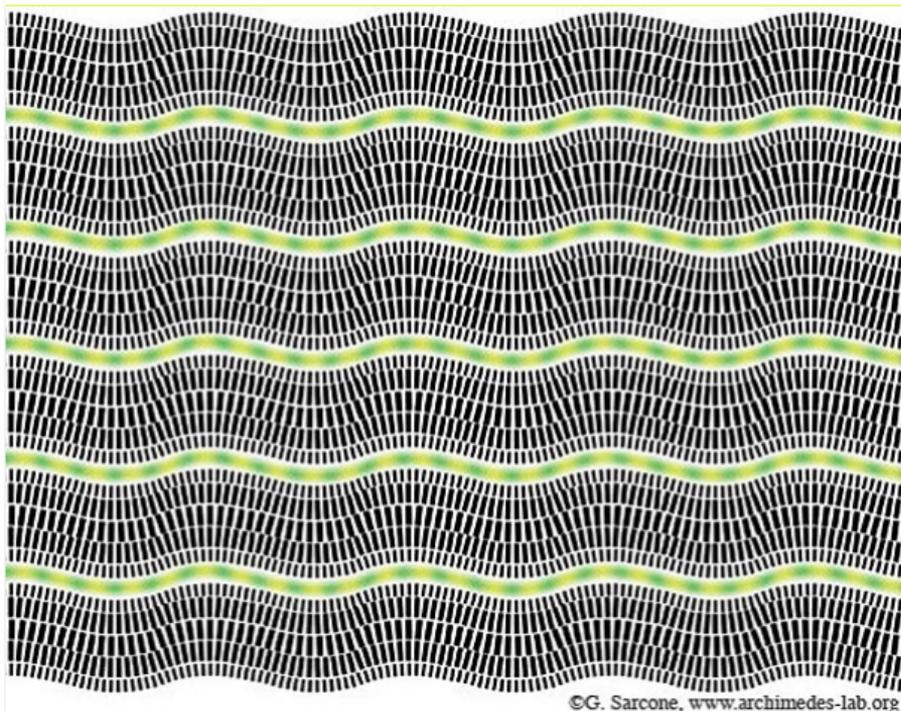


### Op Art Is Alive and Well

Vision scientist Akiyoshi Kitaoka at the Ritsumeikan University in Kyoto, Japan, follows on the footsteps of the great op artists of some decades ago. Waterway Spirals is a compelling and powerful version of Leviant's Enigma. Notice the strong illusory motion along the blue spiraling stripe.

Courtesy of Akiyoshi Kitaoka

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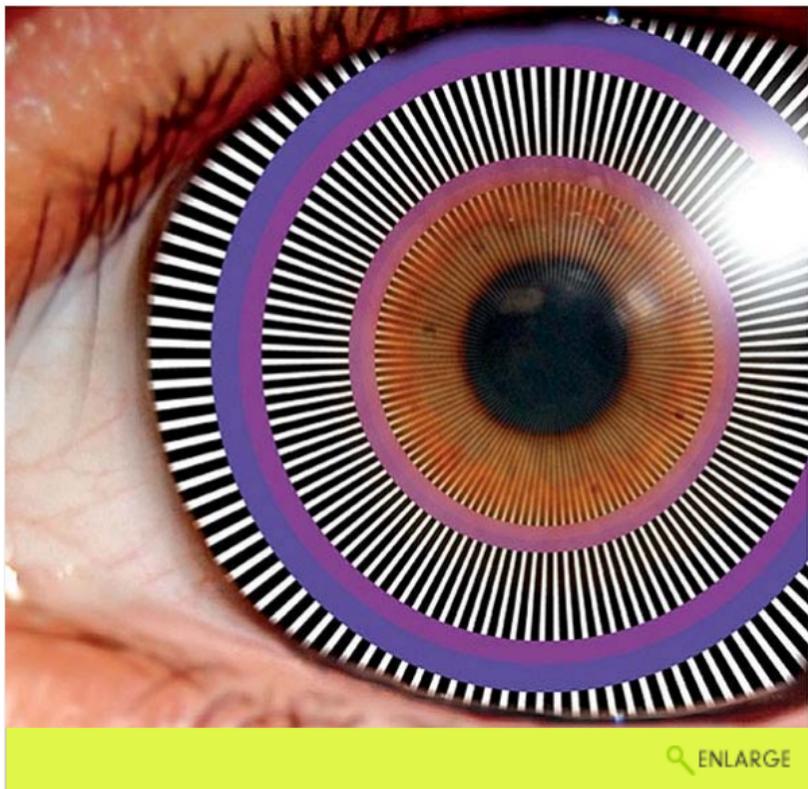


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### Christmas Lights

The Christmas Lights illusion, by visual illusion artist Gianni A. Sarcone, is also based on Leviant's Enigma. Notice the appearance of a flowing motion along the green-yellow stripes.

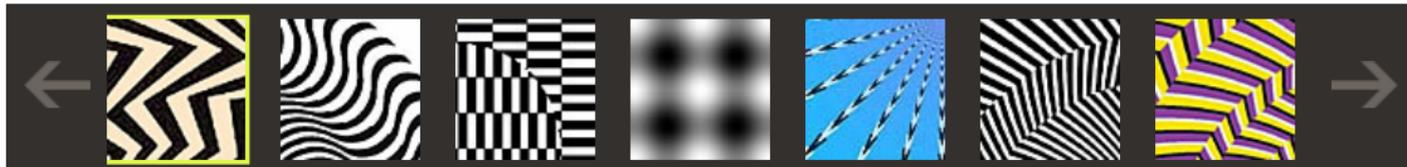


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### Enigmatic Eye

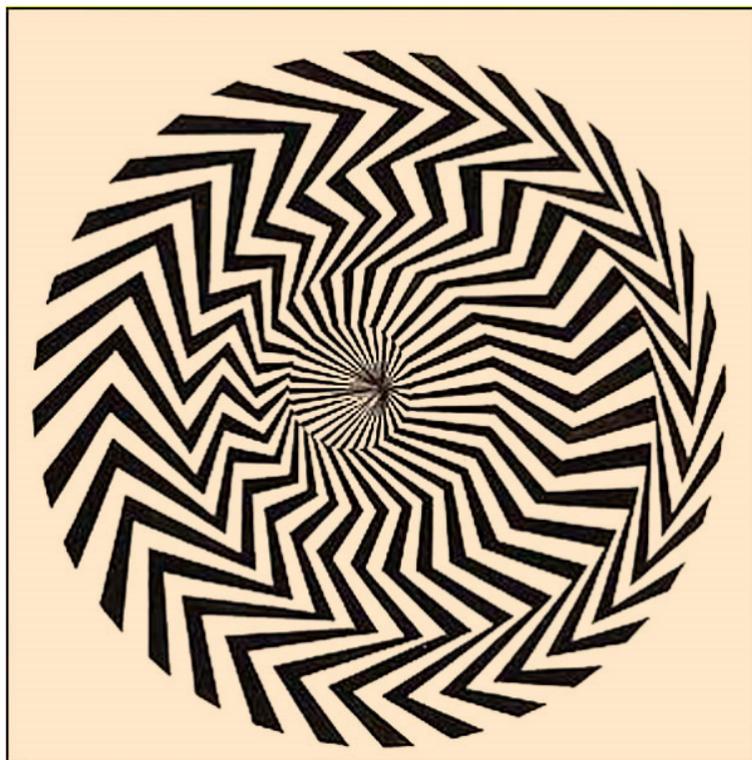
Look at the center of the pupil and you will see the surrounding purple rings fill with rapid illusory motion. Neuroscientist and engineer Jorge Otero-Millan's tribute to Leviant features the illusory motion seen in Enigma, and it also reflects the role of eye movements in the perception of the illusion.



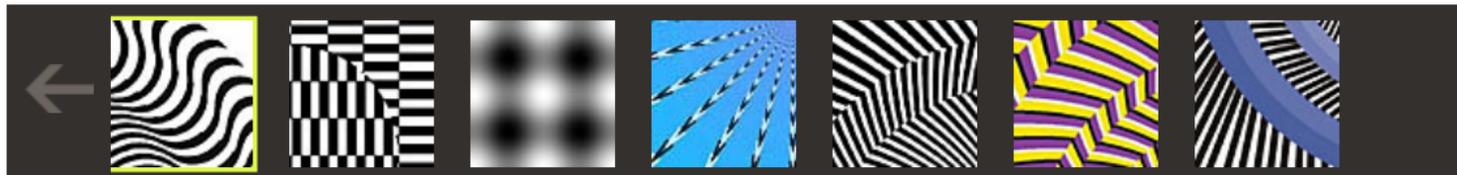
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### Bridget Riley's Motion Illusions

Most of the motion illusions featured in this slide show are potentially triggered by eye movements, both large and small. This pattern, by op artist Bridget Riley, gives the impression of fast spiraling motion as observers move their eyes around the image.



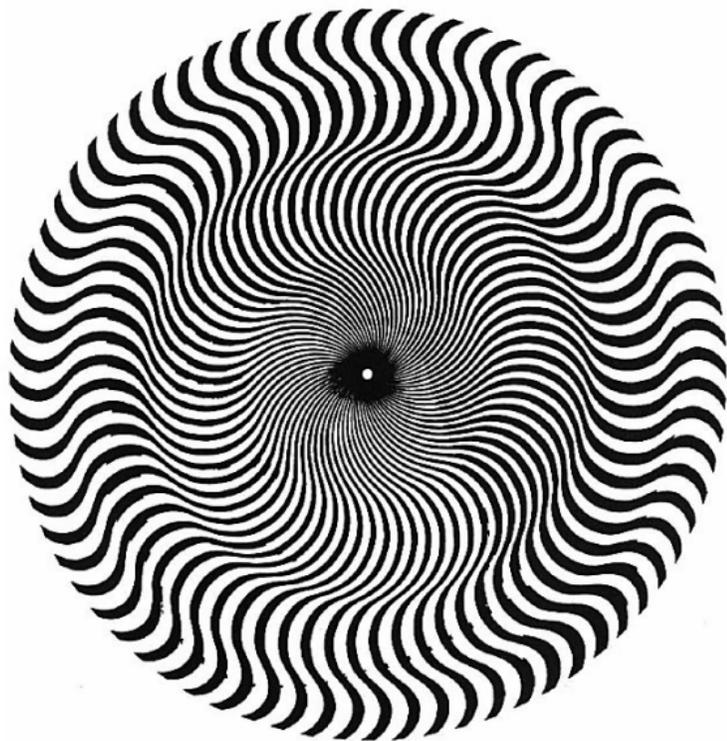
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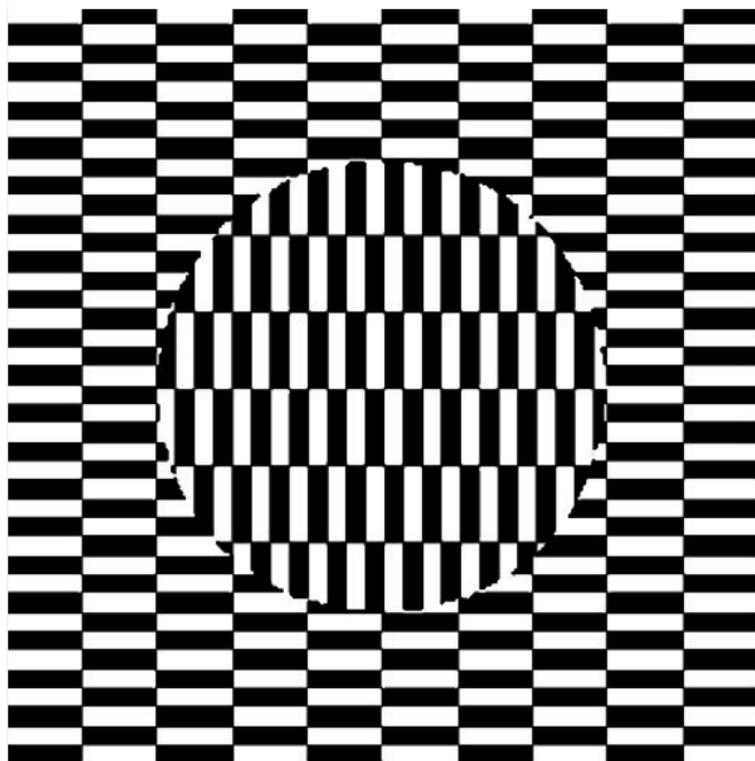
### Bridget Riley's Motion Illusions

In another tribute to Riley, vision scientist Nick Wade of the University of Dundee in Scotland created an example that features both streaming and shimmering motion, and it is reminiscent of various famous Riley artworks.



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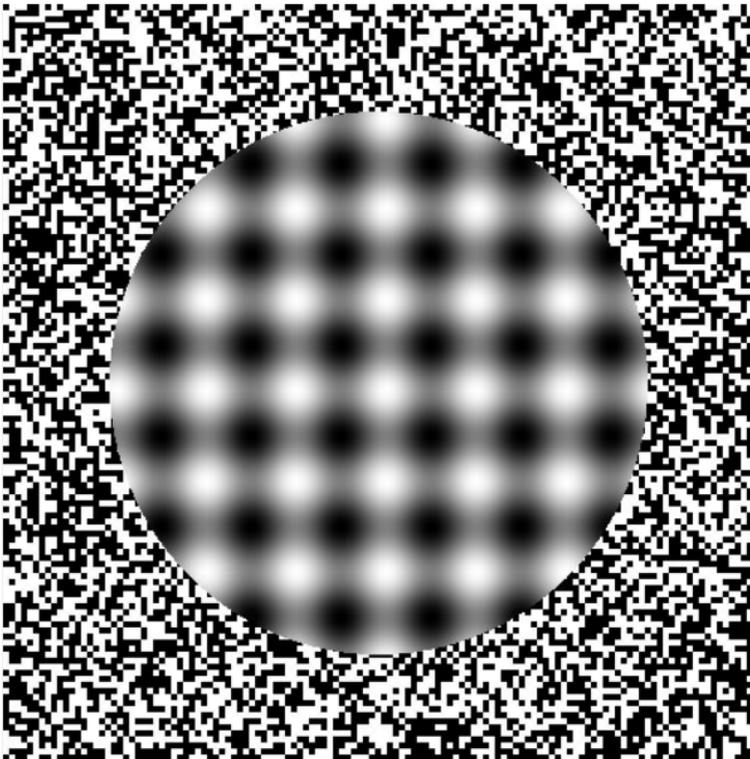
### The Ouchi Illusion

This illusion is by op artist Hajime Ouchi. Move your head back and forth as you let your eyes wander around the image and notice how the circle and its background appear to shift independently of one another. Vision scientist Lothar Spillmann at the University of Freiburg in Germany stumbled upon the illusion while browsing Ouchi's book on *Japanese Optical and Geometrical Art*. Spillmann then introduced the Ouchi illusion to the vision sciences community, where it has enjoyed immense popularity.

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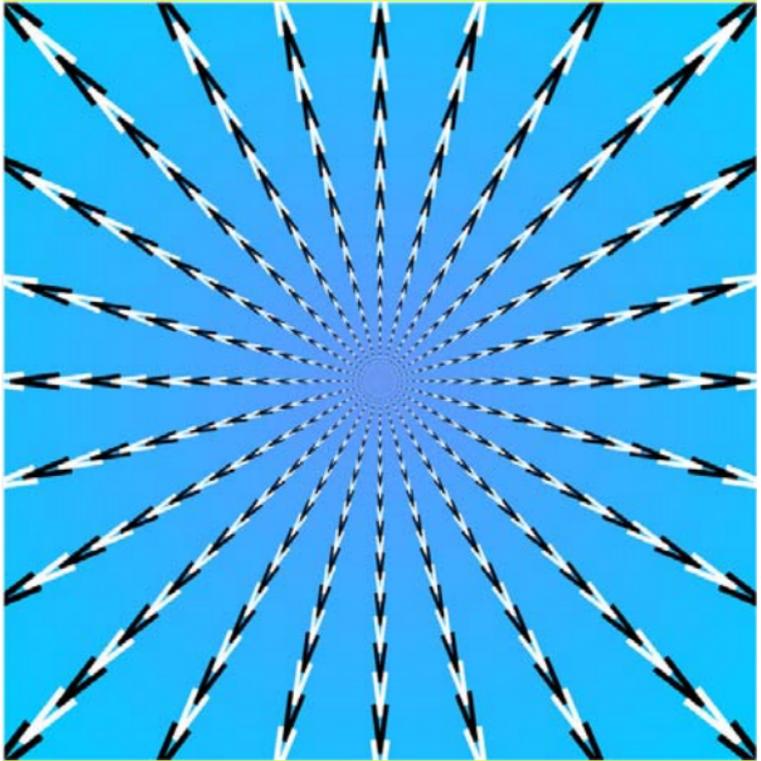
### The Ouchi Illusion

This illusion is a contemporary variation on the Ouchi pattern, by Kitaoka. ♦

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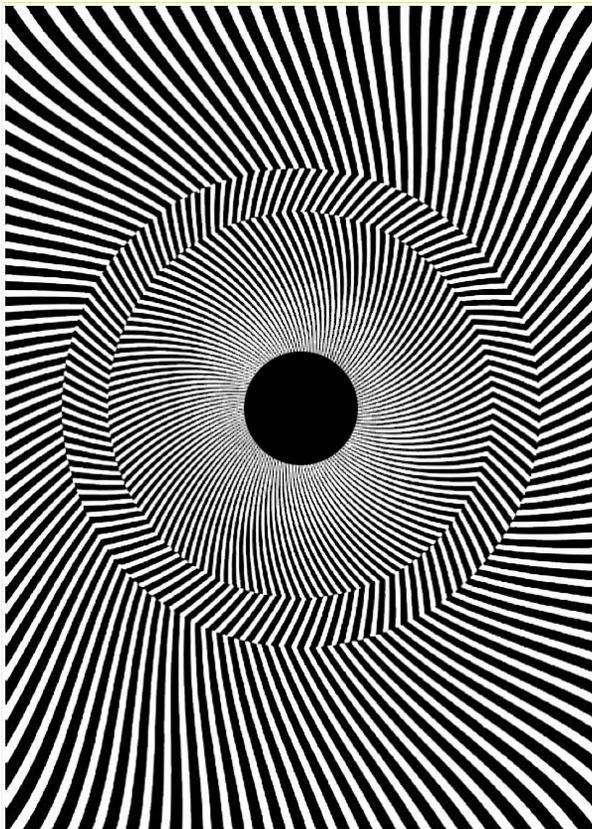
**More of Kitaoka's Op Art**

Hatpin Urchin, by Kitaoka, dramatically demonstrates the importance of eye movements in the perception of this kinetic illusion.

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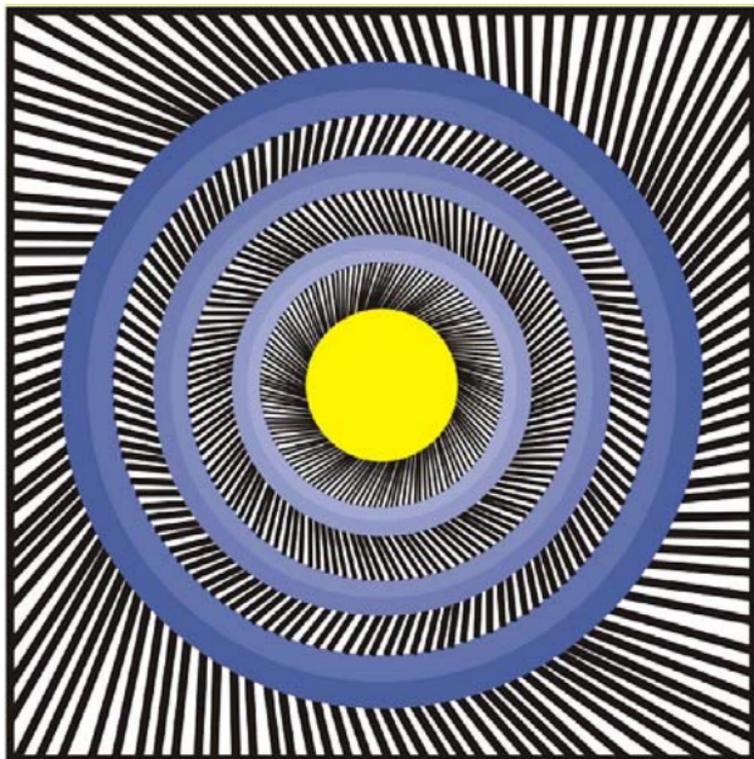
### The Rotating-Tilted-Lines illusion

The Rotating-Tilted-Lines Illusion, by vision scientists [Simone Gori](#) and Kai Hamburger, then at the University of Freiburg in Germany, is a novel variation of the Enigma effect and Bridget Riley's Blaze. To best observe the illusion, move your head closer and then farther away from your computer screen. As you approach the image, notice that the radial lines appear to rotate counterclockwise. As you move away from the image, they appear to rotate clockwise. This illusion was featured in the first edition of the [Best Visual Illusion of the Year Contest](#) (held August 23, 2005, in A Coruña, Spain).

The image is courtesy of Simone Gori.

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#### Combination of the Rotating-Tilted-Lines and Enigma

Gori and Hamburger's combination of the Rotating-Tilted-Lines and the Enigma illusion is both visually arresting and a powerful demonstration of illusory motion from a static pattern. The Enigma illusion, almost three decades after its creation in 1981 by Leviant, continues to inspire visual science as well the visual arts. ♦