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July 8, 2008 in Mind & Brain | 11 comments | Post a comment

## A Perspective on 3-D Visual Illusions

What the Leaning Tower and related illusions reveal about how your brain reconstructs 3-D images.  
By Stephen L. Macknik and Susana Martinez-Conde

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This is the second article in a new Mind Matters series on the neuroscience behind visual illusions.

How could we have missed it? Hundreds, perhaps thousands, of visual scientists, psychologists, neuroscientists, visual artists, architects, engineers and biologists all missed it—until now. The "it" in question is the Leaning Tower Illusion, discovered by Frederick Kingdom, Ali Yoonessi, and Elena Gheorghiu of McGill University. In this illusion, two identical side-by-side images of the same tilted and receding object appear to be leaning at two different angles [see [slideshow](#)]. This incredible effect was first noticed just last year in images of the famed Leaning Tower of Pisa, but it also works with paired images of other tilted objects.

The Leaning Tower Illusion is one of the simplest visual tricks one can produce, but also one of the most profound to our understanding of depth perception. This fact is why vision scientists are shaking their heads in disbelief that they did not notice the illusion earlier. Kingdom and colleagues first announced the illusion at the [2007 Best Visual Illusion of the Year](#) contest, where it won the First Prize. The annual contest, which we organized and which is hosted by the Neural Correlate Society, celebrates the ingenuity and creativity of the world's premier visual illusion creators, both artists and scientists. Contestants submit novel visual illusions (that is, unpublished, or published no earlier than the previous year). An international panel of impartial judges conducts the initial review, and narrows the dozens of submissions down to the Top Ten best entries. The Top Ten creators then compete in Naples, Florida, during a gala celebration, in which the audience chooses the Top Three winners. First, Second and Third prizes take home the coveted "Guido" (a 3-D illusion sculpture created by the renowned Italian sculptor, Guido Moretti).

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Mind Matters is edited by [Jonah Lehrer](#) the science writer behind the blog [The Frontal Cortex](#) and the book [Proust Was a Neuroscientist](#).

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**kiern** at 1:59 PM on 7/08/08

This is not an illusion - it's obvious. The two pictures are identical... If you actually had 2 parallel cylinders in front of you in separate locations, due to perspective, the 2d projections of the two cylinders would result in 2 different images! If the images are identical but in different locations, they cannot be parallel, so it's obvious that the brain would see things that way. Again, this is not an illusion - it's just due to perspective.

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**kiern** at 2:05 PM on 7/08/08

Just want to add - one misunderstanding here is that people forget that eyes (and thus the brain) see the world in angular coordinates - not height and width in pixels. The two 'identical' images when transformed to projected angular images are not really identical.

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**kiern** at 2:28 PM on 7/08/08

Just re-reading the article again - this part really gets me: "This incredible effect was first noticed just last year". This 'illusion' is a simple result of basic trigonometric principles that have been well understood for hundreds of years, how it can be considered a new discovery I have no idea.

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**danshil** at 9:32 PM on 7/08/08

kiern, I think you're missing the point. This doesn't have to do with perspective. In the visual illusion slide show the side-by-side pizza tower and railway pictures are the exact same. Yet the towers appear to be leaning in different directions (one on the right more to the right) and the railway rails appear very different (one on the right appears to run further into the distance, as I see it). This is an illusion, the images are the exact same, yet they appear different.

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**kiern** at 9:07 AM on 7/09/08

The following is a direct response to this [comment](#). This is a simpler way of looking at it, but not entirely accurate as thinking about the angular projection - think about simple perspective drawing principles... when parallel lines get further away, the 2d projection of them converges to a point. The vertical lines in the picture of the tower are all getting further away and therefore they all converge to a point. However, if you copy the picture and put it next to the first, the vertical lines in the second picture do not converge to the same point, therefore they cannot be parallel with the first tower - hence it IS leaning in a different direction. If it was leaning in the same direction it would have to be a different image, where the vertical lines converged with the vertical lines from the first picture. Again, this principle has been understood in art for hundreds of years.

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**czetie** at 6:16 PM on 7/09/08

Kiern and danshil, I think I can reconcile what you both are saying like this: If you look at the two pictures independently you would perceive and describe the towers as leaning the same way -- obviously, since they are identical. BUT when you look at them side by side, your brain tries to make sense of them as a single scene, which is how we usually expect to engage the world. Considered that way, Kiern's explanation makes sense: since the parallel lines don't converge to a common vanishing point, the brain interprets the towers as leaning differently, which they would have to be "if they were part of a single coherent scene". I suspect that this disconnect is what creates the illusion. What scientists are claiming is newly discovered is not the well-understood perspective principle, but the powerful exploitation of it to provoke this gap between perception (different leans) and reality (identical leans) when two pictures are viewed side by side: we see something we "know" isn't true..

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**david\_42** at 8:13 PM on 7/09/08

I find it interesting that they feel it is a function of the way our minds process clues for depth perception. If I cover my dominate eye, I still see the illusion. However, covering my other eye & and viewing the images with just my dominate eye, the illusions disappear.

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**DJ** at 10:23 PM on 7/09/08

Actually that isn't really new, we often noticed that effect as Scientific Photography students at RMIT back in the 1980's.

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**william\_fairholm** at 3:06 PM on 7/10/08

I find that if I close one eye and look at each picture individually I still perceive the angle as different between the two pictures. I can make the angle appear the same by moving my head sideways. This agrees with others who have said that the image is not really the "same" for each eye. I wonder if this is more related to the same effect as looking at a photograph of a person. As you move about, the eyes seem to follow you even to extreme angles. We are interpreting the flat photograph as a 3-d object. The angle you have to the photograph will change the perceived angles in the photograph. Obviously two side by side photos will have different angles. It is not that they are side by side that causes the illusion, it is that they are at different angles on our retina. The side-by-sideness makes this difference more obvious.

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**Eye Illusions** at 5:04 PM on 7/12/08

Eye Illusions are awesome!

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