October 6, 2009 | 6 comments

Illusions: What's in a Face?

This is the ninth article in the Mind Matters series on the neuroscience behind visual illusions

By Susana Martinez-Conde and Stephen L. Macknik

Our brains are exquisitely tuned to perceive, recognize and remember faces. We can easily find a friend's face among dozens or hundreds of unfamiliar faces in a busy street. We look at each other's facial expressions for signs of appreciation and disapproval, love and contempt. We carefully select the images to go with our Facebook profiles. And even after we have corresponded or spoken on the phone with somebody for a long time, we are often relieved when we meet him or her in person and are able to put "a face to the name."

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Illusions Slide Show: What's in a face?

The neurons responsible for our refined "face sense" lie in a brain region called the fusiform gyrus. Lesions or trauma to this brain area result in a rare neurological condition called prosopagnosia, or face blindness. Prosopagnostics fail to identify celebrities, close relatives, and even themselves in the mirror. But even those of us with normal face recognition skills are subject to many illusions and biases in face perception.

This month's slide show focuses on face illusions and their neural bases.

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Illusions Slide Show: What's in a face?

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finaleyes at 07:35 PM on 10/07/09

I think you got the names a little wrong. I don't think it's Oliva and Antonio Torralba but rather Aude Oliva and Antonio Torralba.

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PetriDishFan at 09:04 PM on 10/09/09

This is so amazing. I love things that make my brain think without me really thinking.

If Mona Lisa had a man's name like, Mana Louis, would everyone to this day believe he was a man? His face is so plane it could be a man...

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Bugsy at 12:42 PM on 10/10/09

Dude, I think I might be gay.

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JohnReed at 08:33 PM on 10/11/09

So my thoughts are what does it matter if you like a guy or a girl or both, it takes away the big drama society makes about the issue, yeah guys can be pretty too,no big deal about whatever sex you like.

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DeniseM-TorontoOnt at 03:39 AM on 10/12/09

In Yang's Iris illusion, it looked the other way around to me. What, I wonder, does that mean?

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kasim at 04:29 AM on 10/12/09

can any one remembers his face without seeing in any reflective object?...
the faces which we remember are already present in our mind
once we have captured, remembering those faces is mater of activation ,when we come to contact with those faces again we remember those faces again..

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The 2009 Nobel Prizes
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Richard Russell/Gettysburg College

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The Illusion of Sex

The Illusion of Sex, by Harvard psychologist Richard Russell, won Third Prize at the 2009 Best Visual Illusion of the Year Contest. The two side-by-side faces are perceived as male (right) and female (left). However, both of them are versions of the same androgynous face. The two images are exactly identical, except that the contrast between the eyes and mouth and the rest of the face is higher for the face on the left than for the face on the right. This illusion shows that contrast is an important cue for determining the sex of a face, with low-contrast faces appearing male and high-contrast faces appearing female. And it may also explain why females in many cultures darken their eyes and mouths with make-up. A made-up face looks more feminine than a fresh face.

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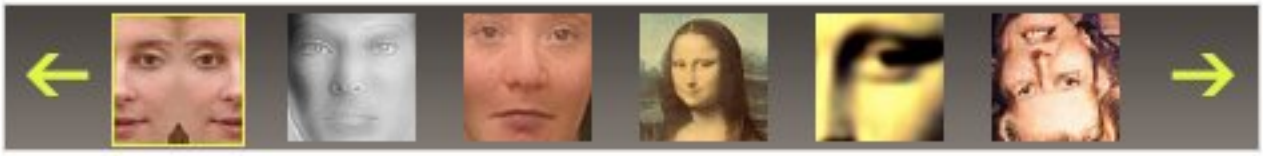

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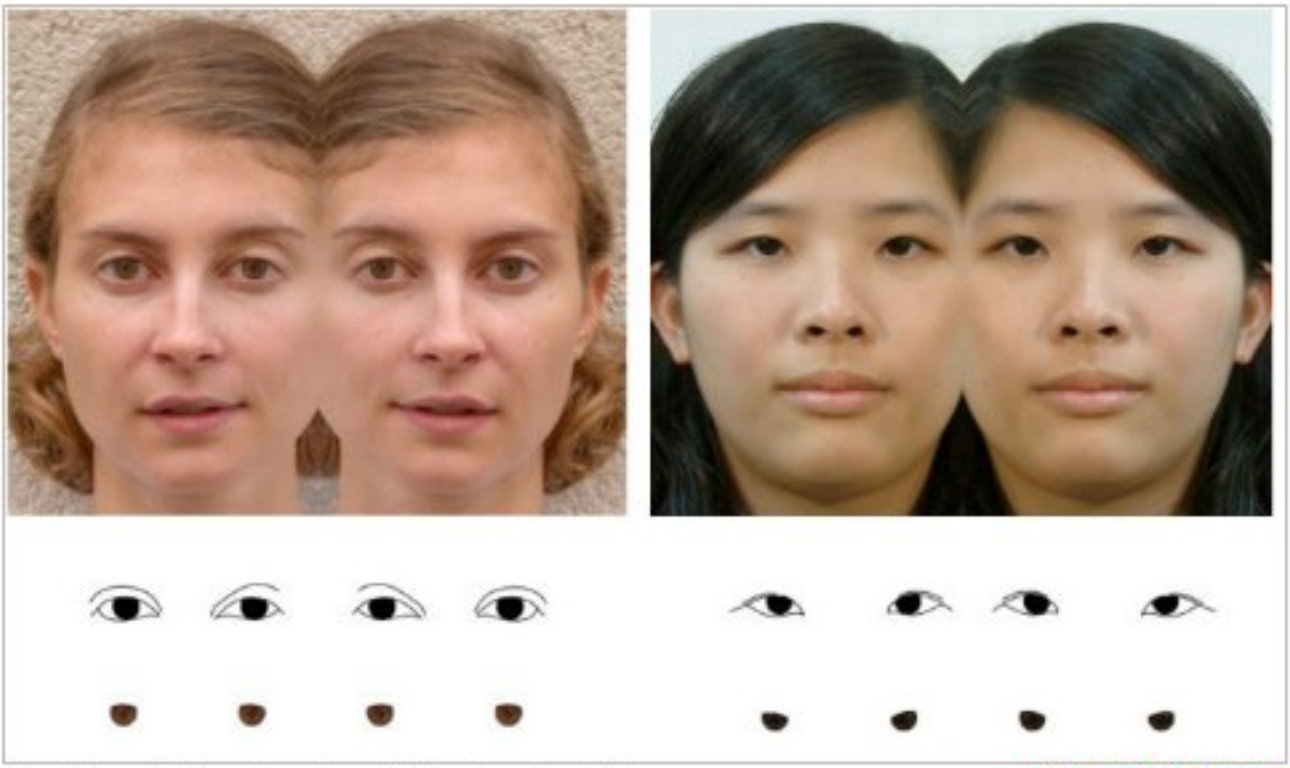

Jisien Yang & Adrian schwaninger (University of Zurich) CLICK TO ENLARGE +

Yang's Iris Illusion

This illusion, by vision scientists Jisien Yang and Adrian Schwaninger, was a TOP 10 finalist in the 2008 Best Visual Illusion of the Year Contest. It shows that context, such as the shape of the eyelids and face, affects the apparent distance between the irises. Consider the pair of Asian faces in the accompanying slide. The distance between the left eye of the right face and the right eye of the left face seems short. In the Caucasian set of faces, the same exact separation looks much wider. It's all an illusion. Notice the drawn reconstructions of the eyes and irises below each face and you'll see that, without the context of the Asian versus Caucasian face and eyelid shapes, the irises are equally spaced.

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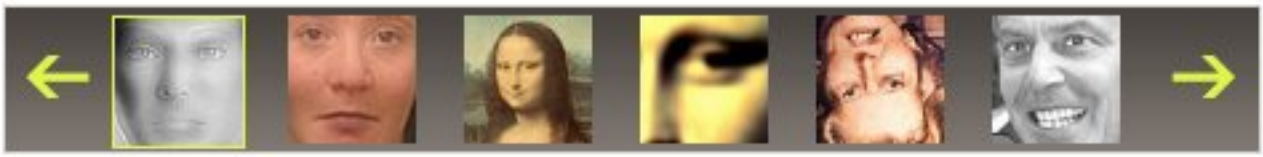

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Aude Oliva, MIT and Philippe Schyns, University of Glasgow

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Dr. Angry and Mr. Calm

MIT vision scientist Aude Oliva and University of Glasgow researcher Philippe Schyns created this illusion by producing hybrids of two images. The left picture shows Dr. Angry, and the picture on the right Mr. Calm. But if you step away from your computer screen you will see that appearances can be deceiving. Nice Mr. Calm becomes Dr. Angry, and that nasty Dr. Angry turns out to be a pretty decent fellow after all. Fine details are blurred away as you step back, leaving you with only the overall shapes and shadings of the images: what vision scientists refer to as the low spatial frequency content of an image. When you step up close again, the images are once again dominated by their fine details, which are referred to as high spatial frequencies. The illusion works because the left face is composed of a high spatial frequency angry face with a calm face in low spatial frequencies. The right face is exactly the opposite. When the images are blurred (by stepping away) the different layers of the hybrid are revealed.

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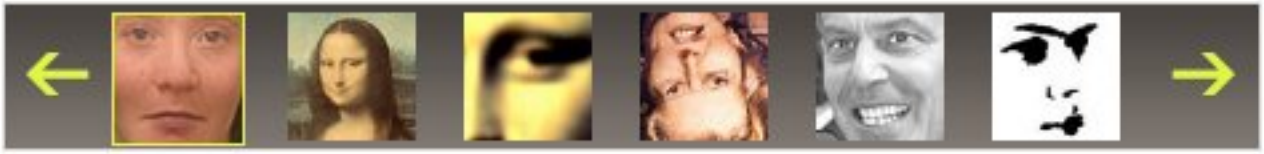

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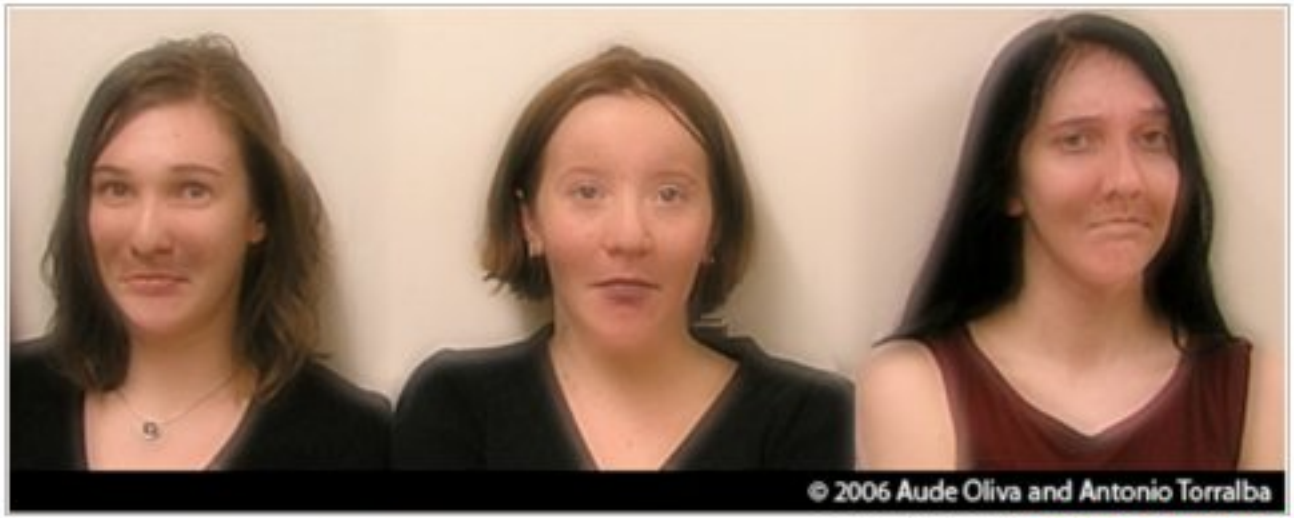

Aude Oliva and Antonio Torralba, MIT

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Happy Pouting

Hybrid effects can be also created with realistic photos, as in this image by Oliva and Antonio Torralba at MIT. The three women look sad at close range, but happy when observed from far away. You guessed it: each face is a hybrid composed of two overlapping pictures of the same woman, one of them with high spatial frequencies (sad) and one with low spatial frequencies (happy).

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Mona Lisa Smile

Mona Lisa's captivating smile is perhaps the most renowned art mystery of all time. Margaret Livingstone, a neurobiologist at Harvard Medical School, showed that Mona Lisa's smile appears and disappears due to different visual processes used by the brain to perceive information in the center versus the periphery of our vision. Look directly at Mona Lisa's lips and notice that her smile is very subtle, virtually absent. Now look at her eyes, or at the part in her hair, while paying attention to her mouth. Her smile is now much wider. The movement of our eyes as we gaze around Mona Lisa's face make her smile come alive, flickering on and off from perception. The center and periphery of the visual field have this differential effect on perception because the neurons at the center of our vision see a very small portion of the world, giving us high resolution vision. Conversely, the neurons in the periphery see much larger pieces of the visual scene and thus have lower resolution.

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Margaret Livingstone, Harvard Medical School

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The Da Vinci Code of Perception

Mona Lisa's smile can be explained by the fact that images are blurred in the periphery of our vision, and her smile is only seen when blurred. Livingstone solved this mystery by simulating how the visual system sees Mona Lisa' smile in the far periphery, the near periphery, and the center of our gaze (panels left to right). The simulation was done in Adobe Photoshop by simply blurring and deblurring the painting to simulate the change in resolution from the center of vision to the far periphery. The smile appears on the left and middle panels (far and middle visual periphery), but is gone on the right panel (center of gaze). The effect is similar to those in slides 3 through 5, and it is also explained by the fact that different retinal neurons are tuned to different spatial frequencies. In a sense, Leonardo Da Vinci painted the Mona Lisa as a hybrid, with a happy Mona Lisa superimposed on a sad one, each having different spatial frequency content.

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Peter Thompson/University of York

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Margaret Thatcher Illusion

This illusion by Peter Thompson of York University (UK) was a critical discovery in our understanding of face perception. When the illusion was discovered in 1980, scientists already knew that faces were difficult to recognize upside-down. But the assumption was that, since the brain always sees faces right-side up, the face-recognition cells were optimized for right-side up faces. This assumption was partially true, but the Thatcher illusion went further to show that the brain doesn't simply process and store representations of whole faces per sé, but rather individual face-features (mouth, eyes, etc) in isolation of each other. The top and bottom row of Thatchers in the accompanying slide are identical to each other, but flipped vertically. The top row looks like two upside-down Thatchers, no problem there. But the bottom row looks like a Thatcher on the left, and a horrible mutant on the right. The reason is that, whereas the left column are normal faces (though the upper face is upside-down), the right column are Frankensteinish composites of Thatcher with only the eyes and mouths flipped vertically. The top right Thatcher doesn't freak you out because the eyes and mouth are right-side up (though the overall face is upside-down), and your face-perception neurons therefore see them as "normal" (even though they don't match the rest of the face). The bottom right image, to the contrary, is creepy because the eyes and mouth are upside down and thus all wrong, despite the fact that the face as a whole is right-side-up. Harvard neuroscientists Winrich Freiwald, Doris Tsao, and Margaret Livingstone have now found neurons in the brain that are selective to specific face-features such as mouths and eyes, confirming the predictions that were made from this illusion several decades earlier.

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Stuart Anstis

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Tony Blair Illusion

Vision scientist Stuart Anstis of the University of California, San Diego, created this illusion in 2005 to celebrate the 25th anniversary of the Thatcher illusion. Anstis reasoned that if face-neurons prefer right-side up face-features, they should also be selective for other evolutionarily stable aspects of faces. He tested this idea by comparing positive and negative images of Tony Blair. Because we have evolved to see faces only in positive contrast, it follows that the perception of individual face-features should fail if shown in negative. As with the Thatcher illusion, manipulating the whole face (as in panel A) made it less recognizable than the normal face (in panel C). Using positive images of the mouth and eyes overlaid on a negative face doesn't look particularly grotesque either (as in panel B). But a positive image of Blair with negative mouth and eyes is just as horrid as the upside-down mouth and eyes in the right-side up Thatcher (previous slide, lower-right).

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Aaron Schurger, Princeton University

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Mooney Faces

Our nervous systems are hardwired to detect and process faces rapidly and efficiently, oftentimes with very scarce details available. The pictures in the accompanying slide are often referred to as Mooney faces, after cognitive psychologist Craig Mooney, who used similar images in his research on perception. Mooney faces illustrate how little visual information it takes to "see" a face.

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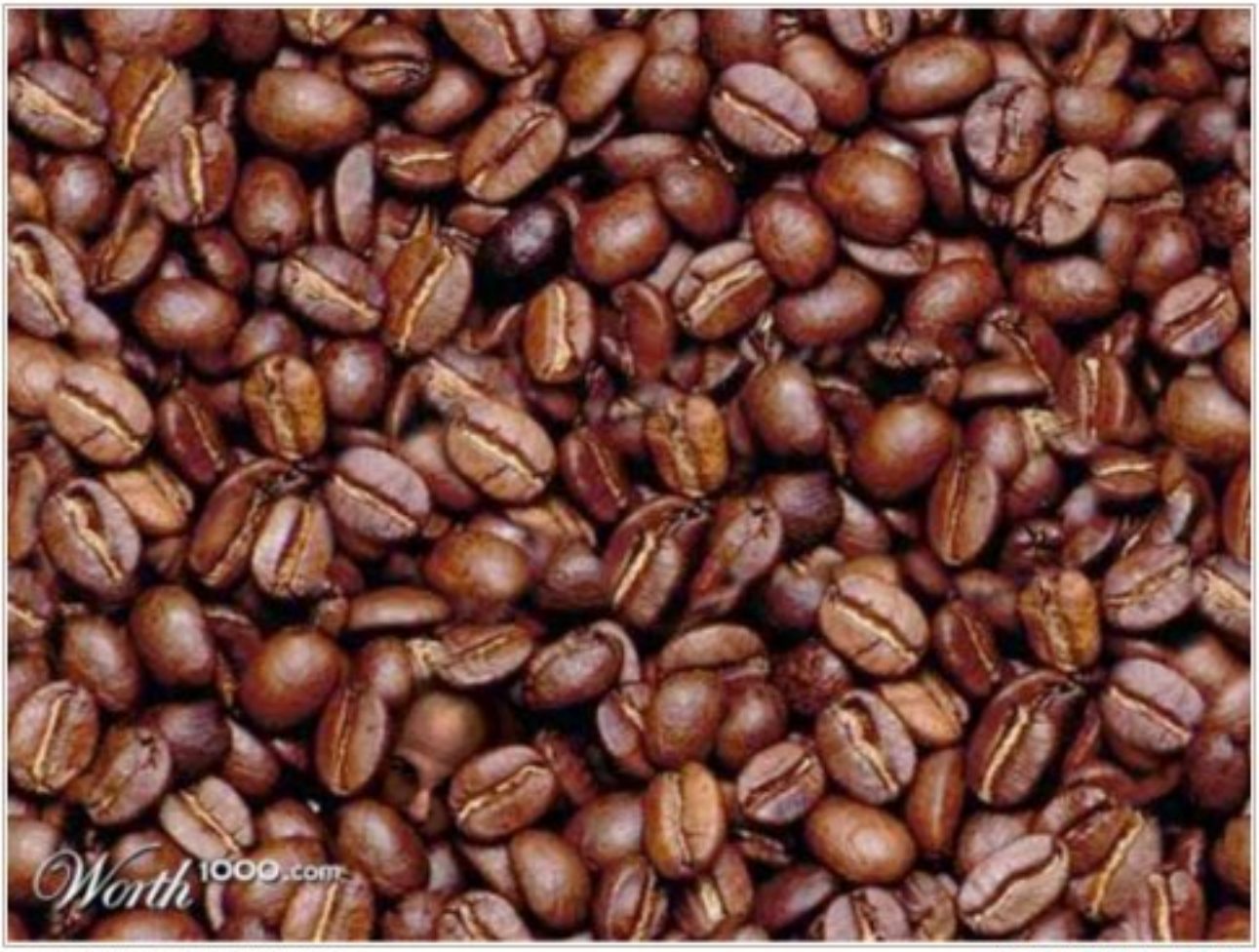

Image courtesy Frits Bonjemoor

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Coffee Face

Our face-detection neural machinery can be overloaded. There's a man's face hidden in this image. But before we spill the beans about its location, look around and see if you can find it yourself. It's difficult! Don't give up too quickly: finding the face may take you a few minutes the first time you look. But once you have seen it, you will always find it immediately in every subsequent search.

Given up? It's in the lower left quadrant near the bottom edge, about one-third across the image from the left.