Hybrid images - the latest optical illusion

Click to Print

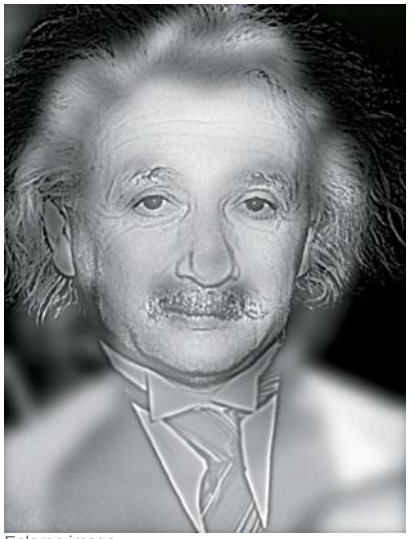
31 March 2007
NewScientist.com news service
Gregory T. Huang

Click on the top right image and take a good look - what do you see? Close up it is clearly a faintly phantom-like image of Albert Einstein. Now step back 5 metres from the screen and take another look. Notice anything different?

It's not just a crafty illusion. This sort of image is being used as a tool to understand better how our brains process visual scenes. On the practical side, some companies are interested in using them to conceal information from unintended observers - or to create printed advertising that morphs before your eyes.

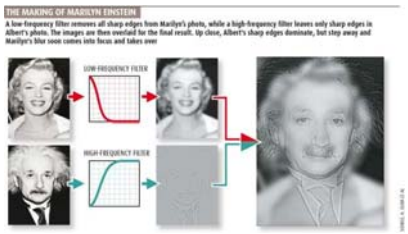
The idea behind hybrid images is not new. For decades artists have been creating works that look different depending on how they are viewed, such as Salvador Dali's 1940 painting *Slave Market with the Disappearing Bust of Voltaire*. Computer-generated hybrid images date back to the mid-1990s when neuroscientists Aude Oliva and Philippe Schyns at the University of Glasgow devised them to help probe how and when the brain recognises objects at different resolutions, such as coarse features versus fine details. When you drive down the street or look out of the window, your eyes are bombarded by objects of different sizes, shapes and colours. By manipulating what you see, researchers are beginning to pin down how your brain deciphers all this information.

The trick in these images lies in the way they are created. Take two original images - Albert Einstein and Marilyn Monroe, say, as on the previous page. The photo of Einstein is passed through software that keeps sharp details such as nose wrinkles but filters out gross features like mouth size. Conversely, the image of Marilyn is passed through software filters that do the opposite, keeping only her coarse features. In each case, the software breaks down each picture into its "spatial frequencies". The low frequencies come from features that change gradually over the picture, like skin tones. Edges and sharp lines translate into high frequencies. Einstein gets his low frequencies removed, so only his sharp-contrast features remain, while Marilyn gets her high frequencies removed, so she looks blurred (see "The making of Marilyn Einstein"). Superimpose the results and you get the hybrid image, a face that looks like Einstein up close but Marilyn from farther away.



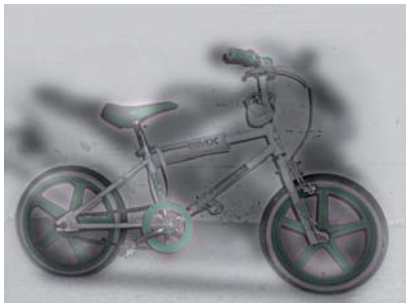
Enlarge image
Behind this great man is a beautiful woman

Enlarge image
Aligning the eyes and heads of the cheetah and tiger (far right) produces a better illusion



Enlarge image

What's going on in your brain when you look at these pictures? The standard view is that when you look at a scene, your brain processes visual information at different scales in parallel. By flashing hybrid images before people for various lengths of time and recording what the viewers said they saw, Oliva and Schyns discovered that there is a timing difference when it comes to processing the different resolutions.



Enlarge image
Viewed from a distance, the shadow dominates the picture

The processing for coarse features, such as groups of large objects, happens fastest, within 50 milliseconds, giving the viewer an immediate general sense of the scene; then come the finer details like edges and faces, which take 100 milliseconds or more to register. If you caught only a glimpse of a city street scene, for instance, you'd tend to notice the buildings before the pedestrians.

To build on their discovery, the researchers wanted a more effective way to demonstrate this boundary between competing brain processes. Together with Antonio Torralba at the Massachusetts Institute of Technology, they refined hybrid images to produce more enduring and reversible illusions, like the ones above, that depend on your distance from the image.

It's all in your head

Two things happen as you step away from the image. First, the sharp details of one overlaid picture give way to the blurry shape of the other. Second, your brain somehow reinterprets this blur as a different person or object - a process known as perceptual grouping. "We have put together two known processes into a way to probe the mechanism of the brain," says Oliva, who is now at MIT.

This technique is useful because it can trigger the brain to arrive at different interpretations of the same scene. What's more, the distance at which the transition between the images occurs can be controlled quite precisely. By tweaking the filters used to modify the original pictures - changing the amount of contrast and blur in the superimposed pictures or the amount of overlap between them, for instance - the researchers can make the transition either slow and ambiguous, or fast and startling. They hope this will allow them to test ideas about how perceptual grouping takes place in the brain, and ultimately which parts of the visual cortex and surrounding regions give rise to visual interpretations of a scene. "This is a tool to study how the brain recognises the visual world, and whether we are conscious of something or not," says Oliva.

Some researchers think hybrid images will be most useful when combined with other brain analysis techniques. "They are cute, an example of how visual psychologists can manipulate what you see," says Christof Koch, an expert in the neurobiology of vision at the California Institute of Technology in Pasadena. However, the images by themselves won't tell us anything specific about visual consciousness, he says.

"For that, we need to crack open the brain and tie visual percepts, such as hybrid images, to specific brain circuits." Researchers are now developing techniques that would allow them to scan people's brains, and even probe individual neurons, while they are being shown these illusions. This would allow the scientists to pinpoint the brain regions and types of neurons that produce the different visual interpretations.

In the meantime, the technique could have intriguing uses in graphics, electronic displays and advertising. Oliva suggests that stores could use hybrid images to display scenes that are eye-catching from afar and transform into merchandise details up close. They could be used to ensure that cashpoint screens, laptops or cellphone displays are legible only when viewed up close, not by someone looking over the user's shoulder.

Further down the road, Oliva aims to combine more than two images at a time, which could produce yet more surprising effects. Imagine walking down the street and seeing every poster change continuously as you move nearer or farther away. Now that would give your brain something to think about.

From issue 2597 of New Scientist magazine, 31 March 2007, page 35-37