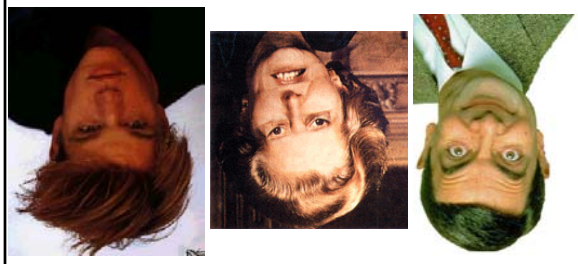
Face Perception

The Thatcher Illusion

Did you notice anything odd about the upside-down image of Margaret Thatcher that you saw before?

Can you recognize these upside-down faces?



The Thatcher Illusion

Thompson P (1980) "Margaret Thatcher: a new illusion." *Perception* **9**, 483-484.

The Face Inversion Effect

Many objects are harder to recognize from unfamiliar views, but the effect is particularly strong for inverted faces.

Perception of overlapped face stimuli

Perception of overlapped face stimuli

Boutet, I. & Chaudhuri, A. (2001) "Multistability of overlapped face stimuli is dependent upon orientation." *Perception* **30**, 743-753.

The Hollow Face Illusion

A concave mask or mould of a face appears convex when viewed from beyond a certain distance. This is the hollow face illusion.

Four views of a hollow mask

What can Hollow Faces tell us about Visual Perception?

The hollow face illustrates how we can use illusions to address important questions in perceptual psychology, for example:

1. How do we perceive three-dimensional space and shape?
2. What prior assumptions do our brains employ in interpreting the visual world?
3. Do our brains process faces in a special way?

Prosopagnosia: inability to perceive faces

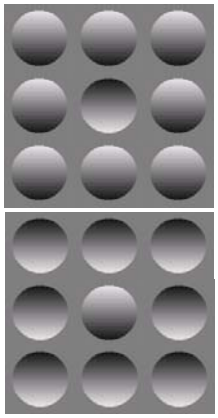
Patients suffering from prosopagnosia have difficulties seeing a face in this image but have no problems identifying component objects that make up the face.

Giuseppe Arcimboldo (1563) *L'Estate*

The Ambiguity of Shape-from-shading

All the normal sources of depth information are present in the hollow face, including shading and stereoscopic disparity.

Shading is fundamentally ambiguous: lighting a convex surface from one direction or a concave surface from the opposite direction produces the same pattern of shading.



The Ambiguity of Shape-from-shading

When the top figure is turned upside-down our perception flips, so that what appeared convex appears concave and vice versa.

It appears that the perception of concavity versus convexity is governed by two implicit assumptions:

1. Lighting is from a single source;
2. The source is located above.

Do our visual systems process faces in a special way?

The hollow face illusion is robust to changes in lighting direction, suggesting that the expectation for faces to be convex outweighs the expectation for lighting to come from above.

The existence of an analogous hollow potato illusion shows that the visual system expects objects in general, not just faces, to be convex. However, the illusion is stronger for faces.

Perception as Hypothesis

In the hollow face illusion, depth information from other sources such as stereoscopic disparity could disambiguate concavity and convexity.

However, this information is over-ridden by the brain's prior assumptions about the world, demonstrating that it is not just the perception of fundamentally ambiguous stimuli that is influenced by prior assumptions.

Thus, we can think of perception as hypothesis testing: a process of matching *bottom-up* sensory information with *top-down* expectations about the world. What exactly constitutes the "top" is unclear: the hollow face illusion persists even when we know we are looking at a hollow mask.

Measuring the Strength of the Hollow Face Illusion

The hollow face illusion disappears when we are too close, typically at viewing distances of one to two meters, as the depth cues in the retinal image become harder for our visual systems to ignore.

The strength of the illusion can be compared for different objects by measuring the distance at which the illusion disappears as we approach different hollow objects. Short distances imply a strong illusion.

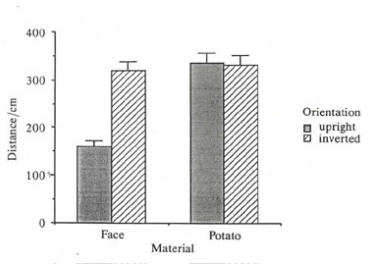
The Hollow Face in Motion

When we move relative to the mask, the changes in the retinal image are also ambiguous.

One side of the face progressively disappears from view as we move around it while the other side gets revealed. The changes in the image of a static concave face are the same as those that would be produced by a convex face turning to follow our movement.

For our perception of a convex face to remain consistent with dynamic occlusion cues requires that the face be seen as turning so as to be self-occluding.

The Effect of Inversion on the Hollow Face & Hollow Potato Illusions



Hill H & Bruce V (1994) "A comparison between the hollow-face and 'hollow-potato' illusions", *Perception* **23**, 1335-1337.

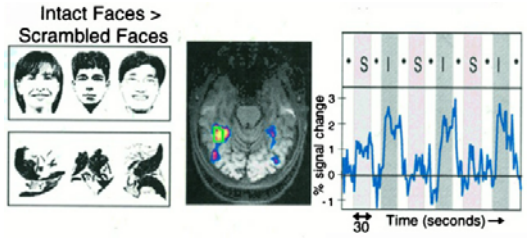
Evidence that we process faces in a special way

1. Dramatic inversion effects.
2. Prosopagnosia.
3. Brain imaging: the fusiform face area (FFA).
4. Holistic processing: context effects.

Perception of Chimeric Faces: Evidence of Lateralized Processing

Observers tend to respond to the emotion presented in their left visual field. This suggests a right hemisphere bias for the processing of emotion.

The Fusiform Face Area (FFA)

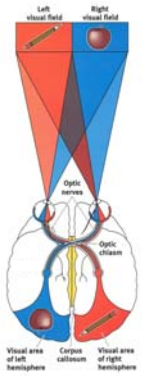


Functional magnetic resonance imaging (fMRI) of the human brain has identified a region of the right fusiform gyrus that responds selectively to faces.

Kanwisher, N. *et al.* (1997) "The fusiform face area: a module in human extrastriate cortex specialized for face perception." *Journal of Neuroscience* **1**, 4302-4311.

Do Mirror-reversed faces appear more expressive?

The right hemisphere bias for the processing of emotion causes emotion to be expressed more strongly on the left side of our face, which falls in the right visual hemifield of an observer. By mirror-reversing a face, the more expressive side falls in the more sensitive left visual hemifield of the observer. Thus, mirror-reversed faces can appear to be more expressive.

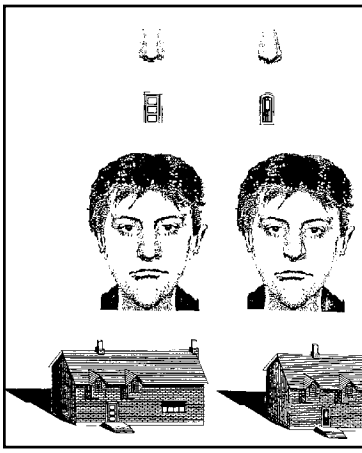


The Mapping of the Visual Field onto Primary Visual Cortex

The *contra*lateral field of view is represented in each hemisphere

Signals from the two eyes run along the respective *optic nerves*, partially crossing over at the *optic chiasm*.

The connections from retina to cortex are arranged such that each *visual hemifield* is represented in the *contralateral* (opposite) hemisphere of the brain.



Holistic Face Processing

Face perception appears to involve a holistic form of processing in which the overall configuration of the parts is important.

Consequently, subjects find it easier to recognize particular facial features when the features are seen in the context of an entire face.

Farah, M. (1996) "Is face recognition 'special'? Evidence from neuropsychology" *Behaviral Brain Research* **76**, 181-189.

Faces are Special

Our faces clearly have a special status in social communication.

Brain imaging studies and the existence of prosopagnosia show that there is a region of the cortex dedicated to processing faces.

Studies of face perception suggest that faces are processed in a special way. Implicit in our visual systems are certain expectations about faces, such as their shape and orientation. When these are not met we can experience some striking illusions.

Brain Teaser: What does a hollow face see when it looks in the mirror?