*Short and Sweet*

PERCEPTION

# The Eyes Wide Shut Illusion

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## Abstract

The new "eyes wide shut" illusion uses a standard enlarging (shaving or makeup) mirror. Close one eye and look at the closed eye in the mirror; the eye should take up most of the mirror. Switch eyes to see the other closed eye. Switch back-and-forth a few times, then open both eyes. You see an open eye. Which eye is it? To find out, close one eye. Whichever you close, that's the eye you see. How can this be possible? The brain is fusing two images of the two eyes! The illusion depends on (a) binocular fusion: The brain combines two images to a single percept; (b) symmetry: Mirrors don't affect appearance of left–right symmetric objects and the eyes are sufficiently left–right symmetric for the brain to combine them. Why aren't the lingering asymmetries sufficient to prevent fusion? (c) Only vision with scrutiny affords conscious access to scene details. Consistent with reverse hierarchy theory, vision at a glance grants conscious perception of the gist of the scene, integrating images of nonperfectly symmetric eyes.

## Keywords

cognition, crowding/eccentricity, features/parts, grouping, imagery, inattention/attention blindness, objects and features, perception, rivalry/bistability, visual illusions

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> together they sing for joy,
> for they **see eye to eye**
> Isaiah 52:8

I discovered an entirely new illusion, the "eyes wide shut" illusion, which I wish to share with you. To experience the illusion, use a magnifying mirror, the kind used for makeup or

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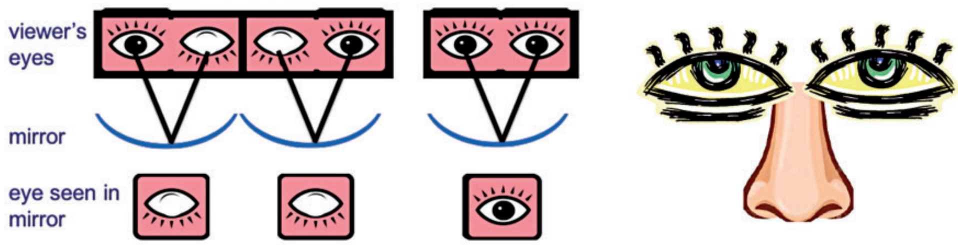


**Figure 1.** The eyes wide shut illusion. Look at a closed eye in a magnifying mirror. Switch eyes and you again see the closed eye. Open both eyes. You perceive a single eye—a composite of the two, each seeing the other. The brain integrates two images, though eyes are asymmetric. Surprisingly, your nose appears on both sides of the composite eye. Bottom: cross-fuse to see different eye images; notice nose on both sides.

shaving, about 10× power. Hold the mirror at eye level, about 15 cm (6 in.) from your nose. Close one eye and look at the closed eye in the magnifying mirror. The image of the closed eye should be in the center of the mirror. Hold the magnifying mirror far enough so the image of the closed eye fills most of the mirror. You may need to stand further away from the mirror if it is lower power.

Now switch eyes so the other eye is closed and look at the now-closed eye in the mirror. You should not need to move the mirror—or your head—to now see the other, closed, eye, with its image filling most of the mirror. Switch back-and-forth several times, opening one, closing the other. You always see the closed eye in the mirror. What will you see if you open both eyes?

Open both eyes; you see an open eye in the mirror. Which eye is it? It's BOTH eyes! Each eye sees the other eye, and the brain fuses the two superposed images and integrates them. Figure 1 demonstrates schematically the three stages of the illusion and what you should see in the mirror, as well as a demonstration, if you can binocularly fuse images.

The integration is accomplished even though eyes are not symmetric and their images aren't identical. Where is your nose in the mirror image? Surprisingly, it's on both sides of the eye. This phenomenon has been presented to many observers, including at Vision Sciences Society (VSS Demo Night, 2017) and Society for Neuroscience (Hochstein, 2017) with ubiquitous surprise, amazement, delight (except those unable to close one eye or with extreme eye dominance (Shneor & Hochstein, 2006)).

## Mirrors

Some aspects of mirror reflections remain puzzling. Why do mirrors seem to reverse left–right but not up–down? Actually, mirrors reverse only forward–backward (Gregory, 1998). Objects between us and a mirror, closer to us, closer to the mirror, appear in the mirror in reverse order: first the further, then the closer, then you. You-A-B—mirror-B′-A′-Your image.

Why do we think mirrors reverse left–right? Real objects can only rotate in space reversing two dimensions at once. When someone turns to face us, he or she has reversed front–back and right–left. They could have stood on their head, facing us, reversing front–back and up–down, but that's unusual. Similarly, compare cars in front of us going in the same direction versus coming toward us. The drivers are on opposite sides of the cars, all on inside lanes. Mirrors are unusual, not reversing right-left. Expecting reversal, nonreversal seems like reversal vis-s-vis expectations.

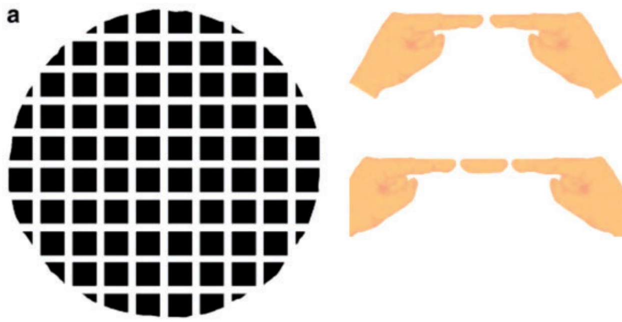


**Figure 2.** Hermann grid illusion demonstrates inappropriate use of mechanisms perceiving relative rather than absolute illumination. Floating-finger frankfurter illusion when eyes cannot fuse two views.

## Visual Illusions

The visual system, bombarded with too much information to grasp and retain, uses tricky shortcuts, condensing information and interpreting scenes in a useful manner. Sometimes, generally appropriate interpretation algorithms are applied inappropriately, resulting in illusions; "seldom taken seriously by science—as errors are generally nuisances to be avoided . . . —illusions . . . reveal how perception works" (Gregory, 2009: 1).

Examples (Figure 2) include the Hermann (1870) grid: Vision transforms absolute illumination intensity to relative brightness, so objects, faces, and texts seem constant over large illumination ranges. Hermann grid gray intersections are less different than their surroundings (four white neighboring "streets") than the streets (two neighboring white-street extensions). Ebbinghaus illusions demonstrate object size perceived relative to surrounding objects (Roberts, Harris, & Yates, 2005). The floating frankfurter illusion (Sharp, 1928), when staring at two nearly touching fingers before the eyes, and diverging the eyes beyond them, reflects inappropriate binocular fusion.

## Binocular Fusion Versus Rivalry

Our eyes commonly receive different views of the world, adding stereo, slant, and luster for objects within limited depth ranges. Outside this range, we see double vision. If you point to a distant object, it doesn't disappear behind your finger because the other eye fills in the view. This phenomenon is so ubiquitous that we don't generally notice it. The exception is when double vision leads to obvious illusions, as the frankfurter illusion. Amblyopia and binocular rivalry reject one scene interpretation (Kovacs, Papathomas, Yang, & Fehér, 1996; Wolf & Hochstein, 2011).

## Scene Gist

Following limited viewing, observers often report only the gist of the scene. Lengthy viewing with scrutiny is required to obtain scene details, leading to change blindness (Rensink, 2002; Sampanes, Tseng, & Bridgeman, 2008), repetition blindness (Kanwisher, 1987), crowding (Levi, 2008), attentional blink (Raymond, Shapiro, & Arnell, 1992), and boundary extension (Intraub & Richardson, 1989).

Hochstein and Ahissar (2002) suggested reverse hierarchy theory (Figure 3) to understand *gist before details* perception. Visual information processing begins with unconscious,

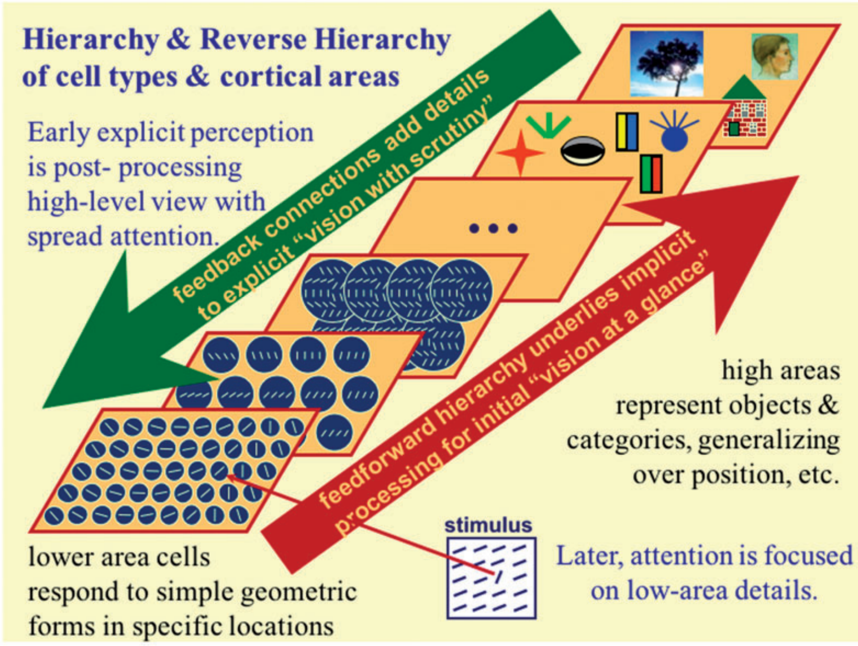


**Figure 3.** Reverse hierarchy theory.

implicit information integration along the visual hierarchy. However, initially only higher level representations are accessed by consciousness. With time and need, consciousness includes scene details through top-down-guided return to access lower level representations. Conscious, reportable, and remembered perception works in reverse hierarchy direction, perceiving first higher level gist with global attention and later with focused attention, scene details.

## Eyes Wide Shut Illusion Demonstrates Binocular Integration and Gist First Reverse Hierarchy

What can we learn from the eyes wide shut illusion? What usually appropriate mechanism is inappropriate here? Binocular fusion is appropriate, but not for reversed asymmetric eye images. The surprise is compounded when noticing our nose on both sides. Why does the brain do it? Because binocular integration is preferred to binocular rivalry if two views are reconcilable. They are, if *vision-at-a-glance* is satisfied with the *gist-of-the-scene*, discounting superfluous, confusing details. Eyes are not symmetric, but close enough. Almond shapes are recognized as eyes; drawings often depict eyes as symmetric—as in Figure 1.

This is the essence of reverse hierarchy theory. Conscious vision begins with "quick-and-dirty" bottom-up scene analyses, discounting discrepancies and achieving most likely interpretations for rapid response. Corrections are left to the following return, down the reverse hierarchy, guided by early gist, to find details already represented there. When discrepancies are found, the visual system surveys alternative interpretations, but in this case, none is found, and binocular integration wins.

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