

# Reversible Figure

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## Reversible Figure

**Primary Disciplinary Field(s):** Cognitive Psychology, Visual Perception, Art Theory

### 1. Core Definition and Ambiguity

A reversible figure is fundamentally defined as an **ambiguous two-dimensional drawing** or visual stimulus that allows the observer's perceptual system to derive two or more distinct, yet equally plausible, alternating interpretations of the implied three-dimensional reality. These figures are compelling because they demonstrate that the sensory input itself is insufficient to determine a singular, stable interpretation. The resulting perception is characterized by an involuntary oscillation, wherein the brain cycles back and forth between the possible views, a phenomenon known as perceptual rivalry or perceptual alternation.

The essence of reversibility lies in the figure's lack of crucial depth or orientation cues, compelling the visual system to generate hypotheses about the spatial organization. The classic example derived from the source material is the **reversible cube** (such as the Necker Cube). This figure is drawn using parallel lines without conventional perspective or shading cues, allowing the two-dimensional representation of the cube to be assigned depth in two different ways. At one moment, the viewer perceives the cube from a high vantage point, with a specific face appearing closest; the next moment, the depth assignment flips, and the same figure appears viewed from beneath, with the previously farthest face now appearing proximal. This inherent instability forces the brain to actively construct and reconstruct the three-dimensional scene repeatedly.

The study of reversible figures is critical because it highlights the **constructive nature of visual perception**. Unlike simple optical illusions, which create a consistent, false perception, reversible figures reveal the brain's necessity to impose order and stability on inherently unstable visual input. The persistence of the figure itself remains constant on the retina, yet the subjective, conscious experience of its organization changes dramatically and automatically. This involuntary cycling underscores the dynamic, active computational processes that underpin the seemingly effortless act of seeing.

### 2. Historical Precedents and Key Examples

The systematic study of reversible figures originated in the 19th century, marking a significant milestone in the development of experimental psychology and visual science. The most famous early example, the **Necker Cube**, was published in 1832 by Swiss crystallographer Louis Albert Necker. Necker initially observed this ambiguity while studying the projected drawings of crystal structures. The cube is simple, consisting only of lines, proving that complex shading or texture is not required to induce perceptual rivalry; the ambiguity rests purely in the structural representation

of depth.

A second major category of reversible figures was formalized in the early 20th century, focusing on the **figure-ground relationship**. Danish psychologist Edgar Rubin introduced the **Rubin Vase** (or Face-Vase Illusion) around 1915. This figure demonstrated that the boundaries within a two-dimensional image could be mutually defined, allowing the viewer to perceive either a central vase (figure) against a background (ground) or two facial profiles (figure) separated by a central space (ground). Rubin's work was instrumental in the formation of Gestalt psychology, emphasizing the principle that perception involves organizing sensory elements into meaningful wholes, and that this organization is inherently unstable when boundaries are ambiguous.

These seminal figures paved the way for modern research and artistic exploitation. Other notable historical examples include the Schröder Stairs, which reverses perceived ascent and descent, and the often-cited ambiguous drawings that present two entirely different semantic interpretations, such as the 'Wife and Mother-in-Law' illustration by W.E. Hill (1915). Collectively, these examples provided the fundamental stimuli required for researchers to dissect the competitive processes that govern the selection and maintenance of a single, coherent visual interpretation.

### 3. Classification and Types of Reversibility

Reversible figures are typically categorized based on the specific type of perceptual ambiguity they exploit, ranging from simple spatial geometry to complex semantic interpretation.

**Depth Reversibility (Geometric Ambiguity):** These figures exploit the ambiguity of spatial arrangement and distance implied by linear perspective on a two-dimensional plane. Examples like the **Necker Cube** and the Schröder Stairs rely on the brain's use of parallel lines and corners to assign depth. The ambiguity forces the visual system to constantly switch which geometric plane is perceived as foreground versus background.

**Figure-Ground Reversibility (Boundary Ambiguity):** This category, exemplified by the **Rubin Vase**, involves the swapping of the perceived object (figure) and the surrounding space (ground). The boundaries are shared between the potential figures, leading to a mutually exclusive perceptual state where one cannot simultaneously perceive the vase and the faces. This type is fundamental to understanding how the visual system establishes contour and object definition.

**Semantic or Content Reversibility (Meaning Ambiguity):** These figures involve higher-level cognitive interpretation, where the visual elements, when organized in different ways, represent two entirely distinct objects or scenes. The 'Duck-Rabbit' image (popularized by Jastrow) or the 'Wife and Mother-in-Law' drawing are classic examples. In these cases, the transition often requires a conscious cognitive "flip," once the brain identifies the set of features belonging to the alternative interpretation, relying heavily on stored semantic knowledge and memory.

While geometric and figure-ground reversals are highly automatic and driven by early visual

processing (bottom-up), semantic reversals often involve a stronger top-down influence, utilizing past experience and knowledge to resolve the ambiguity. However, all types share the core characteristic: the persistence of the stimulus and the alternation of the conscious perception.

## 4. Psychological Mechanisms of Alternation

The relentless alternation observed in reversible figures is attributed to specific neural and psychological mechanisms designed to prevent perceptual fatigue and ensure continuous hypothesis testing of the environment.

The primary explanation involves **neural adaptation and fatigue**. When the visual system locks onto one interpretation (e.g., the cube viewed from above), the neural circuits responsible for maintaining that stable perception become increasingly fatigued or inhibited over time. As the activity of these circuits diminishes, the competing circuits responsible for the alternative interpretation gain dominance. This leads to an automatic perceptual switch. Once the alternative view is stabilized, its corresponding circuits begin to fatigue, initiating the cycle anew. This mechanism ensures that no single ambiguous interpretation dominates indefinitely.

Furthermore, Gestalt principles play a crucial role in establishing the initial interpretations. The brain utilizes heuristics such as **Prägnanz** (the drive toward simplicity and good form), symmetry, and closure to organize the figure. In reversible figures, because both competing interpretations equally satisfy these Gestalt laws, the system is unable to establish a stable preference. The ambiguity is resolved by the dynamic, competitive interaction between the two equally probable perceptual hypotheses.

Although the switch is largely involuntary, attention and intentional focus can influence the duration of one perception. Studies have shown that concentrating visual attention on specific regions of the figure, or attempting to mentally stabilize the image, can temporarily extend the duration of the current percept. This suggests that while the switching mechanism operates at a fundamental, sub-conscious level of the visual cortex, there is a degree of weak **top-down modulation** from higher cognitive centers, demonstrating the interplay between attention and automatic perceptual processing.

## 5. Significance in Cognitive Science and Art

Reversible figures hold immense theoretical and practical significance across various disciplines, serving as crucial tools for understanding the brain's construction of reality.

In **Cognitive Science and Neurobiology**, they provide an invaluable paradigm for studying the neural correlates of conscious perception. Since the physical stimulus remains constant while the conscious experience shifts, researchers can isolate the specific brain activity associated with the

change in subjective interpretation. Imaging techniques, such as fMRI and EEG, have used reversible figures to pinpoint competitive neural networks in the visual cortex and frontal lobes that mediate perceptual switching, offering insights into conditions like amblyopia or attention deficits.

In **Art, Design, and Philosophy**, reversible figures challenge traditional assumptions about representation and reality. The deliberate incorporation of figure-ground reversal is a foundational element in graphic design, highlighting the importance of negative space. Artists such as M.C. Escher systematically utilized geometric reversibility and impossible figures, derived from the Necker Cube concept, to create works that visually and intellectually challenge the viewer's spatial assumptions, thus foregrounding the constructed nature of visual experience. Philosophically, the phenomenon supports **constructivist theories**, demonstrating that perception is not a passive reception of sensory data but an active, internal process of hypothesis generation and confirmation.

## 6. Debates and Modern Research

While the basic mechanism of perceptual rivalry is well-established, modern research continues to refine the understanding of the specific neurological drivers and computational models underlying the alternation rate and stability.

One primary area of debate concerns the precise location of the rivalry resolution: whether the alternation is resolved early in the visual processing stream (V1/V2, low-level competition for features) or later, in higher-order visual areas (e.g., parietal or temporal cortex, high-level competition for object recognition). Evidence suggests that resolution likely occurs at multiple levels simultaneously, with low-level fatigue driving the initial switch, and high-level attention systems modulating the duration of the percept. Recent studies using eye-tracking technology have also explored the relationship between eye movements and switching, finding that while deliberate eye movements can sometimes initiate a flip, the perceptual switch often precedes the physical saccade, suggesting that the primary driver is internal neural competition rather than external scanning behavior.

Furthermore, research on individual differences has shown that factors such as age, personality, and neurological state influence the rate and regularity of alternation. For instance, some studies suggest links between slower alternation rates and certain cognitive profiles or pathologies. The use of virtual reality (VR) environments now allows researchers to manipulate cues like depth and motion parallax dynamically, providing more complex ambiguous stimuli than simple line drawings, thus pushing the boundaries of what is considered a 'reversible figure' into the realm of complex, ecologically valid visual stimuli.

## Further Reading

[Necker Cube \(Wikipedia\)](#)

[Rubin Vase \(Wikipedia\)](#)

[Perceptual Reversal \(Wikipedia\)](#)

[Gestalt Psychology \(Wikipedia\)](#)

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