

RUBIN'S FIGURE

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Introduction to Rubin's Figure and Bistable Perception

The psychological phenomenon known as **Rubin's Figure**, often referred to simply as the **Goblet Figure** or **Rubin's Vase**, stands as one of the most iconic and frequently cited examples in the study of visual perception. It is a quintessential demonstration of **bistable perception**, where a single, static two-dimensional image can be interpreted by the observer in two distinct, mutually exclusive ways. This equivocal shape is structurally designed to challenge the visual system's automatic process of figure-ground segregation, forcing the observer to consciously or unconsciously assign ownership to the central contour. The figure famously oscillates between being perceived as a single, symmetrical white vase or goblet situated against a dark background, and the simultaneous perception of two dark facial profiles facing inward, set against a lighter central area. This inherent ambiguity highlights the active, constructive nature of human sight, demonstrating that perception is not merely a passive reception of sensory input but an active, interpretive process undertaken by the brain.

The core psychological principle illuminated by Rubin's Figure is the fundamental distinction between the **figure** and the **ground**. In any visual scene, the brain must decide which elements constitute the object of focus (the figure) and which elements form the context or backdrop (the ground). Crucially, the figure is typically perceived as having shape, being closer, and standing out from the ground, which appears continuous and shapeless behind the figure. In the case of Rubin's Figure, the boundaries (contours) defining the central area are shared by both potential interpretations. When the central white area is identified as the figure, the viewer perceives the goblet; the surrounding dark area becomes the shapeless ground. Conversely, when the two flanking dark profiles are identified as the figure, the central white area recedes into the background. The visual system cannot maintain both interpretations concurrently, leading to the spontaneous, involuntary switching--a process known as perceptual reversal or oscillation--which continues as long as the viewer attends to the stimulus.

Understanding the dynamics of this perceptual reversal is vital for grasping how the brain allocates attentional resources. The figure is always accorded **contour ownership**; that is, the edge separating the two regions is seen as belonging exclusively to the figure, giving it a definite shape, while the ground is perceived as extending indefinitely behind the figure. Rubin's Figure uniquely ensures that the stimulus properties of both potential figures are largely equivalent, preventing automatic dominance by one interpretation. This careful balance ensures the instability of the perception. Consequently, the switching rate between the vase and the faces can be used by researchers to study various psychological metrics, including the influence of top-down processing, attentional focus, and cognitive load on the maintenance and breakdown of visual organization. This simple illustration thus provides a profound window into the complex, dynamic architecture of the human visual processing system.

Historical Context and the Work of Edgar Rubin

The figure that bears his name was first systematically described and analyzed by the Danish psychologist and philosopher **Edgar John Rubin** (1886-1951). Rubin's foundational work on visual organization was detailed in his highly influential 1915 doctoral thesis, originally written in Danish under the title *Synsoplevede Figurer: Studier i psykologisk Analyse*, which translates roughly to "Visually Experienced Figures: Studies in Psychological Analysis." Although Rubin was a philosopher by training, his empirical research methods and deep exploration of perceptual organization laid critical groundwork for subsequent schools of psychological thought, particularly the burgeoning field of Gestalt psychology. His contribution was not merely the invention of the specific vase/faces drawing, but the rigorous articulation of the principles governing how the visual field is segmented into salient objects (figures) and their environment (ground).

Rubin's research fundamentally shifted the focus from static sensory elements to the active organizational processes underlying perception. Prior to his work, much of visual psychology focused on analyzing stimuli into their smallest components, following the structuralist tradition. Rubin, however, emphasized that certain characteristics--such as shape, location, and dominance--are inherently tied to whether an area is perceived as figure or ground, irrespective of the absolute physical characteristics of the stimulus. He meticulously cataloged the properties associated with the figure, noting that it tends to be bounded, memorable, and perceived as having a specific location in three-dimensional space, whereas the ground is seen as unbounded, continuous, and extending behind the figure. This systematic categorization provided the first comprehensive theoretical framework for figure-ground segregation, establishing it as a primary, non-reducible function of the visual system.

While Rubin himself was not formally a member of the core Gestalt movement (which included Köhler, Wertheimer, and Koffka), his findings were immediately recognized and incorporated by Gestalt theorists because they powerfully supported the core tenet that "the whole is greater than the sum of its parts." The principles Rubin established regarding the dominance of the figure, the nature of contour ownership, and the spontaneous organization of visual input became essential elements of Gestalt theory's explanation of perceptual organization. His work demonstrated empirically that the brain imposes structure upon ambiguous input, searching for the simplest, most stable interpretation. Thus, Edgar Rubin's legacy extends beyond the famous ambiguous figure; he provided the essential conceptual vocabulary and experimental proof that validated the holistic approach to studying visual perception that dominated the field for much of the 20th century.

The Phenomenon of Figure-Ground Reversal and Bistability

The defining characteristic of Rubin's Figure is its **bistability**, the ability to flip back and forth between two discrete perceptual states. This reversal is a powerful demonstration that perception

is inherently unstable when the visual cues are perfectly balanced. The process of reversal is often described as an involuntary oscillation, driven by internal cognitive and neural mechanisms rather than external changes in the stimulus. When an observer focuses intently on one interpretation (e.g., the vase), fatigue gradually sets in within the neural pathways responsible for maintaining that perception. As these neurons become fatigued or inhibited, the opposing neural network--responsible for perceiving the faces--becomes momentarily stronger, resulting in the sudden, often jarring switch to the alternate interpretation. This continuous cycle of activation, fatigue, and inhibition is what sustains the oscillation.

A key factor in the reversal process is the concept of **attentional bias**. While the reversal is typically involuntary, attention can modulate the duration for which one interpretation is held stable. If an observer actively attempts to maintain the perception of the vase, they may succeed for a short period, but eventually, the inherent ambiguity of the contour forces the system to flip. Research has shown that the rate of reversal can be influenced by internal factors such as alertness, expectation, and even personality traits, suggesting a strong influence of higher-level cognitive processes on the seemingly automatic functioning of the primary visual cortex. Furthermore, eye-tracking studies confirm that subtle shifts in fixation points--even unintentional ones--can slightly favor one interpretation by selectively focusing on a portion of the shared contour, temporarily stabilizing that particular figure.

The spontaneous nature of bistable switching is of great interest to neuroscientists because it offers a unique opportunity to study conscious experience in the absence of changing sensory input. Since the physical stimulus remains constant, any changes in perception must be attributable to internal brain dynamics. The alternating perceptions serve as internal markers, allowing researchers to correlate subjective experience (seeing the vase versus seeing the faces) with specific neural activity measured through techniques like functional magnetic resonance imaging (fMRI) or electroencephalography (EEG). This research has demonstrated that when the figure reverses, specific regions of the visual cortex, and even areas associated with attention and decision-making in the parietal and frontal lobes, show corresponding shifts in activity, confirming that bistable figures engage a wide network of perceptual and cognitive control centers.

Influence on Gestalt Psychology Principles

Although Rubin's original work preceded the formal establishment of the Gestalt school in Berlin, his findings became foundational evidence for their primary principles of perceptual organization. The Gestalt psychologists argued that the mind actively organizes sensory input into coherent "wholes" (Gestalten) rather than processing isolated features. Rubin's Figure powerfully illustrates the Gestalt principle of **Figure-Ground Segregation** as an intrinsic and necessary component of visual processing. Without this automatic segregation, the visual field would remain an undifferentiated mass of color and luminance, incapable of yielding discrete, recognizable objects.

The fact that the viewer must actively choose between the vase and the faces demonstrates the brain's imperative to impose structure, even when the input is designed to be structurally neutral.

The figure also touches upon other related Gestalt laws, particularly the concept of **Prägnanz** (often translated as the Law of Good Figure or simplicity). The principle of Prägnanz suggests that the perceptual field will always organize itself into the simplest, most stable, and most coherent structure possible under the given stimulus conditions. In Rubin's Figure, the visual system attempts to achieve simplicity by assigning contour ownership and establishing a definite figure. However, because both the vase and the faces offer equally simple and symmetrical organizations, the system cannot settle on a single, permanent "good figure." The oscillation is, therefore, a manifestation of the visual system continuously attempting to satisfy the Law of Prägnanz under conditions of perfect equilibrium, resulting in a cyclical failure to achieve permanent stability.

Furthermore, Rubin's Vase highlights the critical role of **closure** and **symmetry** in perceptual grouping. Both the vase interpretation and the two face profiles are highly symmetrical and closed shapes. The visual system prefers symmetrical shapes as figures because they are generally perceived as more stable and biologically significant (e.g., faces, tools, or vessels). The design exploits this preference; if the vase were asymmetrical, the faces would likely dominate, or vice versa. The high degree of symmetry in both interpretations ensures their equal perceptual weight, leading to the continuous competition for dominance. This competitive nature underscores the Gestalt view that perceptual laws are not merely descriptive but represent fundamental, hard-wired organizational biases within the neural architecture.

Neural Correlates and Cognitive Mechanisms

Neuroscientific investigation into Rubin's Figure provides crucial insights into how the brain handles ambiguous input. The initial processing of the image occurs in the primary visual cortex (V1), which detects basic features like edges and orientations. However, the decision of whether the central area is figure or ground involves higher-level processing, primarily in the extrastriate visual areas, particularly the lateral occipital complex (LOC), which is known for its role in object recognition, and parts of the parietal cortex, which manage spatial attention. Studies using fMRI have demonstrated differential activation in the LOC corresponding precisely to the subjective perception of the observer; one pattern of activation emerges when the vase is seen, and a slightly different pattern emerges when the faces are seen, even though the stimulus input remains identical.

The mechanism driving the spontaneous switching is hypothesized to involve neural competition and adaptation within these higher visual areas. Specifically, populations of neurons that encode one interpretation (e.g., "vase") are believed to inhibit the populations that encode the alternative interpretation ("faces"). When the "vase" neurons fire continuously, they gradually undergo

adaptation, or neural fatigue, leading to a reduction in their firing rate. As their activity wanes, the inhibition on the "faces" neurons is released, allowing the "faces" interpretation to emerge and dominate the conscious perception. This mechanism is often modeled as a network of mutually inhibitory circuits, where adaptation ensures that no single interpretation can permanently monopolize the perceptual resources, thus guaranteeing the oscillation.

Beyond simple visual processing, the reversal of Rubin's Figure is also strongly linked to **top-down cognitive control**. Attentional mechanisms, governed largely by the prefrontal and parietal cortices, play a significant role in modulating the rate of reversal. When attention is directed externally or the observer is distracted, the reversal rate often accelerates, suggesting that sustained attention is required to stabilize even the temporary perception of the figure. Conversely, when the observer actively focuses on maintaining one state, the reversal rate slows down, demonstrating the brain's ability to exert cognitive influence over involuntary visual processing. This interplay between automatic visual processing (bottom-up) and conscious control (top-down) makes Rubin's Figure an invaluable tool for studying the neural basis of conscious awareness and cognitive flexibility.

Applications in Psychological Research

Rubin's Figure serves as more than just a famous parlor trick; it is a critical experimental paradigm in several branches of psychological and neuroscientific research. Its primary use lies in the study of **attentional allocation** and the temporal dynamics of perception. Since the reversal rate is measurable, researchers can use it as a sensitive metric to assess how different internal states or external manipulations affect the brain's ability to maintain a coherent perceptual organization. For instance, studies examining the effects of psychoactive drugs, fatigue, or neurological damage frequently employ ambiguous figures to quantify changes in processing speed and perceptual stability.

Furthermore, the figure is extensively used in research concerning clinical populations. For example, studies investigating **schizophrenia** and other disorders characterized by attentional deficits often find altered reversal rates or impaired ability to stabilize one interpretation in patients, suggesting disruptions in the neural feedback loops responsible for figure-ground segregation and cognitive control. Similarly, research into developmental disorders, such as autism spectrum disorder (ASD), sometimes utilizes ambiguous figures to explore differences in holistic versus analytical processing styles, as some individuals may exhibit a bias toward one interpretation that is maintained for unusually long periods.

In the field of **visual art and design**, the principles demonstrated by Rubin's Figure are utilized intentionally to create visual interest and dynamic compositions. Artists employ similar techniques of shared contours and balanced positive/negative space to engage the viewer's active

participation in the artwork, ensuring that the piece remains perceptually engaging over time. The illusion provides a practical illustration of how the perception of negative space--the "ground"--is just as important and psychologically potent as the perception of the intended "figure," thereby influencing training in graphic design and visual communication theory.

Related Ambiguous Figures and Contrasts

Rubin's Figure is one of a class of **ambiguous figures**, but it specifically belongs to the category of figures that demonstrate figure-ground ambiguity. It is frequently compared to other classic examples that reveal different types of perceptual ambiguity, such as the famous **Necker Cube**. While both are examples of bistable stimuli, their underlying mechanisms differ significantly. The Necker Cube, which is also referenced in relation to Rubin's work, is an example of **depth ambiguity** or perspective reversal. The Necker Cube is a wire-frame drawing that can be perceived as facing either up-and-to-the-right or down-and-to-the-left in three-dimensional space. The ambiguity lies in the assignment of depth to the lines, not in the segregation of figure from ground. The entire cube remains the figure throughout the oscillation.

Another important contrast is found in figures that involve **semantic ambiguity**, such as the famous "My Wife and My Mother-in-Law" drawing (or the Old Woman/Young Woman illusion). In this case, the ambiguity lies in the cognitive interpretation or categorization of the visual features (seeing a young woman's profile versus an older woman's side view). While these figures also involve reversal, the switching often depends more heavily on semantic priming, expectation, and high-level knowledge, whereas Rubin's Figure is a purer demonstration of the low-level organizational processes of figure-ground segregation. Rubin's Vase is therefore considered the most elemental demonstration of perceptual organization ambiguity, isolating the competition for contour ownership.

The family of ambiguous figures provides a comprehensive toolkit for psychological research, allowing investigators to isolate different levels of perceptual processing.

Rubin's Figure: Tests figure-ground segregation and contour ownership (2D organization).

Necker Cube: Tests depth and spatial interpretation (3D organization).

Semantic Illusions (e.g., Duck/Rabbit): Tests cognitive interpretation and categorization.

The comparison among these figures confirms that the visual system solves different types of ambiguity using different neural and cognitive resources, highlighting the hierarchical complexity of human sight. Despite their differences, all ambiguous figures share the capacity to reveal that the perceived world is a construction, not a direct transcript of reality.