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A new principle of figure-ground segregation: The accentuation

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ABSTRACT

The problem of perceptual organization was studied by Gestalt psychologists in terms of figure-ground segregation. In this paper we explore a new principle of figure-ground segregation: accentuation. We demonstrate the effectiveness of accentuation relative to other Gestalt principles, and also consider it autonomous as it can agree with or oppose them. We consider three dynamic aspects of the principle, namely: attraction, accentuation and assignment. Each creature needs to attract, fascinate, seduce, draw attention (e.g., a mate or a prey animal) or distract, refuse, dissuade, discourage, repulse (e.g., a predator). Similarly, each organism needs to accentuate, highlight, stress, underline, emphasize or distract from another. Thus, accentuation assigns meaning to a visual pattern such as a coat, a plumage or a flower. False eyes (ocelli) and dots (diematic patterns) demonstrate "deceiving camouflage by accentuation" that confuses predators/preys and hides or highlights vital body parts (butterflies/flowers). They also display the deceiving appearance and exhibition of biological fitness. The same accents may serve different or even opposite goals. We conclude that accentuation improves the adaptive fitness of organisms in multifarious ways.

1. Introduction

1.1. On Rubin's principles of figure-ground segregation

The first question in a phenomenological investigation of seeing has to be "What is a visual object? Rubin (1915, 1921) suggested that figure-ground segregation is essential to the existence of phenomenal visual objects. In important phenomenological researches Rubin discovered and studied the basic principles of surroundedness, size, orientation, contrast, closure, symmetry, proximity, convexity, and parallelism, all of which contribute to objectness.

Fig. 1a, shows a variant of the well-known vase/cup-face profiles. The answer to the question "what is this?" is usually "a black cup". However, after protracted observation two close white face profiles, which face each other, suddenly pop out. When this occurs the cup "disappears"; it becomes invisible, simply background, i.e., nothing, not a figure. Once perceived, these two possible outcomes can be easily alternated in favor of the cup or of the face profiles by switching visual attention to one or on the other (Peterson & Gibson, 1993, 1994; Peterson, Harvey, & Weidenbacher, 1991). Other ways to change the relative salience and weight are to reverse the contrast or apply the closure principle, as illustrated in Fig. 1b. The profiles now pop out more strongly and spontaneously, while the cup is invisible or barely perceptible. In Fig. 1c, the figural salience of the two possible results is closely balanced. The result is highly reversible, although the human bias to see faces (pareidolia) perhaps puts the cup at a disadvantage. Indeed, once perceived, the profiles cannot be easily switched off, while the suppression of the cup is easier.

The previous outcomes are also perceived in pure line drawings, using external bounding contours or silhouettes as shown in Fig. 1d.

Similar results emerge when the effects due to pareidolia are removed (Fig. 1e–g). The large convex figures of the square frame alternate with small concave regions (Fig. 1e–f). In Fig. 1g, the convex component is mostly perceived as defined by convexity and proximity.

This is tied up with "figure-ground segregation", the unilateral belongingness of boundaries Rubin (1921) (often called "border-ownership", see Nakayama & Shimojo, 1990; Pinna, 2010a; Spillmann & Ehrenstein, 2004), according to which the shape of a figure derives from its contour (see Hoffman & Singh, 1997; Peterson, 1994; Peterson & Skow, 2008; Pomerantz & Kubovy, 1986). When one segment of an image emerges as "figure", the complement is ignored as "(shapeless) background" (Rubin, 1921) This illustrates the "winner-takes-all" notion (e.g., Grossberg, 1997; Grossberg, Mingolla, & Viswanathan, 2001; Oster, Douglas, & Liu, 2009). It often captures the crux of figure-ground

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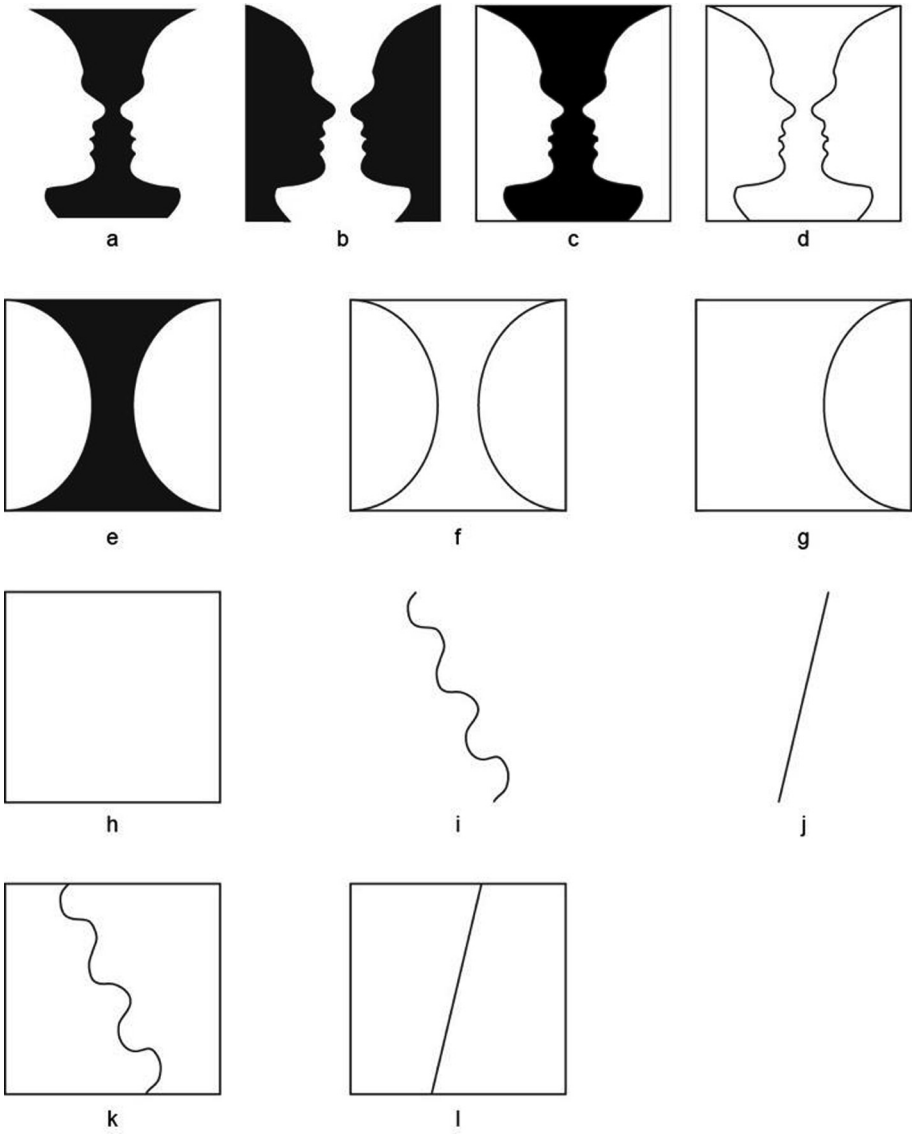

Fig. 1(a–l). Rubin's vase/cup-face profiles with variations and figure-ground segregation induced by simple contours.

segregation. This meta-principle is essential in resolving ambiguity.

Segmentation in biology virtually always implies a choice. One segment is chosen, the other ignored. This makes biological sense when the organism needs to act and does not have the resources to analyze the entire scene in parallel. Thus, any partition should be one-sided. Seeing something necessarily implies not seeing something else at the same time and in the same place. This involves the very definition of "shape" (see Pinna, 2012a, 2012b; Pinna & Deiana, 2014; Pinna & Ehrenstein, 2013). For any organism it is crucial to identify possible preys, predators or mates. Notice that it is equally crucial to hide or deceive, that is to camouflage. We return to these biological issues in the Conclusions section.

A second basic property is the color/brightness of the figure as opposed to its background. It varies from being similar, posing an obvious contrast, or appearing transparent. The figure manifests a unique surface quality (*Erscheinungweise*, Katz, 1930). It may appear as solid and impenetrable or as flimsy as a gauze drapery. In contradistinction, the background appears void, penetrable, and diaphanous, as apparent in Fig. 1d and f–g. More examples will be discussed below.

Yet another property related to the figure-ground segregation is the solidity and volumetric quality of the figure as opposed to the background which appears as a void. This visually explains the unilateral belongingness of the contours and the chromatic/brightness differentiation between figure and ground. All our examples so far show this effect.

These three main attributes of the visual objects can be imparted synergistically by a simple contour, as shown in Fig. 1g. The key point is the asymmetric nature of the visual segmentation in figure and ground. This explains how Fig. 1h displays the full set of figure-ground properties. It might have supposed to be a "square shaped" outer edge, which indeed describes its form, but the outer edge that presumably would have been perceived cannot have any shape, in the sense of the shape of an object.

The phenomenal power of a single line to be like a figure-ground divide pertains to limiting conditions like the simple lines of Fig. 1i–j, either straight or undulated. Both induce a phenomenal figure-ground asymmetry, which is more clearly perceived when they are included within a frame that confines the figure-ground differentiation on both sides of each line segment (see Fig. 1k–l). These limiting conditions demonstrate the strength and, more importantly, the priority of the figure-ground organization over the perception of mere lines. Lines are two-sided, whereas divides or contours are one-sided. Perceived as contours between figure and background, lines represent the visual evolution of a contour into a surface (see Grossberg, 1994; Grossberg & Swaminathan, 2004). Contours spontaneously organize themselves into surfaces delimited by them and present over the background. This