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Subjective contour: The inadequacy of brightness contrast as an explanation

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The perception of subjective contours has been ascribed to organizational factors which utilize implicit depth cues in the configuration. A recent alternative maintains that these apparent edges are due to the operation of simultaneous brightness contrast. Several demonstration figures are presented which show the relative inadequacy of contrast as an explanation for these phenomena.

In 1904, Schumann published a pattern in which there is the perception of an edge or contour in an area of the visual field where there is no objective change in physical light intensity. Since that time, similar subjective contours have been demonstrated in a variety of different patterns (Coren, 1972; Ehrenstein, 1954; Julesz, 1964; Kanizsa, 1955; Lawson & Gulick, 1967).

Only a limited number of theoretical explanations of subjective contours phenomena have been offered. The most frequently occurring is analagous to the Gestalt phenomenon of closure (cf. Kanizsa, 1955). Alternatively, Coren (1972) has suggested that subjective contours result from the organization of the percept around implicit depth cues in the two-dimensional array. The most powerful of these depth cues appears to be interposition, although other monocular depth cues appear to work as well. Coren argues that these potential depth cues are only utilized when the perception of a subjective contour will result in a simpler overall organization in consciousness. Two recent experiments by Lawson (Note 1) and Gregory and Harris (1974) have presented data which seems to support the notion that apparent depth plays a part in the formation of subjective contours. These investigators introduced binocular disparity into configurations which normally result in the perception of subjective contours. The introduction of this additional depth information was found to increase the clarity and saliency of the subjective contours.

Recently, Brigner and Gallagher (1974) have suggested a more peripheral explanation for the appearance of these apparent edges. They suggest that the subjective contour may be a product of the operation of simultaneous brightness contrast. Their argument is somewhat supported by the fact that the subjective controus differ in brightness from the background, in the direction which might be predicted from inhibitory interaction and that they are weaker when the pattern is composed of heterochromatic equal brightness components. There is however, an interesting set of figures which seem to rule out the likelihood that subjective contours are caused by the simple action of simultaneous brightness contrast.

Let us consider Figure 1A. This is redrawn from a figure utilized by Coren (1972), in which a subjective contour is supposedly produced by the operation of interposition. Notice that a white rectangular bar is seen interposed in front of the word STOP. The white of the bar is considerably brighter than the white of the background, and it is bounded by apparent contours which extend over the intermediate areas. It is interesting to compare the white of the bar in this array with the white in the upper portion of the letter P. In the letter, the white area is completely surrounded by black, which should provide the optimal configuration for brightness contrast. Notice, however, that the apparent brightness of the subjectively bounded overlying bar is considerably greater than that of this enclosed region, despite the fact that it is only bounded in an interrupted fashion by black inducing fields. When we look at the negative of this configuration, as depicted in Figure 1B, we again find that the actual percept is at variance with the prediction based upon simultaneous brightness induction. Here, the inner region of the letter P is completely surrounded by the white inducing field and should be seen as darker than the subjectively interposed rectangle. For most observers, it is not. Certainly, the continuous annulus provided by the upper portion of the letter should provide a better field of induction than the interrupted islands of white interspersed with regions of black which surround the subjective contour. Nonetheless, the area bounded by the subjective contour appears to be the darker. A similar argument has been presented by Kanisza (1955, 1974).

There is an alternate set of patterns which make a similar point. Consider Figure 2A, which is redrawn from Coren (1972). Here, the observer sees a

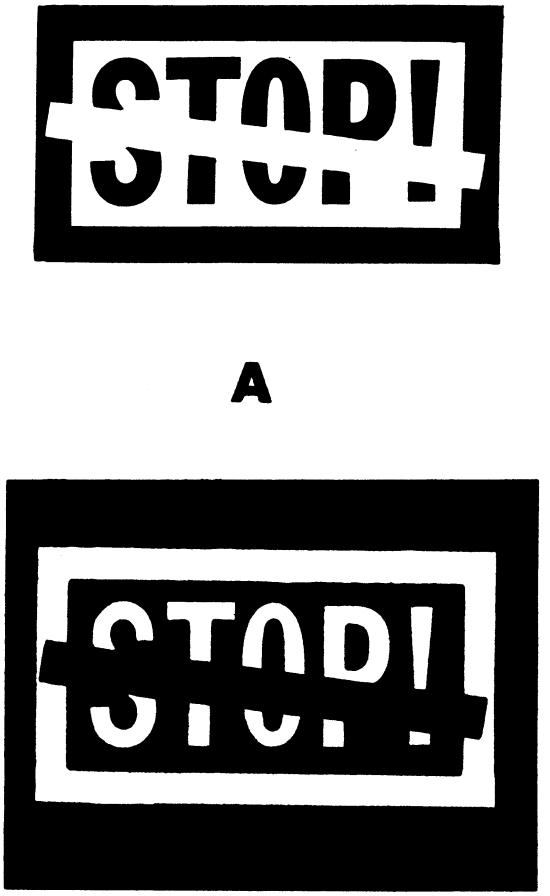

Figure 1. Subjective contours produced by use of the interposition cue for depth. (A) White of subjective contour is brighter than white completely surrounded by black annulus in upper portion of letter P. (B) Black bounded by subjective contour is darker than region completely surrounded by white annulus at top of letter P. (Figures redrawn from Coren, 1972).

subjectively contoured white triangle in the center of the configuration. The white of this triangle is considerably whiter than that of the background. It is clear that if we are to argue that the contour is caused by the operation of simultaneous contrast, the most likely source of brightness induction is the set of three black masses which defined the corners of the apparent figure. Let us now engage in a manipulation of the pattern. Suppose that we now substitute actual black contour lines for the apparent edges as is done in Figure 2B. According to any argument based upon brightness contrast, we have left the primary inducing fields unaltered, and in fact have increased the likelihood of contrast by adding more contiguous black to the configuration. Thus, the apparent brightness of the central triangular region should either be increased, or, at worst, remain unaltered. On the other hand, according to Coren's depth cue analysis, by providing actual physical contours, the necessity for the appearance of the subjective edges is eliminated, since the figure is now adequately organized into a simple configuration. Thus, the apparent contours and the brightness difference which supports them should disappear. Simple comparison of the brightness of the central regions in Figures 2A and 2B reveals that the subjectively bounded area is apparently brighter than the region bounded by actual physical contours as in 2B, despite the fact that the latter actually contains more black.

These demonstrations seem to point out the relative inadequacy of simultaneous brightness contrast as an explanation for the existence of subjective contours. It is however, important to note that to the extent that subjective contours are a function of cognitive processing, they may interact to some extent with contrast processes. Cognitive and organizational factors have already been shown to alter the magnitude of contrast brightness effects. Coren (1969), for instance, shows that the region of the field seen as figure manifests more brightness contrast than does the part of the field seen as ground. Festinger, Coren, and Rivers (1969) show that the distribution of attention across a stimulus configuration alters the magnitude of brightness contrast effects. In fact, these latter investigators even contend that whether contrast effects, or their pheonmenologically opposite effect, assimilation appear in the conscious percept may depend upon cognitive factors.

In sum, it seems that predictions based solely upon simultaneous brightness contrast seem incapable of predicting the actual percept in several subjective contour configurations, such as those shown in Figures 1 and 2. One is thus left with the impression that the locus of the subjective contour effect must be more central or cognitive in origin. The implicit depth cue argument of Coren seems to provide such a central mechanism.

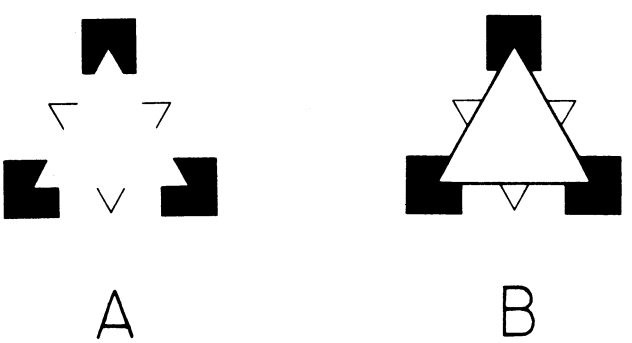

Figure 2. In (A), a subjective triangle is seen (redrawn from Coren, 1972). In (B), the subjective contour has been replaced by real black contours. Despite the addition of black to (B), the apparent brightness of the triangle is greater for the subjective figure seen in (A).

REFERENCE NOTE

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