Interactions of subjective contours with the Ponzo, Müller-Lyer, and vertical-horizontal illusions

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The Ponzo, Müller-Lyer, and vertical-horizontal illusions were generated with real edges, subjective contours, and various control patterns. Subjective contours were differentially effective over control conditions only for the Ponzo illusion. The data are discussed in light of the various theories of subjective contours and illusions.

Optical illusions have been of interest for a considerable time. Many of the classic phenomena, such as the Müller-Lyer, vertical-horizontal, and Ponzo illusions (see Robinson, 1972; Uttal, 1981; see also Coren & Girgus, 1978, for a review), involve distortions of apparent length, but there has been a surge of interest in another illusion, known as the "subjective contour." These latter phenomena involve the perception of an edge in an area of the visual field where there is no objective change in physical light intensity (Coren, 1972; Parks, 1984; Uttal, 1981).

Recently, there has been some discussion as to whether illusory edges can induce phenomena apparent with real lines. Meyer and Garges (1979) reported that illusory contours could produce the Poggendorf illusion, a claim that was previously controversial. Several aftereffects also have been produced with subjective contours (Smith & Over, 1975, 1976, 1979); however, negative results also have been reported. Pomerantz, Goldberg, Golder, and Tetewsky (1981) and Streibel, Barnes, Julness, and Ebenholz (1980) found illusory contours ineffective in some orientation interactions. We wish to examine three optical illusions of length: the Müller-Lyer, Ponzo, and vertical-horizontal illusions. Parks (1984) commented that previous demonstrations of a subjective-contour version of the Ponzo illusion did not have adequate controls.

Six configurations of each illusion were tested (Figure 1). They included the standard illusion with real inducing elements, a subjective-contour version using the Pac-Man-type of inducing element, outline versions of the Pac-Man shape to provide orientation information but no illusory edge, solid dots to provide high contrast but no edge, hollow dots, and a no-inducing element control. These are fairly standard conditions in testing the effects of illusory contours (Meyer & Garges, 1979; Parks, 1984).

Some of these data were presented at the 1977 meeting of the Association for Research in Vision and Ophthalmology, Sarasota, Florida. For reprints, write to G. E. Meyer, Department of Psychology, Lewis and Clark College, Portland, OR 97219.

Figure 1. Versions of the wings-out Müller-Lyer illusion, Ponzo illusion, and vertical-horizontal illusion used in study.

METHOD

Subjects

Thirty-four men and women from an introductory psychology class took part in the experiment. All had normal or corrected-to-normal vision. They were naive as to the nature of the illusions and the purpose of the experiment.

Stimuli

Three $8\frac{1}{2} \times 11$ in. inspection sheets, each with a different illusion, were constructed and duplicated. The stimuli used were the Müller-Lyer wings-out figure, the Ponzo illusion, and the vertical-horizontal illusion. Each sheet contained six versions of an illusion with different inducing contexts: real contours, subjective contours, hollow contours, solid dots, empty dots, and no contour (see Figure 1). The parameters of the real illusions were chosen from various sources (Julesz, 1971; Robinson, 1972) to produce strong effects. The dimensions of the figures were as follows: (1) Müller-Lyer—3.5-cm target lines, 2.5-cm arrows, 15° angle of intersection, 5-mm dots and Pac-Man shapes; (2) Ponzo—2-cm target lines, 6-cm tilted lines which would form a 40° angle if intersected, 7-mm dots and Pac-Man shapes; and (3) vertical-horizontal—1 $\times$ 5-cm rectangles with a 5-mm separation, 7-mm large dots and Pac-Man shapes, 5-mm small dots and Pac-Man shapes. The subjects viewed the sheets from a distance of 5-65 cm. Fluorescent room

lighting was measured at 28 fL on the white sheets. Contrast ratio of the black components was .71.

Procedure

On separate days, the subjects were presented with one of the illusion sheets. The subjects were divided into three groups and received different illusions on different days to control for order effects. For the Ponzo illusion, the nature of the effect was explained, and the subjects were told to rate the strength of the illusion produced by the contours on a 0-5 scale with ties allowed. For the vertical-horizontal and Müller-Lyer illusions, the subjects were instructed to rate the length of the target lines, with 0 being the shortest and 5 the longest. Magnitude estimate seems a reliable measure of illusion strength (Coren & Girgus, 1972; Meyer & Gargès, 1979).

RESULTS

The data for the three illusions and the six conditions are presented in Figure 2. Separate within-subject ANOVAs were conducted on the mean ratings. Significant effects of context were found for all conditions [Müller-Lyer, $F(5,165) = 5.94$; Ponzo, $F(5,165) = 6.83$; vertical-horizontal, $F(5,165) = 7.32$; for all, $p < .05$]. A posteriori Tukey tests ($\alpha = .05$) found that for the vertical-horizontal illusion, all context conditions were significantly different from the no-context condition but not from each other. For the Müller-Lyer illusion, the effect of the real-context illusion was greater than for the four other contexts. These four contexts did not differ from each other but were greater than the no-context control. Finally, for the Ponzo illusion, we see the greatest effect for the real context, followed by the subjective context, which was greater than the three other control contexts, which in turn exceeded the no-context condition.

Figure 2. Mean ratings for the six illusion types used in study for the three illusions. Key refers to the type of inducing element or its absence. See Figure 1.

Thus, only for the Ponzo illusion was there a clear indication of a subjective-contour effect.

DISCUSSION

Only for the Ponzo illusion were the subjective contours more effective than the control stimuli that mimicked various characteristics of the subjective-contour-inducing Pac-Man but did not themselves produce any illusory edge. These findings are similar to our previous Poggen-dorf results (Meyer & Gargès, 1979). This demonstration of the subjective-contour Ponzo seems free of Parks's (1984) concerns of confounding, so such an illusion does seem to exist.

It is possible to offer many speculations about the reasons for this pattern of results. All stimuli are illusions of length. However, the causes of each illusion may be different, as a multitude of papers have suggested. We were surprised that the Müller-Lyer illusion did not show a subjective-contour effect; the illusion has been explained on an inappropriate size scaling based on depth cues, in a manner similar to the Ponzo. However, the illusions may be dissimilar. Factor analysis suggests that the Ponzo illusion is different from the Müller-Lyer and vertical-horizontal illusions (Coren & Girgus, 1978), although the underlying processes were not clear. There are also a large number of subjective contour theories (Parks, 1984), some of which are quite similar to the optical illusion ones. Thus, many reasonable combinations can be made of these factors; however, so many interactions are possible that the endeavor might be fruitless. This analysis of finding a resolution is similar to the one taken by Uttal (1981). Also, there is always the risk of arguing from a failure to reject the null hypothesis; this is the case for the vertical-horizontal and Müller-Lyer illusions. It is quite possible that some other configuration or methodological nuance would find a role for the subjective contour. For now, we conclude that subjective contexts can produce the Ponzo illusion but were not differentially effective for producing the Müller-Lyer and vertical-horizontal illusions. These findings are suggestive as to a different underlying set of processes for each, but is not conclusive.

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