Angle illusion on a picture’s surface

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Abstract—Shapes on picture surfaces are not seen accurately (Arnheim, 1954). In particular, if they depict 3-D forms, angles between lines on a picture surface are misperceived. To test four theories of the misperception, subjects estimated acute and obtuse internal angles of quadrilaterals. Each quadrilateral was shown alone or as part of a drawing of a cube. The drawings showed the tops of the cubes, tilted at various angles around a horizontal axis. This generated different acute and obtuse angles in the drawings. Compared to a quadrilateral on its own, judgments of the acute and obtuse angles in the cube drawings were biased towards 90°. The bias was present over a wide range of intermediate tilts. The results support a perspective convergence theory and run counter to ‘Extreme Foreshortening’, Gestalt and Cognitive theories.

Keywords: Perspective; illusion; pictures; cubes; angles; Gregory; Arnheim.

INTRODUCTION

Artists contend with three major sources of misperception. The first makes its presence known when artists judge the visual angles of objects in the scene to be portrayed. Artists resort to holding a pencil or brush at arm’s length, aligned with the object. The reason is that the linear size of an object often interferes with impressions of its visual angle.

The second source becomes apparent as the artist draws more and more marks on a picture surface to show more and more of the scene. A mark that looks wrong on its own will often look right as soon as perspective shows the depths in the scene (Arnheim, 1954, p. 97; Kennedy, 1974, p. 37) — and vice versa! This source of error is our concern in the present paper.

To be complete, we should mention a third source. Often pictures that are perfect panoramic projections of the world give remarkably distorted impressions. To the deep concern of wealthy patrons whose goal is pictures that look realistic, since the

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late Renaissance artists have found that information about the sizes and angles of parts of the scene is often used quite incorrectly by vision, despite the picture being geometrically correct (Juricevic and Kennedy, 2006).

Of these three domains of enquiry about picture misperception, in the present study we single out for attention the picture surface and illusions to do with angles. Elsewhere, perception of individual objects posed at distinctive tilts was discussed (Kennedy, 1974, 1993, 2001). Here, we test theories of an angle illusion on a picture surface by studying the effects that occur across the full range of possible tilts of a square, from close to 0° to close to 90°.

**Perspective and a picture-surface angle illusion**

Apparent distortions have been of interest to theory of art since the late Renaissance and the development of perspective in the 1400s. The crux of constancy research is how we perceive a 3-dimensional form despite it sending many different projections to our eye as we walk around it. How we avoid distortion was crucial to perception philosophy in the 1600s and 1700s in the writings of British Empiricists Locke, Berkeley, Hume, Bacon and Reid, and central to perception psychology since Helmholtz in the 1800s. It was debated at length in Gestalt and ecological theory of pictures in the Twentieth Century (Arnheim, 1954; Gibson, 1979).

Juricevic and Kennedy (2006) analyze distortions of apparent length in panoramic pictures. Kubovy (1986) considers perceived angles at corners of cubes. Gregory (1963) theorized about illusions resulting from unconscious use of perspective. For present purposes, a helpful case in point is two lines forming an X on the face of a perspective drawing of a cube. The acute and obtuse angles between the two lines depict right angles if the lines are parallel to contours depicting the edges of the face on which they are drawn. At times they may appear to be right angles on the picture surface (Parks, 2001). Indeed, the impetus for the current research stems from a study of EA, a congenitally blind man drawing cubes (Kennedy and Juricevic, 2006). Intriguingly, the Vs representing the corners in EA's drawings of cubes like Fig. 1 look close to 90° on the page, and equal, though in fact they are 25° apart, and the acute and obtuse angles differ from 90° by 10° to 15°.

To test theories of the misperception of angles in pictures, we presented observers with pictures of cubes at various tilts. Figure 1 may demonstrate the illusion to the reader. Two drawings of cubes in the illustration have quadrilateral tops. Two of the nine quadrilaterals below match the tops but the typical observer is unable to make the correct selections. The top on the left matches row three, column three and the one on the right matches row two, column two. Observers fail even if they describe themselves as judging the acute and obtuse internal angles of the quadrilaterals, the vertical extents of the quadrilaterals or parallel lines of the tops and the lower quadrilaterals. The obtuse topmost internal angle of the cube drawing on the left is 143°. Many observers suggest its closest match in the 9 quadrilaterals is in row one column one — a 130° angle. Matching its acute angle (41°) with row one, column one’s acute angle (54°) is an error of 13°, an error of almost one-third.