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Regions of High Curvature Help to Stabilize the Perception of 3D Shape

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Abstract

There is considerable evidence that the visual perception of 3D shape from shading can be influenced by the pattern of illumination. Some experiments have shown that changes in illumination can have dramatic effects on apparent 3D shape, whereas others have shown that these effects are relatively modest. One possible factor that may modulate these results is the 3D geometry of the depicted objects. The central hypothesis of the present experiment is that regions of high curvature on a surface provide perceptual landmarks that can help to stabilize shape perception over changes in illumination or materials. The stimuli were all constructed from plane-faced polyhedra that were subjected to varying degrees of smoothing that reduced the curvature of the polyhedral edges, and these objects were illuminated from either left or right. Their 2D images were judged using two different response tasks: a gauge-figure adjustment task, in which observers estimated the local surface orientation at designated probe points; and a near-point task, in which they marked points on the surface that appeared to be the nearest points in depth. The results suggest that regions of high curvature do indeed stabilize observers' 3D shape perceptions. As the curvature of the polyhedral edges decreased, this produced increased perceptual distortions relative to the ground truth, and the effect of illumination direction on perceived shape was magnified as well.