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# Pinhole viewing strengthens the Hollow-Face Illusion

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**Abstract**

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entrance. These mosaics are composed of successive 'Mach book' figures (see E. Rubin (1921)), defined as two-dimensional shapes which look three-dimensional without a background (see Mach (1883)). The same perceptual phenomenon is also found in the mosaic inlay of what is referred to as the Wheel of Fortune at the fifth composition from the entrance. These mosaics are shaped as parallelograms and consist of white and brown mosaics. Because of the unstable background, these patterns can appear as either a stairway ascending to the right with white steps or as a stairway ascending to the left with alternating brown steps. No previous studies (Mach (1883) among others) have referred to these geometric optical illusions in the Duomo.

◆ **The T-illusion in Variable Contexts**

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If, for the letter T, up- and cross-stroke are equally long, the upstroke will appear longer, both visually and during haptic-tactile exploration (Tedford and Tudor, 1969, Journal of Experimental Psychology, 81(1), 199-201). Recently, I discovered another, purely haptic illusion with this stimulus: When subjects had to "grasp" computer images of individual lines of the T at their respective ends with a pretended thumb and index finger pincer grip, subjects scaled their responses to the length of the upstroke when grasping the cross-stroke, but were quite correct with the upstroke as target, independently of the orientation of the T (Landwehr, 2009, Attention, Perception, & Psychophysics, 71(5) 1197-1202). With regard to the visual illusion, I found an asymmetry in illusion strength depending on which stroke served as standard. Both effects can probably be explained in terms of neural detection mechanisms that register orientation and end-points of lines (cf. Caelli, 1977, Vision Research, 17, 837-841). Since the length of lines is misestimated only in contexts (Verrillo and Irvin, Sensory Processes, 3, 261-274), future investigations of the T-illusion(s) may profit from putting the T into variable contexts. I shall report on a project that focuses on conditions to either enhance or attenuate these illusions.

◆ **Pinhole viewing strengthens the Hollow-Face Illusion**

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The hollow-face illusion is the perception of a concave mask as a convex face when seen from beyond a certain distance. While a real three-dimensional mask is seen as concave at close distances, this is rarely if ever the case for frontal photographs or video of such masks. This suggests that monocular image information alone is insufficient to disambiguate depth. How is it that a three-dimensional mask is seen as concave at close distances when viewed monocularly? Here we tested whether ocular accommodation contributes by manipulating its availability using pinhole glasses. Pinhole viewing increased the distance over which the mask is seen as concave for both monocular and binocular viewing. This is consistent with accommodation disambiguating depth. This effect of pinholes alone was greater than that of monocular viewing alone and closing one eye had no additional effect when wearing pinholes. This suggests vergence may also disambiguate depth at short distance and be disrupted by pinhole viewing. Additional tests investigated the perceived flatness and distance of the illusory face. Observers reported that the illusion appeared more pronounced in depth when viewed through pinholes but that binocularity had no effect on this percept. Apparent distance was affected by both manipulations.

◆ **Intermediate-Level Motion Representations Account for the Hollow Face Illusion**

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Three-dimensional surface structure can be deferred from motion fields and their gradients [Treue and Andersen, 1996, Visual Neuroscience]. In the hollow face illusion (HFI) an unresolved convex/concave ambiguity leads to the percept of a concave face mask being convex when viewed frontally. It has been argued [Heard and Chugg, 2003, Perception] that this demonstrates the use of top-down knowledge to override local feature interpretations. We suggest that local mechanisms of motion computation may already account for the illusory effect. We extend a biologically inspired model that incorporates early and intermediate stages of cortical motion processing to indicate rotations of rigid object around its axes [Raudies et al., 2013, NECO]. Network components sensitive to motion direction/speed, speed gradients and their nonlinear combination to motion curvature build a robust representation of the spatio-temporal input. The model is probed by input sequences with rotating facial masks. Simulated motion responses are integrated at the stage of nonlinear motion curvature cells [Orban, 2008, Physiology Review]. Motion curvature cells selectively respond to the apparent image motion gradient pattern, reflecting the HFI.