Environment maps and the perception of shape from mirror reflections

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INTRODUCTION: Perceiving the shape of a smoothly curved mirror surface is a challenging task because the image intensities are determined both by the surface shape and by the surrounding environment [Fleming et al, Journal of Vision 2004]. We recently showed that humans could perceive qualitative shape from mirror reflections [Faisman and Langer, Journal of Vision 13:5, 2013] with synthetic textures as the environment map (e.g. see “structured” texture below). Here we more thoroughly examine how well subjects can judge shape by considering a greater range of environment maps.

STIMULI: We rendered mirror surfaces, each slanted 40 deg upwards (floors). Environment maps were synthetic textures (disks in center column on left), modulated by an envelope that peaked at 90 deg above the viewer i.e. zenith (left column) or 30 deg above viewer (right column), or not at all (center).

PROCEDURE + TASK: Single points were marked each surface. Subjects judged if a marked point was on a hill or valley, i.e. locally convex or concave.

RESULTS: Modulating the environment map texture with an envelope that peaks at the zenith improved subject’s performance, but modulating with the envelope that peaks just below the terrain normal lowered performance (relative to no modulation). This is presumably due to the preference for “light from above”. Note however that for mirror surfaces and environment maps, the dominant light needs to be near the zenith (90 deg), rather than only “from above” (30 deg) in order to get the increase in performance.

DISCUSSION AND CONCLUSION: Most natural environment maps are dominated by light from above and often the light envelope peaks at the zenith. Humans are able to judge shape from mirror surfaces under natural environmental illumination conditions, but this ability might rely more on shape from shading (see no texture condition) than on shape from specular/mirror reflection, as we argued in [Faisman and Langer, Journal of Vision 13:5, 2013].