

Specularity and shape from line drawings



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Problem.

Line drawings afford observers with a surprising amount of information about shape. For example, Picasso’s *Fragment de corps de femme* (see right) provides an breathtakingly legible depiction of the human form that is rich with shape information — by using merely *four lines*.

Our previous work (Phillips, Casella & Gaudino 2005) as well as the work of others (Cole, Sanik & DeCarlo 2009) has investigated the nature of the underlying 3D geometric information used by artists when executing a line drawing of an object.

Along with essential information such as the boundary contour, illustrators tend to represent internal self-occlusion contours and other features largely determined by the *intrinsic* geometric properties of the object. These include surface curvature contrasts and extrema.

It is well known that material properties that modulate the reflectance function of the object also contribute to the perception of shape. In fact, it is possible to identify objects made of glossy or shiny materials using *only* their specularity.

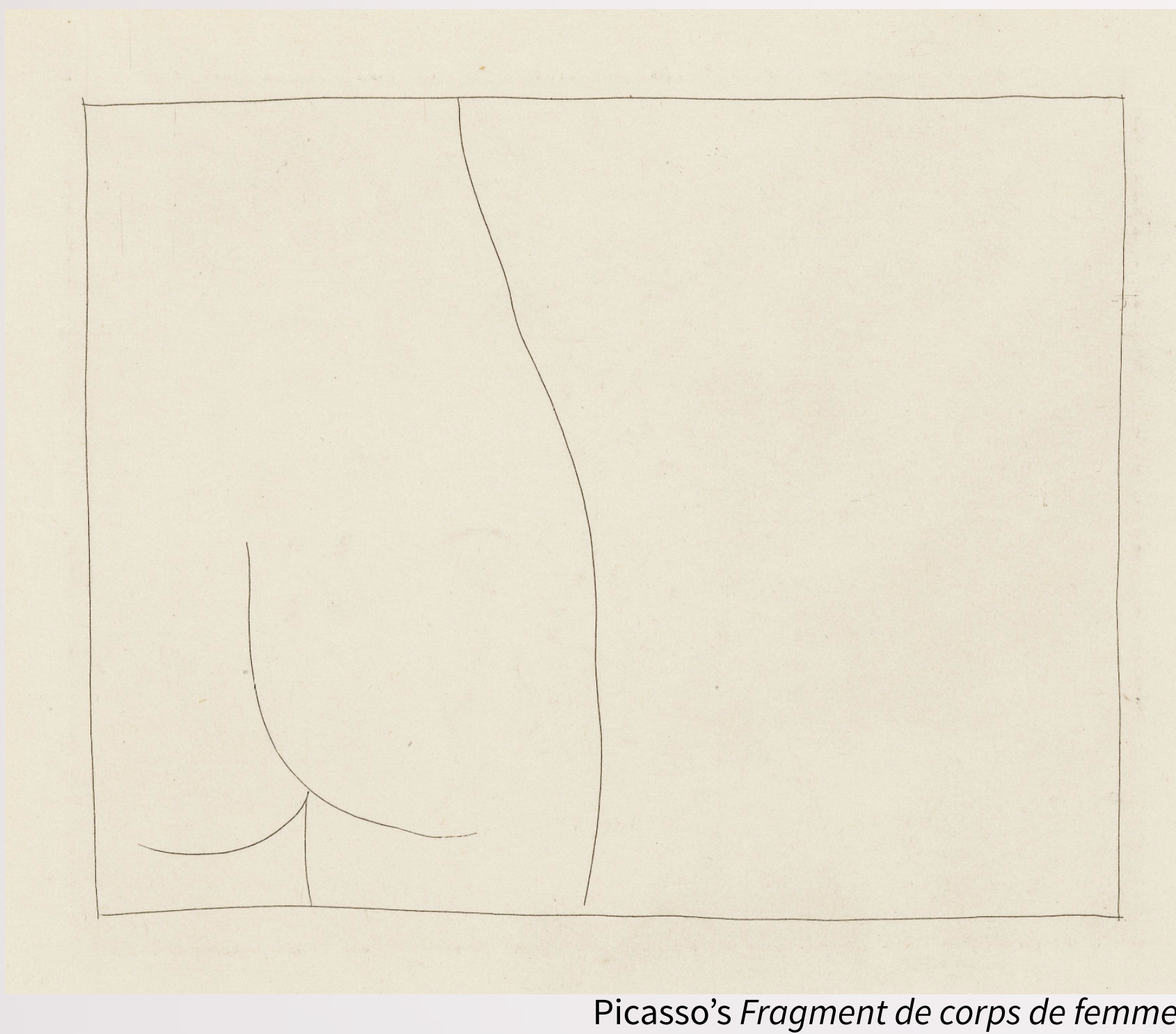
Cartoonist and illustrators regularly add specular reflection information to their line drawings to suggest or emphasize an object’s curvature. The markings frequently come in the form of a window pane — a depiction that cartoonist Mort Walker dubbed the *lucafect*.

Here we investigate drawn specular information and its influence on shape perception.

Method.

A professional artist/illustrator made multiple line drawings of a ball using a variety of indications of shininess produced by a light source from the upper-right. Additionally, a physically-plausible rendering was created using RenderMan. The balls were presented with either no highlight, an illumination-congruent highlight, or an illumination-incongruent highlight.

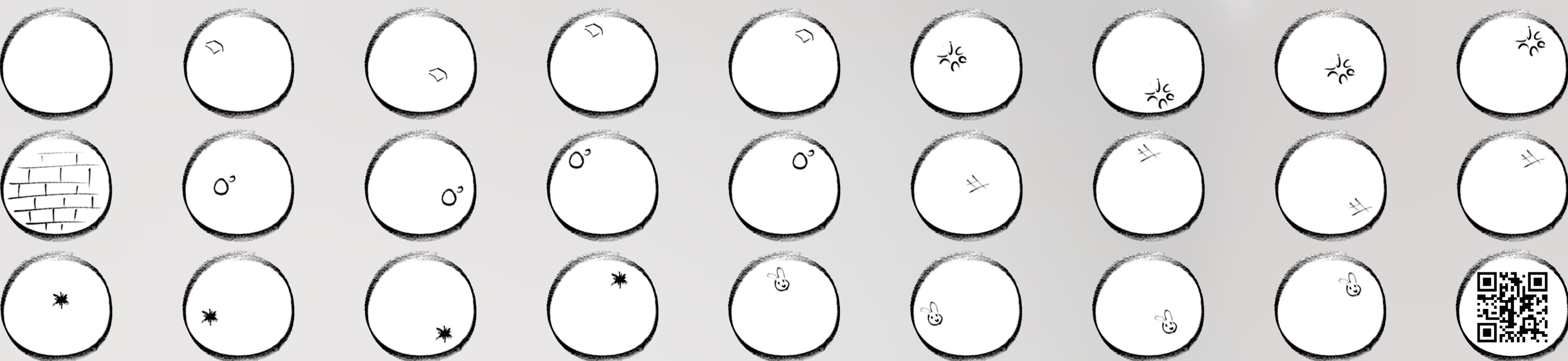
Subjects provided gauge figure adjustments for the various illustration conditions, allowing us to reconstruct the perceived shape of the depicted objects.



Picasso's *Fragment de corps de femme*

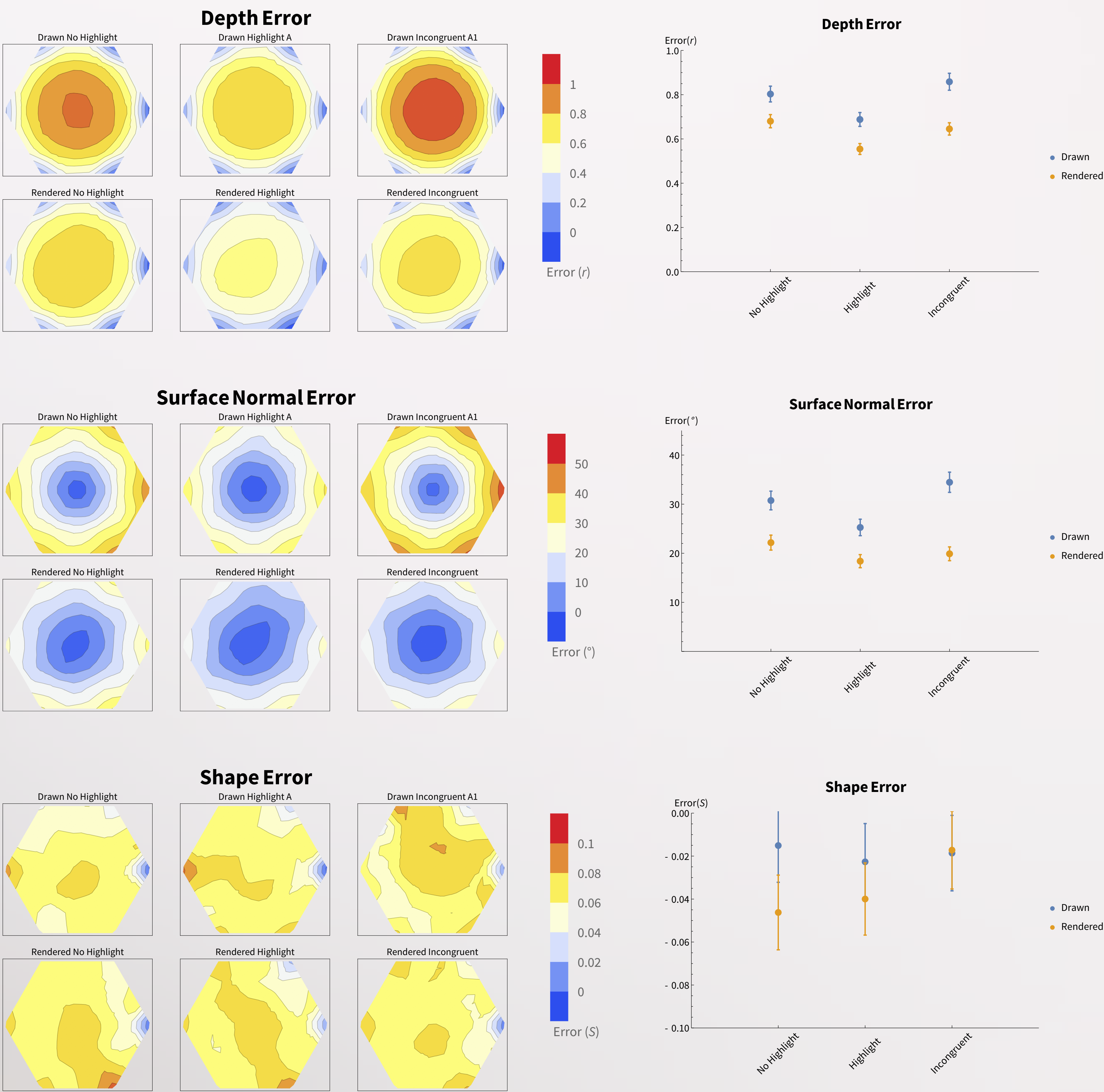


We analyzed three geometric characteristics of the reconstructions — depth, orientation, and differential geometric (e.g. ‘shape’) errors with respect to an underlying ‘ground truth’ hemisphere.



Results.

Depth was *greatly* underestimated in all conditions by an average of 72% Local errors varied by drawing/rendering conditions with slightly less error in the rendered than drawn cases. In all conditions, the presence of congruent highlights reduced error by approximately 10% overall and incongruent highlights caused only slightly more error in the *drawn* cases than no highlight at all.



The errors in depth and orientation are slightly asymmetric in the rendered condition. An analysis of global shape shows that the rendered stimuli were perceived more oblate than the drawn, oriented parallel with the highlight orientation, suggesting an effect of the global diffuse illumination.