Effects of shape and color on the perception of translucency

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Natural materials such as skin, soap, jade, and wax, look translucent because light scatters inside them. Though humans are skilled at discriminating subtle differences in translucent appearance, little is known about the perception of translucency. We study how translucency perception is related to scattering parameters and object geometry, by measuring perceptual similarities between images rendered with varying scattering parameters, and using these similarities to learn low dimensional embeddings of the images. We compare embeddings for color and gray-scale images, and in settings where objects are only partly visible.

Images of a dragon model were rendered, in gray-scale and color, using 16 different parameters from the spherical polydispersion scattering model, under constant natural illumination. Each observer was shown 1680 ordered triplets of images, and asked to indicate whether the center image is more similar to the left or right image. These paired-comparisons were used with a non-metric multidimensional scaling method to learn 2D embeddings of the data.

The 2D embeddings from all observers (n=4) resemble a U-shaped curve, with images consistently ordered from opaque to translucent. To isolate the effect of different cues in the scene, we repeated our experiments using only images from the opaque side of the curve, masking out either the top- (specular highlights) or bottom-half (see-through effect) of the images with a semi-transparent layer. For color images, the embedding had the same shape and, when the bottom-half was masked, same ordering, as under full-view conditions. For the gray-scale images, for bottom-half masked images the embedding does not have clear structure, whereas for top-half masked images, it is U-shaped but with images ordered differently from the color case. This suggests that translucency perception depends on shape, and that there is an interaction between color and shape. The effect of shape on translucency is more significant for gray-scale objects.