# The Perception of Surface Material from Disparity and Focus Cues

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**Abstract**

The visual properties of surfaces reveal many things including a floor's cleanliness and a car's age. These judgments of material are based on the spread of light reflected from a surface. The bidirectional reflectance distribution function (BRDF) quantifies the pattern of spread and how it depends on the direction of incident light, surface shape, and surface material. Two extremes are Lambertian and mirrored surfaces, which respectively have uniform and delta-function BRDFs. Most surfaces have more complicated BRDFs and we examined many of them using the Ward model as an approximation for real surfaces. Reflections are generally view dependent. This dependence creates a difference between the binocular disparities of a reflection and the surface itself. It also creates focus differences between the reflection and physical surface. In simulations we examined how material type affects retinal images. We calculated point-spread functions (PSFs) for reflections off different materials as a function of the eye's focus state. When surface roughness is zero, the reflection PSF changes dramatically with focus state. With greater roughness, the PSF change is reduced until there is no effect of focus state with sufficiently rough surfaces. The reflection PSF also has a dramatic effect on the ability to estimate disparity. We next examined people's ability to distinguish surface markings from reflections and to identify different types of material. We used a unique volumetric display that allows us to present nearly correct focus cues along with more traditional depth cues such as disparity. With binocular viewing, we observed a clear effect of the disparity of reflections on these judgments. We also found that disparity provided less useful information with rougher materials. With monocular viewing, we observed a small but consistent effect of the reflection's focal distance on judgments of markings vs. reflections and on identification of material.

**Citation**

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