Do colored highlights look like highlights?

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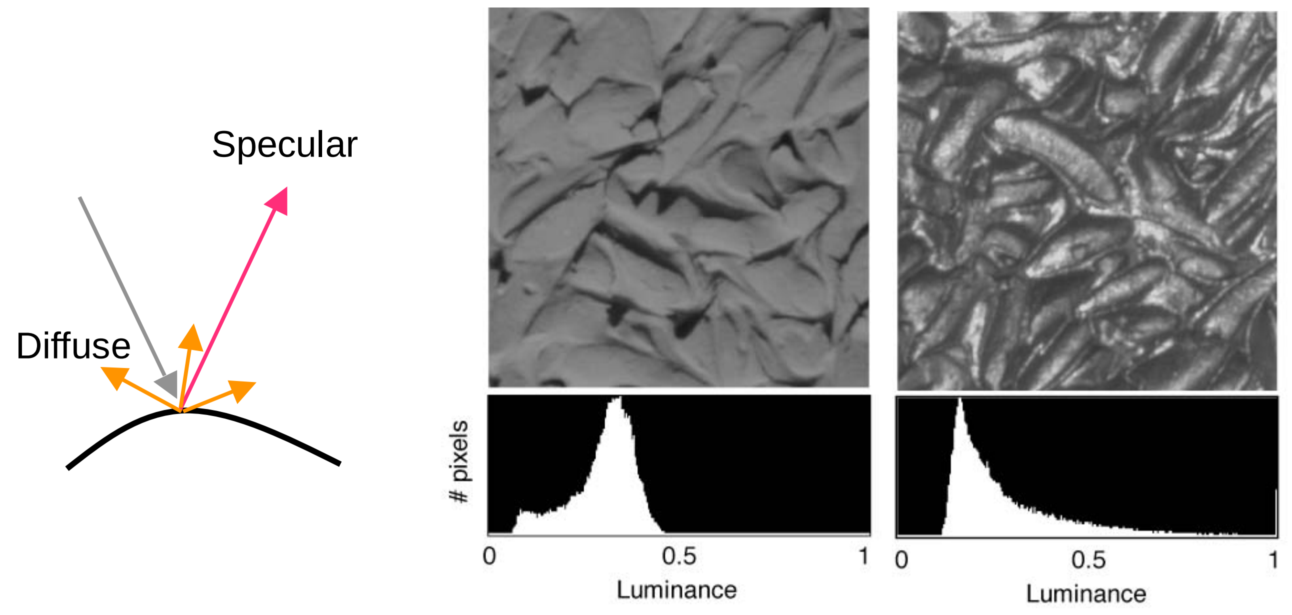
Background

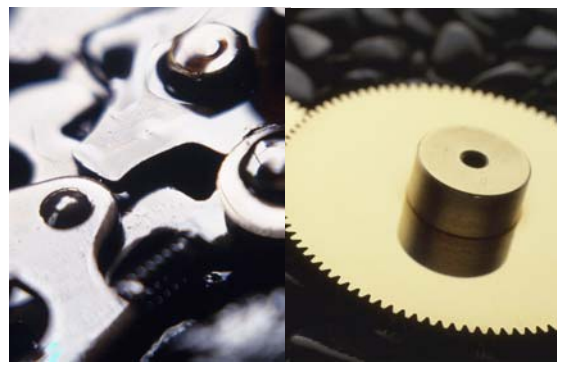
- Gloss is a reflectance attribute characterized by the magnitude of specular reflection relative to that of the diffuse reflection.

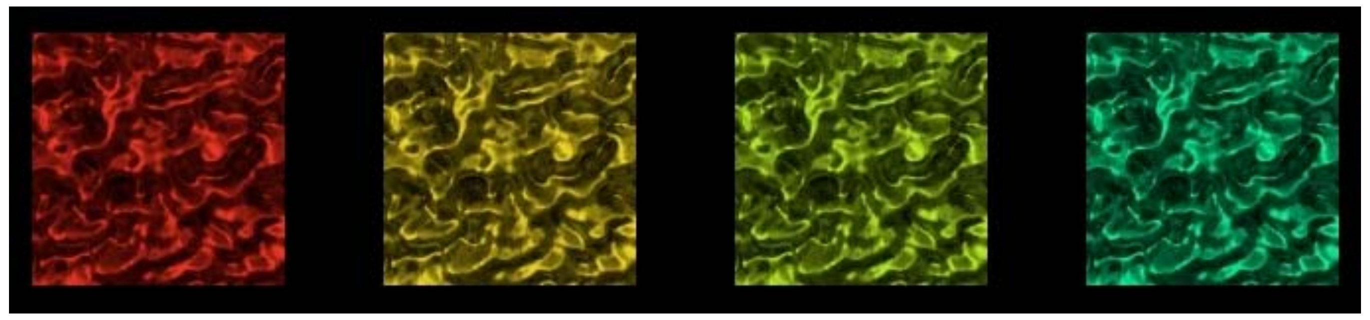


- We have shown that gloss perception for achromatic surface images may be based on the analysis of simple image statistics, such as the skewness of luminance and/or subband histogram (Motoyoshi et al, 2007; Sharan et al, 2008).
- Now we consider how chromatic information influences gloss perception.

Glossy material (1): Metals

- Metal surface reflectance consists only of the specular component that may or may not be spectrally neutral (monochromatic reflectance model: Healey, 1988).
- Observers can use surface color to infer material (e.g., gold, silver, copper), but color does not seem to play an essential role in gloss perception *per se*.





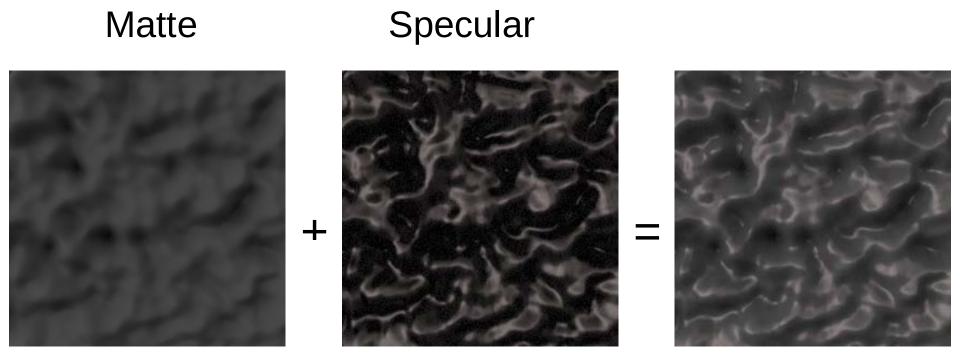
Glossy material (2): Dielectric materials

- The second, and more interesting class of glossy objects is dielectric materials, such as plastic and orange peel.
- The surface of those materials has both the specular and diffuse reflection components, and pixel colors are linear combinations of the colors of the two components (dichromatic reflectance model).

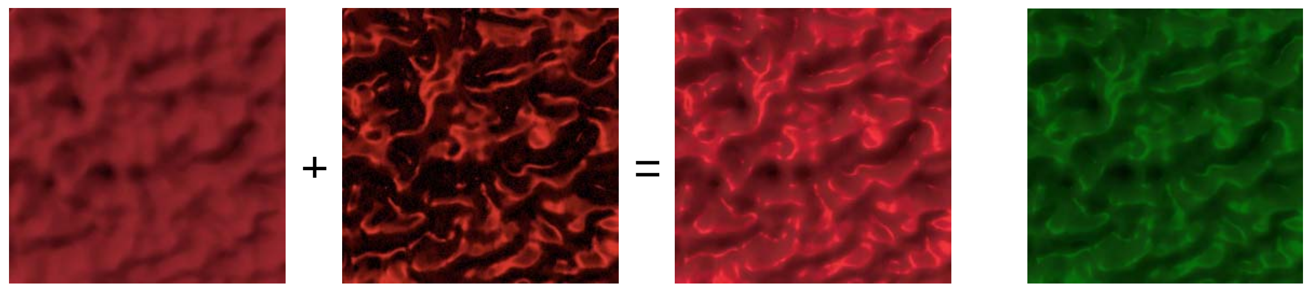
- While the diffuse component has object-specific colors (body color), the specular component is spectrally neutral, i.e., reflecting illumination without changing colors.

Independent color manipulations

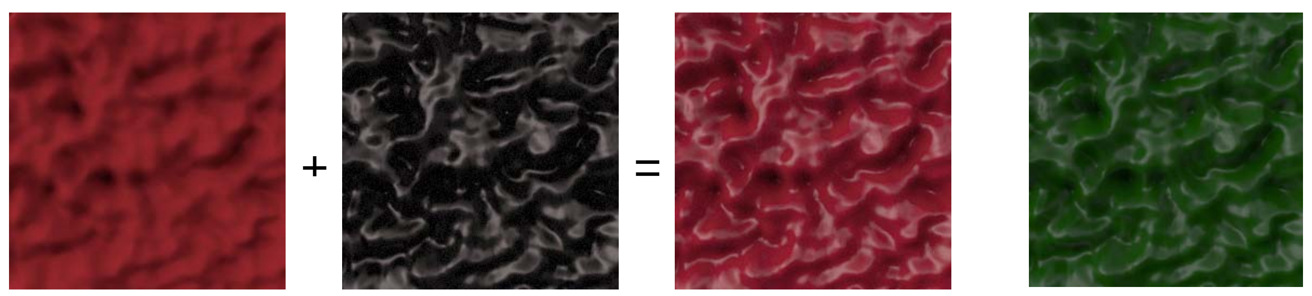
- We generated images of glossy corrugated surfaces and independently changed the colors of the matte and specular components, while keeping the luminance profile fixed. We observed the images using a high-dynamic-range display (Brightside DR37) to obtain sufficiently bright colored highlights.
- **Case I:** When diffuse and specular components were both white, observers perceived normal glossy surfaces.



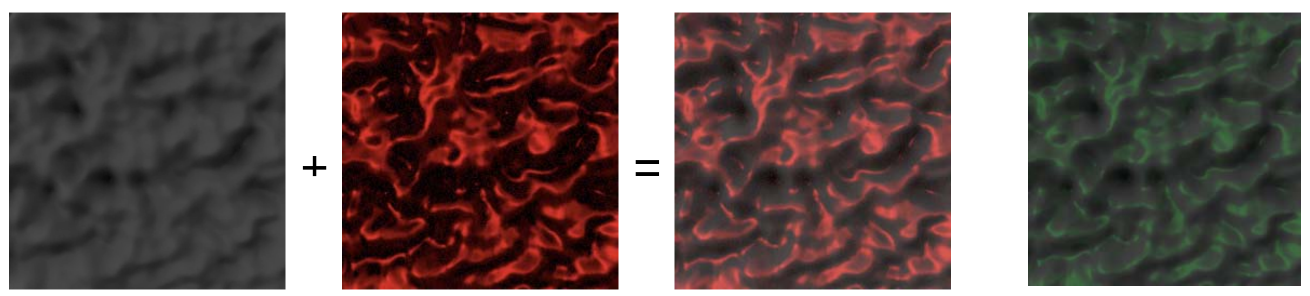
- **Case II:** When diffuse and specular components share the same color (e.g., red on red), observers perceived normal glossy surfaces.



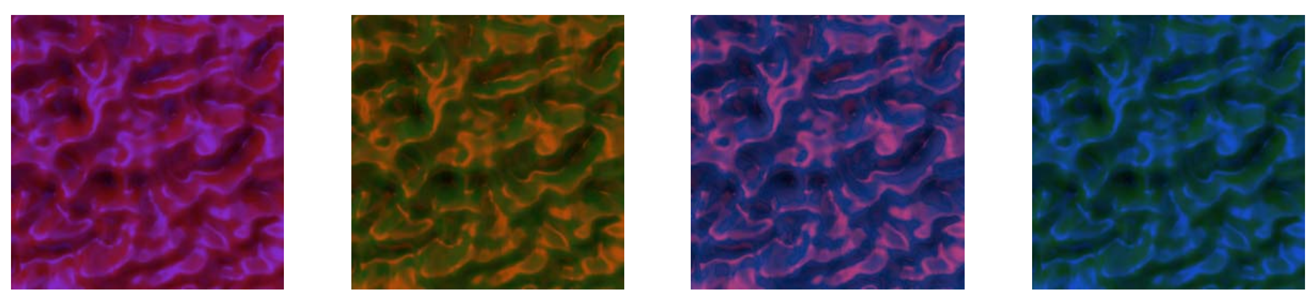
- **Case III:** When the specular component was white and the diffuse component was colored (e.g., white on red), the surface looked even more naturalistic.



- **Case IV:** When a colored specular component was combined with a white diffuse component (e.g., red on white), the surface images looked somewhat strange. They looked less glossy, and more importantly, did not appear to have a uniform reflectance. Colored highlight regions appeared to be spatially segregated from the surrounding white-body regions, as if pieces of colored foil were attached to a white matte surface.

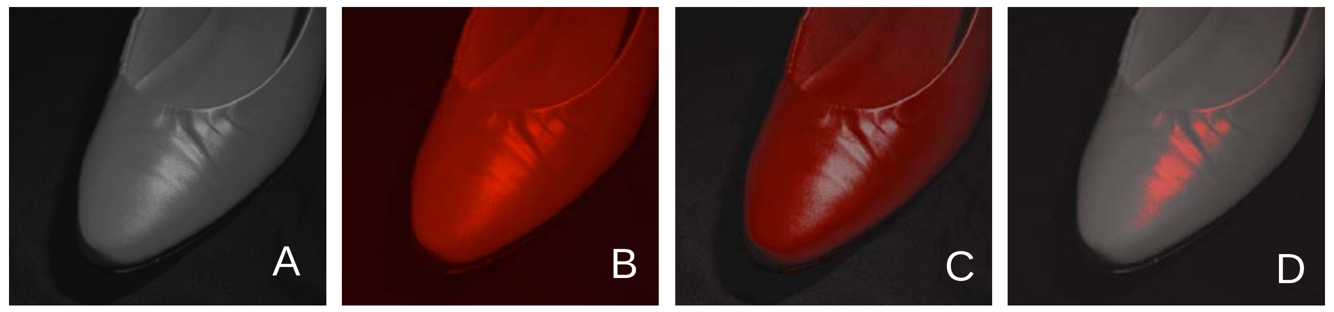


- **Case V:** When both diffuse and specular components were colored but had different hues, highlights do not look like proper highlights as in Case IV.

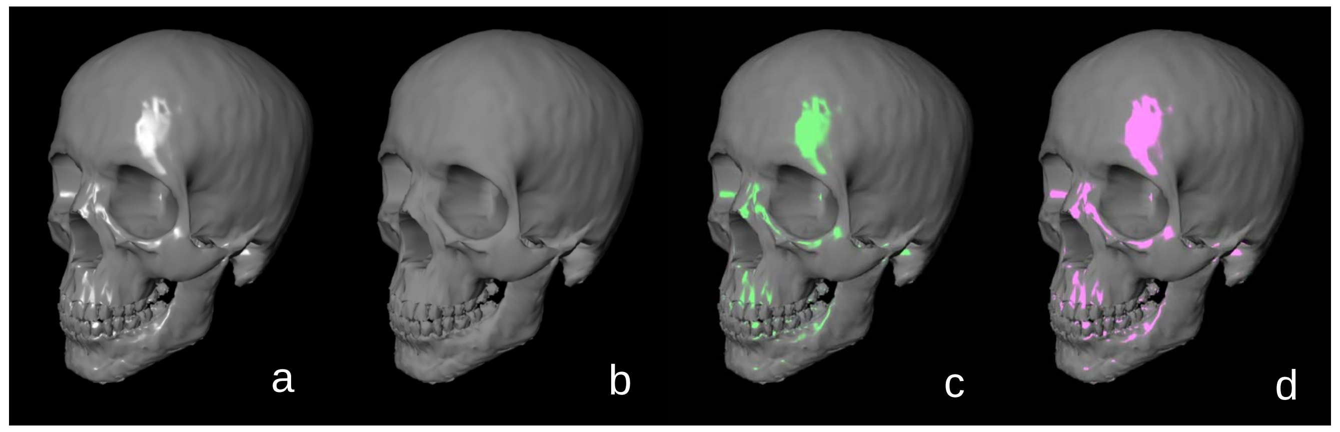


Other examples

- Red highlights do not make a gray shoe look glossy (D).



- White highlights make the whole skull look glossy (a). This propagation of glossiness over the surface is not observed for colored highlights (c, d).



Discussion

Case	Diffuse		Specular	Body reflection	Illumination
I	White	≤	White	White	White
II	Red	≤	Red	White	Red
				Red	Red
III	Red	<	White	Red	White
IV	White	>	Red	?	
V	Red	≠	Blue	?	

- When a dielectric surface is illuminated by a chromatically-uniform light source, the specular component reflects the illumination color, and the color spectrum of the diffuse component should be included in the spectrum of the specular component. This is approximately true for our experiences with dielectric surfaces under natural non-uniform illuminations.
- Our observation suggests that the human visual system correctly takes into account the physical constraint of highlight color when it judges whether a given local luminance change (increment) is introduced by superposition of a highlight, or by other physical causes including reflectance changes.

References

Healey, G.A. (1988). Color reflectance model and its use for segmentation, *Proc. of the 2nd International Conference on Computer Vision*, 460-466.

Motoyoshi, I., Nishida, S., Sharan, L. & Adelson, E.H. (2007). Image statistics and the perception of surface qualities, *Nature*, 447(7141), 2006-2009.

Sharan, L., Yuanzhen, L., Motoyoshi, I., Nishida, S., & Adelson, E.H. (2008). Image statistics for surface reflectance perception, *Journal of the Optical Society of America, A.*, 25(4), 846-865.