

The appearance of glossy, bumpy surfaces

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Introduction

Specular highlights produced by glossy surfaces can affect shape perception. e.g., 1-3

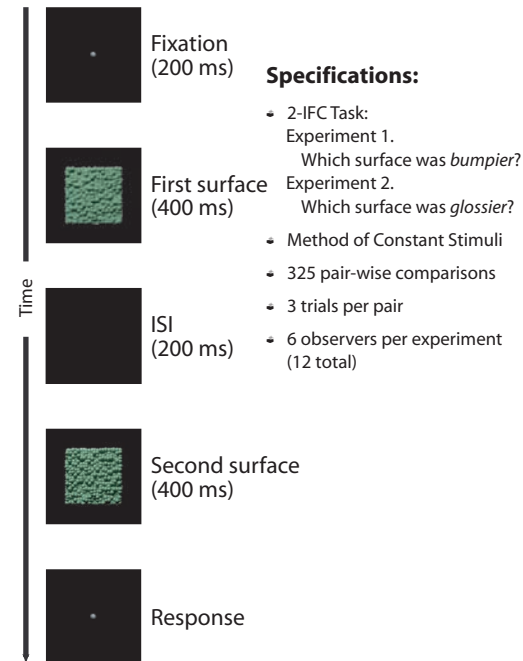
Local shape can affect judgments of surface reflectance (e.g., gloss).⁴



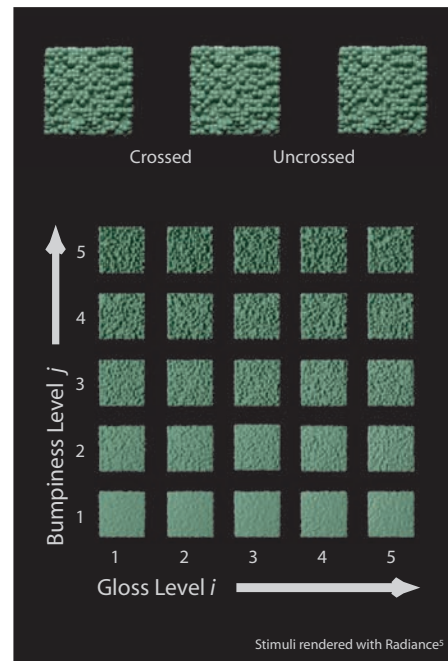
Pick the raspberry that appears glossier and bumpier than the others.

How do microscale structure (gloss) and mesoscale structure (3D surface texture) affect surface material judgments like glossiness and bumpiness?

Methods



Stimuli



Model

Surface S_{ij} has gloss level g_i and bumpiness level b_j . Perceived bumpiness B_{ij}^A is modeled as an additive combination of cues to bumpiness:

$$B_{ij}^A = B_i^g + B_j^b,$$

where B_i^g is the contribution of cues to physical gloss and B_j^b is the contribution of cues to physical bumpiness. When comparing S_{ij} to another surface S_{kl} the observer forms the noise-contaminated decision variable,

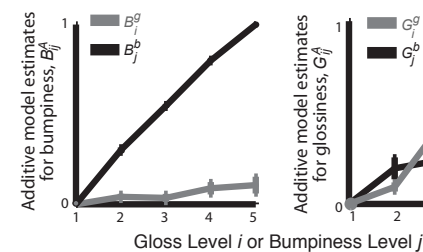
$$\Delta = B_{ij}^A - B_{kl}^A + \varepsilon, \quad \varepsilon \sim \text{Gaussian}(0, \sigma^2).$$

S_{ij} is perceived as bumpier than S_{kl} when $\Delta > 0$. The parameter σ represents the observer's precision in judgment. We anchor the scales by setting $\sigma=1$ and $B_i^g = B_j^b = 0$. We assume a similar model for perceived gloss.

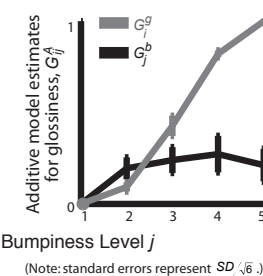
We estimate the remaining 8 parameters by maximum likelihood. We then perform two nested hypothesis tests to determine (1) if observers could ignore cues to the irrelevant property and (2) if this additive model sufficiently describes the interactions.

Results

Experiment 1. Bumpiness



Experiment 2. Glossiness



Did observers successfully ignore irrelevant cues?

We found a significant* effect of cue interaction for 4 out of 6 observers in both experiments. Changes in physical gloss increased perceived bumpiness by as much as 11% of the range of bumpiness levels we used. Changes in physical bumpiness increased perceived glossiness by as much as 27% of the range of gloss levels.

Does the additive model sufficiently capture the interaction between cues?

We found no significant* differences for 5 out of 6 observers in Experiment 1 and 3 out of 6 observers in Experiment 2 between the additive model and a 24-parameter model that models each surface S_{ij} independently.

* $p < 0.008$ at the Bonferroni-corrected level

Conclusions

When making judgments of bumpiness or glossiness, irrelevant cues cannot be ignored.

A simple additive model captures interactions in judgments of surface material.

References

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