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Parametric measurements of lightness in the context of real illuminated objects

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Abstract

Purpose: The visual system achieves partial lightness constancy across illumination gradients and variations in object pose. What scene variables mediate this constancy? Here we report parametric measurements of how the slant and reflectance of a background surface affect the lightness of test spots seen against that surface. Methods: Observers looked into an experimental chamber. Two spatially separated cards provided the immediate backgrounds for a test and matching spot. The slant of the background cards could be varied using computer-controlled rotating stages. Changes in the reflectances of background cards were simulated with a hidden projector. Observers compared the apparent lightness of simulated spots projected onto the background cards. We held the slant and simulated reflectance of one background card fixed and varied the slant and simulated reflectance of the other. We obtained matching curves which related the luminance of a spot on the fixed background card to the luminance of a lightness-matched spot on the variable background card. Results: When there were minimal cues to illumination geometry, matching curves depended only the background card's luminance and were independent of the type of manipulation (reflectance or slant) used to achieve a particular luminance. In addition, the matching curves resembled those obtained previously for simple stimulus configurations where test spots where presented against spatially uniform backgrounds. Conclusion: We have developed a paradigm that allows parametric measurement of object lightness in real scene contexts. Within this paradigm we are able to reduce conditions sufficiently that we can replicate key features of classic results. For richer contexts, we expect new patterns to emerge in the parametric data. The data should address the generalizability of extant models developed with reference to much simpler viewing conditions, and allow development of quantitative models of lightness applicable to natural viewing.

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