The role of background distortions in material matches of transparent objects

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Summary

Based on material matching results it was proposed that optical background distortions can be used to estimate the refractive index. Fleming, Jäkel, and Maloney (2011) considered a two step process (see panel A). We derive and test two predictions related to the first step of this process (panel B, C). Our results contradict these predictions and thus speak against the proposed mechanism.

The results presented in panel D suggest that the subjects’ settings reflect simple image-level matches, unrelated to transparency perception.

(A) A tentative model for estimating refractive indices from distortions (Fleming et al., 2011)

1. step 1
   - distortion field estimate \( \hat{d} \)
   - “The distortion field is a midlevel cue that involves comparing the relative scale of texture elements seen through the transparent object with the elements seen directly.”
   - p. 814
2. step 2
   - refractive index estimate \( \hat{R} \)
   - “[...] the visual system could use some summary statistic of the magnitude of distortions [...] to estimate its refractive index.”
   - p. 818

Methods

Material matching task with different background texture densities in standard and test.

standard (fixed \( R \))
- low
- med
- high

test (adjustable \( R \))
- low
- med
- high

(b) The influence of background texture density

Varying a scene variable that changes neither the distortion field nor the relative scale of texture elements, for example the background texture density, should not systematically influence the \( R \) estimates.

Methods

Same material matching task (see panel B), but in half of the trials the textured surround is replaced by a uniform grey one.

Main results

In contrast to the prediction, neither the mean nor the variance of the \( R \) settings are influenced by the omission of the surround. The results suggest that the subjects refer solely to information within the object boundaries and that they ignore any information available in the surround.

(C) The role of the undistorted surround

If comparing the relative scale of texture elements seen through the transparent object with the elements seen directly is made impossible, then the uncertainty of the \( R \) estimates should increase sharply.

Method

Material matching task (see panel B), but in half of the trials the textured surround is replaced by a uniform grey one.

Main results

In contrast to the prediction, the relative background texture density in standard and test exerts a systematic influence on the \( R \) settings.

(D) Alternative explanation: image-level matches

Hypothesis: deviations reported in panel B and C are due to image-level matches of the background textures.

Methods

Same material matching task (see panel B), but encouragement of image-level matches by isolating the information given in the background and by removing the impression of transparency.

Main results

The general pattern of deviations is similar to that reported in panel B and C. This suggests that in those cases image-level matches also played a critical role.

Comparing the results for all stimuli shows that the size of the deviations decreases with increasing salience of reflection-related information in the stimulus.

References and contact


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