Color transparency from motions of backgrounds and overlays

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Motion in specific configurations is sufficient to create impressions of moving transparent layers and of movement behind holes. By translating one of 6 spectrally selective transparent circular filters on backgrounds selected from 280 spectrally selective surface reflectances, we created vivid percepts of moving transparency. Using the same filters and reflectances, by moving the background alone inside a static circular segment, we created a vivid percept of a transparent hole. When the hole with internal motion is moved in a manner similar to the filter, the percept is of a moving filter, despite T-junctions instead of transparency consistent X-junctions, revealing the powerful role of motion cues. Using matches with adjustable spectral reflectance on achromatic backgrounds (Fig 1), we quantified the perceived colors of the overlays in all three conditions. We repeated all three measurements with the surround of the filter and hole turned to black. In that case the filter configuration looked like a moving spotlight on a stationary background and the hole as flow illuminated by a stationary spotlight.

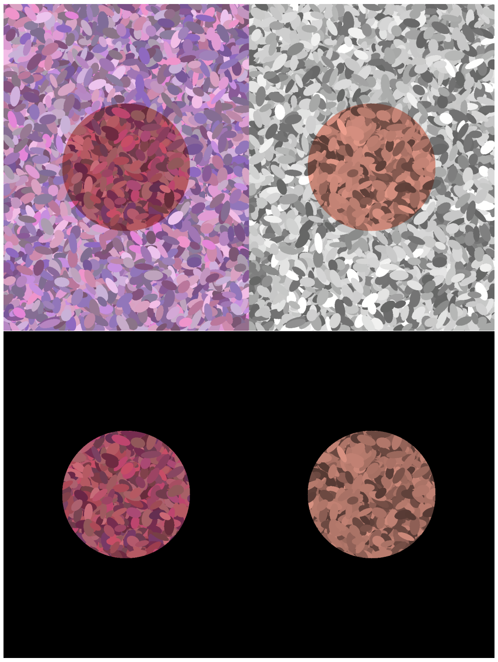

Figure 1

Khang and Zaidi (2004) matched moving filters and spotlights. To estimate the color of the spotlight with spectrum $E_f(\lambda)$, they proposed a luminance weighted grey-world model based on calculating $\rho_k(E_f)$ $(k = 3)$ the absorptions of three cone types with spectral sensitivity $R_k(\lambda)$:

$$\rho_k(E_f) = \sum_x V_x^n \int E_f(\lambda) S_x(\lambda) R_k(\lambda) d\lambda.$$

Where the cone catch for each pixel x with object reflectance $S_x(\lambda)$ is weighted by its luminance raised to a power V_x^n (n=0 means no weighting, and the larger the n the higher the weight of the brightest objects). This model predicted that the average color of the background would bias the spotlight color estimate, and provided a good fit to the empirical matches biased from veridical on different sets of colored backgrounds. To estimate the color of the filter with spectrum $E_f(\lambda)$ relative to the color of the illuminant on the visible surround, the model assumed that each of the two illuminants was estimated separately with the weighted grey-world model, and the relative filter color was estimated by the ratio of the three weighted cone absorptions. This approximate heuristic was justified by the empirical fact that filters in general change cone absorptions from all background objects by one multiplicative constant per cone type, and this ratio provides a good estimate of the multiplier. This model provided a satisfactory fit to the empirical filter matches, which were generally close to veridical when the background illuminant was equal energy white. Here we test if the model for the moving filter also explains the case of the stationary and moving hole configurations.

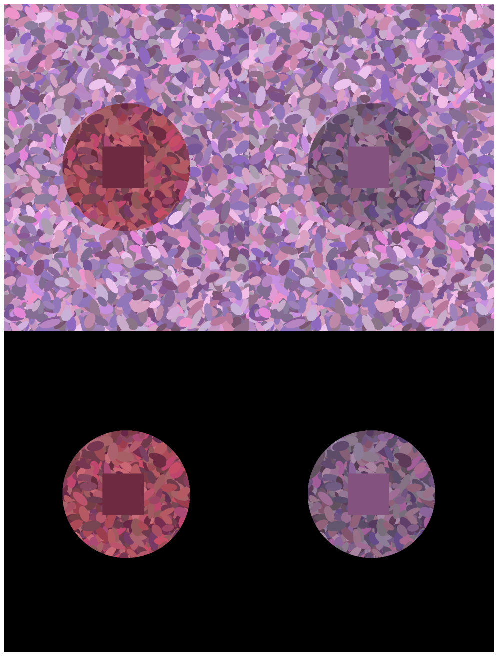

Figure 2

Using the same filter and object spectra, but with a distinctly shaped background element, we also quantified the perceived colors of overlaid elements in all six conditions, by matching the colors seen behind the test filter with an adjustable reflectance seen behind a neutral density filter on the same background (Fig 2). This is a more stringent test of color scission. Once the spotlight color or relative filter color is estimated using the heuristic model, the same empirical fact justifies a model where the cone catches from the matched reflectance under the neutral density filter, multiplied by the estimated cone catches for the spotlight or filter, should be equal to cone catches from the target element. Here we use this test to compare the extent of color scission in the filter conditions versus the hole conditions.

Reference

Khang, B. G., & Zaidi, Q. (2004). Illuminant color perception of spectrally filtered spotlights. *Journal of Vision*, *4*(9), 2-2.