

## **Adaptation to natural color environments assessed by adapting images to observers**

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Adaptation can strongly affect color appearance and is thought to be important for optimizing color coding. Yet how color vision might be adapted to specific environments and the consequences of these adjustments remain unclear. We explored the effects of color contrast adaptation in a new way – by adapting images rather than observers to simulate theoretically complete adaptation. This allowed us to probe effects of long-term adaptation over time scales that are difficult to test by adapting observers. The adaptation was modeled as gain changes in the cones and in post-receptoral channels selective for different color-luminance directions. Image sets were sampled from different environments and rendered after adjusting the gains so that the average response within each channel was equal across two environments. This centers contrast responses on the average color for a given environment and scales sensitivity inversely with the range of stimulus contrasts. Changes in color appearance were assessed by determining how hue loci should vary in the same observer under different adaptation states, and provide a measure of the extent to which individual differences in color appearance might be attributable to differences between environments. Visual performance was assessed with a search task for colored targets among neutral distracters, both shown as Gaussian blobs superimposed at random locations across the images. Search times were compared for pairs of original and adapted images and targets that were equivalent except for the simulated changes with adaptation. For natural environments that vary widely in their distributions, pronounced changes in color appearance and search times are readily demonstrated and thus lend support to functional accounts of contrast adaptation. Assessing performance across the range of environments routinely encountered allows us to assess the extent to which adaptation might significantly impact color coding or when performance could be enhanced by pre-adapting images for observers.

Supported by NIH Grant EY-10834

