HIDDEN STRENGTH OF THE CLASSICAL SIMULTANEOUS CONTRAST ILLUSION

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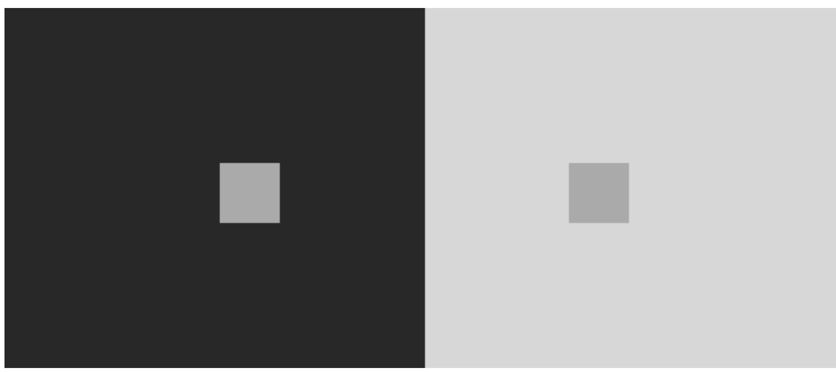
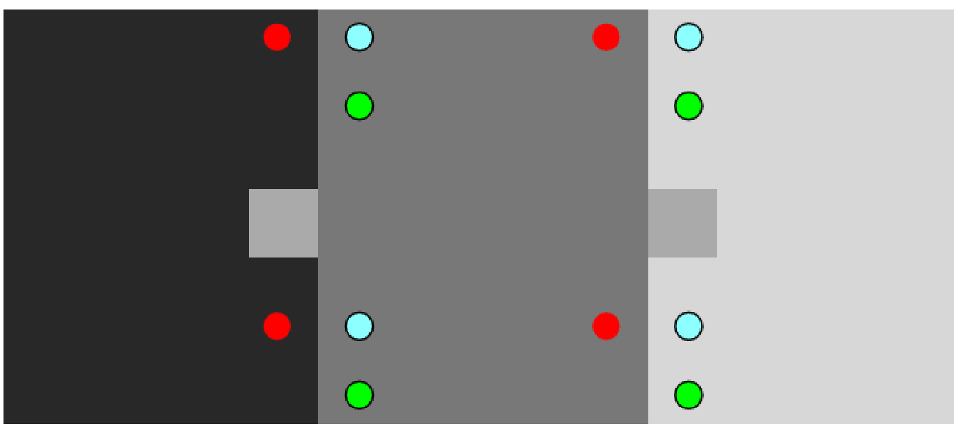
The simultaneous contrast (SC) illusion has served as the starting point for many studies of brightness perception. In the standard display shown below, this illusion is a weak one (the square on the lighter background appears only marginally darker than the other square). Other manipulations, such as the inclusion of cues suggesting specific kinds of perceptual organization, shadows or transparency are needed to enhance the illusion. An important implication of this observation is that edge-contrast cues, by themselves, can only induce a very weak brightness effect. More global scene-level attributes appear to be needed for generating the more striking brightness illusions.



Here we probe whether the brightness illusion in the classical SC display is indeed a weak one. An alternative explanation of the illusion's weakness is that some aspect of the display makes it difficult to compare the relative brightness of the two squares. A crude analogy to this issue is the following: imagine that the left and right halves of the SC display were on two separate walls, one in front and the other behind an observer. The observer can only look at one wall at a time. This setup would make it difficult for the observer to assess just how different the two inner squares are. Is there a similar factor at work here? Is it possible that if we could somehow facilitate the comparison, we would find that the brightness difference in the classical display is larger than what we have believed so far?

The most straightforward way of facilitating the comparison is to make the two small squares sit adjacent to each other. However, a simple implementation of this idea does not work. If we just translated the two squares towards each other so that they touch at their boundary, the continuity of the resultant rectangle effectively destroys the illusion. This is shown below. The two squares lose their distinct identities and the rectangle formed looks homogenous.

How else might we bring the two squares together? We have used stereo-fusion for this purpose. The idea is to bring the two squares next to each other in the cyclopean view while leaving them apart in the physical display. We treat the two halves of the simultaneous contrast display as a stereo pair. The tricky issue here is to somehow avoid confounds due to luminance averaging. It is possible that any brightness differences observed between the two inner squares could be due to the luminance of one being averaged with the darker background and that of the other with the lighter background. While it is not certain that luminance averaging will happen in this setting (Chris Tyler's work has shown that averaging takes place only when the luminances are quite close to each other), we would want to be absolutely sure that this is not a confounding factor. In order to control for this problem, we have designed the display shown below. The colored dots serve as anchors for fusion. Once they are put in register, the two inner squares are placed side by side and the luminance with which they could potentially be averaged is the same for both of them. (It helps to fixate on the upper or lower triad of dots; fixating on the smaller squares tends to make them fuse.)



When viewing the two squares side-by-side in the cyclopean view, they are perceived to have a significant brightness difference, much larger than what is evident in the original display. This seems to suggest that a potent brightness illusion may in fact exist in this display, but some extraneous factor interferes with our ability to compare the two brightnesses. This result has important implications for the relative roles of low and high-level factors in explaining brightness perception.
