Context effects for complex brightness patterns

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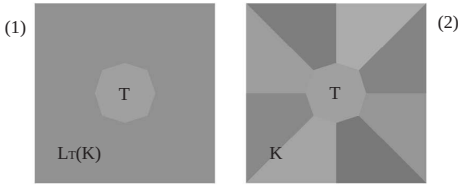
IF A TARGET patch T shows the same appearance in (1) a homogenous context with intensity L_T and (2) a complex context pattern K, then $L_T(K)$ is the *equivalent homogenous context pattern for pattern K with respect to the target T* (Bruno et al., 1996). How is $L_T(K)$ derived from K?



Hypotheses

Spatial Averaging: If the brightness of T is computed relative to the *spatial geometric average* for the whole pattern, then $L_T(K)$ should be independent of T for all patterns K.

Highest Luminance: If the brightness of T is computed relative to the *highest luminance in a pattern* then

(1) if T itself is the highest luminance of the pattern then $L_T(K)$ should be independent of K, since every luminance less than T is an acceptable value for $L_T(K)$,

(2) if T is not the highest luminance then $L_T(K)$ should be equal to the maximum luminance in K.

Stimuli

We measured $L_T(K)$ for 12 different context patterns K (samples to the right) and 9 target intensities T.

Context Patterns	min. lum.	max. lum.	geom. aver.
wide range, med. av.	11.22	89.12	31.62
narr. range, low av.	11.22	28.18	17.78
narr. range, med. av.	19.95	50.12	31.62
narr. range, high av.	35.48	89.12	56.23

Center Patches

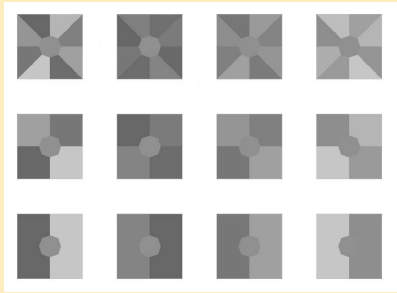
9 center target luminances T, equally spaced on a log scale from 10.0 to 100.0 cd/m².

Visual angles

Whole pattern: 10.6 deg, center: 3.6 deg.

Background

Full and bright visual field, central area: 31.6 cd/m².

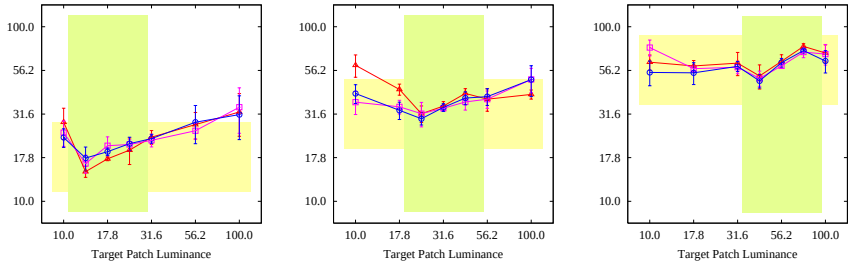


Subjects

We report data from 5 subjects. There was one training session and two data sessions with conditions completely randomized.

Procedure

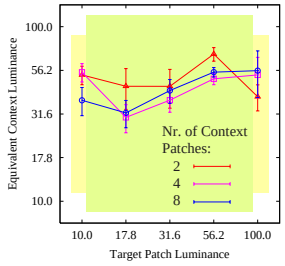
Subjects see a single pattern. The central patch luminance T is constant. The context pattern changes its contrast continuously such that it is equal to the complex pattern K at maximum contrast and is a homogenous field with luminance L at minimum contrast. Modulation of contrast ist sinusoidal with a period of 2.4 s. The subject adjusts the luminance L until there is no longer any apparent brightness modulation in the center patch. This is taken as equivalent homogenous context intensity $L_T(K)$. The above stripe shows an example of such a modulation sequence.



Results: Effect of Target

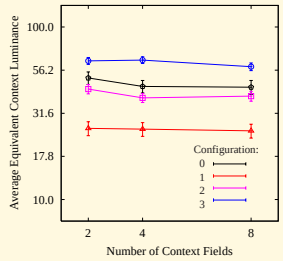
There is a significant effect of target luminance. The yellow and green areas indicate the range of context intensities. Note the similarity of all graphs with respect to the range of context luminances. All graphs show an initial decrease for the lowest target within the context range and then are monotone increasing within the context range. The reason may be a reduced crispening effect (Takasaki, 1966) for complex context patterns. Low and high luminance targets outside of the context luminance range result in equivalent luminance values which are higher than predicted by the geometric spatial averaging hypothesis. The hypothesis of anchoring at the highest luminance predicts that for all targets within and below the context range equivalent luminance should be at the maximum luminance in the context pattern which corresponds to the upper edge of the yellow horizontal bars.

The data indicate a compromise between the two rules with an additional crispening effect being absent in complex patterns and enhanced for homogenous patterns by the modulation procedure.

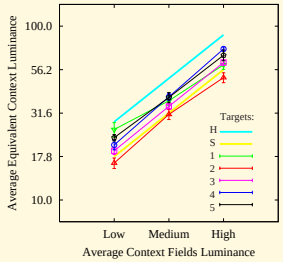


References:
Bruno, N., Bernardis, P., & Schirillo, J. (1997). Lightness, equivalent backgrounds, and anchoring. Perception and Psychophysics, 59, 643-654.
Takasaki, H. (1966). Lightness change of grays induced by change in reflectance of gray background. Journal of the Optical Society of America, 56, 504.

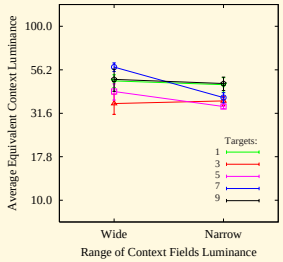
Results: Effect of the Context



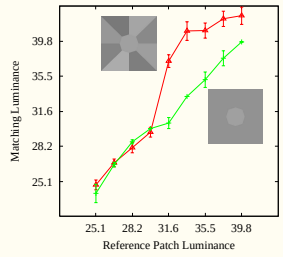
There is no statistically significant effect of the number of context patches.



Equivalent luminance is strictly increasing with average and maximum context luminance. Targets are numbered according to their position in the context range. 5 always ist the maximum luminance in a pattern. H and S are predictions of the highest luminance rule and the spatial averaging rule respectively.



A wider range of context intensities results in higher values for equivalent luminance for targets 5 and 7. A much higher increase is predicted by the highest luminance rule for targets 1 to 7. Spatial averaging predicts no effect of contrast range.



Results of a control study

There is no crispening effect with complex context patterns but there is strong brightness enhancement for uniform context fields. This confirms the conjecture that the target dependence in our results are due to a reduced crispening effect for complex context patterns.