The Slope of Self-Luminous Neutral Scale

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Abstract

Perceived neutral (brightness, lightness or gray) scale depends upon luminance, e.g., of visual targets, their adjoining background(s). Just-noticeable differences (JNDs) of target gray scale accumulate as target luminance diverges from background luminance. Luminance is continuous. Gray scale is continuous. Therefore it is intriguing to consider the slope of self-luminous gray scale: the ratio of changes of gray scale JNDs to small changes of target luminance (at fixed background luminance).

Eric Heinemann[1] offered experimental data on the slope of the self-luminous brightness scale (versus target log luminance, for several fixed background luminances), which he filed with the U.S. Library of Congress. By applying the chain rule, we can convert these to slope estimates versus target luminance. Paul Whittle[2] later published a logarithmic formula (based upon his own data from a different experimental paradigm than Heinemann's) for cumulative self-luminous brightness scale as a function of target and background luminances. By transforming Heinemann's data to slopes versus luminance, and by differentiating Whittle's formula with respect to target luminance, we obtain two independent estimates of the slope of self-luminous neutral scale.

When plotted against each other (see Figure 1), these independent estimates (for the same target and background luminances) correlate 0.937 for 156 observations by Heinemann's two observers, or 0.966 if the data from the two observers are averaged.

The results encourage calculation of self-luminous neutral scale, and they support the concept of neutral scale as a cumulative continuous (integrable and differentiable) quantity.

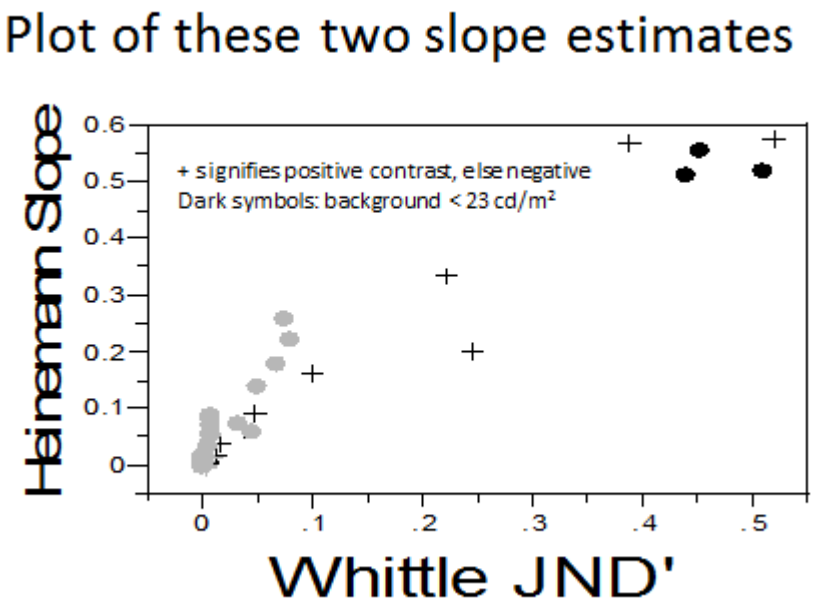

Figure 1. Independent estimates of the slope of neutral scale: Ordinate is derived from Heineman 1961, i.e., the inverse of the increment threshold. Abscissa is the definition of derivative applied to Whittle's1992 logarithmic brightness formula.

References

1. Heinemann EG. The Relation of Apparent Brightness to the Threshold for Differences in Luminance. J Exp Psychol 1961; 61: 389-399
2. Whittle P. Brightness, Discriminability and the "Crispening Effect." Vis Res 1992; 32: 1493-1507

Author Biography

Robert Carter is chairman of CIE Technical Committee 1-93, calculation of self-luminous neutral scale. He is retired, living in Pennsville NJ. Dr. Carter was a research administrator at New Jersey Institute of Technology, and Captain Carter was a Research Psychologist in the U.S. Navy. He earned B.S. and M.S. degrees from Rensselaer Polytechnic Institute, an M.B.A from Virginia Polytechnic Institute and State University and a Ph.D. from The Pennsylvania State University. He has contributed multiple publications in several areas: visual search with color, effects of small subtense on color perception, selection of maximally conspicuous colors (including gray scale), repeated measurements of human performance, research management and calculation of gray or neutral scale.