A Fixation on Visual Search with Color

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Introduction

Color can make visual search targets appear to pop-out from among distractors on a visual display. Carter and Carter[1] in 1981 demonstrated that during color-coded visual search the discrimination gradient between a search target color and distractor colors is a nonlinear function of the color difference between the target and each distractor. Smallman and Boynton[2] in 1990 explored the alternative hypothesis that color name concepts determine color discriminations; they concluded that calculated color difference is indeed the causal factor.

There are two major practical problems with this application of color difference calculations. First, color difference calculations are based upon 4 and 10-degree standard observers. Typical symbols or image segments in visual search subtend less than a degree. Carter and Carter[3] in 1988 demonstrated the reliable and substantial degradation of search performance associated with decreasing the subtense of search symbology (two degrees to 7.5 minutes) while keeping CIE target-distractor color difference constant. The second major problem is that color difference calculations are usually applied to small color differences of very few units. Color differences in designed displays are tens or hundreds of units. For these reasons and others, there generally isn't much scientific or practical interest in applying color science and technology to small visual fields. This paper will discuss some reasons for this disinterest. Although the application of color difference to symbol conspicuousness in visual displays is important, existing color technology is not ideally suited to this application because the technology was intended for large-field, small color difference applications.

This paper will describe two recent advances: 1) use of DE 2000 is shown to improve the precision (MS Error) of modeling target-distractor color-discrimination gradients by 17% compared with the CIE LAB and LUV metrics used by Carter and Carter in 1981; and 2) Highnote's 2003 dissertation[4] finding (using psychophysical tasks and self-luminous displays) that elongation of small symbols enhances achromatic discriminations and interferes with chromatic discriminations is replicated using data from search of Munsell-paper targets. Individual differences among observers, and their effect on search performance will be discussed. For instance, the concept of a standard observer is called into question by the overwhelming differences among observers, which emerge in the context of color discrimination of small targets[4]. Future directions for color research and application will be indicated.

References

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Author Biography

Robert Carter received BS and MS degrees from Rensselaer Polytechnic Institute (1971, 1972), and the PhD in psychology from the Pennsylvania State University (1979). He served as a US naval officer for 26 years, most recently as Head, Human Systems Science and Technology (S&T) Department and as Director, Cognitive, Neural and Social S&T Division at Office of Naval Research. In addition to his own dozen publications related to color, he was instrumental in government support for the color research of others, for example, reference 4.