How does color blindness affect color preferences?

July 21 2015, by Christopher Packham

Credit: colourblindawareness.org

(Medical Xpress)—Dichromacy is a color vision defect in which one of the three types of cone photoreceptors is missing. The condition is hereditary and sex-linked, mostly affecting males. Although researchers have explored color perception in dichromats, there are few studies of their affective response to color, such as color preference. A group of researchers from Spain and the United Kingdom have recently conducted a study about the color preferences of red-green dichromats, and have published their results in the *Proceedings of the National Academy of Sciences*.

In trichromats (who have normal color perception), cones respond to two chromatic cone opponent mechanisms: red-green and yellow-blue. They

also respond to achromatic mechanisms based on small, medium and large wavelengths— L-M and S-(L+M). Dichromats who lack the cone type sensitive to long wavelengths are protanopes; those lacking the cone type sensitive to medium wavelengths are deuteranopes.

Humans with normal color perception are known to have preferences for some colors over other colors, favoring blue and disfavoring yellow-green at very high rates. The researchers were interested in, among other things, finding whether or not dichromats also have preferred and disliked colors based on the differences with which they perceive the world.

The researchers recruited 15 male and 17 female participants with normal color vision, and 17 deuteranope males and 15 protanope males with dichromatic color vision. Their color vision was tested with a set of psychophysical diagnostic tools, and were then assigned to groups. Participants completed a color-preference task and a timed color-naming task.

How red-green dichromacy affects color perception

The researchers found the dichromacy affects color perception more in protanopes than in deuteranopes. Deuteranopes demonstrated stronger similarity in responses to people with normal color perception than protanopes for both color naming and color perception.

"Prior research has argued for a residual red-green mechanism influencing dichromat color naming for stimuli over 3°," the researchers write. "Here, we show that such a mechanism is likely at play when deuteranopes decide how much they like light colors and provides evidence of residual red-green discrimination in an aesthetic aspect of color perception."

The mechanisms of color preference

The study found that cone contrast was quite effective in determining preferences between colors that vary mainly in hue; it was less effective when colors varied strongly in saturation and lightness. The researchers found that dichromat color preferences patterns were analagous to those of trichromats if they altered the variables to consider their altered cone responses.

Additionally, the researchers show that the degree to which males, but not females, like a color is related to how easy it is to name. Up to half of the variance in trichromat males was related to quick response times in the naming test. "Because color perception has adaptive uses related to the speed and ease of processing (e.g., when locating something useful or dangerous), it seems logical that males prefer colors that are easier to name and therefore process." They add that the lack of such a pattern of preference in females merits further study.

General principles of aesthetics and perception

There's a contemporary theory that proposes that the more easily a stimulus can be processed, the more it is liked, i.e., stimuli with greater degrees of contrast, symmetry, familiarity, and prototypicality. The current study shows that similar ease of processing, at least for males, relates to color preference.

"Combined, the findings on cone contrast and color naming suggest that the more psychological specificity colors have, the more they are preferred," the authors write. "By 'psychological specificity,' we mean the extent to which colors produce the greatest response in the visual system and the extent to which they are salient, distinctive, and less prone to be confused with other colors."

More information: "Color preference in red–green dichromats." *PNAS* 2015 ; published ahead of print July 13, 2015, DOI: 10.1073/pnas.1502104112

Abstract

Around 2% of males have red–green dichromacy, which is a genetic disorder of color vision where one type of cone photoreceptor is missing. Here we investigate the color preferences of dichromats. We aim (i) to establish whether the systematic and reliable color preferences of normal trichromatic observers (e.g., preference maximum at blue, minimum at yellow-green) are affected by dichromacy and (ii) to test theories of color preference with a dichromatic sample. Dichromat and normal trichromat observers named and rated how much they liked saturated, light, dark, and focal colors twice. Trichromats had the expected pattern of preference. Dichromats had a reliable pattern of preference that was different to trichromats, with a preference maximum rather than minimum at yellow and a much weaker preference for blue than trichromats. Color preference was more affected in observers who lacked the cone type sensitive to long wavelengths (protanopes) than in those who lacked the cone type sensitive to medium wavelengths (deuteranopes). Trichromats' preferences were summarized effectively in terms of cone-contrast between color and background, and yellow-blue cone-contrast could account for dichromats' pattern of preference, with some evidence for residual red–green activity in deuteranopes' preference. Dichromats' color naming also could account for their color preferences, with colors named more accurately and quickly being more preferred. This relationship between color naming and preference also was present for trichromat males but not females. Overall, the findings provide novel evidence on how dichromats experience color, advance the understanding of why humans like some colors more than others, and have implications for general theories of aesthetics.

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