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Discomfort glare from daylight: Influence of transmitted color and the eye's macular pigment

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Designing architectural façades that allow sufficient daylight to create visually comfortable and pleasant environments is a challenging aspect of building design as it requires to account for visual comfort and discomfort glare risks, and understand the factors that influence them. Amongst the key factors that contribute to one' s perception of discomfort glare, we find the quality and quantity of daylight transmitted through the façade on the one hand, and the characteristics of the human eye and its synergistic functioning with the brain on the other hand. In the last two decades, several prediction models have been developed to quantify discomfort glare by considering almost exclusively the photometric properties and spatial distribution of incoming light. Although these empirical models have been derived to best match the user perception of glare, they fail to account for the significant inter-individual variability that exists in glare perception and are furthermore limited in their applicability in certain visual environments.
Focusing on the factors not considered in these models so far, we conducted user studies investigating the influence of the color of (day)light and the human eye morphology, as these seemed, based on the available literature, to be two particularly promising factors in terms of their potential impact on discomfort glare perception. More specifically, we examined the influence of i) the color of a small-sized, intense glare source (visible sun) resulting from the use of saturated-colored glazing (red, green, blue, and grey) and ii) the macular pigment density in the retina. By means of three psychophysical experiments conducted in office-like test rooms along with ocular examinations of the participants, we determined the influence of these factors on discomfort glare from daylight for young and healthy individuals. Each experiment followed a similar protocol of exposing every participant to four daylight glare scenarios and recording their responses to questionnaires. The four daylight scenarios differed only in the color and transmittance of the glazing through which the sun was visible as the main glare source.
Results do indicate that the color of daylight can have a strong influence on human perception of glare. The sunlight filtered through the four types of colored glazing of the same transmittance indeed caused different levels of perceived discomfort glare amongst the participants. More precisely, participants experienced statistically higher levels of glare under the red and blue glazing than the grey or green glazing. As far as eye morphology was concerned, while macular pigment density in the retina did not seem to have an influence on sensitivity to glare under color-neutral conditions, it did have a significant effect under saturated blue glazing for the sampled population: participants with higher pigment densities indeed experienced lower levels of discomfort glare under daylight filtered through the blue glazing used. To advance our understanding of discomfort glare and extend the applicability of the discomfort glare prediction models to colored daylit scenarios, these findings can provide useful insights on building design strategies for achieving better visual comfort.

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