Effects of Lighting Environment Factors Upon Human Thermal Sense

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Abstract

A human subject experiment was conducted to evaluate the combined effects of thermal and lighting environments on physiological and psychological responses. The study aimed to explore potential energy savings by modulating perceived temperature through lighting adjustments, thereby reducing air conditioning demand. Three air temperature conditions were tested, with wall surface temperatures matched to air temperatures to ensure thermal uniformity. Six levels of horizontal illuminance and five correlated color temperatures (CCTs) were used as lighting variables. Fifty-four healthy young female participants were involved. Physiological responses were assessed via mean skin temperature, while psychological responses included thermal sensation, thermal comfort, visual thermal sensation, and visual thermal comfort. No significant differences in mean skin temperature were observed across conditions, indicating stable physiological responses. However, significant variations in thermal sensation were found, demonstrating that visual stimuli—especially CCT—can influence thermal perception independently of physical heat exchange. In slightly warm environments, higher CCTs (above 3800 K) improved thermal sensation and mitigated discomfort through higher-order cognitive processing of spatial impressions. Although the influence of CCT on overall thermal comfort was weaker than its effect on thermal sensation, the results support the feasibility of using lighting design to enhance subjective comfort. These findings suggest that thermal discomfort caused by moderately elevated air temperatures, as part of energy-saving strategies, can be partially offset by adjusting lighting CCT, offering a practical approach to maintaining comfort while reducing HVAC energy consumption.

Keywords

Correlated color temperature, Illuminance, Air temperature, Skin temperature, Thermal sense.