International Journal of Applied Home Science
(An International Double Blind Peer Reviewed / Refereed Research Journal of Home Science)
Volume 12 (3 & 4), March & April (2025) : 94-99
Received : 07.02.2025; Revised : 21.02.2025; Accepted : 07.03.2025

RESEARCH PAPER
ISSN : 2394-1413 (Print)
DOI: 10.36537/IJAHS/12.3&4/94-99

Effects of Direct Lighting on Readability among Youth

SARJOO PATEL[1], NEHA RATHORE[2] AND JAHNAVI LUHAR*[3]
[1]Associate Professor, [2]Assistant Professor and [3]Research Scholar
Department of Family and Community Resource Management, The Maharaja Sayajirao University of Baroda, Vadodara (Gujarat) India

*Corresponding Author

ABSTRACT

Background: The importance of lighting has been extensively studied and is thought to be crucial for the performance of the occupant. Moreover, lighting contributes to the creation of a visually engaging environment that improves the appearance of interior space. The tasks to be accomplished and the comfort of all users must be taken into consideration when designing lighting in a human-centric manner. The present research aimed to study and compare the extent and rate of readability under three different Corrected Colour Temperatures (CCTs) of Direct lighting.
Methods: The research design for the present study was Experimental. The respondents were selected using a purposive sampling technique. A total of 61 respondents consented to participate in this experimental research. A simulated darkened room was prepared with a table lamp having programmable CCT being the only source of light. Respondents were given the Ishihara colour-blindness test first and then made to read a paragraph below three distinctive CCTs (Warm white light-3000K, Natural white light-4000K, and Cool white light-6500K) of a Direct Lighting fixture. They were given 60 seconds break before switching to another CCT of Direct Light, and their perception was recorded with the interview schedule.
Results: The findings revealed that the Extent of Readability and Rate of Readability of the respondents was highest under Natural white light-4000K. A significant relationship was found between the Extent of Readability of the respondents and Natural white light-4000K CCT of Direct Light.
Conclusion: Based on the results of the present study, guidelines were developed for creating a better reading environment in residential spaces. These guidelines included recommended CCT and Luminance (lux) of lighting for better reading.

Keywords: Correlated Color Temperature (CCT), Direct Lighting, Readability, Visual Discomfort

INTRODUCTION

The term vision originates from the Latin word videre, meaning "to see." Vision is enabled by light, which makes the world around us visible and supports our daily activities. Without light, vision cannot occur. Despite its essential role, lighting is often taken for granted due to its widespread availability (Anshel, 2019). In physical terms, light is a form of electromagnetic energy. It is a segment of the electromagnetic spectrum that includes other forms such as X-rays, infrared, ultraviolet, and radio waves (Durmus, 2021). The human eye, as part of the visual system, is sensitive to a specific range of this electromagnetic energy, which is responsible for producing the sensation of sight.In the context of interior spaces, lighting can be broadly categorized into natural and artificial lighting. Artificial lighting is commonly used to illuminate interiors where natural light is insufficient or unavailable. It can be manipulated in terms of direction, intensity, and color temperature to serve both functional and aesthetic purposes. The color of artificial light is described by its Correlated Color Temperature (CCT), which is measured in Kelvin (K). Lower CCT values (~2700K) result in a yellowish or warm appearance, while higher CCT values (~6500K or above) produce a bluish or cool appearance (Gordon, 2003). Different CCTs are used in interiors to evoke specific moods, improve functionality, and enhance visual comfort.Research has

How to cite this Article: Patel, Sarjoo, Rathore, Neha and Luhar, Jahnavi (2025). Effects of Direct Lighting on Readability among Youth. *Internat. J. Appl. Home Sci.,* **12** (3 & 4) : 94-99.

shown that lighting characteristics such as intensity, distribution, and color temperature significantly affect how spaces are perceived and experienced (Nakamura, 2021). For instance, warm lighting is generally associated with relaxation and comfort, making it suitable for residential areas, while cool lighting enhances alertness and concentration, making it ideal for offices and educational settings (Islam *et al.,* 2021). Studies have further revealed that lighting influences not only visual clarity but also emotional responses, productivity, and even physiological parameters such as circadian rhythms and sleep patterns (Khan and Ayub, 2021; Sasidharan *et al.*, 2022).Visual comfort is a crucial aspect of interior lighting. Inadequate lighting can lead to visual discomfort, eye strain, fatigue, and reduced task efficiency (Bano and Khan, 2015; Bhardwaj *et al.*, 2021). These effects are particularly relevant in indoor environments where prolonged visual tasks such as reading, writing, or working on digital screens are common. Studies outside India have highlighted the impact of lighting quality on performance, particularly in workplace and educational contexts, where poor lighting conditions were linked to decreased concentration and productivity (Khan and Ayub, 2021; Rasheed and Munir, 2021).On the other hand, Indian research in this area has primarily focused on energy consumption and lighting efficiency, with limited attention given to the perceptual and cognitive impacts of lighting (Mehta, 2017; Bano and Khan, 2015). The available studies emphasize the importance of balancing energy-efficient lighting with adequate illumination levels to maintain user comfort and spatial aesthetics. Moreover, emerging research suggests that color temperature and illumination levels directly influence the visual appeal of a space, thereby shaping the user's perception and experience (Sasidharan *et al*., 2022; Islam *et al*., 2021).Beyond the general effects of lighting on mood and perception, few studies have explored the specific impact of lighting—particularly CCT—on readability. Reading is a highly visual task that requires appropriate lighting to optimize visual performance and reduce strain. The clarity with which text is perceived under varying lighting conditions can influence both the extent and rate of readability, particularly when comparing warm and cool color temperatures under direct lighting (Gadhe, 2019; Bhardwaj *et al.,* 2021).A thorough review of literature was conducted through platforms like ResearchGate, Web of Science, and Academia to assess the current state of research. Additionally, prior studies within the department were reviewed. It was observed that while numerous studies explored illumination levels, daylight intensity, and energy efficiency, there is a noticeable gap in studies focusing on the relationship between color temperature and reading performance.In light of this, the present study was conceptualized to fill this research gap. Recognizing the dearth of focused research on how CCTs affect readability, the current investigation was undertaken with the aim to study and compare the extent and rate of readability under three different correlated color temperatures (CCTs) of direct lighting.

METHODOLOGY

Sampling:

For the present study, 61 students from five departments of Faculty and Family and community Sciences of The Maharaja Sayajirao University of Baroda were purposely selected as sample. The sampling selection is briefly presented in Fig. 1.

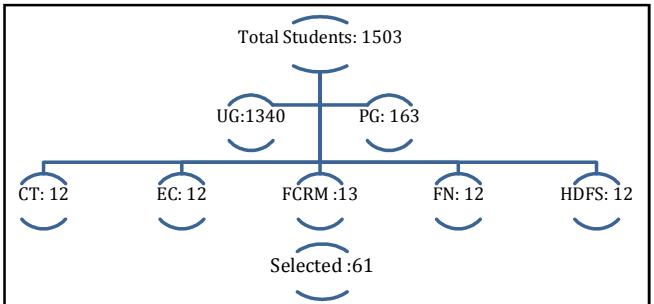

Fig. 1 : Sample Selection

Data was collected on the eye-sightedness of the students. Only those students who had their power ranging from 0.00 to -5.00 were taken into consideration for the present study. 12 students from each department were selected to participate in the study who fell the above-mentioned criteria.

Data Collection methods and procedure:

For the present research, a simulated darkened room was prepared wherein the only light source was a table lamp with a programmable CCT (Correlated color temperature) of light *i.e.*, Syska Smart Pumpkin Wi-Fi 9W Bulb 3 in 1 color (3000k-4000k-6500k) which was used for the reading. The respondents were given the Ishihara color blindness test, in which respondents have to look at the images, which have numbers embedded in

dots of color. It contains 12 plates having numbers in different colors than the background. On the basis of the ability of the respondent to identify the correct number, the percentage of colored vision is evaluated [Shinobu Ishihara, 1917; Reevaluated by Marey, *et al.,* 2014)]. Afterwards they were made to read a paragraph below the distinctive CCT of a Direct Lighting fixture *i.e.,* the table lamp and their reading time was recorded under each CCT of Direct Light. The windows of the room were covered with black paper to make sure that no natural light entered the room during the experiment. The respondents were given 60 seconds break before switching to another CCT of Direct Light, after which their perception was recorded with the interview schedule.

Methodology:

The research design for the present study was experimental in nature. The Interview schedule used for the study consisted of 5 sections: Section 1 consisted of background information of the respondents, section 2 consisted of statements regarding general information on visual discomfort and sections 3, 4 and 5 included statements concerning the effect of warm white light (3000k), natural white light (4000k) and cool white light (6500k) CCT of Direct lighting, respectively on respondent's reading ability. To study the extent of visual discomfort and Readability among the respondents, the scoring was computed using a 3-point continuum Likert rating scale. The scores of each of the items of the scale were summated and the possible range of minimum and maximum scores were divided into three categories having equal interval which were "High"," Moderate" and "Low". The respondents were given a paragraph having the same number of words to read in each CCT of Direct lighting where time taken to read was also recorded. Rate of readability was computed by dividing the average word count and average time taken by the respondent under each CCT of Direct lighting. The data was analyzed by applying descriptive statistics (frequencies, percentage, mean and standard deviation) as well as relational statistics (Analysis of Variance [ANOVA], t-test and correlation).

The study was approved by the institutional ethics committee for human research (IECHR), Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, Vadodara with the ethical approval number IECHR/FCSc/M.Sc./2022/05.

RESULTS AND DISCUSSION

Background Information of Respondents:

The respondents in the present study were in the age range of 18 to 28 years with the mean age being 21.09 years. Nearly two-third 65.57 per cent of the respondents were females. The respondents were majorly (91.80 %) students. The findings on the Eye sightedness of the respondents revealed that 39.34 per cent of them were wearing lenses/glassesand 50 percent of them were having their power of eye sight of the right eye between (-0.1) to (-2.4) and the left eye between (-2.5) to (-5). 58.33 percent of the respondents had tinted glasses/ lenses and 37.5 per cent of the respondents had UV-protected glasses/ lenses. The findings of the Ishihara color-blindness test revealed that the majority (93.44 %) of the respondents had normal color vision.

Extent of General Visual discomfort while reading :

Visual discomfort refers to general discomfort that respondents experienced while reading which was studied using an interview schedule. 54.09 per cent participants of the study had headaches due to sensitivity of light. 57.37 per cent respondents unintentionally re-read the same line while reading. 49.18 per cent of the respondents lose focus on a page while reading. However, complaints about dry, watery and redness in eyes were comparatively found to be less prevalent.

The findings revealed that 24.59 per cent of the respondents experienced moderate extent of visual discomfort and 75.40 per cent of the respondents experienced low extent of visual discomfort.

Respondent's perception of reading in simulated lighting conditions:

The perception of the respondents was recorded with the scale containing the same statements for each CCT of direct light. The responses for each statement were 'agree', 'undecided' and 'disagree'. The data presented in Fig. 2 highlights the responses of the participants which were in agreement.

The findings revealed that the majority *i.e.*, 86.88 per cent of the respondents found Natural white light (4000k) comfortable. 78.68 per cent respondents agreed that their eyes did not strain while reading under Natural white light (4000k). 78.68 per cent of respondents experienced no glare under warm white light (3000k). 86.68 per cent and 83.60 per cent of the respondents did

not feel their eyes were watery while reading under Natural white light (4000k) and warm white light (3000k), respectively. 67.21 per cent of the respondents were satisfied with the color of Natural white light (4000k). 62.29 per cent of the respondents felt no visual distraction due to light under cool white light (6500k). 70.49 per cent of the respondents agreed that their eyes did not feel tired under natural white light (4000k) and light did not hinder their reading task. 78.68 per cent of the respondents did not face any difficulty in seeing the letters clearly under natural white light (4000k). 72.13 per cent participants did not feel anxious due to light while reading under natural white light (4000k). 70.49 per cent respondents agreed that light was pleasant for reading under natural white light (4000k).

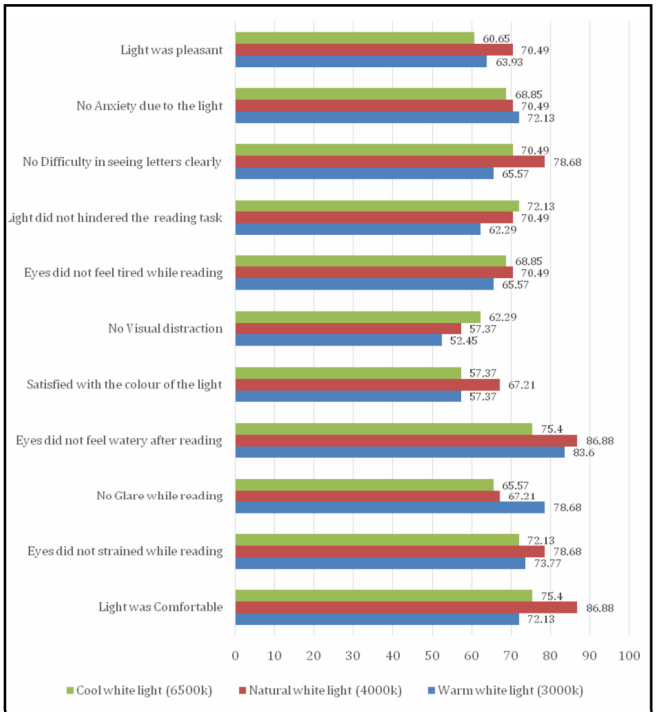

Fig. 2 : Perception of Reading under each CCT of Direct Light

Extent of Readability of the respondents while reading in three different CCTs of Direct Lighting:

A probe was made to find out the Extent of Readability while reading in different CCTs of Direct Light. The scoring was computed using Likert rating scale where responses were 'Agreed', 'Undecided' and 'Disagree' and scores of 3, 2, 1 were ascribed, respectively. The scores of each of the items of the scale were summated and the possible range of minimum and maximum scores were divided into three categories having equal intervals which were 'High Extent of Readability', 'Moderate Extent of Readability', and 'Low Extent of Readability'. The Minimum score was 11 and the Maximum score was 33 to study the Extent of Readability among respondents. Higher scores represented a high extent of readability among respondents.

The data presented in the Table 1 shows that overall respondents had 'High extent of readability' with 70.49 per cent, 81.96 per cent and 67.21 per cent under warm white light (3000k), natural white light (4000k) and cool white light (6500k) respectively. As highlighted in the Table 1, Natural white light had a high extent of readability in comparison with warm white (3000k) and cool white light (6500k).

Table 1 : Extent of readability of the respondents while reading in three different CCTs of Direct Lighting

Extent of readability	Range of scores	n	%
Warm White Light (3000k)			
High Extent of Readability	26-33	43	**70.49**
Moderate Extent of Readability	19-25	13	21.31
Low Extent of Readability	11-18	5	8.19
Natural White Light (4000k)			
High Extent of Readability	26-33	50	**81.96**
Moderate Extent of Readability	19-25	4	6.55
Low Extent of Readability	11-18	7	11.47
Cool White Light (6500k)			
High Extent of Readability	26-33	41	**67.21**
Moderate Extent of Readability	19-25	13	21.31
Low Extent of Readability	11-18	7	11.47

Rate of readability among respondents while reading in three different CCTs of Direct Lighting: ***Time taken by each of the respondents under three different CCTs ofDirect Lighting:***

The data presented in Table 2 shows that 59.01 per cent of the respondent's recorded time to read under warm white light (3000k) was between 60 seconds – 120 seconds. Under natural white light (4000k), 72.13 per cent of the respondent's recorded time to read was

Table 2 : Rate of readability under three different CCTs of Direct light

CCTs of Light	Rate of Readability
Warm white light (3000k)	2.46 words /second
Natural white light (4000k)	2.76 words /second
Cool white light (6500k)	2.54 words /second

between 60 seconds – 120 seconds. 65.57 per cent of the respondent's recorded time to read under Cool white light (6500k) was between 60 seconds – 120 seconds.

Rate of Readability:

The text given to the participants to read under three different CCTs was divided into 3 pages. The word count on page 1 was 294, on page 2 was 286 and on page 3 was 298. To calculate the rate of readability the average of word count (293 words) was computed. The reading time was recorded for each of the respondents in each CCT of the light. The average time was computed to calculate the rate of readability. The average time to read in warm white light (3000k) was 119 seconds; in natural white light (4000k) was 106 seconds and in cool white light (6500k) was 115 seconds. For the present study, Rate of Readability is total number of words per average time taken to read in each CCTs of Direct light which was calculated using this formula.

$$\text{Rate of readability} = \frac{\text{Total number of words (count)}}{\text{Average time taken (seconds)}}$$

The data presented in Table 2 shows that the rate of readability of the respondents in warm white light (3000k) was 2.46 words/ second; in Natural white light (4000k) was 2.76 words/ seconds and in Cool white light (6500k) was 2.54 words / seconds.

Testing of Hypotheses::

Several hypotheses were formulated to test the relationship within the dependent and independent variable of the study. Analysis of Variance (ANOVA) was computed & it was found that there exists variation in Extent of Readability under Cool white light (6500k) CCT of Direct Lighting with tinted glasses/ lenses. The computation of t-value depicted that there exists no significant difference in the Extent of Readability of the respondents under three different CCTs of Direct Light with their personal variable- Eye sightedness. Coefficient of correlation was computed to find out the relation between the Extent of Readability of the respondents and three CCTs of Direct Lighting. A significant relationship was found between Extent of Readability of respondents and 4000k CCT of Direct Lighting.

Conclusion:

The data was collected from individuals who are in the age group of 18-28 years from Vadodara city through Interview schedule, in order to ascertain the Extent of Readability under three different CCTs of Direct Lighting. It was found that slightly less than one-half of the respondents were in the age group of 21-24 years. A little less than two third of the respondents were female. Majority of the respondent's medium of language was English. Majority of the respondents were students. Less than two third of the respondents had normal vision. One-half of the respondents were having their power of eye sight of the right eye was between (-0.1) – (-2.4). A little less than two-third of the respondents were having their power of eye sight of the left eye was between (-0.1) – (-2.4). More than one-half of the respondents were not having their glasses/ lenses tinted. Majority of the respondents had normal color vision.

It was found that slightly more than three-fourth of the respondents experienced a low extent of general visual discomfort while reading. Majority of the respondents agreed that they did not feel their eyes were watery after reading under warm white light (3000k). Majority of the respondents agreed that the light was comfortable and they also did not feel their eyes were watery after reading under natural white light (4000k). A little less than three-fourth of the respondents agreed that the light was comfortable and they also did not feel their eyes were watery after reading under cool white light (6500). It was found that Majority of the respondents had High Extent of Readability under Natural white light (4000k). It was found that Rate of Readability of the respondents was highest under the Natural white light (4000k) with 2.76 words/ second. Based on the findings of this study and comprehensive review of literature, guidelines for improved reading were developed which included suggestions regarding angle of reading surface, type of direct lighting source and recommended illuminance (lux) and CCT (k).

Ethical Approval :

The study was approved by the institutional ethics committee for human research (IECHR), Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, Vadodara with the ethical approval number IECHR/FCSc/M.Sc./2022/05.

Author Contribution:

Conception and design of the study: SP, NR, JL; Acquisition of Data: JL; Analysis and interpretation of data: JL; Drafting the manuscript: SP, NR; revisiting the

manuscript critically for important intellectual content: SP, NR.

Declaration of competing interest:

The authors declare that they have no conflict of interest.

Acknowledgement:

We thank all the teaching staff members for providing their valuable suggestions for the present study. We are also grateful for the support provided by non-teaching staff of the department in smoothly carrying out the experiment in the department premises.

REFERENCES

Anshel, J. (2019). *Visual Ergonomics Handbook*. Boca Raton, FL: CRC Press, Taylor & Francis Group.

Bano, F. and Khan, A. (2015). Energy Efficient Lighting in Indian Context: Opportunities and Challenges. *Energy Studies Review*, **9**(2) : 48–55.

Bhardwaj, P., Malik, A. and Singh, R. 2021. Evaluation of Reading Comfort under LED Lighting. *J. Visual Ergonomics & Design*, **14**(2) : 15–22.

[Departmental Studies Reviewed] – Unpublished internal research conducted in the Department of Interior Design, Maharaja Sayajirao University, 2023.

Durmus, A. (2021). Correlated Colour Temperature: Use and Limitations. *Lighting Research and Technology*. DOI: 10.1177/14771535211034330

Gadhe, R. (2019). Light and Readability: A Comparative Study of LED and CFL in Reading Environments. *Internat. J. Educational Res.& Innovation*, **6**(4) : 102–110.

Gordon, G. (2003). *Interior Lighting for Designers* (4th ed.). John Wiley & Sons, Inc.

Islam, A., Rashed, R. and Amin, A. 2021. Influence of Lighting Color Temperatures on Human Mood and Productivity. *J. Environ. Psychol. & Design*, **12**(3) : 45–56.

Khan, S. and Ayub, A. 2021. The Role of Indoor Lighting in Enhancing Workplace Productivity. *Internat. J. Built Environ.*, **19**(1) : 12–19.

Mehta, V. (2017). Lighting Design in Indian Homes: Energy Use and Aesthetic Impact. *J. Sustainable Architecture*, **5**(1) : 33–40.

Nakamura, H. (2021). *Lighting and Human Perception: Designing for the Visual Mind*. Tokyo: LightScape Publications.

Rasheed, K. and Munir, S. 2021. Lighting and Visual Discomfort: A Study on Office Workers. *Journal of Occupational Health & Environment*, **13**(1) : 27–34.

Sasidharan, P., Natarajan, P. and Praveena, R. 2022. Influence of Indoor Lighting on Visual Comfort and Spatial Perception. *Internat. J. Interior Design & Res.*, **17**(2) : 60–68.

****