Asian Journal of Home Science, (December, 2010) Vol. 5 No. 2 : 271-274

Research Paper :

Study of visual task performance under different lighting conditions

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Received : *July, 2010;* **Accepted :** *September, 2010*

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ABSTRACT

Illumination is important to humans because it alters stimuli to the visual system and the operating state of the visual system itself. Researches have shown that proper lighting make a positive contribution to our physical and mental health, to our physical comfort and to our safety. The present study was conducted to analyze visual task performance under different lighting conditions. Results revealed that task performance was affected by different light sources. Results showed that maximum numbers of mistakes were made and maximum time was taken under incandescent filament bulb of 60 watt. Changes in physiological parameters; heart rate and blood pressure were also observed and most preferred source of light was fluorescent straight light (tube light, 40 watt).

Agarwal, Shalini and Sharma, Promila (2010). Study of visual task performance under different lighting conditions, *Asian J. Home Sci.,* 5 (2) : 271-274.

Key words : Light sources, Visual task performance, Physiological parameters

Many of our oldest and wisest sayings deal with the eyes. That's probably because vision is our primary connection with the world. We use our eyes to interact with our environment in more than a million ways every second. The eyes really are an extension of the brain and a direct link between our environment and our minds. More than 80% of our learning comes from our vision, which indicates how important our sense of sight is in our daily lives. The process of vision begins with visible light — a portion of the radiation spectrum that stimulates the nerve endings in the retina.

Illumination is important to humans because it alters stimuli to the visual system and the operating state of the visual system itself. The visual system is composed of the eye and brain working together. Interior lighting is almost always sufficient for the visual system to be operating in the photonic region. If concerned with the colour appearance as well as colour discrimination, choose a light source that gives both good colour discrimination and the desired colour appearance. Differences between persons in visual capabilities are common and are usually dealt with by providing lighting that is more than adequate for visual performance and visual comfort.

Ibn al-Haytham (Alhacen), the "father of optics", pioneered the scientific study of the psychology of visual perception in his influential Book of Optics in the 1000s, being the first scientist to argue that vision occurs in the brain, rather than the eyes. He pointed out that personal experience has an affect on what people see and how they see, and that vision and perception are subjective. He explained possible errors in vision in detail, and as an example, describes how a small child with less experience may have more difficulty interpreting what he/she sees.

The visual sense is the most important channel of information in information-intensive work. From the point of view of seeing and eye fatigue, the ordinary visual displays are not the most optimal solutions. Stability of the image, lighting conditions, reflections and glare, as well as the invisible flicker are among the most common factors affecting the visual observations.

Lighting in the dwelling should provide certain emotional and aesthetic satisfaction. Researches have shown that proper lighting make a positive contribution to our physical and mental health, to our physical comfort and to our safety. The efficiency of light sources largely depends upon the extent to which electrical energy (watts) is converted to light energy (lumens). The lighting in a room is typically designed to provide a predetermined illumination level. Higher illumination levels are required for more demanding visual tasks. This is because human visual discrimination abilities continue to improve with more light (Sheedy *et al.*, 1984). Proper illumination is

important and it should be evaluated for each task. The relationship between illumination on the task and performance achieved will vary according to the type of task (Boyce and Simons, 1977). They said that the effect of illumination upon task performance will vary according to:

– The visual details of the task

– The extent to which the visual part of the task determines the overall performance.

It is important not to over-design illumination, lest adverse health effects such as headache frequency, stress, and increased blood pressure be induced by the higher lighting levels. In addition, glare or excess light can decrease worker efficiency (DiLouie, 2006).

METHODOLOGY

In order to study task performance under different sources and different intensity of light, an experiment was conducted in Visual Ergonomics Laboratory, Dept. of Family Resource Management, College of Home Science, G.B.Pant University of Agriculture and Technology, Pantnagar. Before conducting the experiment, the individuals were prepared for the experiment. They were taken to the dark room and were allowed to rest for 10 minutes. Then their anthropometric measurements (height, weight, eye height standing and eye height sitting) were recorded, their blood pressure and heart rate were also recorded. For normal vision, their vision test was also conducted through scientific equipment. Then they were taken to the laboratory, and then they were asked to read different paragraphs in different lighting conditions (different sources and different intensity) and after reading their heart rate and blood pressure were recorded. After each reading, they were allowed to rest for 5 minutes and again their heart rate and blood pressure were measured.

The time taken to read the paragraph and mistakes made while reading were recorded on the experimental table already prepared. The time taken was categorized and coded as:

1 min.- 5 min. (2)

more than 5 min. (1)

Similarly, number of mistakes made was also categorized, quantified and scored.

1-5 mistake (2)

6-10 mistakes (1)

Different sources and intensity of lights used were fluorescent straight tube light (40 watt), incandescent filament bulb (60 watt and 100 watt) and compact fluorescent lamp CFL (15 watt ,20 watt). While selecting different intensity light, especially incandescent and CFL, it was checked that the intensity of bulbs selected should be approximately equal to that of selected CFL light source.

A sample size of 12 respondents between age group 25- 40 yrs possessing similar educational qualification were selected for the experiment.

FINDINGS AND DISCUSSION

Results depicted in Table 1 reveal that maximum numbers of mistakes (4.2) were made under incandescent bulb of 60 watt (029 lux) and minimum mistakes (2.5) were made under incandescent bulb of 100 watt (059 lux). Maximum time (4.41 min.) was taken under incandescent bulb of 60 watt (029 lux) and minimum mistakes (3.41min.) were made under fluorescent straight tube light of 40 watt (085 lux).

Data in Table 2 depict score values for number of mistakes made and time taken to complete the activity. Results depicted that all respondents (100.0 per cent) made mistakes under incandescent bulb of 100 watt (059 lux) and CFL 14 watt (029 lux), though the number of mistakes made ranged from 1-5 only while 25.0 per cent respondents made mistakes between 6-10 under incandescent bulb of 60 watt (029 lux). Results also depicted that all respondents (100.0 per cent) took only 5 minutes time to complete the activity under fluorescent straight tube light of 40 watt (085 lux) where as 75.0 per cent respondents took more than 5 minutes time to complete the task under incandescent bulb of 60 watt (029 lux) and incandescent bulb of 100 watt (059 lux), respectively.

Table 3 deals with effect of different lighting conditions on physiological parameters like heart rate and blood pressure before and after the activity. Results revealed that though there was increase in heart rate under

Table 1 : Visual performance under different lighting conditions (n =12)

Sr. No.	Parameters	Lighting conditions (Lux)					Standard deviation
		Fluorescent straight (Tube light) (40 watt) (085 lux)	Incandescent halogen bulb (60 watt) (029 lux)	Incandescent halogen bulb (100 watt) (059 watt)	Compact fluorescent lamp (14 watt) (029 lux)	Compact fluorescent lamp (20 watt) (037 lux)	
1.	Number of mistakes	3.3	4.2	2.5	2.9	3.1	0.6324
2.	Time taken (minutes)	3.41	4.41	4.21	3.13	3.99	0.4053

Table 2 : Quality performance (n=12)

Sr. No.	Different sources of light	Parameters							
		Number of mistakes				Time taken (minutes)			
		1-5		6-10		1-5		6-10	
		F	Score	F	Score	F	Score	F	Score
1.	Fluorescent straight (Tube light) (40 watt) (085 lux)	11 (91.6)	22	1 (8.3)	1	12 (100.0)	24	0	0
2.	Incandescent halogen bulb (60 watt) (029 lux)	9 (75.0)	18	3 (25.0)	3	9 (75.0)	18	3 (25.0)	3
3.	Incandescent halogen bulb (100 watt) (059 watt)	12 (100.0)	24	0	0	9 (75.0)	18	3 (25.0)	3
4.	Compact fluorescent lamp (14 watt) (029 lux)	12 (100.0)	24	0	0	10 (83.3)	20	2 (16.6)	2
5.	Compact fluorescent lamp (20 watt) (037 lux)	10 (83.3)	20	2 (16.6)	2	10 (83.3)	20	2 (16.6)	2
	Mean	-	21.6	-	2	-	20	-	2.5
	SD		2.607		1.303		2.44		1.224

*Figures in parentheses represent percentages

Table 3 : Relation between physiological parameters and visual task performance (n=12)

Sr. No.	Different sources of light	Physiological parameters					
		Heart rate/ min.		Blood pressure (mmHg)			
		Before	After	Before		After	
				Systolic	Diastolic	Systolic	Diastolic
1.	Fluorescent straight (Tube light) (40 watt) (085 lux)	86.4	89.2	100	90	102	89
2.	Incandescent halogen bulb (60 watt) (029 lux)	82	84.5	104	91	107	92
3.	Incandescent halogen bulb (100 watt) (059 watt)	80.1	85.6	101	85	103	86
4.	Compact fluorescent lamp (14 watt) (029 lux)	87.2	89.2	102	83	105	85
5.	Compact fluorescent lamp (20 watt) (037 lux)	86	87.5	104	85	106	86
	Mean	84.34	87.2	102.2	86.8	104.6	87.6

all lighting conditions after completing the activity but maximum increase was noticed under incandescent bulb of 100 watt (059 lux). It was also noticed that there was increase in systolic blood pressure in all lighting conditions after task completion but maximum increase was noticed under incandescent bulb of 60 watt (029 lux), similarly increase in diastolic blood pressure was noticed except under fluorescent straight tube light of 40 watt (085 lux) and maximum increase was noticed under CFL (14 watt) (029 lux).

Similar type of result was reported by Tsunetsugu *et al.* (2002). Thus it can be concluded that different type of lights may affect certain physiological parameters like heart rate and blood pressure as well as task performance of an individual.

Results shown in Fig.1 reveals that most of the respondents preferred fluorescent straight light (tube light, 40 watt) for reading followed by Compact fluorescent lamp (CFL) of 20 watt.

Result in Fig. 1 also depicts that nearly 75.0 per cent respondents were more comfortable under tube light. Nearly 65.0 per cent respondents performed well under tube light. About 70.0 per cent respondents said that maximum stress to eyes was felt under incandescent filament bulb of 60 watt. In the same source of light, nearly 75.0 per cent respondents complained of uneasiness while performing the task. Only 8.4 per cent respondents complained problem of double vision while performing

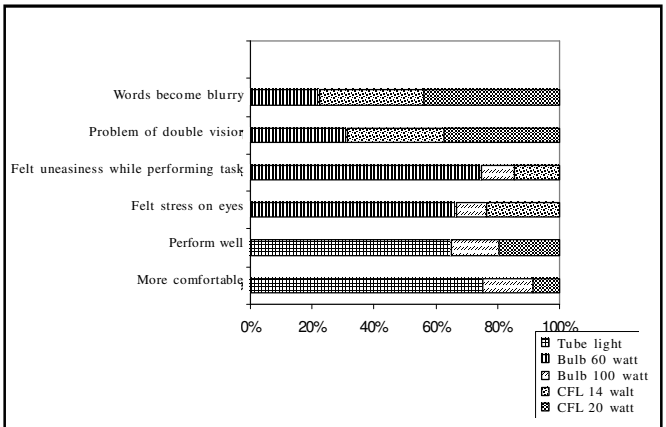

Fig. 1 : Assessment of light sources on different parameters

the task under CFL of 14 watt and same per cent respondents complained of words becoming blurry in both type of light; 60 watt bulb and 14 watt CFL. Thus, from the results it was felt that if proper source and intensity of lighting is not used, it effects our visual task performance.

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