COLOUR AND LIGHT AND THE HUMAN AREA FOR VISUAL COMFORT

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Abstract

In the study three interaction models man, light, colour and space in three descending levels of quality was designed from the preferences of the Lighting Designer. The subjects recognised the three descending levels of quality and evaluated them to a high extent in the same way as the designer. The room with the highest quality of interaction according to the lighting designer's preferences, Room number 2, was the most appreciated by the test subjects. A suggested reason for acceptance among the subjects is the possibility to stay within or close to visual preferences here measured in the visual comfort test. A second reason for the acceptance for Room 2 is the room being within a general preference for soft contrasts, absence of glare, a low level of visual variation. A third factor is a general preference for light distribution generating a welcoming atmosphere due to the higher level of vertical illumination compared to the other two rooms in the study. The results indicate that there is despite a vast spread of visual preferences among the subjects, a human area for colour and light and visual comfort equivalent to other indoor climate factors.
Keywords: Lighting quality, visual comfort, Visual preferences

1. Introduction

The design of human visual comfort is a matter of a well functioning interaction between man, light, colour and space. The design process goes through the designer's senses in the same way as it does for the design of the colour scheme, the interior design or the drawings of the architecture. An increased knowledge about known and unknown subject´s visual preferences contributes to a lighting design based on the human area for visual comfort. The aim of the study was to test subject's experiences of three quality levels of the interaction between man, light, colour and space. The study includes the questions: will the subjects recognise the three levels of the design and will they evaluate the three rooms in the same order as the lighting designer? Why do they or why do they not accept the lighting design in the three rooms? The aim of the complementary study was to measure the preferences of 18/36 subjects for levels of light at the work table, as well as for the level of ambient light.

2. Methods in the main study

The study was conducted at the School of Engineering at Jonkoping University in December 2005. 36 university students completed all segments of the main study. For the complementary visual comfort preference study, all students

at the Department of Lighting Science were invited by e-mail to participate in a study to establish individual levels of light sensitivity and preferences for supplementary levels of ambient light. 54 subjects were tested. 18 members of this group expressed their interest in participating in a later study. The measurements from these 18 participants are compared here with those of the researcher. The test subjects consisted of 10 women and 8 men with a mean age of 25.2 years and all participated later in the main study.

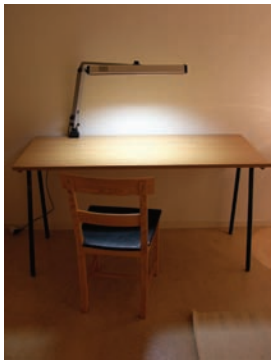
2.1 Instruments used in the main study

The perception of the lighting quality in the ambient light (table 1) was measured through a questionnaire, on which test subjects were asked to circle the three words that best described their perception of the lighting in the room among 34 light descriptive words, 21 positive and 13 negative. Three words were chosen and the words good and comfortable were counted with 1p per word. The point for good and comfortable was put together and the mean for Room 1, 2 and 3 was compared. The quality of the light at the reading and working area (Table 4) was measured with a semantic scale 1-7 from little too much. The light at the reading area was evaluated with 16 words, the word unpleasant was chosen and was counted as 1p=3, 2p=2, 3p=1, the rest of the values (4, 5, 6, 7) was counted as 0. The support from the light when reading was measured from very bad to very good, 1-4 was counted as 0 and 5=1, 6=2, 7=3. The experience of the light at the workspace and the support for the light when reading was measured in the same way. The experience of the room (table 2) was measured with a freely formulated questionnaire asking the subjects with their own words describe the room they just stayed in. The positive room descriptive words were counted. 1word = 1p. There was no limit of the points. A visual comfort test measured the subjects preferences for level at light at the worktable and for the ambient light.(Table 3,5,6,7,8) the visual preferences was recorded in vertical and horizontal illumination. The level of pleasantness in the rooms (Table 1) was measured with semantic scale 1-7 from little too much. From 36 words in the test the word pleasant to unpleasant was chosen.

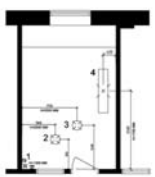
2.2 Instruments used in the complementary visual preference study

A table and a chair were placed in a room measuring 4,620 mm x 3,030 mm. Lights were affixed to the ceiling. These were regulated by remote control through. A calibrated Luxmeter and two dimmers were placed on the table. No light was switched on at the start of the experiment. The test subjects received instructions on the various stages of the experiment via tape recording and a loudspeaker. They started the experiment with Dimmer 1 in position 0 and then increased the amount of light coming from the source to the maximum strength before slowly reducing it to the level they deemed would allow them to be comfortable while reading black text from a sheet of white paper that was lying on a black desk. The level was measured with a Luxmeter and the value was recorded by the test subject. With the selected lighting level on the workspace maintained, the test person was instructed to increase the amount of light in the room by sliding the dial on Dimmer 2 to its highest setting before reducing the brightness to the level of the ambient light that had previously been selected as a comfortable supplementary level. This test routine was conducted three times in total.

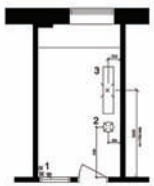





2.3 The design of Room 1, 2 and 3



ROOM 1



ROOM 2

ROOM 3

Fig. 1
Room nr.1 workplace
Fig. 2
Room nr. 1 reading place
Fig. 3
Room nr.2 workplace
Fig. 4
Room nr. 2 reading place
Fig. 5
Room nr. 3 workplace
Fig. 6
Room nr. 3 reading place
Fig. 7: Room 1.Floor standing reading lamp 40W halogen G9 clear, limited dimmer, without lampshade. 2. Pendant luminary Halogen, 100W, clear. 3. down light compact fluorescent 26W, 3000 K. 4. Pendant task lighting, Fluorescent, Asymmetric light distribution. 49W/830. 3000 K. Filter-Full CTB. Slider changed to switch DIM device.
Fig. 8:Floor plan, Room 2
1. Floor lamp with cloth shade, Halogen A 100W opal, 50W 50 degrees, 230V, GU10. 2. White cloth lamp, 3 A60 60W, evenly spaced3. Task lighting, compact fluorescent 36W / 840. 4000 K.
Fig.9: Floor plan, Room 3
1. Floor standing reading lamp 40W halogen G9 clear, limited dimmer, without lampshade. 2. Pendant luminary Halogen, 100W, clear. 3. Down light compact fluorescent 18W / 830/ 4p. 4. Pendant task lighting 20/80. 2x28 W fluorescent 3000 K 661-228 T5. Switch dimmer, 28W/ 830. Filter, CTB.

Table 1.
Lighting conditions in the study

Horizontal illumination Lux	Room 1	Room 2	Room 3
Working table	75-950	53-3100	41-520
Reading table	410	900	430-580
Reading chair	590	300	420
Ambient light	135(49)	120	88(35)
Illuminance cd/ m2			
Wall 1A	90 (100)	150	44
Wall 2L	39-53 (44-66)	105-132	30-75
Wall B	14	23	7-14

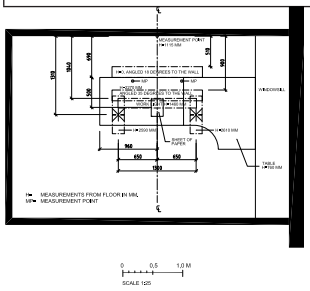


Fig. 10: Floor plan: room for studying individual values obtained from viewing illuminated surfaces with a high level of visual comfort and measured preferences for supplementary levels of ambient light. 1, Pendant fluorescent 2. Pendant fluorescent 3, Pendant fluorescent. Control dimmers on table, 1-10V converter, and digital dimmer. Lighting control 1, Lighting control 2. . Lighting control 3. Light source 80-3950 Lux. Work lamp gives 0-(80)-3950 Lux. Ambient light gives 0-(10)-550 Lux. Total 0(90)-4.500 Lux

Table 2. Perception of lighting quality: ambient light
Table 3. Perception of lighting quality: reading place and workspace
Table 4. Positive descriptive words
Table 5. Preferences for level of light at the work table and for ambient light

2.4 The design of the room for the complementary visual preference study

2.5 Methods of analyses

The material was analysed with the help of the analytical software SPSS. The subject's experiences in Room 1, 2 and 3 was compared to each other by means.

3. Results

Table 2

Mean	Room 1	Room 2	Room 3
	0,2	0,6	0,1

Table 3

Mean value	Room 1	Room 2	Room 3
Reading area light	0,8	2,0	0,6
Workspace light	0,3	0,8	0,4

Table 4

Mean value	Room 1	Room 2	Room 3
PRB	0,9	3,4	0,6

Table 5

	Test 1		Test 2		Test 3	
TS	Table A	Surr.	Table A	Surr.	Table A	Surr.
1	3950	1480	3950	1530	3950	1300
2	3950	830	3700	1000	3000	1400
3	3000	980	3790	760	3700	530
4	1510	130	2400	290	1560	140
5	2740	930	1620	580	1280	570
6	1320	70	1310	90	1230	70
7	2060	590	1680	540	810	270
8	1940	470	1440	390	1380	320

9	3300	490	3070	300	1150	160
10	870	670	1280	390	1150	990
11	1840	650	1830	740	2060	320
12	3800	1730	3950	680	3950	1000
13	1500	350	2400	510	3100	550
14	2790	770	3200	1030	3320	1160
15	2650	500	3270	760	3000	680
16	2360	220	3060	1810	2760	330
17	730	1480	2720	1200	2300	790
18	970	60	420	280	810	110
M	2293	689	2505	716	2250	594

Table 6. Preferences for level of light at the work table and for ambient light

	Test1	Test 1	Test 2	Test 2	Test 3	Test 3
	Table A	Surr.	Table A	Surr.	Table A	Surr.
M. Säter	443	82	355	92	368	119
Mean18/36 sub	2293	689	2505	716	2250	594

Table 7. Visual preferences and lighting conditions in Room 1, 2 and 3. *Within= the preference and dimmable to the preference , **Close to preference=+- 200 Lux.

Subj.	Workpl.	Amb	Room1 w.pl	Room1 amb l	Room 2 w.pl.	Room 2 amb l	Room 3 w.pl.	Room 3 amb l
			75-950	35(49)	53-3100	120	41-520	88(35)
1	3950	1300	-	-	-	-	-	-
2	3000	1400	-	-	Within	-	-	-
3	3700	530	-	-	-	-	-	-
4	1560	140	-	-	Within	Close	-	Close
5	1280	570	-	-	Within	-	-	-
6	1230	70	-	Close	Within	Within	-	Close
7	810	270	Within	-	Within	Close	-	Close
8	1380	320	-	-	Within	Close	-	-
9	1150	160	Close		Within	Close	-	Close
10	1150	990	Close	-	Within	-	-	-
11	2060	320	-	-	Within.	Close	-	-
12	3950	1000	-	-	-	-	-	-
13	3100	550	-	-	Within	-	-	-
14	3320	1160	-	-	-	-	-	-
15	3000	680	-	-	Within.	-	-	-
16	2760	330	-	-	Within	-	-	-
17	2300	790	-	-	Within	-	-	-
18	810	110	Within	Close	Within	Close	-	Close
Subj.			2*/2**	0*/4**	14*/0**	1*/6**	0*/0**	0*/5**

4. Discussion

The results show a relation between visual preferences and level of positive experiences of lighting quality. The study is affected by the fact that the balanced order of presentation did not give the subjects a possibility to compare the three rooms at one glance. It is also affected by the restricted number of subjects (36).

5. Conclusions

The subjects recognised the three descending levels of quality in the lighting design and evaluated them to a high extent in the same way as the designer. The room with the highest quality of interaction according to the lighting designer's preferences, Room number 2, was the most appreciated by the test subjects. Room number 2 was described as having the highest quality in ambient light; it was seen as the room with the highest quality of light for the reading place and for the workplace. When leaving the rooms the subjects described this room with the highest number of positive room descriptive words. Psychologically, the subjects verify a positive impact from the designed higher level of visual variation in colour and light in Room 2 and the higher level of vertical illumination. Physiologically, Room 2 promotes a well- functioning situation that can be read in the chosen positive room descriptive words. Visually, the designed higher level of visual comfort in Room 2 is verified in the more positive evaluation of the light at the workplace and reading place done by the subjects compared to Rooms 1 and 3. A suggested reason for acceptance among the subjects is the possibility to stay within or close to visual preferences measured in the visual comfort test. In Room nr. 2, 14/ 18 measured subjects had the possibility to read within and 0/18 subjects close (+-200 Lux) to their visual preferences for the level of light at the workplace. In Room 1, 2 subjects were within and 2 were close to their visual preferences. For Room nr. 3, 0 subject was within and 0 close to their visual preferences. For the ambient light less subjects had the possibility to stay within or close to their visual preferences R1=0 within, 4 close, R2=1 within, 6 close, R3= 0 within, 5 close. A second reason for the acceptance for Room 2 is the room being within a general preference for soft contrasts, absence of glare, a low level of visual variation and a welcoming atmosphere due to the higher level of vertical illumination compared to the other two rooms. The low level of light is connected to a weak input to release stress hormones and to give a decrease in level of arousal that is generally relaxing. A third reason for the high acceptance for Room 2 is that comfort and relief is experienced when the subjects stay in light designed close to their visual preferences and physiological needs, Davydov D. M (1). The result of the study confirms that the subjects preferred a soft (ergonomically) combination of contrasts and light and a restricted visual variation (not too much alerting, not too much relaxing due to the lighting designer's opinion). The response for Room 2 confirmed that there is a common human area for visual comfort equivalent to temperature and sound in the indoor environment that attracts subjects despite measured differences in visual preferences. Light is stimuli for the psychological and physiological experience as well as the visual, Berson D. M (2). The more healthy light of tomorrow, Liljefors A (3) needs to go through the visual sight and in that colour and adaptive visual responses are crucial.

6. References

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7. Acknowledgment

The author gratefully acknowledges the financial support from Lena Gustavsson and family through the Bertil and Britt Svensson’s Foundation for Lighting Technology for my PhD studies and for their foresighted support of the topic Lighting Science.