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LAMPS FOR LIGHTING PEOPLE

by

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TABLE OF CONTENTS

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LIST OF TABLES

LIST OF TABLES (cont.)

LIST OF FIGURES

INTRODUCTION

The word "light", as usually employed, has two distinct meanings: the radiant energy, which by its action upon the eye enables vision to take place, and the sensations in the eye, that is the images of light and color perceived. Objects, including persons, do not have an unvarying appearance independent of the lighting. Appearance depends entirely upon values of light reflected into the eyes of observers. A change in the direction or color of lighting will alter the light reflected from the object. Thus, light not only influnces, but determines the appearance of everything. Many people understand that light has some effect on appearance, but they do not follow through to the logical conclusion that visual consciousness is concerned with images of light and that intelligent lighting can give considerable control over appearances.

Color and light

People usually associate color with physical objects that are viewed in sharp contrast to their surroundings, such as beautiful flowers, or multi-hued leaves in autumn. Color, in design, is often considered an integral part of texture and surfaces - walls, carpets. But in addition to these colored "things", color also is associated with visual impressions and is viewed as the intangible mood-setting effect of colored lights. Williams(1954) in his book Lighting for Color and Form stated "The contours of a person or object can be emphasized by variatious of intensity and angle in the lighting, while character and mood are suggested by carefully related differences in the color of the illumination".

Color associated with objects can be changed simply by changing the light source. Colored light on colored surfaces can produce rare and potent effects.(Howard, 1954) If one has ever seen a red car parked under a clear mercury street lamp at night, he will have noticed that the car was easily mistaken for brown in color. The effect of artificial light on colored surface is something important to the artist and designer. Table 1 shows broad descriptions of the color changes under different types of illumination.

Light sources

Throughout most of the Twentieth Century, a plentiful supply of cheap energy in its various forms was available. As the end of the century approaches, the 1973 oil embargo finally awakened the world to recognize the need of conservation all forms of energy. Lighting is the most visible form of energy used. Obviously, energy can be saved by the effective utilization of electric lighting power and energy.

TABLE 1.

Refection of colors under different types of illumination.
(Taylor,1962)

Surface color under daylight	under incandescent light	under white fluorescent	under SOX light	under mercury light
Dark red	vivid wine-red	light purple red	dark brown	deep brown-red
Red	slightly orange	slightly magenta	brown	dark brown or black
Light red	no change	vary pale pink	yellow-brown	brownish red
Brown	chocolate brown	yellowish brown	brown	grey
Orange-red	brilliant red	greyish-red	yellowish-brown	brownish-red
Orange	slightly deeper	yellowish-orange	brown	brownish
Yellow	vivid orange-yellow	strong greenish-yellow	yellow	greenish-yellow
Green	greyish-green	green	brownish-yellow	deeper green
Blue-green	slightly greyed	slightly greyed	darker brownish	deeper green
Blue	greyish-blue	slightly brightened blue	dark brown or black	deep violet-blue
Dark blue	dull greyish blue	slightly purpled	black	deep violet
black	black	blue-black	black	black

One key to reduced energy consumptions is conversion to higher efficacy light sources. Dorsey reported in 1978 that the total potential, if the least efficient lighting was converted to the most efficient lighting, would be nearly a fourty percent reduction in kilowatt-hour consumptions.(See Figure 1 and Table 2)

The selection of a light source can be made from natural sources, such as the sun, moon, skylights, or man-made sources like electric lamps. The types of electric lamps in use today vary greatly. Continual research and development with light source materials has produced remarkable improvements in today's light sources. Basically there are two groups used: incandescent and discharge.(Fisher and de Boer,1978) Discharge lamps can be further devided into two groups, according to the pressure of the gas contained. With these two groups, six different types of electric lamps are achieved. There are incandescent lamps, flourescent lamps, low-pressure sodium(SOX) lamps, mercury vapor lamps, high-pressure sodium (HPS) lamps, and metal halide lamps. The last three types are usually called High-Intensity Discharge(HID) lamps.

Light source character

Two of the characteristics of a lamp that determine its range of application are of general significance; the luminous

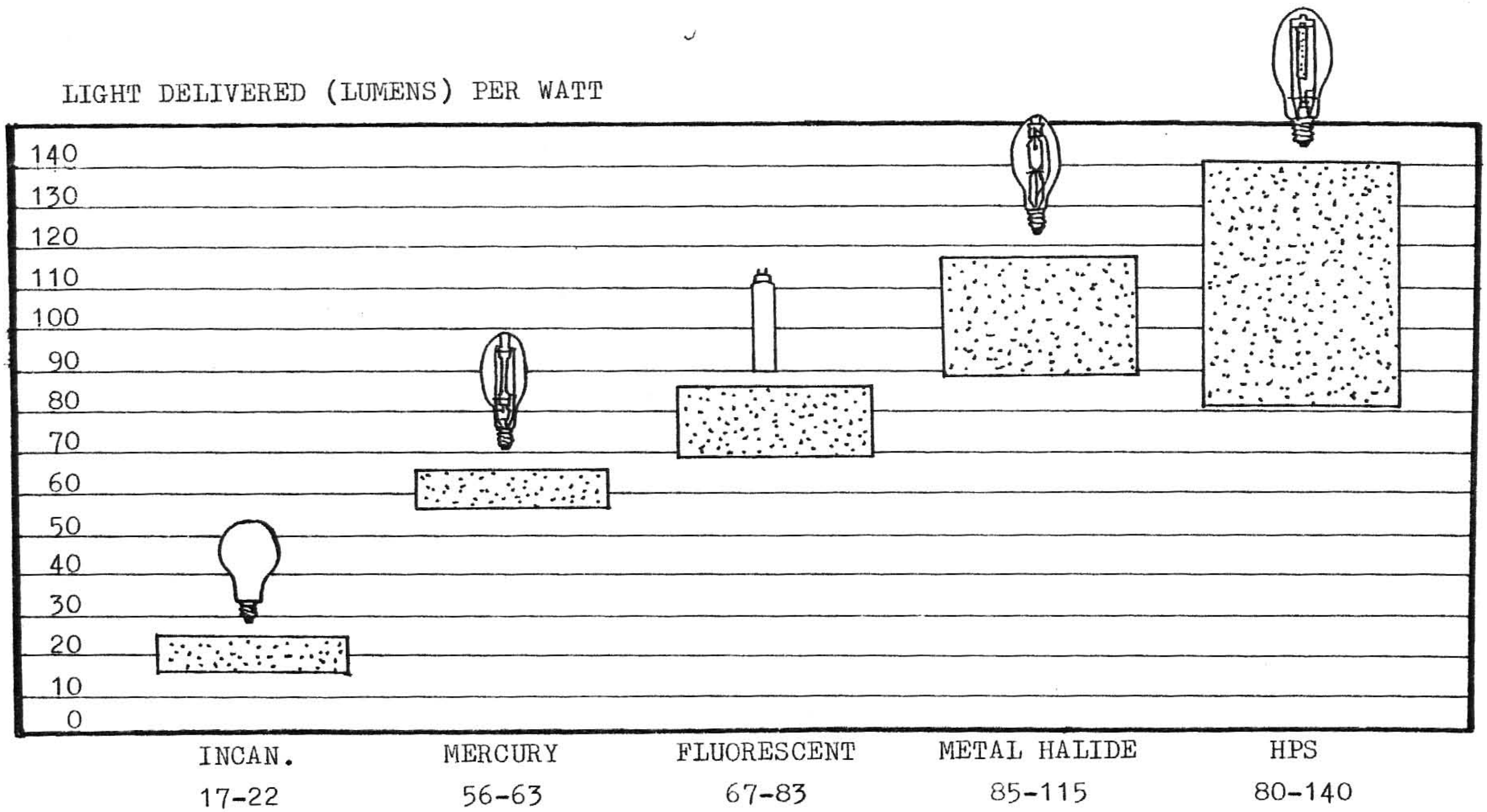

Figure 1. Efficacy of electric lamps.(Dorsey,1978)

TABLE 2.

Conversion to higher efficiency sources.(Dorsey,1978)

	INCANDESCENT	FLUORESCENT	MERCURY	METAL HALIDE	HPS
Estimated percent of lighting KWHR	35	51	11	1	2
Lumens per watt (approximate)	20	60	50	100	120
Actual KWHR x 10^9 based on KWHR sales of $392x10^9$ for lighting (25 percent of total KWHR sales)	137	200	43	4	8
Percent saving if converted to HPS	$\frac{120-20}{120}$ 83%	$\frac{120-60}{120}$ 50%	$\frac{120-50}{120}$ 58%	$\frac{120-100}{120}$ 16%	
Actual KWHR saving(10^9)	(83%x137) 114	(50%x200) 100	(58%x43) 25	(16%x.8) 1	...... Total 240

$\frac{240}{392}$ = 61 or 39 percent saved efficacy and the color rendering.(Opstelen,Radielovic and Verstegen,1975) The term "color rendering" with reference to light sources is a measure of the degree to which the percived colors of objects illuminated by various light sources will match the percived colors of the same object when illuminated by the standard light sources(incandescent) for specified viewing conditions.

Total lumen output and wattage, which are the ingredients of efficacy, are prime considerations that enter most decisions regrading the source or type of the lamps to be employed. The chart in Table 3 is listed for comparison of different lamp types. The LPS lamp has the highest efficacy of 138.9 lm/w, but the lamp life is shorter then the mercury vapor lamp and the HPS lamp. The HPS lamp has the second hightest efficacy of 125 lm/w, which is more than double the efficacy of the mercury lamp, with the same life hours as the mercury lamp. The incandescent lamp, unfortunately, has both the lowest efficacy and the lowest hours of life. The other two types, metal halide and fluorescent, are somewhere in the middle range.

The color rendering properties of lamp types are determined by a rating system called the Color Rendering Index(CRI). The concept for CRI is devided into two parts. The first part establishes the color temperature of a given light source on the CIE(Commission Internationale de l'Echariage

TABLE 3.

Efficacy and life hours of some electric light sources.
(Erhardt,1977)

Source description	luminace (cd/cm^2)	power (watts)	efficacy (lm/watt)	life (hours)
Incandescent				
2095K carbon filament	5.3×10	50	1.6	500
2100K metalized carbon	9.5×10	50	4.0	500
2980K tungsten filament	1.2×10^3	200	20.0	750
3350K tungsten filament	4.5×10^3	2000	32.0	250
Fluorescent				
low loading T-12	0.8	40	78.6	18000
medium loading T-12	1.1	61	68.0	12000
heavy loading T-12	2.0	215	71.2	9000
Low-pressure sodium	5.5	90	138.9	15000
High-intensity				
Mercury arc, clear	1.5×10^2	400	52.5	24000
Mercury arc, phosphor	1.3×10	400	56.3	24000
Sodium vapor, clear	4.2×10^2	400	125.0	24000
Metal halide, clear	6.0×10^2	400	85.0	15000

- the International Commission on Illumination) chromaticity diagram(see Figure 2). The color temperature is refered to the absolute temperature in degrees Kelvin of a theoretical body where color appearance matches that of the light source in question. Such a body is a special form of thermal radiator and the color appearance is black at room temperature, red at 800K, yellow at 3000K, white at 5000K and palebluish between 8000K and 10000K.

When a light source has a low temperature, the color of the light is more reddish or yellowish. Incandescent lamp(2600K to 3100K) and high-pressure sodium lamp(2250K) are considered as "warm" light source. In a reverse way, a high temperature light source, which has more bluish colored light such as metal halide lamp(5200K) or fluroescent lamp (4200K), is considered as a "cool" light source.(Table 4)

The second part of the CRI concept is a comparison between a given light source and the reference light source. The comparison is evaluated by a ratio of how closely the given light source matches the color rendering ability of the reference light sources. The reference light sources, which are selected by the C.I.E. are a tungsten filament lamp operating at 2854K, same lamp plus a specific filter operating at 4870K, and the same lamp with a different filter operating at 6770K. Table 4 shows that incandescent lamp

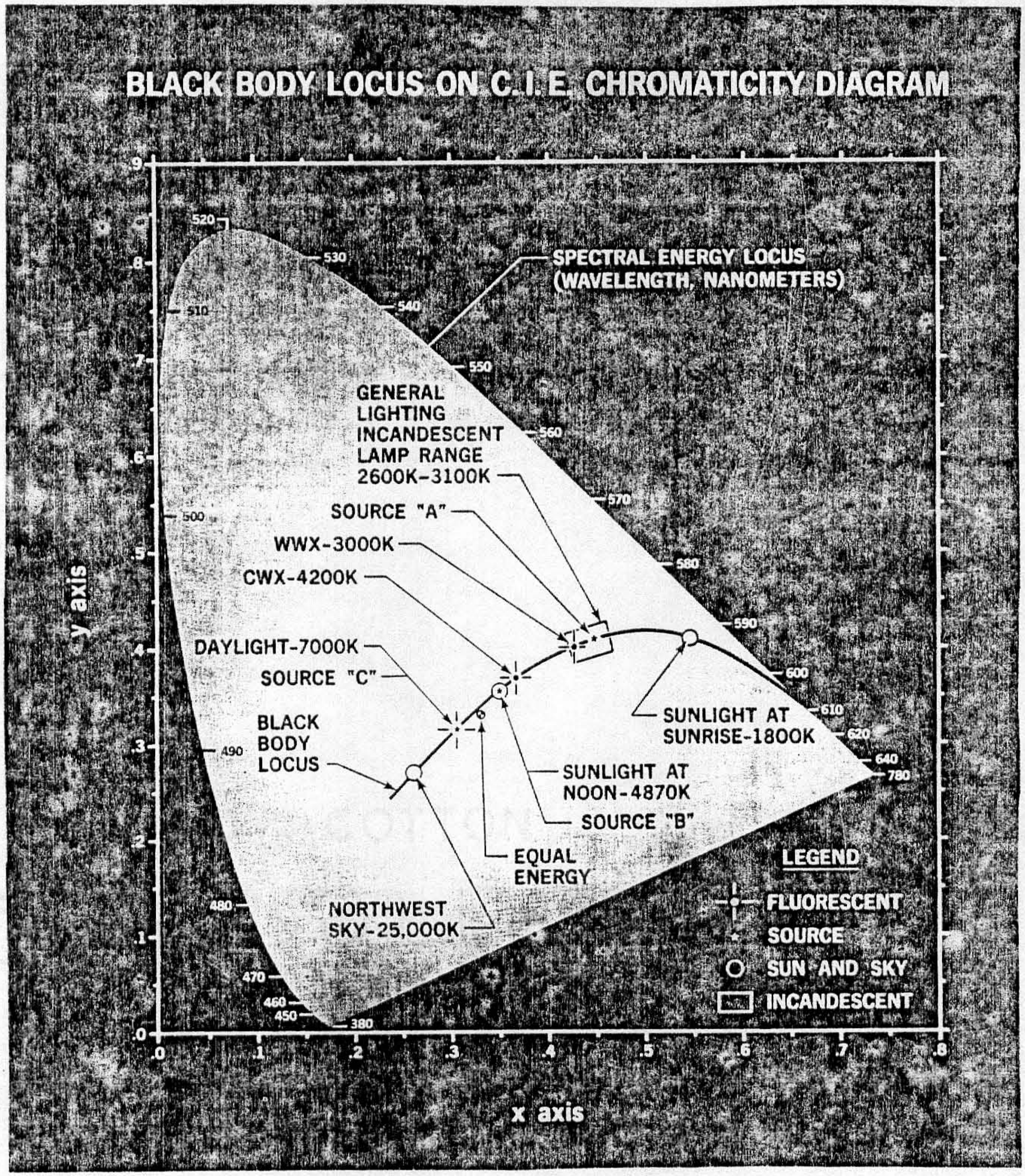

Figure 2. Color temperature of light source on C.I.E. chromaticity diagram. (G.E.,1968)

TABLE 4.

Color rendering properties of some typical light sources. (Erhardt,1977)

SOURCES	COLOR RENDERING INDEX (CRI)	BLACK BODY TEMPERATURE
Tungsten-halogen	99	3086
Tungsten 3000K	89	3000
Fluorescent cool white deluxe	85	4050
Flourescent cool white	67	4370
Metal halide	72	5200
Mercury deluxe white	47	3351
Sodium, high pressure	21	2250

has a almost perfect color rendering property(99%) while the high-pressure sodium lamp has the poorest color rendering ability(21%) of these shown.

With the combinations of efficacy and CRI properties, it can be seen that, in general, a higher luminous efficacy is often associated with a poorer color rendering, and vice versa. The extremes are the incandescent lamp which gives perfect color rendering but has only 20 lm/w efficacy, and the low-pressure sodium lamp which makes everything yellow, brown or black, but has a much higher efficacy(138 lm/w).

Light source acceptability

Although lamp efficacy and light source color rendering are major characteristics for lamp application, they are not the whole story of light source acceptability. The acceptability depends on the purpose the light source is to serve. With different lighting requirements, the acceptability of light sources varies accordingly. Incandescent lamps are characterized by their low efficacy and short life, but still remain the mainstay of home lighting for their pleasant color appearance and low lamp cost.

For street lighting, large quantities of light are required at low cost, without color discrimination. Lamps of high efficacy and long life as mercury lamps, low-pressure sodium lamps are used. Towards a town center, a better color is desirable, thus high pressure sodium lamps or color-corrected mercury lamps are used.

For office lighting, general considerations are high lamp efficacy, good color rendering property, long hours of life and minimal flicker. The source has been used most often to satisfy these requirements is the fluorescent lamps.

A study of "the effect of light source color on user impression and satisfactions" was done by Flynn and Spencer in 1977. It conclued that HID sources, particularly HPS, require special care in design for commercial and institutional interiors where subjective acceptability of light source color is important.

Yuan and Bennett(1980) did an experiment about the acceptability of HID lighting for offices. The evaluations of fluorescent lamps and HID lamps (metal halide and HPS) based upon visual acuity and color discrimination tests, and subjective responses, showed that these light sources were equally acceptable for interiors.

For areas that mainly devoted to social activities, such as restaurants, lobbies, lecture theatres, or convention rooms, no visual task is performed but looking at people, then the facial looking becomes the key of the light source acceptability. With the finding of Yuan and Bennett's study that HID lamps and fluorescent lamps are equally acceptable, there is a further need for research on the subjective acceptability of light sources depending on their rendering of human faces.

Subjective reactions to color of faces

Most of the studies which concern the human reactions to light and color have been done in the field of stage lighting. These subconscious reactions are utilized to dramatize the mood and meaning of the show. Rubbin and Watsib(1954) stated "Interpretati on of mood is the ultimate contribution of lighting. Every production has a predominent mood of comedy or tragedy or farce or melodrama. There is a constant series of changing moods and emotions within each production. Though the use of symbolism, color, line, light, and shade, illumination can often help evoke emotional responese." Woll(1964) also pointed out that lighting has been used to create "atomosphere" or mood on the stage in the movies, in the home and eleswhere.

Most of the accepted beliefs concerning psychological reactions to color, concern pigmented area rather than colored light. Peoples' reaction to the color pigment do not always correspond to their reactions to the same color light. For instance, green as a colorant is considered a restful, relaxing color, but deep green light thrown onto a person probably produce a macabre effect. Table 5 gives some claims about emotional reactions associated with pigment and colored light.

In the study of human perceptual and cognitive reactions, the human face is an increasingly popular stimulus for research use(Ellis, Shepher, and Davies, 1979). It is a familiar type of pattern with which we have a tremendous amount of experience. In the study of light source acceptability, knowledge about the subjective evaluations on lighting of human faces and figures are important for any confidence regarding what kind of light source to use for what kind of spaces.(Barton, Spivack, and Powell,1972) Wherever people are illuminated the color rendering capability of the lamps used comes under severest scruting. For roadway lighting, very poor color rendition seems to be acceptable, but, where people are looking at people, as in shopping areas, proper appearance of flesh tones is of great importance and requires much better proformance from the lamp.

Fisher(1973) in "A luminace concept for working interiors" used the perceptibility of the features on human face as the ceiterion for adequate lighting levels. Kuman(1976) studied the effect of direction of illumination on the pleasantness and intelligibility from the subjective evaluation of the potographs of faces.

TABLE 5.
Associations of color and mood.(Williams,1954)

Pigment color	Associated emotion
Red	Exciting
Orange	Stimulating
Yellow	Elating
Green	Relaxing
Blue-green	Cooling
Violet	Depréssing
Magenta	Subduing

Color of light	Associated emotion
Red	Danger
Orange	Warmth and excitment
Sun color	Contentment
Pale green	Kindness
Green	Macabre effect
Peacock-blue	Sinister
Blue	Quiet depth of feeling
Violet	Delicate emotion
Cerise	Deep affection
Leavender	Wistfulness

An important experiment has been carried out in 1972 on the acceptability of mercury lamp for lighting people by Thornton. He found that addition of blue light, complementary to excessive yellow light from the high pressure mercury discharge lamp, results in remarkable improvement of color rendition of skin tones. Also skin tones under the deluxe mercury white lamp are still too yellow and seem to constitute the main drawback to wider acceptance of mercury lamp wherever people are illuminated.

Racial differences in color response

For years, researchers have investigated the relation between visibility and human performance. In the study of subjective aspects of lighting, Flynn(1977) wrote "human responses to spatial lighting patterns are, to some extent, shared experience of recognizing and assimilating communicative patterns". If an individul's habits constitute the residues of his experience, and if culture includes the complex of accumlated behavior patterns of people, then the study of culture and the study of habit-development are necessarily related. Since human learning does not take place in a cultural vacuum, psychology must include the study of cultural influences on human behavior.

The cultural or racial differences in color perception and in color vocabulary has the longest and most sustained research history in the culture and perception area.(Segall, Campbell and Herskovits,1966) There is a wide variety of studies supporting the hypothesis that perception varies from person to person in accord with selective forces, both inhibiting and reinforcing, provided by culturally mediated experiences.

In addition to cultural differences, there is another probably more important factor in perception of the races: color differences in skin, eye, and hair. So easily perceptible are veriatious in skin color that many peoples of the world who have never heard of anthropology, classify themselves and each other in terms of these traits. As a matter of fact, skin color is evidentialy influenced both by race and climate. Coon in 1962 stated that skin color is somehow dependent on the amount of ultraviolet radiation penetrating the atmoshpere. The nordic races are more frequently blond and light-eyed. Snow and ice is a part of their natural heritage and the sun has a higher Kelvin rating in these latitudes.

In an unpublished study, William Beck(President of Donald Guthrie Foundation for medical research) found that hair color differences were related to light source color preference. He stated in a letter to Dr. Corwin Bennett that a tremendous majority of the blondes liked to see themselves under relatively cool light, whereas the brunettes preferred a much warmer lamp. This result held true for the complexion rather than the actual hair color. He studied several young women who are brunette but had chosen a blond bleach, they preferred the warm light despite the actural hair color.

Thus, for the research of light source color acceptability, deeper insights into possible differences among groupings of individuals and among varying cultures and national backgrounds are something worth developing.

PROBLEM

The purpose of the current research is to find out the acceptability of various light sources with respect to the effect of light source color on human complexion. HID sources will be compared with two commonly used light sources: incandescent lamps and fluorescent lamps.

Past research on subjective light source acceptability was concerned mostly about luminance level, visual performerce, visual comfort and so on. The subjective responses to light source color are relatively new criteria for the acceptability evaluation. Studies have been done regarding light source color in respect to lighting system, but involved no consideration of the satisfaction of complexion nor the racial differences.

This research will use different racial subjects to evaluate relative subjective responses to the light source color on human facial looking. The null hypothesis for testing racial differences is that there are no differences among races in light source acceptability.

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METHOD

Semantic differential scaling and factor analysis

The semantic differential scaling technique was originated by Osgood and his associates in 1957. It is a general method to measure the meaning of a concept.

Each semantic scale consists of two words which are opposite in meaning located on each side of the scale. The scale is devided into several segments, the segments convey degrees between the two anchor words in an ascending or descending order. For example:

pleasant ___:___:___:___:___:___:___ unpleasant

Prograssing from left to right, the segments are defined as "extremely pleasant", "very pleasant", "slightly pleasant", "neutral", "slightly unpleasant", "very unpleasant", amd "extremely unpleasant".

When the ratings on the various differential scales are compared, it usually turned out that the scales show a fair degree of correlation with each other. One may have a large number of scales which convey the same meaning or similar meaning. A statistical procedure called factor analysis is used to determine the number and nature of factors entering into semantic description and judgment, and to select a set of specific scales corresponding to these factors which can be standardized as a measure of meaning.

A series of studies using the semantic differential technique for subjective lighting have been done mainly with light sources and lighting patterns(Flynn,1977, Bennett,Ali, Percherla and Rubison,1978, ect.). Their results verified the validity and feasibility of this technique in investigating effects of lighting on users' impressions and satisfaction. As the result of IES project no.92, the semantic differential scaling method has been adopted for measuring subjective impressions in lighting(Flynn,1979). Several broad categories of impression can be cued or modifed by lighting systems. Those categories of particular interest are:

Perceptual categories

- impression of visual clarity
- impression of spaciousness
- impression of color tone
- impression of glare

Behavior setting

- impression of public vs. private space
- impression of relaxing vs. tense space

Overall Preference

- impression of preference (like/dislike)
- impression of pleasantness

In this study, only light source color is concerned. The associated impressions are color tone from perceptual category and overall preference. Twelve scales were used for the subjective evaluations.(Figure 3)

Light source and apparatus

Six light sources were selected and numbered 1 to 6.(Figure 4) These were incandescent, fluorescent warm white, fluorescent cool white, low-pressure sodium(SOX), high-pressure sodium(HPS), and metal halide. Each light source was held by a wooden fixture with an opening of 10.5" by 20.5". Some wire screens were fastened to the openings to reduce the light output to the required illuminance. The selected illumination level for the task was twenty footcandles on subject's face. This is the recommended lighting level for rooms not used continuously for working purpose or having simple visual demands(Fisher and de Boer,1978). All the light sources with illuminance higher than 20 fc. were screened and checked by a light meter before the experiment started to provide the same lighting level.

HPS, SOX and metal halide lamps which need warm-up and cooling time before start and restart were kept on all the time. Three four-layers black curtain were used to block their lights while not in use.

The light source under viewing was placed on a wooden table behind a plastic diffuser window. The window had the

Subject No.:________ Light Source:________

RATING SHEET

unpleasant	___:___:___:___:___:___:___	pleasant
cool	___:___:___:___:___:___:___	warm
sad	___:___:___:___:___:___:___	happy
sick	___:___:___:___:___:___:___	healthy
colorless	___:___:___:___:___:___:___	colorful
unlikeable	___:___:___:___:___:___:___	likeable
ugly	___:___:___:___:___:___:___	beautiful
unusual	___:___:___:___:___:___:___	usual
invisible	___:___:___:___:___:___:___	visible
morbid	___:___:___:___:___:___:___	wholesome
discontented	___:___:___:___:___:___:___	contented
unacceptable	___:___:___:___:___:___:___	acceptable

Comments:

Figure 3. Form of subjective evaluation sheet.

LAMP 1	Incandescent
LAMP 2	Fluorescent - cool white
LAMP 3	Fluorescent - warm white
LAMP 4	Low-pressure sodium (SOX)
LAMP 5	High-pressure sodium (HPS)
LAMP 6	Metal halide

Figure 4. Types of light sources studied.

same size as the light source opening, and was located 22" in front of subject and 45 degrees above subject's eye level which is the most pleasing direction of illumination(Kumar,1976). Under the window, a mirror was placed. The mirror was sized 27" by 19.5"(Figure 5).

Tasks

The tasks for the present study were the evaluations of facial appearance lighted by six different light sources on twelve semantic differential scales. Each subject was asked to sit in front of a mirror and to perfrom the tasks by looking at himself through the mirror. Some related information about the subject was asked for skin clor, hair color, sex, and native nation.

Experimental design

The illumination levels were nearly constant among the six light sources. And the other environmental variables, such as room size, finishes, background which was a wooden board with natural wooden color, ect. remained constant. So the principal environmental variable was the color of light. A 60 watts incandescent lamp was placed by the diffuser window to provide lights for subject's reading and to prevent subject looking at light source directly during the light source change.

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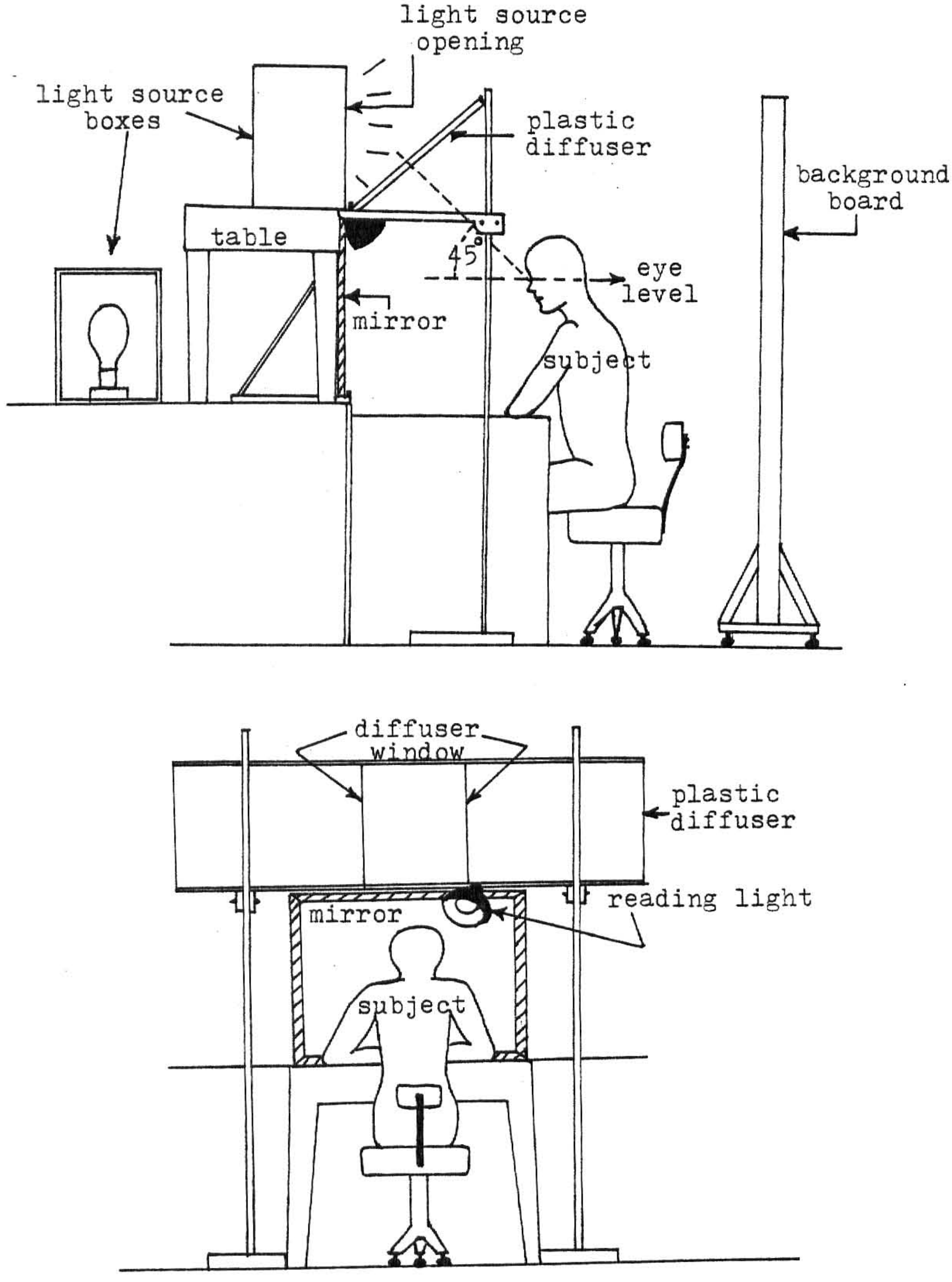

Figure 5. Apparatus.

When subject entered the room, he was given the "Instructions and Informed Consent"(Figure 6). After he consented to participate the experiment, he signed the Informed Consent Statement Form(Figure 7). A white cloth was put on the subject to eliminate the color effect of his clothes. The subject's skin luminance was measured by a photometer as a basis for determining skin reflectance. Then the six light sources were presented in a predetermeined and randomly assigned (by using the random table) order for the subject. Table 6 shows these random orders. The total experiment time for one subject was estimated at twenty minites.

Subjects

Sixty subjects participated. They were 34 males and 26 females with the age range from 19 to 30 (except for one 50). which represents the population of college students. The subjects were recruited by asking people who were passing by the experimental room located in the engineering and architecture building. Foreign students were specially encouraged.

The race of the subject was judged by the skin color and native nation given by the subject. Subjects with white skin color and native of USA or Europe, or brown skin color and native of south-west Asia were considered as white race. Subjects came from northern and eastern Asia, Malysia, and

INSTRUCTIONS AND INFORMED CONSENT

This experiment is designed to study the subjective acceptability of different light sources. Your task will be simply to evaluate six light sources on some bipolar scales as described later. You will be asked to sit in front of a mirror and look at yourself through the reflection of the mirror under a specific light source. By the feeling of your facial looking, you will be asked to mark down a "X" in the possition in each scale that most accurately describes your impression. After you finished all the scales, a new sheet for another light source will be given. Same rating procedure will be applied for the new light source, and you will be asked to do the same procedure for six different light sources.

The rating scales are designed to have two adjectives opposite in meaning to each other. Toeal scale is divided into seven segments. For example:

pleasant __:__:__:__:__:__:__ unpleasant

The degrees from left to right are extremely pleasant, very pleasant, slightly pleasant, neutral, slightly unpleasant, very unpleasant, and extremely unpleasant. If you feel that a particular light source is very pleasant, then put a "X" on the scale as shown below:

pleasant __:_X_:__:__:__:__:__ unpleasant

Figure 6. Instructions and informed constent.

Each rating should be done in a similar way. Be sure to read the words at each end of the scale before you place "X". The approximate time to complete this experiment will be 20 minutes. There are some magazines on the table for your reading during the changing of light source. Please not to look at the light source directly before you finish the experiment.

There will be no risk nor discomfort in this experiment. However, you are free to stop your participation at any time. If you have any questions, please feel free to ask. Any comments about the procedure and experiment are hightly appreciated. Please write them on the space below the scales.

Now, if you are ready for the experiment, please sign the conformed constent statement form given by the experimenter.

Thanks for you cooperation.

Figure 6. (cont.)

INFORMED CONSENT STATEMENT

Having read the informed constent, I hereby freely agree to be a subject in the research entitled "Lamps for lighting people".

Subject No.	Signature	Date

Figure 7. Informed consent statement.

TABLE 6.

The order of light sources assigned to each subject.

Subj. No.	Light source order						Subj. No.	Light source order					
1	3	2	1	6	5	4	31	5	4	6	3	1	2
2	4	1	5	6	2	3	32	4	5	6	2	1	3
3	2	6	3	4	1	5	33	3	4	1	6	5	2
4	6	4	3	2	5	1	34	5	2	3	6	1	4
5	5	6	1	3	2	4	35	2	5	6	1	3	4
6	6	3	4	5	1	2	36	1	3	6	4	2	5
7	4	1	3	5	2	6	37	5	3	2	1	6	4
8	6	2	3	5	1	4	38	2	3	5	1	6	4
9	4	1	3	6	5	2	39	4	3	6	5	1	2
10	6	1	5	2	3	4	40	2	6	3	4	5	1
11	5	1	2	4	3	6	41	3	5	2	1	6	4
12	4	6	3	2	1	5	42	4	5	6	2	3	1
13	1	3	4	2	6	5	43	5	2	6	1	3	4
14	1	5	2	6	4	3	44	3	2	1	5	6	4
15	4	3	6	1	5	2	45	4	2	5	1	3	6
16	2	4	6	3	5	1	46	1	5	2	4	3	6
17	6	1	4	5	3	2	47	3	1	6	4	5	2
18	2	4	6	5	3	1	48	2	4	6	5	1	3
19	6	4	1	5	2	3	49	5	3	1	2	4	6
20	1	5	2	6	4	3	50	3	2	4	6	5	1
21	3	2	5	1	6	4	51	5	6	4	1	2	3
22	6	3	1	2	4	5	52	2	4	5	3	1	6
23	2	3	4	6	5	1	53	4	5	6	1	2	3
24	1	6	2	3	4	5	54	2	6	3	4	5	1
25	4	3	2	6	5	1	55	1	5	3	2	4	6
26	4	6	2	3	1	5	56	2	5	3	4	1	6
27	1	4	3	5	6	2	57	5	1	3	4	6	2
28	4	5	6	1	3	2	58	6	1	4	5	2	3
29	2	6	3	4	1	5	59	1	4	2	3	6	5
30	1	2	4	5	3	6	60	6	2	5	1	4	3

American Indians with yellow or brown skin color were considered as yellow race. Subjects with black skin color and native of USA or Africa were considered as black race.(Coon,1962)

RESULTS

The subjective evaluations by subjects for the six light sources on the twelve rating scales are given in Appendix. The seven steps of each bipolar rating scale were assigned numerical values beginning with a 1 for the left-most step (generally nagative) and proceeding sequentially with a 7 assigned to the right-most step (generally positive). The mean value of the scale was 4 with a meaning of neutral. The letters SC1, SC2,....., SC12 used are for the twelve semantic differential rating scales. Figure 8 shows how these scales were numbered. LAMP, numbered from 1 to 6, represents the six light sources used.(Figure 4)

The subjective rating scales were factor analyzed using the statistical analysis system computer program (User's guide to SAS79, North Corolina, SAS Institude Inc.,1979). Table 7 shows the correlation matrix for the tweleve scales. Two factor were extracted and rotated. Table 8 shows the two factors found from the twelve scales with their respective loadings. Loadings greater than 0.50 will be considered to be "high". In this respect, high loadings on Factor 1 occurred with the scales unpleasant-pleasant, sad-happy, sick-healthy, unlikeable-likeable, ugly-beautiful, unusual-usual, morbid-wholesome, discontented-contented, and unacceptable-acceptable. Factor 1 was named "Evaluation". High loadings

SC 1	unpleasant - pleasant	
SC 2	cool - warm	
SC 3	sad - happy	
SC 4	sick - healthy	
SC 5	colorless - colorful	
SC 6	unlikeable - likeable	
SC 7	ugly - beautiful	
SC 8	unusual - usual	
SC 9	invisible - visible	
SC10	morbid - wholesome	
SC11	discontented - contented	
SC12	unacceptable - acceptable	

Figure 8. The twelve semantic scales.

TABLE 7.
Correlation Matrix.

	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
pleasant(SC1)	1.000	0.226	0.770	0.758	0.285	0.803	0.788	0.697	0.422	0.735	0.770	0.777
warm(SC2)		1.000	0.338	0.300	0.459	0.253	0.273	0.156	0.329	0.264	0.211	0.194
happy(SC3)			1.000	0.861	0.432	0.831	0.822	0.713	0.489	0.773	0.773	0.756
healthy(SC4)				1.000	0.438	0.875	0.853	0.735	0.446	0.819	0.805	0.796
colorful(SC5)					1.000	0.403	0.405	0.284	0.467	0.364	0.326	0.297
likeable(SC6)						1.000	0.901	0.794	0.443	0.809	0.850	0.861
beautiful(SC7)							1.000	0.776	0.422	0.819	0.839	0.824
usual(SC8)								1.000	0.426	0.772	0.765	0.785
visible(SC9)									1.000	0.450	0.437	0.397
wholesome(SC10)										1.000	0.819	0.807
contented(SC11)											1.000	0.878
acceptable(SC12)												1.000

TABLE 8.

Rotated factor pattern for the scales.

Scales	Factor 1 "Evaluation"	Factor 2 "Color"
pleasant	0.85	0.18
warm	0.06	0.81
happy	0.83	0.36
healthy	0.87	0.32
colorful	0.20	0.81
likeable	0.91	0.25
beautiful	0.90	0.26
usual	0.86	0.13
visible	0.36	0.63
wholesome	0.87	0.25
contented	0.91	0.17
acceptable	0.92	0.13

on Factor 2 are cool-warm, colorless-colorful, and invisible-visible. Factor 2 was named "Color". Figure 9 shows the rotated factors and Table 9 shows the mean comparative ratings for the twelve scàles.

The analysis of variance for light source effects was carried out for each factor as shown in Table 10 and 11. The significance level chosen was 5%. The results show that the light source differences were significant in both factors. Following are the Duncan's multiple range test in Table 12 and 13, which are conducted for the variance analysis. Some two-tail $\underline{t}$ tests were carried out on the light source factor means. In each factor, both the highest mean and the lowest mean were compared with the average of the remaining five factor means. The result is given in Table 14 which indicates that in evaluation factor, the highest mean was not significantly better than the average of other means, but the lowest mean was found significantly lower than the average of others. In the color factor, no significant difference was found.

The column REFLC in Appendix represents the facial skin reflectance of the subjects. It is the comparative percentage of luminace from subject's facial skin to magnesium carbonate which has a 98% reflectance. Two numbers under SEX are 1 and 2 representing male and female respectively. HARCO is named for subjects'hair color. Numbers 1, 2, and 3 was used for blond, brown and black. SKNCO is the skin color of the sub-

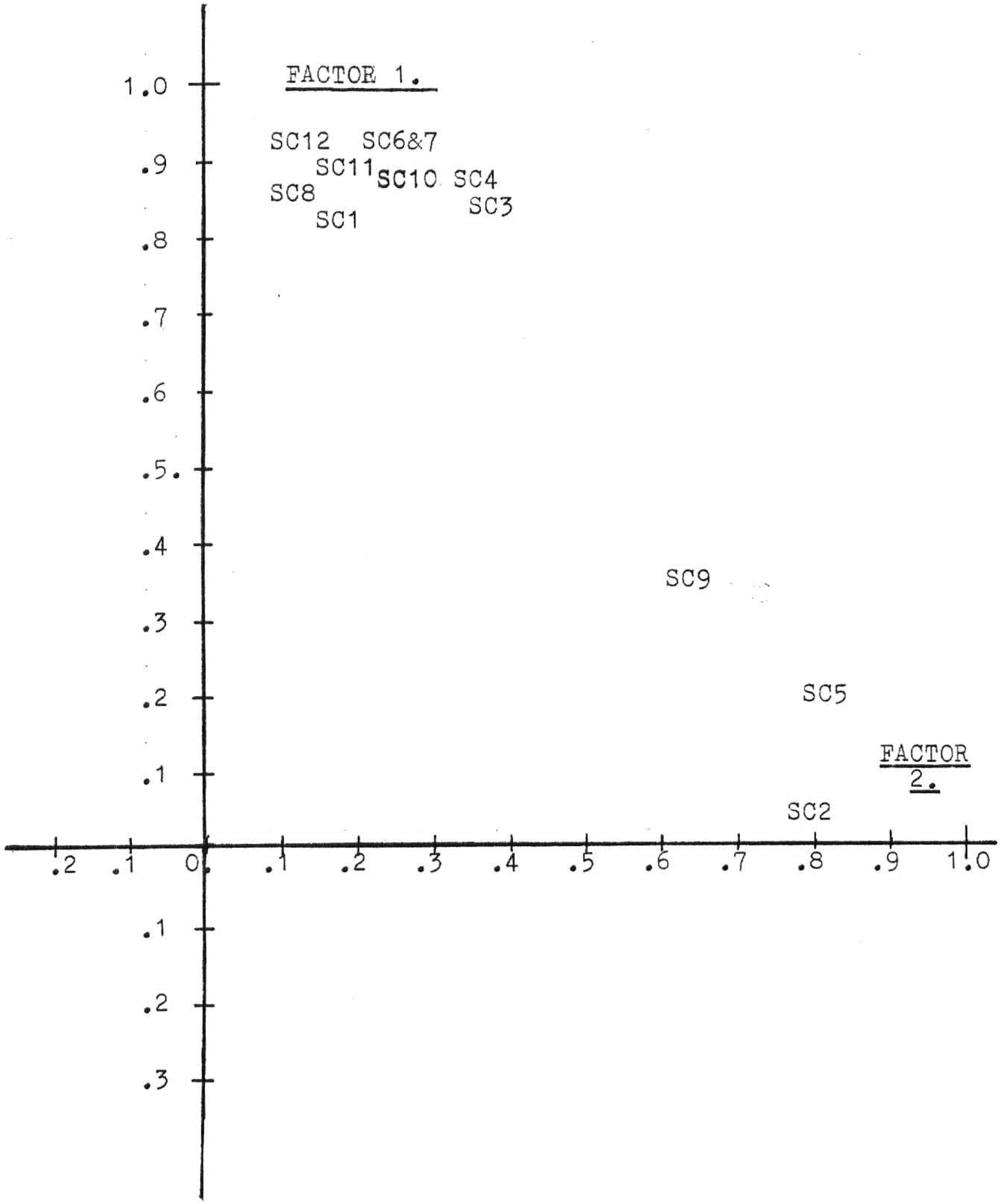

Figure 9. Orthogonal factor rotation.

TABLE 9.

Mean comparitive ratings.

Scales	Incandescent	Fluorescent cool white	Fluorescent warm white	High-pressure sodium(HPS)	Low-pressure sodium(SOX)	Metal halide
pleasant	5.317	4.717	4.967	4.033	2.350	4.733
warm	4.833	3.400	4.167	4.817	3.600	3.533
happy	4.850	4.433	4.483	4.117	2.483	4.217
healthy	5.267	4.533	4.733	4.150	2.067	4.383
colorful	4.833	4.250	4.383	4.533	3.617	3.767
likeable	5.200	4.817	4.950	4.200	2.133	4.417
beautiful	5.067	4.600	4.683	4.100	2.177	4.417
usual	5.083	4.700	4.983	3.633	1.817	4.717
visible	5.167	4.867	5.050	4.733	3.967	4.750
wholesome	5.150	4.783	5.017	4.183	2.433	4.683
contented	5.200	4.917	4.900	4.183	2.333	4.700
acceptable	5.333	5.233	5.267	4.383	2.150	5.000

TABLE 10.
Evaluation factor: analysis of variance for light sources.

Source of variance	df	Mean square	F	Sifnificance level
Between model				
-light source	5	69.411	65.36	0.0001 *
-subjects	59	2.904	2.73	0.0001 *
Errors	295	1.062		
Total	359			

* Significantly different at 5% level.

TABLE 11.
Color factor: analysis of variance for light sources.

Source of variance	df	Mean square	F	Significance level
Between model				
-light source	5	12.426	8.81	0.0001 *
-subjects	59	2.178	1.54	0.0109 *
Errors	295	1.411		
Total	359			

* Significantly different at 5% level.

TABLE 12.

Evaluation factor: Duncan's multiple range test.

Light source	Means	Grouping
Incandescnet	5.163	A
		A
Fluorescent warm white	4.887	A B
		B
Fluorescent cool white	4.748	B
		B
Metal halide	4.596	B
High-pressure sodium(HPS)	4.109	C
Low-pressure sodium(SOX)	2.209	D

@ Means with the same letter are not significantly different.

TABLE 13.
Color factor: Duncan's multiple range test.

Light source	Means	Grouping		
Incandescent	4.944	A		
		A		
High-pressure sodium(HPS)	4.694	A		
		A		
Fluorescent warm white	4.533	A	B	
			B	
Fluorescent cool white	4.172		B	C
				C
Metal halide	4.017			C
				C
Low-pressure sodium(SOX)	3.728			C

@ Means with the same letter are not significantly different.

TABLE 14.

Two-tail *t* tests for light source factor means.

(1) Highest mean vs. remainder.

Source	df	t-calculated	t-table
Factor 1 (evaluation)	295	1.324	1.960
Factor 2 (color)	295	0.941	1.960

(2) Lowest mean vs. remainder.

Source	df	t-calculated	t-table
Factor 1 (evaluation)	295	4.6115 *	1.960
Factor 2 (color)	295	0.6267	1.960

* means significant at 5% level.

jects with 1, 2, and 3 representing white, yellow, and black groups respectively.

RACE was determined according to the subject's skin color and native nation. The numbers 1, 2, and 3 were used to represent the races of white, yellow, and black in the Appendix. Table 15 shows how the subjects were distributed into racial groups. A two-way least square analysis of variance was carried out for each factor to test the racial effects. The results, shown on Table 16 and 17, indicate that racial difference was significant in the evaluation factor, but not significant in the color factor. The racial effect (interactions between the races and the light sources) was found significantly different for both factors. The Duncan's tests for racial difference in evaluation factor and racial effects in both factors are shown in Table 18, 19, and 20.

Least-square variance analysis was carried out for hair color, skin reflectance and sex in each factor respectively. The results are shown in Table 21 and 22 for hair color, Table 23 and 24 for skin reflectance, and Table 25 and 26 for sex. The difference was found significant in color factor for sex. Table 27 shows the mean of each sexual group. Subjects' written comments were gathered and are shown in Table 28.

TABLE 15.
Distribution of races.

Race	Native country (observed skin color)	number of subject
White	U.S.A.(white)	24
	Iran(white)	1
	India(brown)	5
	Bangladesh(brown)	1
		31
Black	U.S.A.(black)	2
	Nigiria(black)	3
	South Africa(black)	1
		6
Yellow	Taiwan(yellow)	20
	Korea(yellow)	1
	Malysia(brown)	1
	Panama(brown)	1
		23

TABLE 16.
Evaluation factor: analysis of variance for light source and race.

Source of variance	df	Mean square	F	Significance level
Model				
-light source	5	69.411	52.97	0.0001 *
-race	2	5.299	4.04	0.0184 *
-light source * race	10	2.589	1.98	0.0351 *
Error	342	1.310		
Total	359			

* Significantly different at 5% level.

TABLE 17.

Color factor: analysis of variance for light source and race.

Source of variance	df	Mean square	F	Signigicance level
Model				
-light source	5	12.426	8.52	0.0001 *
-race	2	0.003	0.00	0.9983
-light source * race	10	4.587	3.15	0.0007 *
Error	342	1.459		
Total	359			

* Significantly different at 5% level.

TABLE 18.
Evaluation factor: Duncan's test for races.

Race	Means	Grouping	
Black	4.56	A	
		A	
White	4.39	A	B
			B
Yellow	4.08		B

@ Means with the same letter are not significantly different.

TABLE 19.
Evaluation factor: Comparative rating means for races by light source.

Light source	Race	Means	Grouping				
Incandescent	white	5.05	A				
	yellow	5.36	A				
	black	4.96	A	B			
Fluorescent							
- cool white	white	4.57	A	B			
	yellow	4.79	A	B			
	black	5.44	A				
- warm white	white	4.16	A	B			
	yellow	4.68	A	B			
	black	5.31	A				
Metal halide	white	4.70	A	B			
	yellow	4.28	A	B			
	black	5.28	A				
High-pressure sodium	white	4.43	A	B			
(HPS)	yellow	3.81		B	C		
	black	3.63		B	C	D	
Low-pressure sodium	white	2.59				D	
(SOX)	yellow	1.55					E
	black	2.76			C	D	

@ Means with same letter are not significantly different.

TABLE 20.

Color factor: comparative rating means for races by light source.

Light source	Race	Means	Grouping			
Incandescent	white	4.60		B	C	
	yellow	5.48	A			
	black	4.67	A	B	C	
High-pressure sodium (HPS)	white	4.99	A	B	C	
	yellow	4.49		B	C	
	black	3.94			C	D
Metal halide	white	3.83			C	D
	yellow	4.09			C	D
	black	4.72	A	B	C	
Fluorescent						
- warm white	white	4.60		B	C	
	yellow	4.45		B	C	
	black	4.50		B	C	
- cool white	white	3.88			C	D
	yellow	4.57		B	C	
	black	4.17			C	D
Low-pressure sodium (SOX)	white	4.17			C	
	yellow	3.04				D
	black	4.06			C	D

@ Means with same letter are not significantly different.

TABLE 21.

Evaluation factor: analysis of variance for hair color.

Source of variance	df	Mean square	F	Significance level
Hair color	3	0.511	0.22	0.882
Errors	356	2.332		
Total	359			

TABLE 22.

Color factor: least-square analysis of variance for hair color.

Source of variance	df	Mean square	F	Significance level
Hair color	3	1.761	1.04	0.375
Errors	356	1.689		
Total	359			

TABLE 23.
Evaluation factor: least-square analysis of variance for skin reflectance.

Source of variance	df	Mean square	F	Significance level
Skin reflectance	28	2.642	1.15	0.274
Errors	331	2.289		
Total	359			

TABLE 24.
Color factor: least-square analysis of variance for skin reflectance.

Source of variance	df	Mean square	F	Significance level
Skin reflectance	28	1.758	1.04	0.408
Errors	331	1.685		
Total	359			

TABLE 25.
Evaluation factor: least-square analysis of variance for sex.

Source of variance	df	Mean square	F	Significance level
Between sex	1	8.859	3.85	0.061
Errors	358	2.298		
Total	359			

TABLE 26.
Color factor: least-square analysis of variance for sex.

Source of variance	df	Mean square	F	Significance level
Between sex	1	11.219	6.74	0.010 *
Errors	358	1.663		
Total	359			

* Significantly different at 5% level.

TABLE 27.
Color factor: Duncan's test for sex.

Sex	Means	Grouping
Male	4.37	A
Female	3.95	B

@ Means with the same letter are not significantly different.

TABLE 28.
Subjects' written comments.

Incandescent

- slightly dim
- the most comfortable
- good for imtimate space

Fluorescent cool white

- appears pale
- glare
- it seems to be meditative
- seems like doctor's office or hospital

Fluorescent warm white

- nice
- all right
- very close to white light

Metal halid

- would be easier to study under than low-pressure sodium
- a little dim, if brighter would be good in an office or other place of activity
- not bright enough but it didn't distort colors
- gives a nice happy feeling

High-pressure sodium(HPS)

- didn't change skin tones in the mirror a lot, it grew a glow that was bothersome.
- uncomfortable
- seems alright
- it doesn't seem to be very practical, but it would be nice for entertainment
- a bit too dim, but otherwise it isn't too bad

TABLE 28. (cont.)

- real good for restaurant or some place that very laid-back, perhapes reminiscent of a fireplace on a cold night

Low-pressure sodium(SOX)

- a slightly sick feeling
- a green tint, very distracting
- terrible
- diffcult to distinguish color
- I thought it was relaxing. It would be hard to study by but I like it
- it's terrible, everything looks terrible

great for spook house, or to show that a space is not to be entered, just seen

DISCUSSION

Factor analysis

The twelve semantic differential rating scales were subjected to a principal components factor analysis based on the raw data obtained from the experiment. This analysis yielded two factors with factor loadings as follows:

Evaluation factor	
pleasant/unpleasant	0.851
happy/sad	0.827
healthy/sick	0.865
likeable/unlikeable	0.914
beautiful/ugly	0.859
wholesome/morbid	0.867
contented/discontented	0.906
acceptable/unacceptable	0.915

The evaluation factor shows the preference of the light source color. The higher the factor loading, the more representative the factor is of a given rating scale. The subjects treated these scales in a similar way. Table 9 shows the mean rating value for each scale. The higher the value in the table, the more the light source was preferred.

Color factor	
warm/cool	0.810

colorful/colorless	0.811
visible/unvisible	0.625

The second factor is not as well-defined as the previous factor. This factor may have resulted from a fortuitous correlation of the impressions of "color" and "clarity". The color factor suggests that there was a tendency for certain light sources (incandescent, fluorescent warm-white, and HPS) to be judged more warm, colorful, and visible than the other light sources (fluorescent cool-white, SOX, and metal halide). The ralatively low loading of the visible scale indicates that this was only a general tendency.

Light source effects

The analysis of variance for the factor means in Tables 10 and 11 indicates significant differences dependent upon light sources. Duncan's tests on Tables 12 and 13 revealed how the six light sources varied.

In the impressions of "evaluation", the extremes of difference are the incandescent color and the SOX color with the fluorescent (both cool-white and warm-white), metal halide and HPS colors falling between. The principal finding indicated in Table 12 is a evident advantage for the incandescent, fluorescent, and metal halide colors. The HPS and SOX (particularly SOX) are significantly weaker in this category. Two tail t tests for the highest mean and the lowest mean versus the average mean of the remaining five were done to test absolute preference among the light sources. As the result shown on Table 14 indicates, incandescent color is not absolutely better than the others, but SOX color is less preferred.

The study of the "color" response again indicates that the extrems of difference are the incandescent color and the SOX color compared with the other light sources falling in between. The finding indicated in Table 13 indicates that the incandescent, HPS, and fluorescent warm white sources were rated higher than the fluorescent cool white, metal halid and SOX sources. This result verifies the usual warm/cool light source distinctions. One exception of possible interest here is the rating of the SOX color. This light source in spite of the fact that SOX emits most of lights with yellow and orange colors. This phenomenon requires further study in future tests. As the two tail t test shows (Table 14), in the color factor, neither incandescent color nor SOX color is different from others.

Both favorable and negative comments were given about HPS and Sox sources. HPS was thought "to be noce for entertainment or for a resturant", but seemed "impractical". "Good for a spook house", "terrible", and "relaxing" were commented for SOX. Metal halide had "happy feeling", "good for an office", and "better than SOX colors".

The major finding of the light source color acceptability in the present study is that HPS color, in terms of facial appearance, is not liked while SOX color is least preferred of all.

In Yuan and Bennett's study (1980), no difference was found among HPS, metal halide, and fluorescent cool-white colors. But in the present study, HPS and SOX are significantly less preferred. One explanation for the conflicting results is the task difference. The task for previous study was the evaluation of lighting environment, including the impressions of spaciousness and social prominence. The task for the present study was the evaluation of faces. Another explanation is the difference of experimental design. An "independent groups design" was used in the Yuan study. Each observer saw only one light source. Here, each subject viewed all six light sources. Since the subject was told to rate his facial appearance and since the light source color was the only change, he would be sensitized to any obserable difference amongst the light sources. Eventually, some of these light sources are discriminable.

As commented on by Flynn in 1977, HPS requires special care in designing for commercial and institutional interiors. Also Erhardt(1977) said that the spectral distribution of HPS is too weak in reds, greens, and blues to result in a satisfactory appearance of illuminated objects, which require "natural" color, the comment from the current study is that careful evaluations for HPS color acceptablility on human complexion is required before it is applied in settings with sustained human occupancy. Another comment for SOX is that SOX lamps are not suitable for lighting people at low lighting levels because the color of the light then gives a drab impression. Color improvements are required before it can be used indoors.

Racial difference

As shown in Table 15, the sixty subjects were distributed into three racial groups. They were thirty-one of the white race, six black race, and twenty-three yellow. Since the sample size of the black race was only six, it might not be representative sample.. Futher study with larger, more representative samples to draw more accurate inferences about racial differences.

The least-square analysis of variance was carried out for light source and race in each factor.(Tables 16 and 17) The difference was found in the evaluation factor. Table 18 shows the Duncan's test on racial means for this factor. The result indicates that the black race rated themselves higher than the yellow race with whites intermediate (but the two were quite similar). A possible explanation for the yellow races' lowest rating is the conservative nature of the Oriental people. They are used to showing their feelings mildly without using extreme words. This result verified the racial differences in human perception and color preference.

Racial-lighting effects

The racial-lighting effect, which was the interaction between the race and light source preference, was found significant in both factors. Tables 19 and 20 shows the grouping of the comparative rating means generated by Duncan's procedure.

In the evaluation factor(Table 19), "A" group shows a equal acceptability among the three races for the incandescent, fluorescent cool white, fluorescent warn white, and metal halide, plus the white race for the HPS. "B" group contains the white and yellow race for the fluorescent cool white, fluorescent warm white and metal halide, the black race for the incandescent, and the three races for the HPS. B group is less preferable than A group. It was found that black race rated the incandescent lower than any other light source in the A group, while the white and yellow races rated in the reverse way. As the "C" "D" and "E" groupings shows, the balck race had a higher acceptability of SOX and the yellow race had a low preference for SOX.

For the light source color preference is as much a function of individual perferences as a function of light sources, both functions are possibly good explanations for the difference. "Good" appearance is generally interpreted to mean the "familar" appearance. Objects, including faces, assume "familiar" colors only by being frequently seen under certain types of light sources. For example, the HPS color was accepted better by the white race than by the yellow and black. One possible explanation is that white race has had more visual experience of HPS than the other races. This was shown by interviewing some subjects of the black and yellow races. HPS is not popular in Asia and Africa.

Besides the visual experience, another explanation may associate with the light source color appearance. The finding that SOX was rejected by yellow race was an example. Possibly the yellowish light from SOX changes the skin tones to a sickly yellow that is particularly disgusting to the yellow race. Several yellow racial subjects felt it hard to distinguish objects under the SOX, but no similar response was given by other racial subjects.

Looking at Table 20, the Duncan's test for "color" factor, group "A" was rated more colorful than the other groups. An equal color impression was shown among the metal halide for the black, the HPS for the white, and the incandescent for the yellow and black races. "C" group revels that the white and black races judged the six light sources equally colorful, but the yellow race manifested a particular preference to the incandescent and a rejection to the SOX. An interesting finding from the table is that the most colorful light sources for the white and black races were HPS and metal halide respectively, while the most colorless light sources were the HPS for the black and the metal halide for the white. This reverse response may be explained as the result of mysterious cultural influences or as a fortuitous, experimental mistake. A further study in this respect is recommended.

Other Variables

Other related variables, such as hair color, sex, and facial skin reflectance, were analyzed by least-square variance analysis. No differences were found in hair color and the skin reflectance. The difference between male and female existed in the color factor as shown in Table 26. Table 27 shows the male subjects rated themselves higher than the female subjects. This result shows that personal taste in color varies with sex, and for the current study, males rated themselves more colorful than the females.

Implications

The present study finds differences of light source color acceptability, based on facial appearance, among the six light sources. SOX light shows the poorest acceptability and metal halide light shows a better impression than HPS light. Although it had been found that HPS light was an usable alternative light source for office use, it is suggested that for the areas where facial appearance is important, the HPS light should be carefuly evaluated before being applied.

The second finding is the racial differences in light source color acceptability. With different cultures, national backgrounds, and visual experiences, the preference of light source color varies among the groupings of individuals. The differences are likely to be the result of culturally mediated differences in experience. This important difference should be taken into consideration before selecting the light source. HPS light was found more acceptable by white racial people and SOX light was least preferred by yellow racial people.

More research should be done with larger and more equal numbers of racial groupings of subjects, or with independent subject design, to obtain independent responses.

CONCLUSION

The following conclusions can be drawn from the present research.

1. Two factor were extracted from the correlations among the subjective rating scales, and were named "evaluation" and "color".
2. HPS and SOX are less preferred than the other light sources.
3. Incandescent, fluorescent warm white, and HPS are "warmer" than fluorescent cool white, SOX, and metal halide light.
4. HPS needs special care in indoor application for lighting people. SOX is not suitable for interiors where facial appearance is important.
5. Racial difference was found significant in light source acceptability. HPS can be accepted by white race better than yellow and black races. Yellow race has the lowest acceptability on SOX color.
6. Futher studies can be done as a continuation or amendment of the present study. With larger and more equal number of subjects and race, or with independent subject design, independent racial responses can be obtained. Further studies in HPS lighting people should be carried out with care.

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APPENDIX

THIS BOOK IS OF POOR LEGIBILITY DUE TO LIGHT PRINTING THROUGH OUT IT'S ENTIRETY.

THIS IS AS RECEIVED FROM THE CUSTOMER.

STATISTICAL ANALYSIS SYSTEM 1

12:21 THURSDAY, FEBRUARY 12, 1981

OBS	SUB	REFLC	AGE	SEX	SKNCO	HARCO	NATION	LAMP	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
1	1	21	30	1	2	3	2	1	5	6	6	6	6	6	6	6	6	6	6	6
2	1	21	30	1	2	3	2	2	4	4	4	5	4	5	5	5	5	5	5	5
3	1	21	30	1	2	3	2	3	5	5	5	4	4	5	5	5	5	5	5	5
4	1	21	30	1	2	3	2	4	1	5	1	1	1	1	1	2	4	2	2	2
5	1	21	30	1	2	3	2	5	2	5	3	3	4	3	3	4	4	3	4	4
6	1	21	30	1	2	3	2	6	4	5	5	5	4	4	5	4	4	5	5	5
7	2	44	28	2	1	2	1	1	6	5	5	4	1	5	5	7	1	7	7	6
8	2	44	28	2	1	2	1	2	5	1	6	6	1	6	5	5	1	7	7	6
9	2	44	28	2	1	2	1	3	7	6	6	6	6	7	6	5	5	6	7	7
10	2	44	28	2	1	2	1	4	3	4	3	2	6	1	2	1	7	3	2	1
11	2	44	28	2	1	2	1	5	3	4	3	3	2	3	4	2	6	3	2	1
12	2	44	28	2	1	2	1	6	6	1	6	7	1	7	6	6	7	6	7	6
13	3	31	24	1	1	1	1	1	3	3	5	5	4	4	4	5	3	4	3	4
14	3	31	24	1	1	1	1	2	5	4	5	3	3	4	4	6	4	5	4	6
15	3	31	24	1	1	1	1	3	3	3	3	3	2	3	4	2	2	3	3	3
16	3	31	24	1	1	1	1	4	1	6	1	1	1	1	1	1	3	1	1	1
17	3	31	24	1	1	1	1	5	2	3	2	2	2	3	3	2	2	2	2	3
18	3	31	24	1	1	1	1	6	2	2	3	2	2	3	3	3	2	4	3	4
19	4	26	22	2	1	2	1	1	4	3	4	5	4	5	4	5	3	4	6	6
20	4	26	22	2	1	2	1	2	5	3	4	4	3	4	4	4	4	4	5	5
21	4	26	22	2	1	2	1	3	4	5	5	5	5	5	4	6	4	4	5	6
22	4	26	22	2	1	2	1	4	2	6	4	3	7	2	3	3	5	4	3	3
23	4	26	22	2	1	2	1	5	5	6	5	4	5	4	4	3	5	4	4	4
24	4	26	22	2	1	2	1	6	4	4	5	5	5	5	4	7	5	5	5	7
25	5	24	18	1	1	2	1	1	3	4	3	3	3	4	4	3	5	3	2	3
26	5	24	18	1	1	2	1	2	5	6	5	5	4	5	5	4	5	6	5	5
27	5	24	18	1	1	2	1	3	6	5	5	5	6	5	5	5	4	5	4	5
28	5	24	18	1	1	2	1	4	1	2	2	2	2	1	1	2	3	2	2	1
29	5	24	18	1	1	2	1	5	2	5	3	3	4	3	3	3	6	2	3	3
30	5	24	18	1	1	2	1	6	6	6	5	6	4	5	5	4	6	5	4	5
31	6	36	18	1	1	1	1	1	4	5	4	3	4	3	3	4	4	4	3	3
32	6	36	18	1	1	1	1	2	3	3	3	3	3	4	4	4	4	4	5	5
33	6	36	18	1	1	1	1	3	5	4	6	6	6	5	5	6	5	5	5	5
34	6	36	18	1	1	1	1	4	1	1	1	2	1	1	1	1	1	1	1	1
35	6	36	18	1	1	1	1	5	4	4	5	5	5	5	5	6	4	4	5	5
36	6	36	18	1	1	1	1	6	4	4	3	2	4	1	3	4	3	4	4	4
37	7	41	20	1	1	2	1	1	6	2	3	4	6	6	4	6	6	6	5	6
38	7	41	20	1	1	2	1	2	2	1	3	5	4	4	3	5	2	3	3	4
39	7	41	20	1	1	2	1	3	3	2	3	2	5	4	4	4	6	3	4	5
40	7	41	20	1	1	2	1	4	2	6	4	2	3	4	3	2	6	2	2	2
41	7	41	20	1	1	2	1	5	5	5	4	5	6	6	4	2	5	5	4	5
42	7	41	20	1	1	2	1	6	6	3	5	5	3	5	4	4	5	4	5	5
43	8	23	35	1	2	3	2	1	3	6	6	7	6	7	7	7	7	6	6	6
44	8	23	35	1	2	3	2	2	3	3	3	4	5	5	5	5	4	5	5	6
45	8	23	35	1	2	3	2	3	3	5	5	5	6	6	6	6	6	6	6	6
46	8	23	35	1	2	3	2	4	1	1	1	1	1	1	1	1	1	1	1	1
47	8	23	35	1	2	3	2	5	3	5	3	3	6	3	3	2	2	3	3	5
48	8	23	35	1	2	3	2	6	3	3	3	3	3	3	5	3	3	3	3	6
49	9	38	32	1	2	3	2	1	6	5	6	7	6	6	6	6	6	6	6	7
50	9	38	32	1	2	3	2	2	6	6	5	5	6	6	6	6	6	6	6	6
51	9	38	32	1	2	3	2	3	5	4	5	5	4	4	5	5	6	5	5	5
52	9	38	32	1	2	3	2	4	2	2	2	2	2	2	2	3	7	2	4	6
53	9	38	32	1	2	3	2	5	5	4	4	4	4	5	5	5	6	5	5	5
54	9	38	32	1	2	3	2	6	5	5	5	5	5	4	5	5	6	5	5	5
55	10	39	26	2	2	3	2	1	7	7	4	7	7	6	6	5	5	5	7	7

APPENDIX. Sujective ratings for each scale for the six light sources.

OBS	SUB	REFLC	AGE	SEX	SKNCC	HARCL	NATION	LAMP	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
56	10	39	26	2	2	3	2	2	2	1	2	1	1	1	2	1	4	3	4	3
57	10	39	26	2	2	3	2	3	4	3	3	3	2	3	2	3	2	3	5	4
58	10	39	26	2	2	3	2	4	1	4	1	1	7	1	1	1	3	1	1	1
59	10	39	26	2	2	3	2	5	4	7	6	7	7	7	6	4	5	6	4	7
60	10	39	26	2	2	3	2	6	4	2	3	1	2	1	2	3	2	3	3	4
61	11	36	20	1	1	2	1	1	5	3	5	5	2	4	4	5	4	4	3	5
62	11	36	20	1	1	2	1	2	5	3	4	5	3	6	4	6	5	5	5	6
63	11	36	20	1	1	2	1	3	5	5	5	6	6	7	5	6	6	5	6	7
64	11	36	20	1	1	2	1	4	2	2	2	1	2	1	2	2	3	3	1	1
65	11	36	20	1	1	2	1	5	5	5	4	3	3	4	4	3	4	3	4	5
66	11	36	20	1	1	2	1	6	5	4	5	4	4	6	5	5	6	4	5	5
67	12	46	18	2	1	2	1	1	5	3	2	3	5	4	4	3	4	3	4	5
68	12	46	18	2	1	2	1	2	5	2	2	3	3	5	3	3	5	3	3	5
69	12	46	18	2	1	2	1	3	6	3	3	3	2	4	4	6	2	3	5	6
70	12	46	18	2	1	2	1	4	5	2	3	4	5	6	5	3	5	4	6	6
71	12	46	18	2	1	2	1	5	3	3	3	3	5	4	3	3	6	3	4	5
72	12	46	18	2	1	2	1	6	5	3	4	3	1	4	4	3	2	4	5	5
73	13	35	29	1	2	3	2	1	4	5	4	4	4	4	4	3	3	4	3	3
74	13	35	29	1	2	3	2	2	4	4	4	5	5	5	5	5	5	5	5	5
75	13	35	29	1	2	3	2	3	2	3	3	3	3	3	3	4	4	3	3	3
76	13	35	29	1	2	3	2	4	1	1	1	1	1	1	1	1	1	1	1	1
77	13	35	29	1	2	3	2	5	2	6	3	3	5	3	3	3	3	4	3	3
78	13	35	29	1	2	3	2	6	4	4	4	4	4	3	4	4	5	3	3	3
79	14	36	33	1	2	3	2	1	6	6	5	5	4	5	5	5	7	6	5	5
80	14	36	33	1	2	3	2	2	4	4	5	2	3	3	4	3	7	5	5	5
81	14	36	33	1	2	3	2	3	7	4	7	7	2	7	6	7	7	7	7	7
82	14	36	33	1	2	3	2	4	3	2	2	1	7	1	1	1	7	1	1	1
83	14	36	33	1	2	3	2	5	4	4	4	3	6	2	2	2	7	3	3	3
84	14	36	33	1	2	3	2	6	6	4	6	6	2	6	6	6	7	6	6	6
85	15	46	20	1	1	2	1	1	7	7	6	6	6	6	5	7	7	6	6	7
86	15	46	20	1	1	2	1	2	4	3	4	3	3	4	4	4	6	4	4	5
87	15	46	20	1	1	2	1	3	6	5	4	6	6	7	6	7	7	7	6	7
88	15	46	20	1	1	2	1	4	2	4	3	1	1	1	1	1	6	1	2	2
89	15	46	20	1	1	2	1	5	7	7	6	6	6	6	5	5	6	5	6	6
90	15	46	20	1	1	2	1	6	6	5	4	5	2	5	5	6	5	4	5	5
91	16	34	22	1	1	1	1	1	5	4	5	6	5	6	6	5	6	5	6	6
92	16	34	22	1	1	1	1	2	5	3	5	5	5	6	5	2	4	5	5	6
93	16	34	22	1	1	1	1	3	6	6	5	5	5	5	5	6	6	5	4	4
94	16	34	22	1	1	1	1	4	3	4	3	2	6	2	2	2	3	3	3	3
95	16	34	22	1	1	1	1	5	4	5	3	3	5	4	4	3	5	4	3	3
96	16	34	22	1	1	1	1	6	6	5	5	6	5	6	6	5	6	6	6	6
97	17	20	36	1	3	3	2	1	4	5	3	4	5	3	4	3	4	5	3	3
98	17	20	36	1	3	3	2	2	5	3	4	5	6	6	6	5	5	5	5	5
99	17	20	36	1	3	3	2	3	4	4	4	4	5	5	5	5	6	6	5	4
100	17	20	36	1	3	3	2	4	1	7	2	2	4	1	1	1	2	4	1	1
101	17	20	36	1	3	3	2	5	2	4	3	3	3	3	3	2	2	3	2	2
102	17	20	36	1	3	3	2	6	6	2	4	5	5	6	6	6	6	6	6	7
103	18	36	30	2	3	3	2	1	5	7	7	7	7	6	6	5	5	5	5	5
104	18	36	30	2	3	3	2	2	6	4	3	2	1	3	3	4	4	4	4	5
105	18	36	30	2	3	3	2	3	5	5	4	5	2	4	5	6	5	5	5	6
106	18	36	30	2	3	3	2	4	1	1	1	1	3	1	1	1	3	1	1	1
107	18	36	30	2	3	3	2	5	4	5	4	4	5	4	4	4	5	3	4	4
108	18	36	30	2	3	3	2	6	4	4	4	4	1	5	5	7	7	6	5	7
109	19	31	27	1	1	2	1	1	6	3	6	6	6	6	6	7	7	6	7	7
110	19	31	27	1	1	2	1	2	4	3	3	3	4	4	4	5	5	4	3	4

OBS	SUB	REFLC	AGE	SEX	SKNCL	HARCC	NATION	LAMP	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
111	19	31	27	1	1	2	1	3	4	3	4	4	5	5	5	4	5	4	4	4
112	19	31	27	1	1	2	1	4	2	5	2	1	2	2	3	2	4	2	2	2
113	19	31	27	1	1	2	1	5	5	6	5	5	5	5	5	6	6	5	6	5
114	19	31	27	1	1	2	1	6	6	5	5	6	5	6	5	6	5	4	5	6
115	20	14	20	1	3	3	3	1	6	3	3	4	2	4	4	2	3	2	4	4
116	20	14	20	1	3	3	3	2	6	4	4	5	2	4	4	4	6	6	6	6
117	20	14	20	1	3	3	3	3	7	4	4	6	4	5	4	7	5	6	6	7
118	20	14	20	1	3	3	3	4	2	7	4	1	7	1	1	1	5	3	2	1
119	20	14	20	1	3	3	3	5	6	5	6	6	6	6	6	2	2	6	6	6
120	20	14	20	1	3	3	3	6	6	7	4	6	4	5	4	7	7	7	5	7
121	21	41	21	2	1	2	1	1	5	3	4	5	4	5	4	5	5	4	5	3
122	21	41	21	2	1	2	1	2	2	7	4	4	7	2	2	4	6	5	2	2
123	21	41	21	2	1	2	1	3	7	1	4	4	5	3	4	4	7	7	4	4
124	21	41	21	2	1	2	1	4	1	2	1	1	1	1	1	1	2	1	1	1
125	21	41	21	2	1	2	1	5	2	3	3	2	2	2	2	3	3	3	3	1
126	21	41	21	2	1	2	1	6	3	1	1	3	3	4	3	3	3	4	5	4
127	22	44	22	2	1	2	1	1	6	6	6	5	6	6	7	6	5	5	6	5
128	22	44	22	2	1	2	1	2	3	2	2	4	3	3	3	3	3	2	3	4
129	22	44	22	2	1	2	1	3	5	5	5	5	5	6	5	4	5	6	6	6
130	22	44	22	2	1	2	1	4	1	3	2	1	7	1	1	1	4	1	1	1
131	22	44	22	2	1	2	1	5	5	3	3	4	5	5	5	5	3	4	4	5
132	22	44	22	2	1	2	1	6	5	2	4	4	3	4	4	3	3	4	5	5
133	23	39	23	1	1	2	1	1	3	4	5	6	6	5	5	5	3	5	5	3
134	23	39	23	1	1	2	1	2	6	3	3	5	5	6	6	3	3	5	6	6
135	23	39	23	1	1	2	1	3	6	6	5	7	7	7	7	6	5	7	7	7
136	23	39	23	1	1	2	1	4	2	5	4	2	7	3	2	2	7	2	4	2
137	23	39	23	1	1	2	1	5	3	7	5	7	6	5	6	3	6	7	6	6
138	23	39	23	1	1	2	1	6	5	4	4	4	4	4	5	6	2	5	6	6
139	24	40	22	2	2	3	2	1	6	6	5	5	5	5	4	5	7	5	4	7
140	24	40	22	2	2	3	2	2	4	4	4	5	5	4	5	5	5	5	4	4
141	24	40	22	2	2	3	2	3	6	6	5	5	5	5	6	6	6	5	5	6
142	24	40	22	2	2	3	2	4	1	1	1	1	1	1	1	1	5	3	1	1
143	24	40	22	2	2	3	2	5	4	7	5	5	6	5	5	5	7	6	5	6
144	24	40	22	2	2	3	2	6	4	2	2	2	2	2	2	3	5	4	2	2
145	25	24	26	1	1	3	1	1	4	6	5	5	5	4	5	5	4	5	6	5
146	25	24	26	1	1	3	1	2	3	3	5	5	4	4	5	5	5	5	5	4
147	25	24	26	1	1	3	1	3	4	1	4	5	4	5	5	6	6	6	6	6
148	25	24	26	1	1	3	1	4	6	2	4	1	2	3	2	3	3	4	1	3
149	25	24	26	1	1	3	1	5	6	7	6	5	6	6	5	5	6	5	5	6
150	25	24	26	1	1	3	1	6	2	6	2	2	4	2	3	2	3	4	2	3
151	26	44	18	2	1	2	1	1	5	3	4	4	2	5	4	6	3	4	5	6
152	26	44	18	2	1	2	1	2	5	2	4	4	2	5	4	6	2	5	4	6
153	26	44	18	2	1	2	1	3	5	3	4	5	2	6	4	6	3	4	4	6
154	26	44	18	2	1	2	1	4	2	4	3	3	5	3	4	3	5	4	3	3
155	26	44	18	2	1	2	1	5	5	2	5	6	3	5	5	5	3	5	4	5
156	26	44	18	2	1	2	1	6	5	2	3	3	2	5	5	6	2	6	5	6
157	27	19	32	1	3	3	3	1	6	6	3	6	5	6	6	3	6	5	5	3
158	27	19	32	1	3	3	3	2	7	1	7	7	1	7	7	7	7	7	7	7
159	27	19	32	1	3	3	3	3	7	7	7	7	1	7	7	7	7	7	7	7
160	27	19	32	1	3	3	3	4	6	6	6	7	7	7	7	7	6	6	2	2
161	27	19	32	1	3	3	3	5	1	6	3	7	7	2	2	2	6	5	6	5
162	27	19	32	1	3	3	3	6	7	2	7	7	1	7	7	7	7	4	7	7
163	28	39	50	1	2	3	2	1	4	5	6	6	5	6	4	6	6	5	5	5
164	28	39	50	1	2	3	2	2	6	3	6	6	5	6	6	6	6	6	6	6
165	28	39	50	1	2	3	2	3	4	3	5	6	5	6	5	7	6	6	6	6

OBS	SUB	REFLC	AGE	SEX	SKNCC	HARCC	NATION	LAMP	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
166	28	39	50	1	2	3	2	4	2	6	2	2	5	2	1	2	3	3	2	2
167	28	39	50	1	2	3	2	5	3	5	5	5	4	5	5	6	6	5	5	5
168	28	39	50	1	2	3	2	6	4	3	4	3	4	4	5	5	4	5	5	6
169	29	13	25	1	3	3	3	1	7	1	7	7	7	7	7	7	7	7	7	7
170	29	13	25	1	3	3	3	2	5	2	7	7	7	7	7	6	6	6	7	7
171	29	13	25	1	3	3	3	3	5	5	4	4	4	5	5	5	5	6	5	6
172	29	13	25	1	3	3	3	4	2	5	3	3	3	2	4	2	4	4	3	3
173	29	13	25	1	3	3	3	5	2	5	4	4	4	3	3	3	7	4	4	4
174	29	13	25	1	3	3	3	6	6	2	6	7	6	7	6	6	6	6	6	6
175	30	28	21	1	1	2	1	1	6	5	5	5	6	6	5	6	6	4	5	5
176	30	28	21	1	1	2	1	2	3	1	4	3	5	3	4	4	3	3	3	3
177	30	28	21	1	1	2	1	3	6	6	5	6	4	5	4	6	5	6	6	7
178	30	28	21	1	1	2	1	4	1	7	3	1	7	2	1	1	7	1	1	1
179	30	28	21	1	1	2	1	5	6	7	5	5	7	5	5	5	7	4	7	5
180	30	28	21	1	1	2	1	6	3	1	4	3	7	4	4	5	5	4	3	4
181	31	44	24	2	1	2	1	1	6	1	3	5	1	5	5	4	1	5	5	6
182	31	44	24	2	1	2	1	2	1	5	1	1	6	2	2	2	7	1	2	1
183	31	44	24	2	1	2	1	3	3	3	4	4	1	5	4	5	1	6	5	5
184	31	44	24	2	1	2	1	4	1	3	1	1	7	1	1	2	7	1	1	1
185	31	44	24	2	1	2	1	5	1	6	2	1	7	1	1	3	7	1	1	1
186	31	44	24	2	1	2	1	6	4	3	5	5	3	4	3	3	5	4	4	3
187	32	35	24	1	1	1	1	1	6	6	6	5	5	6	5	7	6	6	6	7
188	32	35	24	1	1	1	1	2	6	6	6	6	6	7	5	5	5	5	5	6
189	32	35	24	1	1	1	1	3	6	6	7	7	6	7	5	7	7	7	7	7
190	32	35	24	1	1	1	1	4	6	5	6	6	6	6	5	3	3	4	6	6
191	32	35	24	1	1	1	1	5	7	5	7	7	7	7	5	5	6	5	6	6
192	32	35	24	1	1	1	1	6	7	6	7	6	6	6	6	6	7	6	6	6
193	33	29	24	1	3	3	1	1	7	5	7	7	6	6	5	7	6	5	6	7
194	33	29	24	1	3	3	1	2	7	1	7	7	6	7	7	7	7	7	7	7
195	33	29	24	1	3	3	1	3	6	2	5	6	4	7	6	7	6	7	6	7
196	33	29	24	1	3	3	1	4	5	3	1	1	3	1	1	2	6	1	3	1
197	33	29	24	1	3	3	1	5	5	4	6	5	6	6	5	6	6	6	6	5
198	33	29	24	1	3	3	1	6	6	2	6	6	5	6	4	6	5	4	6	5
199	34	21	27	1	3	3	1	1	6	6	6	6	6	6	6	6	6	6	6	6
200	34	21	27	1	3	3	1	2	6	2	6	6	6	6	6	6	6	6	6	6
201	34	21	27	1	3	3	1	3	6	2	6	6	6	6	6	6	6	6	6	6
202	34	21	27	1	3	3	1	4	6	6	6	4	6	6	6	1	6	6	6	6
203	34	21	27	1	3	3	1	5	6	5	6	6	6	6	6	6	6	6	6	6
204	34	21	27	1	3	3	1	6	6	2	6	6	6	6	6	6	6	6	6	6
205	35	37	27	1	2	3	2	1	7	7	6	6	6	6	6	6	6	6	6	6
206	35	37	27	1	2	3	2	2	6	6	6	6	6	6	6	6	6	6	6	6
207	35	37	27	1	2	3	2	3	6	6	6	6	6	6	6	6	6	6	6	6
208	35	37	27	1	2	3	2	4	1	1	1	1	1	1	1	1	1	1	1	1
209	35	37	27	1	2	3	2	5	2	2	2	2	2	2	2	2	3	2	2	2
210	35	37	27	1	2	3	2	6	5	5	5	5	5	5	5	5	5	5	5	5
211	36	31	26	2	2	2	2	1	3	4	3	4	5	4	4	4	4	4	4	4
212	36	31	26	2	2	2	2	2	3	3	3	4	4	4	4	4	3	4	4	4
213	36	31	26	2	2	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4
214	36	31	26	2	2	2	2	4	1	2	1	1	2	1	1	1	2	1	1	1
215	36	31	26	2	2	2	2	5	2	3	2	3	4	2	2	3	2	3	2	3
216	36	31	26	2	2	2	2	6	2	4	2	2	3	2	2	3	3	3	2	3
217	37	31	26	1	2	3	2	1	5	5	5	5	5	5	4	5	5	5	5	5
218	37	31	26	1	2	3	2	2	5	5	5	5	4	5	4	5	5	5	5	5
219	37	31	26	1	2	3	2	3	5	4	4	4	4	5	4	5	4	5	5	5
220	37	31	26	1	2	3	2	4	3	3	3	3	3	3	3	3	3	3	3	3

OBS	SUP	PEFLC	AGE	SEX	SKNCC	HARCI	NATION	LAMP	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
221	37	31	26	1	2	3	2	5	3	3	3	3	4	3	4	4	4	4	3	4
222	37	31	26	1	2	3	2	6	4	4	4	4	4	5	4	5	5	5	5	5
223	38	32	22	1	1	2	1	1	5	3	5	5	4	5	5	4	4	5	5	5
224	38	32	22	1	1	2	1	2	5	3	5	5	4	5	4	4	4	4	4	5
225	38	32	22	1	1	2	1	3	6	4	5	5	4	5	5	4	4	5	5	6
226	38	32	22	1	1	2	1	4	5	4	5	5	6	5	5	4	4	5	5	5
227	38	32	22	1	1	2	1	5	4	4	5	5	5	5	4	4	5	5	5	5
228	38	32	22	1	1	2	1	6	5	3	5	5	5	5	5	5	4	5	5	5
229	39	23	24	1	3	3	1	1	7	6	6	7	6	6	6	6	7	7	7	7
230	39	23	24	1	3	3	1	2	6	5	5	7	7	7	6	7	7	7	7	7
231	39	23	24	1	3	3	1	3	5	3	4	4	5	4	5	3	6	3	3	3
232	39	23	24	1	3	3	1	4	3	5	3	4	2	3	4	3	3	3	4	3
233	39	23	24	1	3	3	1	5	5	5	5	5	5	5	5	4	6	6	5	6
234	39	23	24	1	3	3	1	6	5	4	5	5	6	4	5	4	6	6	6	6
235	40	22	34	1	3	3	1	1	6	5	5	5	4	5	5	6	7	4	5	5
236	40	22	34	1	3	3	1	2	6	2	6	6	2	6	5	6	6	6	6	6
237	40	22	34	1	3	3	1	3	5	5	4	4	4	5	5	5	6	5	5	5
238	40	22	34	1	3	3	1	4	6	2	6	6	6	6	6	4	5	5	6	6
239	40	22	34	1	3	3	1	5	6	4	4	4	5	5	4	5	5	4	4	4
240	40	22	34	1	3	3	1	6	6	5	4	4	4	4	5	5	6	5	5	5
241	41	24	26	1	3	3	1	1	3	3	3	4	5	5	4	5	6	5	4	4
242	41	24	26	1	3	3	1	2	6	2	6	7	5	6	6	3	7	6	6	6
243	41	24	26	1	3	3	1	3	5	5	4	5	4	4	4	4	6	5	4	5
244	41	24	26	1	3	3	1	4	2	3	2	1	1	2	1	1	2	2	2	2
245	41	24	26	1	3	3	1	5	6	3	5	4	3	5	5	5	5	6	4	6
246	41	24	26	1	3	3	1	6	6	2	4	5	2	3	3	5	3	4	3	3
247	42	38	24	1	2	3	2	1	7	7	6	4	5	6	6	5	6	6	7	7
248	42	38	24	1	2	3	2	2	6	5	4	3	5	5	5	7	7	6	6	6
249	42	38	24	1	2	3	2	3	5	4	4	3	3	3	4	3	3	4	4	4
250	42	38	24	1	2	3	2	4	1	1	4	4	3	1	1	1	7	4	2	3
251	42	38	24	1	2	3	2	5	4	5	4	3	1	4	4	3	3	3	4	5
252	42	38	24	1	2	3	2	6	3	5	5	5	4	5	5	5	6	5	6	5
253	43	25	22	2	2	3	2	1	5	6	5	5	5	6	6	6	6	6	6	6
254	43	25	22	2	2	3	2	2	4	4	4	4	4	4	4	4	4	4	4	4
255	43	25	22	2	2	3	2	3	3	3	4	4	4	4	4	5	5	5	5	5
256	43	25	22	2	2	3	2	4	1	1	1	1	1	1	1	1	2	1	1	1
257	43	25	22	2	2	3	2	5	3	5	2	3	4	3	4	3	3	3	3	4
258	43	25	22	2	2	3	2	6	5	4	4	5	5	5	5	5	5	6	6	6
259	44	30	29	1	2	3	2	1	7	7	6	6	6	5	7	4	5	5	6	6
260	44	30	29	1	2	3	2	2	6	4	4	5	5	5	6	7	7	5	6	7
261	44	30	29	1	2	3	2	3	3	2	3	2	2	3	3	3	6	2	3	5
262	44	30	29	1	2	3	2	4	2	2	2	2	1	1	1	1	5	1	2	2
263	44	30	29	1	2	3	2	5	6	7	6	6	6	6	5	3	3	5	6	5
264	44	30	29	1	2	3	2	6	4	3	3	2	2	3	3	3	6	3	3	3
265	45	34	28	1	1	3	1	1	6	6	6	7	7	5	5	3	7	6	3	5
266	45	34	28	1	1	3	1	2	4	3	4	4	4	5	4	6	2	4	6	5
267	45	34	28	1	1	3	1	3	5	6	5	6	6	5	4	4	5	6	3	6
268	45	34	28	1	1	3	1	4	2	5	2	1	7	1	1	1	7	1	3	1
269	45	34	28	1	1	3	1	5	3	7	4	4	7	3	4	2	7	5	3	4
270	45	34	28	1	1	3	1	6	4	4	4	4	1	5	4	5	2	4	6	6
271	46	26	20	1	3	3	3	1	3	4	2	3	3	3	4	2	2	4	3	3
272	46	26	20	1	3	3	3	2	4	5	5	4	5	5	4	3	4	3	4	5
273	46	26	20	1	3	3	3	3	5	3	4	3	5	5	4	5	3	4	3	5
274	46	26	20	1	3	3	3	4	4	5	4	3	1	5	2	2	6	5	4	3
275	46	26	20	1	3	3	3	5	4	2	5	4	1	3	4	3	3	4	4	3

CBS	SUB	REFLC	AGE	SEX	SKNCO	FARCO	NATION	LAMP	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
276	46	26	20	1	3	3	3	6	4	3	4	5	5	3	4	3	4	5	2	3
277	47	44	27	2	2	2	2	1	6	6	4	5	5	6	5	6	6	5	5	5
278	47	44	27	2	2	2	2	2	4	3	5	4	5	5	5	5	6	4	5	6
279	47	44	27	2	2	2	2	3	2	2	1	1	4	3	3	4	4	4	4	1
280	47	44	27	2	2	2	2	4	2	2	2	1	2	1	3	1	3	2	3	3
281	47	44	27	2	2	2	2	5	4	3	4	5	4	6	5	4	5	5	4	5
282	47	44	27	2	2	2	2	6	4	3	3	4	3	3	4	3	4	3	4	4
283	48	35	27	1	2	3	2	1	4	3	4	4	4	3	4	3	3	4	3	3
284	48	35	27	1	2	3	2	2	3	3	4	4	3	3	3	3	3	4	3	3
285	48	35	27	1	2	3	2	3	4	3	4	4	5	4	5	3	4	4	5	4
286	48	35	27	1	2	3	2	4	2	6	2	2	6	2	2	2	3	3	3	2
287	48	35	27	1	2	3	2	5	2	5	2	3	5	3	3	3	3	3	3	3
288	48	35	27	1	2	3	2	6	3	5	5	4	5	3	3	3	3	3	3	3
289	49	42	26	2	2	3	2	1	7	6	7	7	6	7	7	7	6	7	6	7
290	49	42	26	2	2	3	2	2	4	3	4	4	5	5	4	5	5	4	5	6
291	49	42	26	2	2	3	2	3	5	4	4	5	5	5	4	5	5	4	5	5
292	49	42	26	2	2	3	2	4	2	6	2	2	1	2	3	1	3	1	2	2
293	49	42	26	2	2	3	2	5	6	5	5	5	4	4	4	3	5	5	5	5
294	49	42	26	2	2	3	2	6	5	5	5	5	4	5	4	3	5	3	4	5
295	50	25	38	1	3	3	1	1	3	5	2	2	2	2	2	2	5	2	2	2
296	50	25	38	1	3	3	1	2	6	3	3	3	3	3	3	3	5	3	3	3
297	50	25	38	1	3	3	1	3	6	5	3	3	3	3	3	3	6	3	3	3
298	50	25	38	1	3	3	1	4	7	4	6	6	6	6	6	5	6	6	6	6
299	50	25	38	1	3	3	1	5	6	5	3	4	2	3	4	3	6	3	3	3
300	50	25	38	1	3	3	1	6	6	3	5	5	5	5	5	5	6	5	6	6
301	51	25	26	2	2	3	2	1	7	6	7	7	4	7	7	7	7	7	7	7
302	51	25	26	2	2	3	2	2	5	4	5	5	5	5	5	5	6	5	5	5
303	51	25	26	2	2	3	2	3	4	6	4	4	4	4	4	4	4	4	5	5
304	51	25	26	2	2	3	2	4	1	2	1	1	7	1	1	1	2	1	1	1
305	51	25	26	2	2	3	2	5	2	6	1	1	5	2	2	2	5	2	2	2
306	51	25	26	2	2	3	2	6	6	3	5	6	5	6	5	5	5	6	6	6
307	52	34	29	2	2	3	2	1	5	5	5	6	6	6	6	5	6	6	6	6
308	52	34	29	2	2	3	2	2	5	6	6	6	7	7	6	6	6	4	4	7
309	52	34	29	2	2	3	2	3	6	6	6	6	6	6	5	4	6	4	4	6
310	52	34	29	2	2	3	2	4	2	1	1	1	1	1	1	1	3	2	2	1
311	52	34	29	2	2	3	2	5	4	5	3	3	4	4	4	4	4	4	4	4
312	52	34	29	2	2	3	2	6	4	4	4	6	6	6	6	6	6	6	6	6
313	53	33	23	2	2	2	2	1	5	6	5	5	6	5	5	6	6	6	5	6
314	53	33	23	2	2	2	2	2	7	7	7	7	6	7	7	7	6	7	7	7
315	53	33	23	2	2	2	2	3	7	6	7	7	6	7	6	7	6	7	7	7
316	53	33	23	2	2	2	2	4	1	2	2	2	2	1	1	1	3	2	2	1
317	53	33	23	2	2	2	2	5	6	6	5	5	4	5	5	5	5	5	5	5
318	53	33	23	2	2	2	2	6	4	5	4	4	4	4	4	4	4	5	4	5
319	54	47	19	2	1	2	1	1	7	6	7	7	6	7	7	6	6	7	7	7
320	54	47	19	2	1	2	1	2	6	2	3	4	4	5	4	3	3	4	6	7
321	54	47	19	2	1	2	1	3	5	5	4	4	4	3	3	3	5	3	3	3
322	54	47	19	2	1	2	1	4	1	5	1	1	1	1	1	1	1	1	1	1
323	54	47	19	2	1	2	1	5	4	5	5	5	4	6	6	6	6	6	7	7
324	54	47	19	2	1	2	1	6	6	2	3	3	3	5	5	5	6	5	6	6
325	55	47	24	2	1	1	1	1	6	5	5	5	5	5	4	5	5	5	6	6
326	55	47	24	2	1	1	1	2	4	3	4	4	4	4	4	3	4	4	4	3
327	55	47	24	2	1	1	1	3	4	3	3	4	3	3	4	5	5	5	4	4
328	55	47	24	2	1	1	1	4	3	5	3	3	6	3	3	2	6	2	3	3
329	55	47	24	2	1	1	1	5	6	6	6	6	6	6	5	3	6	5	6	7
330	55	47	24	2	1	1	1	6	4	3	4	4	3	4	4	5	3	4	3	5

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   7

12:21 THURSDAY, FEBRUARY 12, 1981

OBS	SUB	REFLC	AGE	SEX	SKNCL	HARCC	NATION	LAMP	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
331	56	19	17	2	3	3	3	1	6	6	6	6	6	6	6	6	6	6	7	7
332	56	19	17	2	3	3	3	2	6	4	6	6	6	6	7	7	3	6	6	6
333	56	19	17	2	3	3	3	3	6	4	5	5	6	6	6	5	4	5	5	6
334	56	19	17	2	3	3	3	4	1	2	2	1	2	2	2	2	2	2	2	2
335	56	19	17	2	3	3	3	5	4	4	4	4	3	2	4	3	2	4	3	3
336	56	19	17	2	3	3	3	6	7	7	7	7	7	7	7	7	7	7	7	7
337	57	43	18	2	1	2	1	1	7	6	5	7	4	5	5	3	5	6	7	5
338	57	43	18	2	1	2	1	2	5	4	5	4	4	5	4	3	5	5	5	6
339	57	43	18	2	1	2	1	3	5	5	4	6	7	5	5	4	5	6	5	5
340	57	43	18	2	1	2	1	4	3	5	3	3	3	2	3	1	2	1	1	1
341	57	43	18	2	1	2	1	5	7	6	7	5	7	6	7	5	5	5	7	5
342	57	43	18	2	1	2	1	6	7	1	7	6	4	5	5	6	5	6	6	6
343	58	38	26	2	2	3	2	1	5	3	4	5	4	5	4	5	5	5	5	6
344	58	38	26	2	2	3	2	2	5	3	4	5	3	4	4	6	5	5	6	6
345	58	38	26	2	2	3	2	3	5	4	5	5	4	5	4	6	6	6	5	6
346	58	38	26	2	2	3	2	4	2	6	1	1	6	1	1	1	4	4	1	1
347	58	38	26	2	2	3	2	5	5	5	6	5	4	6	5	5	5	6	5	6
348	58	38	26	2	2	3	2	6	3	2	3	2	2	2	2	6	6	5	3	3
349	59	29	20	2	1	4	1	1	5	4	4	6	3	5	4	5	6	6	6	6
350	59	29	20	2	1	4	1	2	6	2	5	4	4	5	5	5	6	6	6	7
351	59	29	20	2	1	4	1	3	5	4	5	5	6	6	6	4	6	5	6	5
352	59	29	20	2	1	4	1	4	3	3	2	1	3	3	1	3	4	3	4	2
353	59	29	20	2	1	4	1	5	3	4	3	4	2	5	4	2	5	4	4	5
354	59	29	20	2	1	4	1	6	4	4	4	3	4	4	4	5	4	4	4	3
355	60	28	18	2	3	3	3	1	5	5	4	5	6	5	5	6	6	5	6	5
356	60	28	18	2	3	3	3	2	4	3	4	3	4	3	3	4	5	4	5	4
357	60	28	18	2	3	3	3	3	4	4	4	5	4	5	4	4	6	5	5	4
358	60	28	18	2	3	3	3	4	1	2	1	1	1	1	1	1	2	1	1	1
359	60	28	18	2	3	3	3	5	2	4	2	1	1	2	2	1	3	2	3	2
360	60	28	18	2	3	3	3	6	3	3	2	2	3	2	2	2	4	3	3	3

LAMPS FOR LIGHTING PEOPLE

by

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ABSTRACT

This report describes the effect of light source color on facial appearance and user impressions among three racial groups. The objective of this study was to find out the subjective acceptability of light source colors for lighting people.

The light sources used were incanscent, fluorescent cool white and warm white), metal halide, HPS and SOX. Each subject was exposed to the six light sources one at a time and evaluated the light source color on a set of twelve semantic scales. The evaluation was based on his facial appearance by watching himself through a mirrow in front. After perfroming the tasks, the subject was asked to give hia racial informations such as native country and skin color.

Sixty subjects participated with 31 of white, 6 of black and 23 of yellow. The data was factor analyzed and two factors, named "evaluation" and "color", emerged as a result of the analysis. Further analysis showed that there were effects of light source color and racial difference on the subjective acceptability. The HPS and SOX were less preferred than the other light sources. HPS color was better accepted by the white race than the yellow and black races. The yellow race had the lowest acceptability on SOX color.

Further research of light source acceptability with deeper insights into differences among groupings of individuals and among varying cultures and national backgrounds is encouraged.