Design Research Seminar

on

Emotion Based on Light and Color

Guided by Prof.Girish Dalvi

Submitted by Vinoth VV
126130005

- **Introduction**
- **Light and color**
- **Emotion**
- **Connecting emotion to light and color**
- **Literature Research**
- **Design of experiment**
- **Approach**
- **Questionnaire**
- **Experiment protocol**
- **Analysis Protocol**
- **Pilot Test**
- **Actual Experiment**
- **Collected Data**
- **Analysis**
- **Descriptive analysis results**
- **Box plot**
- **Conclusion**

Introduction

Initial idea of the project was to understand the emotions based on light and colour using some wearable device, which will help the designer and the lay man to set the mood and to take the informed decisions. But due to the time constrain the project this had to be converted to a research project where the said things are understood and proved using experiments.

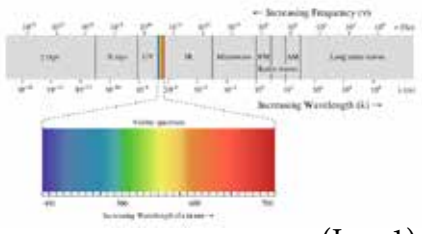
The whole process of the experiment introduced me to the research process starting from the literature review, designing questionnaire & experiment, defining protocol, Analysing the data, both qualitative and quantitative, descriptive statistics, box plot, finding co-relation and so on.

From the understanding from the literature, there had been lot of work done around the colour and emotion, but less is been explored on the different saturation level of coloured lights. Due to time constrain the research if restrained to only two colours and analysis based on descriptive statistics and box plot.

Light and Color

Light is the Natural agent that simulates sight and makes thing visible.
Visible light is an electromagnetic radiation which is visible to human eyes, that is in the range of 400x10-9 to 700x10-9. (Img.1)
Light is a form of energy, and can be measured in energy units (joules, calories) or in quantum units (quanta, einsteins).
Light can be measured subjectively, based on the brightness seen by the human eye. Units include candles, lumens, footcandles and lux.

Lighting or illumination is deliberate use of light to achieve practical and aesthetic effect.



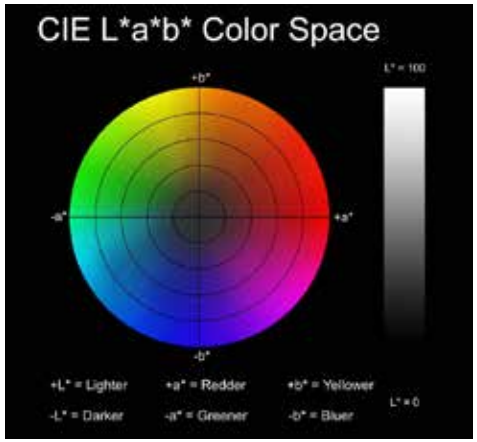
(Img.1)

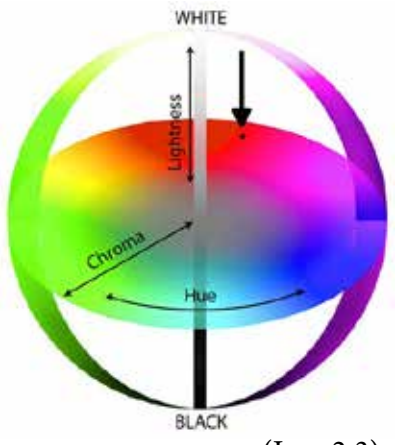
Colour is the way we distinguish different wavelengths of light. The subject of colour is a rather complicated one, as it involves both the spectral characteristics of the light itself, the spectral reflectance of the illuminated surface as well as the perception of the observer.

Mixing light of different colours When coloured light beams are mixed, the result will always be brighter than the individual colours, and if the right colours are mixed in the right intensities, the result will be white light. This is known as additive colour mixing. The three basic light colours are red, green and violet-blue. These are called the primary colours and additive mixing of these colours will produce all other light colours, including white.

So:
red + green = yellow
red + violet-blue = magenta (purplish red)
green + violet-blue = cyan (sky blue)
red + green + violet-blue = white
The colours yellow, magenta and cyan are called secondary or complementary colours as they are made up of combinations of primary colours.

Subtractive colour mixing occurs for example when coloured paints are mixed on a palette. This always gives a result darker than the original colours and if the right colours are mixed in the right proportions, the result will be black. Subtractive colour mixing of any of the primary light colours will always produce black but subtractive colour mixing of the secondary light colours can produce all other visible colours.
So:
yellow + magenta = red
yellow + cyan = green
magenta + cyan = violet-blue
yellow + magenta + cyan = black





(Img.2,3)

Most models of perceived color contain three components: hue,saturation, and lightness. In the CIE L*a*b* model, color is modelled as a sphere, with lightness comprising the linear transform from white to black, and hues modeled as opposing pairs, with saturation being the distance from the lightness axis. (Img .2,3)

Some general terms in colour theory;
Colourfulness, chroma, purity, or saturation: how “intense” or “concentrated” a color is with respect to the purity of color.
Hue: the colour’s direction from white, for example in a color wheel or chromaticity diagram.
Shade: a colour made darker by adding black.
Tint: a colour made lighter by adding white.
Value, brightness, lightness, or luminosity: how light or dark a colour is.

Emotion:

Affect is a generic term that covers a broad range of feelings that people experience. It encompasses both emotions and moods.
Emotions are intense feelings that are directed at someone or something.
Moods are feelings that tend to be less intense than emotions and that often (though not always) lack a contextual stimulus.

The major theories of motivation can be grouped into three main categories: physiological, neurological, and cognitive. Physiological theories suggest that responses within the body are responsible for emotions. Neurological theories propose that activity within the brain leads to emotional responses. And cognitive theories argue that thoughts and other mental activity play an essential role in the formation of emotions.

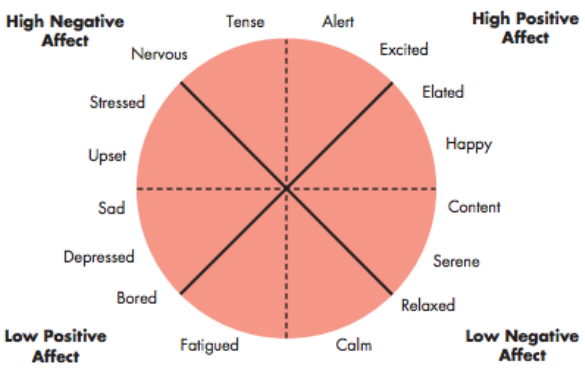
There are many theories of emotion but four of them are perhaps the most commonly discussed. They are called the James-Lange theory, Cannon-Bard theory(physiological theory of emotion), Schachter-Singer theory(Cognitive theory of emotion), and Opponent Process theory of emotion.

- Emotion is caused by specific event very brief in duration (seconds or minutes) Specific and numerous in nature (many specific emotions such as anger, fear, sadness, happiness, disgust, surprise). It is usually accompanied by distinct facial expressions and it is action-oriented in nature.

- In mood Cause is often general and unclear, Last longer than emotions (hour or days) More general (two main dimensions—positive affect and negative affect that are composed of multiple specific emotions) ,Generally not indicated by distinct expressions and it is cognitive in nature.

Enough researchers have agreed on six essentially universal emotions along a continuum: happiness—surprise—fear—sadness—anger—disgust.

Some sources of emotions and mood are personality , day and time,weather, stress, social activities, sleep, exercise,age gender and external constraints like organisational influenza and cultural influenza.



(Img.4)

Connecting Emotions to color and light:

The literature research is based on certain domains, first a part from history with Goethe and his color theory, then a more global overview of color-meaning from Cluadia Cortes,
Followed by a user test conducted by Naz Kaya, the view of a Shirley Willett, a commercial product Color Wheel Pro mostly for designing websites.

Emotional Association based on Naz kaya's experiment.

Principle Hues	***Positive***	***Negative***	***No emotion***
Red	63 (64.3)	32 (32.7)	3 (3.1)
Yellow	92 (93.9)	6 (6.1)	0
Green	94 (95.9)	0	4 (4.1)
Blue	78 (79.6)	17 (17.3)	3 (3.1)
Purple	63 (64.3)	32 (32.7)	3 (3.1)
Total	390 (79.6)	87 (17.8)	13 (2.6)
Intermediate Hues			
Yellow-red	73 (74.5)	18 (18.4)	7 (7.1)
Green-yellow	24 (24.5)	70 (71.4)	4 (4.1)
Blue-green	80 (81.6)	15 (15.3)	3 (3.1)
Purple-blue	64 (65.3)	30 (30.6)	4 (4.1)
Red-purple	75 (76.5)	15 (15.3)	8 (8.2)
Total	316 (64.5)	148 (30.2)	26 (5.3)

Note. The cell numbers indicate frequencies; the percentages are listed in parentheses.

(Img.5)

The relation of the emotion with respect to colour and light is explored in many of the research and theories as mentioned above, but none of them went in to the saturation level of the colour. And the theories overall states the difficulty in interpreting things about colour.

The data gathered from this literature research is usable in the proof of concept. The amount of color meanings is deep and wide which makes it hard to work with. The most valuable part is the research conducted by Naz Kaya, it provides a good view on what meaning colors can have. Shirley Willets model (Img.5) however shows a compact model giving clear answers to what a color can be. And the last model by Yan Xue shows a very simple way of how to interpret the three basic colors RGB.

Also according to Flynn's theory it was that as you change the lighting stimulus along these dimensions, you will produce changes in the human response in terms of the impressions that are reinforced

Before mapping of emotion to colour, we need to define what emotion are we going to address in here, Based on the different emotions addressed before decided to primarily focus on the emotion of joy and distress, which are on the opposite sides of the wheel. Approach:

To understand and prove the emotional response of human we have to conduct experiments under controlled stimuli and use qualitative and quantitative methods to understand the emotion of subjects psychologically and physiologically.

Approach and details of the experiment is explained below;

Experiment setup:
To conduct the experiment I wanted a closed interior with neural background. Fortunately one of my colleagues(Deepanwitha) P2 project was on the similar line, The setup she designed, was a closed space using bamboo, and multi coloured LED light is used to create a immersive experience.where people can sit inside and relax. which happened to be a perfect match for my requirement and I used the same for my experiment.

Literature Research:

Cognitive & Emotional Responses to Lighting:

This is your Brain on Lighting

By Written by: Robert G. Davis, PhD, FIES
Director, Product Innovation & Marketing

The author talks about the deeper understanding of the broad range of human responses to the lighting stimulus thorough three threads of works by Flynn gives us a thread of a stimulus described by lighting modes, linked to the human response of subjective impressions of environments. Kaplan and Kaplan give us a thread of a preference response that appears to be linked to environmental stimuli that are both coherent and complex ñ we can make sense of them and they are interesting enough to elicit our involvement. And Russell gives us a thread of primary emotional responses to stimuli that apparently drive our assessments of any environment, as we integrate a response along the dimensions of pleasantness and arousal.

Opinion:

The paper gives an idea of how the lighting modes and environment affects the cognitive and emotional aspects of people and the relation through flynn's concept of lighting psychology by which designers manipulate in creating the the environments they desire ñ bright/ dim, uniform / non-uniform, central/ perimeter, and warm / cool and asepcts of uniform and non uniform lighting. And in another thread stating Kaplan's concepts of environment preferences of humans and also coherence and complexity which determine the low/hihg familiar and low /hihg preferences.

In another thread the author talks about the Russell's concepts of emotional like arousal or pleasant and the control of an environment in response to stimulus like light and finally he talks about the unified design approach using all these threads.

Mapping emotion to color

Niels A. Nijdam
Human Media Interaction

The sensitive artificial listener (SAL) project is interested in ways to elicit emotions from humans. This paper tries to provide a method for generating colors to elicit a certain feelings calm, aggressive, energetic, happy etc.
and to find ëWhat color does an emotion have', by doiung literature research of Goethe, claudia cortes,Naz Kaya(TheMunsell color space),ColorWheel Pro,ShirleyWillett,Yan Xue(Philips ICat). Then the mapping of emotion to colors is been mapped in to 2de graph with Arousal and pleasure in xy axis and the output is analysed based on this.

Opinion:

The paper gives clear idea of different theories of color classification and the importance of Munshells color system in emotional analysis. Also the usage of Russels axes of pleasure and arousal. And by analysis it gives fast way finding the relation of color and emotion.

Relationship between color and emotion: a study of college students
Naz Kaya,Ph.D.Assistant Professor
HELEN H. EPPS, PH.D.Professor
College of Family and Consumer Sciences
The University of Georgia

Ninety-eight college students were asked to indicate their emotional responses to five principle hues (i.e., red, yellow, green, blue, purple), five intermediate hues (i.e., yellow-red, green-yellow, blue-green, purple-blue, and red-purple), and three achromatic colors (white, gray, and black) based on Munshells color system and the catogarization of hue, value and chrome and The color samples were prepared by using Freehand 10.0 software,

Participants were tested individually in an office space where they were seated

at a personal computer. Each color sample (10 cm _ 12 cm) was displayed in the middle of the computer screen one at a time on a neutral gray background, Munsell N/7.

Participants were asked, "What emotional response do you associate with this color? How does this color make you feel?" and "Why do you feel this way?" These questions were adapted from Boyatzis and Varghese (1994) and Hemphill (1996).

Data was analyzed using Statistical Package for Social Sciences (SPSS) software program. Descriptive statistics were used to summarize data.

Opinion:
The primary goal of this study was to examine the color-emotion associations among college students, referencing color stimuli from the standardized Munsell Color System. Based on Munsell Color System, the present study used five principle (i.e., red, yellow, green, blue, and purple) and five intermediate hues (i.e., yellow-red, green-yellow, blue-green, purple-blue, and red-purple), in addition to three achromatic colors (i.e., white, gray, and black). Overall, the participants' responses of color-emotion associations for the principle hues were positive (79.6%), compared with the positive responses for the intermediate hues (64.5%) and achromatic colors (29.2%).

Affective Computing
R. W. Picard
MIT Media Laboratory,; Perceptual Computing;

This paper presents the future of computers with emotion and discusses key issues in \affective computing," computing that relates to, arises from, or influences emotions. Models are suggested for computer recognition of human emotion, and new applications are presented for computer- assisted learning, perceptual information retrieval, arts and entertainment, and human health and inter-action. affective computing, coupled with new wearable computers, will also provide the ability to gather new data necessary for advances in emotion and cognition theory.

Damasio's idea is that there are certain features of stimuli in the world that we respond to emotionally frst, and which activate a corresponding set of feelings (and cognitive state) secondarily. Such emotions are \primary" and reside i the limbic system.

We cannot currently expect to measure cognitive influences; these depend on self-reports which are likely to be highly variable, and no one can read your mind (yet). How ever, we can measure physiological responses (facial expression,
and more, below) which often arise during expression of emotion.

The most common four appearing on these lists are: fear, anger, sadness, and joy. Plutchik [33] distinguished among eight basic emotions: fear, anger, sorrow, joy, disgust, acceptance, anticipation, and surprise.
Also the paper talks about the Limbic perception,Thinking and feeling axis, conversation with a computer and the sentic modulation of based on emotion, facila recognition, pattern recognition.

It also states the level of can/cannot perceive affect, can/cannot express affect.

Based on these the few affective computing scenarios where suggested and com related. Entertainment, expression, Film/video, Environment, aesthetic pleasure, Design and affective wearable computers.
Conclusion:

Design of experiment:

To understand and prove the emotional response of human we have to conduct experiments under controlled stimuli and use qualitative and quantitative methods to understand the emotion of subjects psychologically and physiologically.

Approach and details of the experiment is explained below;

Experiment setup:

To conduct the experiment we wanted a closed interior with neural background. Fortunately one of my colleagues (Deepanwitha) P2 project was on the similar line. The setup she designed, was a closed space using bamboo (Img.5) and multi coloured LED light is used to create a immersive experience, where people can sit inside and relax. which happened to be a perfect match for my requirement and I used the same for my experiment.

Stimuli:

Coloured light is the stimuli here. Color is perceived through different medium , of that light is one of the important factor in deciding human action when exposed to it.Also understanding the emotion based on light in different saturation level will help designers and common people to decide suitable colour to set in, the mood.

We have taken the red and green light which is perceived as opposite in the emotional colour wheel and stimulate a different set of moods,

Saturation of the coloured light is achieved through LED light with wireless intensity controller. This LED module is installed inside the closed experiment setup, Where it distributes light uniformly and the intensity is changed from outside.

To achieve the gradual change of situation the experiments is started with the normal cool white and is then moved on to Red in the low intensity range and then to Red in high intensity followed by Green of Low and High in intensity.

Approach:

Subject is exposed to each level of light for 2 mins and the psychological rameters are recorded during the experiment.

Intensity of the light is measured using the light intensity meter and the temperature of the colour is measures using the camera sensor with colour temperature measuring facility.

Parameters to be measured: What, Why, How, When?

Most of the experiments is done during the evening and the night hours,to avoid the external song and to get the feel of the different coloured light in its different intensity in its full form.

Based on the change in body parameters like arousal, heart rate, temperature, sweat in hands, etc with respect to emotion is measures using respective devices for the same.

Diastolic and systolic rate of the Blood pressure is measured using the Automatic Blood pressure monitor, before and after the experiment.

Body temperature is measured using the Non conduct IR thermometer, before and after the experiment.

Skin conductance ration is measured using the Galvanic skin response, which is connected to the persons fingers and the aurosel level of the subject is measured real time during the experiment.

Participants Profile:
Due to the lack of availability of the subjects and for the ease of analysis the total number of participants is limited to 16 Numbers.

It is split in to age group of 20-35 and 35-50 years.
Of that 5male and 5 female in 20-35 years of age.
3 males and 3 females in 35-50 years of age.

Qualitative questionnaire:

Pre Experiment Questions:

Name:
Age:
Gender:
Profession:

1.What is your favorite color?

2.What is your way of relaxing?

3.Do you have the habit of wearing watch?

4.Have you ever worried about the lighting in a room?

Post Experiment Questions:

5.Have you felt any change of mood during the experiment?

6.If then, at what point, have u noticed?
What color light you enjoyed while sitting inside?

7.what color lighting you think would ease you?

8.Have you ever felt agitated about shadow/dark?

9. Do you think color play a role while shopping?

Quantitative questionnaire:

Data Sheet

Date :

Name :
Age :
Gender :
Profession :

Exp. Start Time:
Exp. End Time:

Temperature:

Sl.No	Temperature Before/C	Temperature After/C	Note

Blood Pressure

Sl.No	Before the exp.: Systolic	Diastolic	After the exp.: Systolic	Diastolic

Galvanic Skin Response:

Sl.No	0 min	2min	4min	6min	8min

ECG (This is average value during different color intensities.)

Sl.No	Low intensity Red 0-2mins	High intensity Red 0-4mins	Low intensity Green 4-6mins	High intensity Green 6-8mins

Experiment Protocol
Experiment Protocol (Major Tasks)

1.Setting up the space and light for the experiment.
(Stimuli: colored Light, Parameters: light intensity measurement, temp measurement)

2.Getting subjects for experiment:
(Preparing them and Collecting qualitative (questioner) Data Pre experiment)

3.Measuring physiological data of the subject pre experiment:
(Parameters: Pulse, BP, Body Temperature, ECG)

4.Performing the experiment:
Changing the saturation light color in regular intervals and measuring data)

5.Again collecting the qualitative and quantitative data after experiment.

Repeat the step1

Experiment Protocol (Detailed Tasks)
Assuming that the appointment with the subjects is fixed.

1.Setting up the space and light for the experiment.

a. The specially designed closed space in the --studio is cleaned.
b. The temperature of the closed space is maintained at about 25c.
c. Set the mood of the space by adjusting the controller to neutral stimulus

2.Getting subjects for experiment:
(Preparing them and Collecting qualitative (questioner) Data Pre experiment)
a. The subject is shortly briefed about the experiment and
b. pre exp. Qualitative Questioner is given for them to fill up.
c. The subject is ushered in to the room and give a demo.

3. Measuring physiological data of the subject pre experiment:

(Data are to be recorded on the specified sheet)
a. Using the thermometer measure the body temperature of the subject.
b. strap the blood pressure monitor on the subjects hand and measure the readings. Measure the pulse rate using the same instrument.
d. measure the ECG
e. measure the skin conductance

4.Performing the experiment:

a. Once the subject is seated inside the room begin the experiment.
b. Change the color to red in its least saturation point.
c. Note down the intensity of the light and the temperature of the color at all pre set saturation levels in the sheet specified for that.
d. Note down the time, And at regular interval (20 sec (yet to be opti mized)) change the saturation of the light to 4 pre set levels. (have to figure out, how to measure the physiological parameters at each level)
e. After all the level is been reached the subject is informed via alarm.

5. Collecting the qualitative and quantitative data post experiment

a. The user is given the Post qualitative analysis questioner
b. The subject is subjected to post quantitative analysis and the parameters are measured and recorded.

6. Resetting the entire experiment

a. Bring the light to normal condition
b. Set the instruments back to the normal state.

Repeat the steps for each subject.

Analysis Protocol:

Basic details to classify the subject.

1,10. assuming that , their favorite dress color will give idea of their color choice/preferences and their shopping preferences.

2. This will give an idea weather they are practicing any relaxing methods or used to any.

3.The leisure time activity will five an idea of their sensitivity towards things and their mental perceptions(like attitude of sportsmen, imaginative world of fiction book reader,)

4,5.This direct question will clarify about the subjects change of mood

6,7,8. to understand the sensitivity of the subject about light and shadow

9. to find their easiness while measuring the physiological parameters.

interpretation of the pulse, temperature, skin conductance are done by descriptive statistics and box plot.

Pilot test:

Pilot test is conducted as per the protocol ,with a Research assistant as a subject in the institute, under the guidance of Prof.Girish Dalavi and the following are the feed backs after the test.

- I should follow a Proxy objective,while briefing the subject about the experiment.
- A pre talk is very necessary, to ease the subject.
- I should develop my interpersonal skills.
- Perceive the time exactly, before starting the experiment, Try to reduce the noise during the experiment,
- Check all the machine and devices and keep track of it.

Actual Experiment

With the feedback from the pilot test, changes were made and the setup is made ready for the actual experiment.

The protocol is followed and the experiment is repeated for the 14 subjects and the data is recorded both qualitatively and quantitatively.
(For the data sheet,check the attached excel.)

The qualitative and quantitative data collected during the experiment:

Analysis:

Before proceeding with the analysis protocol, the key elements of Analysis are explained below.

Nominal Data:

Nominal data is based on labelling, or "coding" information into categories. Generally, you creating names for the information based on characteristics. For example, you could classify hair colors into brunette, blonde, red or black. When entering your data, you assign a code, or number, to each category: For example, brunette = 1. This number is simply a shorthand that means "brunette."

Ordinal Data

Ordinal data describes the order of data based on a scale. In the scale, there's no way to tell the relative difference among the groups. For example, we can say a car arrived first, second or last, but we don't know the time between each car without more information. Scales are often used for attitudes — for example, satisfied to unsatisfied. Another type of data is interval data, where we know the difference between groups. An example is income: We know the exact difference between earning $20,000 and $30,000 per year

Descriptive statistics:

Descriptive statistics is used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of virtually every quantitative analysis of data.

Central Tendency: The central tendency of a distribution is an estimate of the "center" of a distribution of values. There are three major types of estimates of central tendency:
Mean,Median,Mode.

The **Mean** or average is probably the most commonly used method of describing central tendency. To compute the mean all you do is add up all the values and divide by the number of values.

The **Median** is the score found at the exact middle of the set of values. One way to compute the median is to list all scores in numerical order, and then locate the score in the center of the sample

The **mode** is the most frequently occurring value in the set of scores. To determine the mode, you might again order the scores as shown above, and then count each one. The most frequently occurring value is the mode,

Dispersion refers to the spread of the values around the central tendency. There are two common measures of dispersion, the range and the standard deviation.

The **range** is simply the highest value minus the lowest value.

The **Standard Deviation** is a more accurate and detailed estimate of dispersion. A measure of the dispersion of a set of data from its mean. The more spread apart the data, the higher the deviation. Standard deviation is calculated as the square root of variance.

Primarily the Descriptive statistics is been used in the analysis of the data.

Descriptive analysis based on the Quanlitative data is given below:

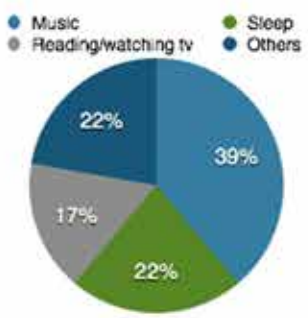
Of the 16 subject No. of people who relax through		
Total	16	100%
Music	7	43.75%
Sleep	4	25%
Reading/watching tv	3	18.74%
Others	4	25%

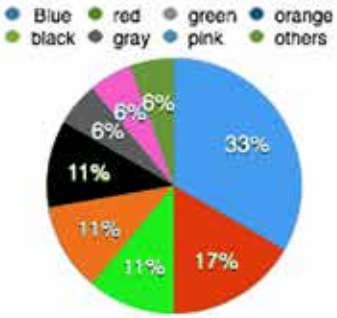
	Color Preference of the 16 subjects:
Blue	6
red	3
green	2
orange	2
black	2
gray	1
pink	1
others	1

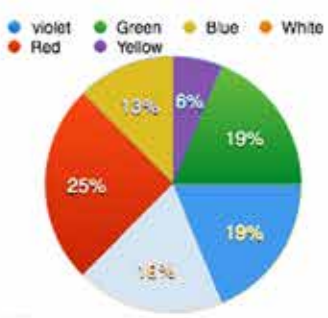
Color which can ease	
violet	1
Green	3
Blue	3
White	3
Red	4
Yellow	2

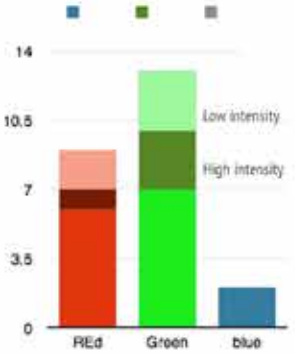
Color of liking	Total	low intensity	high intensity
REd	6	1	2
Green	7	3	3
blue	2		

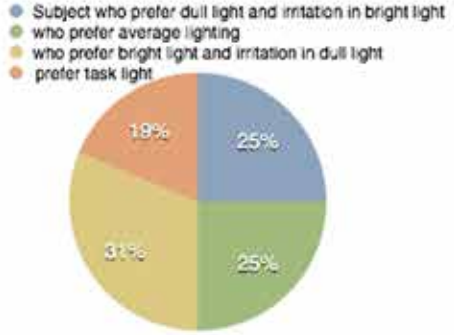
Subject who prefer dull light and irritation in bright light	4
who prefer average lighting	4
who prefer bright light and irritation in dull light	5
prefer task light	3

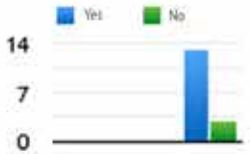


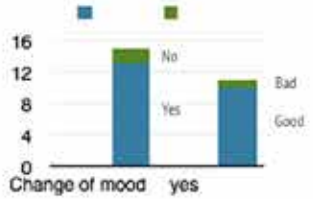


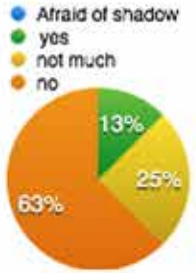


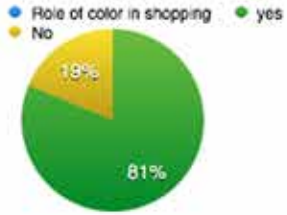












Worried about lighting		
	yes	no
	13	3

Change of mood	yes	No
	13	2

yes	good	bad
	10	1

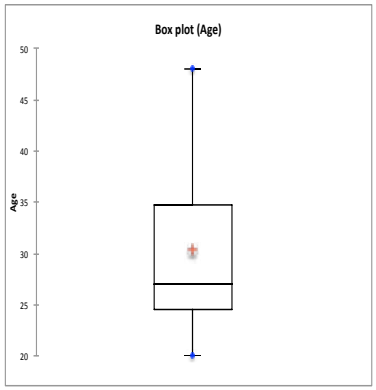
Afraid of shadow	
yes	2
not much	4
no	10

Role of color in shopping	
yes	13
No	3

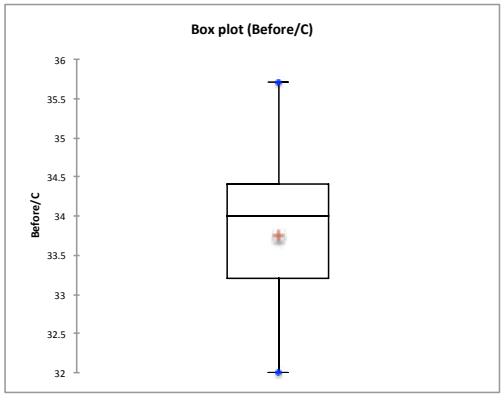
People who wear watch	Yes	no
	14	2

Box plot based on the Quantitative and qualitative data is given below:

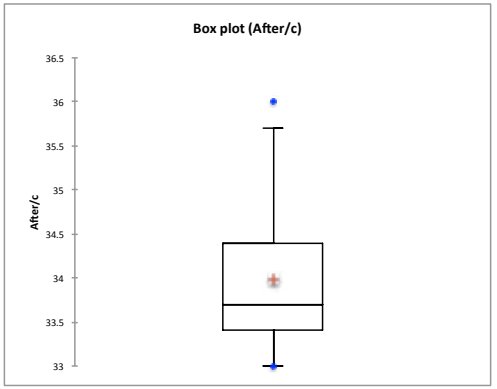
Statistic	Age
No. of observations	16
No. of missing values	0
Sum of weights	16
Minimum	20.000
Maximum	48.000
Freq. of minimum	1
Freq. of maximum	1
Range	28.000
1st Quartile	24.500
Median	27.000
3rd Quartile	34.750
Mean	30.375
Variance (n-1)	73.583
Standard deviation (n-1)	8.578
Skewness (Pearson)	0.817



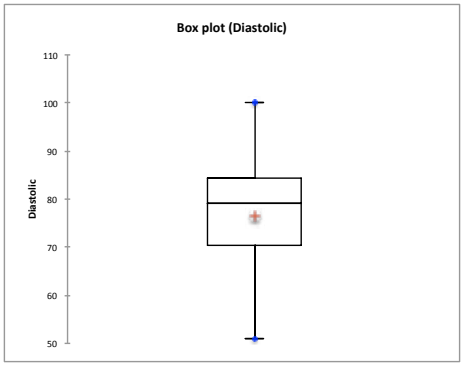
Statistic	Temp Before/C
No. of observations	16
No. of missing values	1
Sum of weights	15
Minimum	32.000
Maximum	35.700
Freq. of minimum	1
Freq. of maximum	1
Range	3.700
1st Quartile	33.200
Median	34.000
3rd Quartile	34.400
Mean	33.747
Variance (n-1)	0.927
Standard deviation (n-1)	0.963
Skewness (Pearson)	0.093



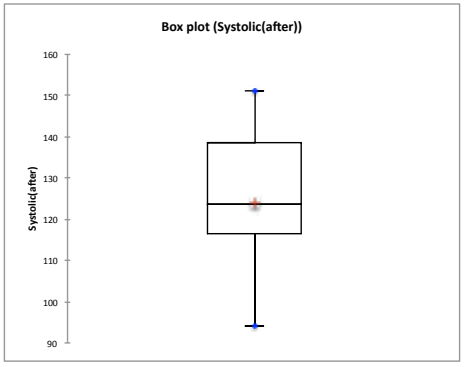
Statistic	After/c
No. of observations	16
No. of missing values	1
Sum of weights	15
Minimum	33.000
Maximum	36.000
Freq. of minimum	2
Freq. of maximum	1
Range	3.000
1st Quartile	33.400
Median	33.700
3rd Quartile	34.400
Mean	33.993
Variance (n-1)	0.856
Standard deviation (n-1)	0.925
Skewness (Pearson)	0.968



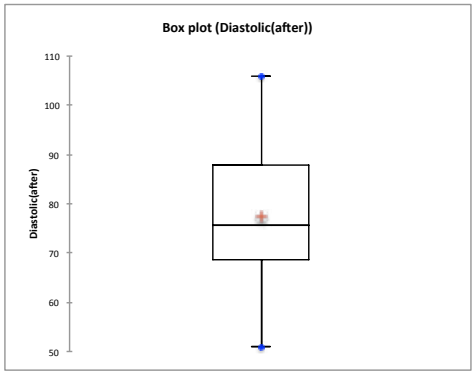
Statistic	Diastolic
No. of observations	16
No. of missing values	1
Sum of weights	15
Minimum	51.000
Maximum	100.000
Freq. of minimum	1
Freq. of maximum	1
Range	49.000
1st Quartile	70.500
Median	79.000
3rd Quartile	84.500
Mean	76.600
Variance (n-1)	187.400
Standard deviation (n-1)	13.689
Skewness (Pearson)	-0.243



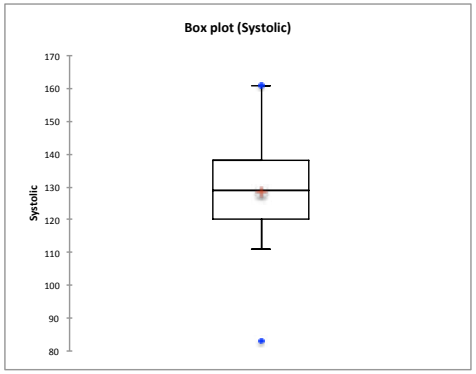
Statistic	Systolic(after)
No. of observations	16
No. of missing values	2
Sum of weights	14
Minimum	94.000
Maximum	151.000
Freq. of minimum	2
Freq. of maximum	1
Range	57.000
1st Quartile	116.500
Median	123.500
3rd Quartile	138.750
Mean	124.000
Variance (n-1)	302.615
Standard deviation (n-1)	17.396
Skewness (Pearson)	-0.300



Statistic	Diastolic(after)
No. of observations	16
No. of missing values	2
Sum of weights	14
Minimum	51.000
Maximum	106.000
Freq. of minimum	1
Freq. of maximum	1
Range	55.000
1st Quartile	68.500
Median	75.500
3rd Quartile	87.750
Mean	77.357
Variance (n-1)	275.170
Standard deviation (n-1)	16.588
Skewness (Pearson)	0.217



Statistic	Systolic
No. of observations	16
No. of missing values	1
Sum of weights	15
Minimum	83.000
Maximum	161.000
Freq. of minimum	1
Freq. of maximum	1
Range	78.000
1st Quartile	120.000
Median	129.000
3rd Quartile	138.000
Mean	128.467
Variance (n-1)	335.552
Standard deviation (n-1)	18.318
Skewness (Pearson)	-0.623



Conclusion:

Based on the descriptive statistics, Analysis and conclusion yet to be added.