COLOUR-EMOTION ASSOCIATIONS IN INTERIOR SPACES

A DISSERTATION
SUBMITTED TO THE DEPARTMENT OF INTERIOR ARCHITECTURE AND ENVIRONMENTAL DESIGN AND THE GRADUATE SCHOOL OF ECONOMICS AND SOCIAL SCIENCES OF İHSAN DOĞRAMACI BİLKENT UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN ART, DESIGN AND ARCHITECTURE

By
Elif Helvacıoğlu
July, 2011

To my parents

Oya & Kadir Helvacıoğlu

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Ph.D. in Art, Design, and Architecture.

Assist. Prof. Dr. Nilgün Olguntürk (Principal Advisor)

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Ph.D. in Art, Design, and Architecture.

Prof. Dr. Hakime Demirkan

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Ph.D. in Art, Design, and Architecture.

Assoc. Prof. Dr. Çiğdem Erbuğ

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Ph.D. in Art, Design, and Architecture.

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Ph.D. in Art, Design, and Architecture.

Assist. Prof. Dr. Güler Ufuk Demirbaş

Approved by the Graduate School of Fine Arts

Prof. Dr. Bülent Özgüç, Director of the Graduate School of Fine Arts

ABSTRACT

COLOUR-EMOTION ASSOCIATIONS IN INTERIOR SPACES

Elif Helvacıoğlu

Ph.D. in Art, Design and Architecture

Supervisor: Assist. Prof. Dr. Nilgün Olguntürk

July, 2011

Colour as an effective design tool influences people's emotions in interior spaces. Depending on the assumption that colour has an impact on human psychology, this study stresses the need for further studies that comprise colour and emotion association in interior space in order to provide healthier spaces for inhabitants. Emotional reactions to colour in a living room were investigated by using self report measure. Pure red, green and blue were chosen to be investigated as chromatic colours, whereas gray was the achromatic colour used as a control variable. The study was conducted at Bilkent University in Ankara, Turkey. Hundred and eighty people from various ages and academic departments participated in the study. Participants first watched a short video showing an overlook of a 3D model of a living room. Next, they were asked to match the distinct coloured living rooms with facial expressions of six basic emotions that covers anger, disgust, surprise, happiness, fear, sadness and in addition with neutral. The results of the study indicated that the most stated emotions associated for the room with red walls were disgust and happiness, while the least stated emotions were sadness, fear, anger, and surprise. Neutral and happiness were the most stated emotions for the room with green walls and anger, surprise, fear and sadness were the least stated ones. The most stated emotion associated for the room with blue walls was neutral, while the least stated emotions were anger and surprise. Neutral, disgust and sadness were the most stated emotions for the room with gray walls. Gender differences were not found in human emotional reactions to living rooms with different wall colours.

Keywords: Colour, Emotion, Associations, Interior Space.

ÖZET

İÇ MEKÂNLARDA RENK-DUYGU İLİŞKİLENDİRMELERİ

Elif Helvacıoğlu

Güzel Sanatlar, Tasarım ve Mimarlık Fakültesi

Doktora Çalışması

Danışman: Yrd. Doç. Dr. Nilgün Olguntürk

Temmuz, 2011

Renk, etkili bir tasarım aracı olarak, iç mekânlarda insanların duygularını etkiler. Rengin insan psikolojisine etkisi olduğu varsayımına dayanarak, bu çalışma insanlara daha sağlıklı mekânların sağlanması için, iç mekânlarda renk ve duygu ilişkisine dair çalışmaların geliştirilmesi gerekliliğini vurgular. Oturma odalarında renge verilen duygusal tepkiler özbildirim ölçekleri kullanılarak incelenmiştir. Çalışma için kromatik renkler olarak saf kırmızı, yeşil ve mavi seçilmiş iken, akromatik renk olarak gri kontrol değişkeni olarak kullanılmıştır. Çalışma Bilkent Üniversitesi, Ankara, Türkiye'de yürütülmüştür. Çalışmaya farklı yaş ve akademik bölümlerden olmak üzere yüz seksen kişi katılmıştır. Katılımcılara öncelikle 3 boyutlu olarak modellenmiş bir oturma odasına bakışı gösteren kısa bir video izlettirilmiştir. Daha sonra katılımcılardan farklı renklerdeki oturma odalarını kızgınlık, iğrenme, şaşkınlık, mutluluk, korku, üzüntü ve ek olarak nötr duygularını temsil eden yüz ifadeleri ile eşleştirmeleri istenmiştir. Çalışma sonuçlarına göre kırmızı duvarlı oda ile en çok eşleştirilen duygular iğrenme ve mutluluk iken, en az eşleştirilen duygular üzüntü, korku, kızgınlık ve şaşkınlıktır. Nötr ve mutluluk, yeşil duvarlı oda ile en çok eşleştirilirken, üzüntü, korku, kızgınlık ve şaşkınlık en az eşleştirilen duygulardır. Mavi duvarlı oda ile en çok eşleştirilen duygu nötr iken, en az eşleştirilen duygular kızgınlık ve şaşkınlıktır. Nötr, iğrenme ve üzüntü gri duvarlı oda ile en çok eşleştirilen duygulardır. Farklı duvar renklerindeki oturma odalarına verilen duygusal tepkilerde cinsiyete dayalı farklılıklar bulunmamıştır.

Anahtar Kelimeler: Renk, Duygu, İlişkilendirme, İç mekân.

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1. INTRODUCTION

Emotion is not a simple phenomenon. Although emotions are accentuated almost in all of the significant aspects of our lives, they are the least understood facet of human experience with their nature, causes and consequences (Ben-Ze'ev, 2001). Even describing emotion is an extremely complex task. People find it very difficult to articulate what they thought of an emotion to be. They mostly prefer to simply name some emotions like anger, happiness or sadness (Lupton, 1998). For those who try to give an explanation, emotion is often described as a feeling, with respect to the related phenomena such as a mood or a sentiment.

Colour affects every part of our lives. It has an impact on human being psychologically and physiologically. In addition, as a vital design element, colour has a strong relationship with emotion. These statements are supported by manifestations of colour not only in product design and marketing, but also in a variety of other fields like colour therapy, colour mediation and image consulting (Jin, Yu, Kim, Kim, & Chung, 2009).

Just as the phenomenon of colour and emotion relationship has been studied by consumer, marketing and advertising industry and by industrial design. For the

last twenty years, consumer and marketing researchers have been acknowledging the effective role of emotions in their field of research, and they have developed instrument for measuring emotional responses to advertisement and consumer experiences (Desmet, 2003). Due to the rapid development of technology, computer has also become a player in the field of measurement of emotions in the last ten years. In industrial design, measurement of emotional responses to products has become important in order to link the character of a product with marketing as an important selling point (Denton, McDonagh, Barker, & Wormald, 2004). The role of emotion is investigated for being equipped to create positive emotional responses in their users as people express affection, appreciation or admiration through products (Norman & Ortony, 2003), and to reduce possible negative emotion issues drawn by the design of a product (Norman, 2002; Norman, 2004).

Many colour research studies have been conducted on the relationship between human emotions and colour. These studies mostly focused on the human emotional reactions to a specific colour sample to form positive and negative connotations by using defined adjectives for mood tones and emotions. In these studies, participants simply match the adjectives with different colours without any reference to interior space (Terwogt & Hoeksma, 1995; Zentner, 2011; Gao & Xin, 2006; Manav, 2007; Pos & Green-Armytage, 2007).

Although there are numerous studies about both colour and emotion, there are not enough research handling the association of emotion and interior space, and also there is a lack of research combining both the concepts of colour and

emotion in the scope of interior design. It is important to design colour according to user's emotional reaction. When designing with colour, living environments should be analyzed as they may influence human reaction psychologically and physiologically: This approach is called 'emotionally ergonomic approach to design' (Jin et al., 2009). Therefore, this research is based on the argument that a conscious endeavour to demonstrate the strong relationship between colour and emotion specifically in interior environments should be developed.

1.1. Aim of the Study

Developing an argument in respect to colour and emotion associations within the framework of interior environment is necessary for understanding how colour in spaces influence inhabitants. It is vital for designers and interior architects to understand the effect of colour to reduce possible psychological threats and to create environments of emotional well-being.

The main objective of this study is to examine the relationship between two phenomenons of design *colour* and *emotion* in interior space. The research questions are:

- *How individual colours affect human emotional reactions in interior spaces*,
- *Do the human emotional reactions to individual colours differ in the same interior space?*
- *In what way colours' emotional influences are differing from each other?*

- *Do emotional reactions to individual colours in interior spaces differ with gender.*

1.2. The General Structure of the Dissertation

This section gives a brief overview regarding each chapter for further research. There is a review of the related literature in each section.

The second section of this dissertation explores the emotion phenomenon. The definition of emotion, its differences from the related phenomena such as feeling, mood and sentiment, and its importance on human psychology are stated. Additionally, the issue of emotion, its main components, process of occurring, influences on human beings, relation with culture and with human experiences are explained. Finally, the emotion measurement instruments are elaborated.

A review on colour phenomenon is presented in the third section. The definition of colour from different approaches and basic colour terminologies that includes hue, saturation and brightness and finally the affect of colour on human physiology and psychology are included.

The relation between colour and emotion is examined in the fourth chapter. The symbolic meanings of chromatic and neutral colours and review of the studies on colour emotion associations are given in detail to draw attention to employed methodologies and emotion measurement instruments.

The fifth section explores the place of colour in interior space in the framework of emotion is stated with some of the conducted studies in the field.

The sixth section describes the experiment with the aim, research questions and hypotheses. The methodology of the experiment is defined with the identification of the sample group, description of the setting, and the explanation of the experiment procedures in detail.

The findings of the experiment that are statistically analyzed and evaluated are given with the visual materials in the seventh section. In the eighth section the discussion of the findings follows in relation to previous studies relevant to the subject. The ninth chapter presents the major conclusions of the study and suggestions for further research.

Visual and written materials that are involved in the experiment and results of the statistical analysis which are not stated in the main body of the dissertation are included in the appendices.

"Let's not forget that the little emotions are the great captains of our lives and we obey them without realizing it."

~Vincent Van Gogh, 1889

2. EMOTION

2.1. About Emotion

2.1.1. Definition of Emotion

Emotions have a central role in peoples' lives and they are of interest to everyone. Everyday conversation is loaded with emotion language (Ben-Ze'ev, 2001). Poems, novels, movies, historical accounts, psychological studies, and philosophical discussions provide a host of information about emotions. Even though the term is used frequently, the question "what is an emotion?" rarely derives the same answer from different individuals, scientists or laymen (Scherer, 2005). It is a highly complex phenomenon that requires a careful and systematic analysis of its characteristics and components. The complexity of emotion is due to its great sensitivity to personal and contextual circumstances (Ben-Ze'ev, 2001). Additionally, as the field of emotion is related to psychology and other human sciences like clinical psychology and psychiatry, psychoanalysis neurology, neurophysiology, physiological biochemistry and psychopharmacology, its' complexity increases (Izard, 1977; TenHouten, 2007).

The term emotion cannot be described completely by having a person to describe his/her emotional experiences; by electrophysiological measures of occurrences in the brain, the nervous system, or in the circulatory, respiratory,

and glandular systems; or, by the expressive patterns or motor behaviours that occurs as a result of emotions (Izard, 1977). A complete definition of emotion must take into account the three aspects or components as:

> "(a) The experience or conscious feeling of emotion,
>
> (b) The processes that occur in the brain and nervous system,
>
> (c) The observable expressive patterns of emotions particularly those on face" (p. 4).

Parkinson (1997) argued that emotions are characteristically intentional states; they take an object of some sort. He stated that "it is hard to imagine a pure state of pride, anger, or love without the state being directed at something: You are proud of your success; angry with someone who has insulted you, in love with someone in particular, rather than just proud, angry, or in love per se" (Parkinson, 1997, p. 2). Thus, emotions express a certain relationship with a person or some object, person that including the self, or event that may be real, remembered, or imagined. This relation refers to an intrinsically evaluative one. If someone is emotional, that person will be good or bad, approving or disapproving, relieved or disappointed about some state of affairs or some definite object –whether imagined or real. These reactions are not permanent; they will not last too long. Therefore, emotions are considered to be evaluative, affective, intentional, and short-term conditions (Parkinson, 1997).

2.1.2. Related Phenomena

As it is mentioned, emotion is a very complex task to describe; it is not a simple phenomenon. Emotions are something that people suppose they can recognize

when they experience them; however it is difficult to define them unambiguously (Ben-Ze'ev, 2001). The term is confused with other terminologies such as feelings, sentiments and moods.

Feelings

Feelings and emotions are generally confederate in everyday discourse (TenHouten, 2007). Feelings mean "a person's own state of mind, especially with reference to an evaluation of what is agreeable and disagreeable, pleasant or unpleasant" (p. 4). Emotions contain actions and movements, often in public view, appeared in facial expression, posture, gesture, specific behaviours, and conversation. Unlike emotions, feelings are private, playing out not in the body but in the mind and at a higher level (TenHouten, 2007). Thus, feelings contain some kind of pressure towards action (Levy, 1984).

Sentiments

Sentiments involve romantic love, parental love, loyalty, patriotism, trust, friendship, happiness. A particular person or object is typically central in sentiments. "A person can have a longstanding love for a mate or parent, a longstanding sorrow for someone who has died, and a longstanding hostility to a rival or competitor" (TenHouten, 2007, p. 6). As they relate to specific objects, situations, and processes, they are derived and continue to exist.

Sentiments are mostly acquired on the basis of previous experience and social learning. On the other hand, certain sentiments such as dislike for seeing blood or of unstable surfaces may have an innate basis (Frijda, 1994).

Unlike sentiments, emotions are acute, related to an eliciting situation, and episodic in nature. Emotions have a powerful feeling dimension, and with respect to another person or a social situation, they are triggered by perceived changes in the environment (TenHouten, 2007).

Moods

Moods are distinguished from emotions in terms of time course, moods last longer than emotion (Ekman, 1994). Moods may last for hours even for days. However, if it states for weeks or months, it is not identified as a mood but identified as an affective disorder.

Moods basically cite the subject's own situation. Contrary to emotions, moods are generally of less intensity (TenHouten, 2007). Clark and Isen (as cited in Parkinson, 1997) claimed that moods are affective states like emotions; they have an evaluative component as feeling of good or bad. But unlike emotions, moods do not usually take a definite object (you can just be grumpy as a result of "getting out of bed the wrong side" without any particular focus to the experience) (Parkinson, 1997, p. 3).

Another feature distinguishing moods from emotion is about having own facial expression. Contrary to many of the emotions, moods do not have their own unique facial expression; "one infers an irritable mood by seeing many facial expressions of anger, but there is no distinctive facial expression of irritability itself" (Ekman, 1994, p. 57).

Emotion and Motivation

Emotion is one of the most important and thoroughly explored forms of affect (feeling), and motivation is essentially just a new name for conation (willing) (Parkinson & Colman, 1997). As interlocking processes, biologically defined urges and desires, acquired affinities and aversions, and the implementation of conscious intentions, are encompassed by motivation (Parkinson & Colman, 1997). A complete statement of any motivational phenomenon always includes reference to an interaction of both internal and external factors, and to instinct as well as learning. Kuhl (as cited in Sorrentino & Yamaguchi, 2008) defined cognition, motivation, and emotion as:

> It is assumed that cognitive, emotional, and motivational subsystems relate to the world in three different ways. The term cognition is reserved for those processes that mediate the acquisition and representation of knowledge about the world, i.e., processes that have a representative relation to the world of objects and facts. Emotional (affective) processes evaluate the personal significance of those objects and facts. Motivational processes relate to the world in an actional way, e.g., they relate to goal states of the organism in its attempt to produce desired changes in its environment. (p. 6)

As it is highlighted, both emotion and motivation are related to the relationship between the organism and its environment. In the case of motivation, the emphasis is on how the individual acts with respect to the situation that is of interest. On the other hand, in the case of emotion, the emphasis is on the evaluative aspect of this relationship: How the situation makes the person feel.

2.1.3. Emotion States and Traits

Emotion phenomena have two forms, namely, state or trait that indicates if the emotions are transient or stable. The terms “state” and “trait” show different

characteristics primarily in terms of intensity and the duration of an emotion experience. State and trait do not represent disparities in the quality of the experience, only emotion state has a greater range of intensity than emotion trait (Izard, 1977). The term "emotion state" as an instance 'anger state', designates to a particular emotion process of limited duration while the term "emotion trait" as an instance 'anger trait' designates to the tendency of the individual to experience a particular emotion with frequency in his day-to-day life. In this context, according to Izard (as cited in Izard, 1977) emotion threshold is a complementary concept. A person probably experiences guilt frequently, if he has a low threshold for guilt. Lazarus (1991) defined an emotion trait as "a characteristic of a person, and so is not really an emotion but a disposition or tendency to react with one "(p. 46). On the other hand, he defined an emotion state as "a transient reaction to specific encounters with the environment, one that comes and goes depending on particular conditions" (p. 47).

2.2. Process of Emotion

2.2.1. The Category of Emotion

Although many emotion theorists have stated that some emotions are *basic* and the others are not, there is not an agreement on what the basic emotions and on what it means for an emotion to be basic in the literature (Ortony, Clore & Collins, 1988). Although researchers disagree about how many basic emotions there are, there is an agreement on some of them. These include joy, distress, anger, fear, surprise, and disgust (Evans, 2002). These emotions are universal and innate; they are not learned and they are hardwired into the brain.

According to Izard (1992) due to essential biological and social functions in evolution and adaptation, some emotions are seen as basic. Particular emotions are assumed to be basic as they have innate neural substrates, innate and universal expressions, and unique feeling-motivational states. Additionally, in the conception of emotions becoming motivations, some emotions become basic as they constitute a basis for some actions such as coping strategies and adaptation.

On the other side, Ekman and Friesen (1971) suggested that there are six basic biologically programmed emotions. These involve happiness, sadness, fear, anger, surprise, and disgust, each with its own distinctive facial expression.

Addition to the categorization of emotion as basic or not, Izard (1977) approached with a different perspective: 'it is worth to consider if it is sufficient to classify emotions simply as positive of negative'. He asserts that emotions such as anger, fear, and shame cannot be labelled categorically negative or bad. Under some circumstances anger can positively be correlated with survival, with defence, maintenance of personal integrity and the correction of social injustice. Instead of classifying emotions as positive or negative, it is more suitable to say that "there are some emotions which tend to lead to psychological entropy, and others which tend to facilitate constructive behaviour or the converse of entropy" (p. 9).

Higher cognitive emotions are the other category of emotions that are more cortical than the basic emotions. They are more capable of being affected by

conscious thoughts; they exhibit more cultural variations (Evans, 2002). They take longer time to build up and to die away, than the basic emotions. Higher cognitive emotions involve love, guilt, shame, embarrassment, pride, envy and jealousy.

2.2.2. Components of Emotions

According to Parkinson (1997) the way of approaching the question of what emotion necessitates requires looking at the different aspects and components of emotional experience that are cognitive evaluations of the situation, bodily responses, facial (and other) expressions, and action impulses. These four kinds of phenomena are associated with emotional experience and considered as characteristics of emotional experience. Thus, it is important to differentiate emotions and distinguish them from other states by its components (Desmet, 2003).

1. Situational evaluations and interpretations:

A situation is experiencing something as positive or negative, in a good or bad light. Appraisal is a crucial concept in evaluative aspect of emotion (Parkinson, 1997).

The appraisal process includes a set of decision-making components (Lazarus, 1991). These create evaluative patterns that differentiate among each of the emotions. Lazarus (1968) suggested two facets for emotional appraisal and classified as primary and secondary appraisal. In primary appraisal, the concern was on the motivational stakes in adaptation encounter (Lazarus, 1991);

the individual evaluates the relevance of the current situation to personal well-being, weighing up whether it has good or bad implications for pre-eminent concerns, and implicitly asking the question: *Am I in trouble or am I OK?* (Lazarus, 1968). In secondary appraisal, the concern is on the options for coping and expectations; the individual evaluates his or her capacity for handling the situation -coping potential-, asking, in other words, *What can be done about it?* (Lazarus, 1968). The primary appraisal components are goal relevance, goal congruency or incongruency and type of ego-involvement; the secondary appraisal components are blame or credit, coping potential and future expectations (Lazarus, 1991, p. 39). By the pattern of primary or secondary appraisal component, each individual emotion is differentiated.

Different emotions are characterized by different evaluations of the situation (Parkinson, 1997). For instance, happiness and pride as positive emotions are associated with primary appraisals that the situation is beneficial to personal concerns, whereas anger, fear, and sadness as negative emotions suggest that the situation is being appraised as detrimental to the individual.

According to Parkinson (1997) by using a relatively small set of appraisal dimensions, various emotional experiences can be differentiated. He asserted that "the most important dimensions relate to the event's pleasantness or unpleasantness; its unfamiliarity or familiarity; its unexpectedness; its beneficial or harmful implications; uncertainty about its implications; your own and other people's responsibility for the event; the controllability or uncontrollability of the event; whether the event is relevant to your well-being

or someone else's; and whether the event conforms to or conflicts with your norms" (p. 6-7).

2. Bodily changes:

Lazarus (1991) maintained that Autonomic Nervous System (ANS) activity and its end-organ effects, brain activity, and hormonal secretions are sometimes phenomena of emotions. The responses may occur in characteristic of increase in heart rate and blood pressure (Arnold, 1960), perspiration, and other bodily stirrings (Dennis, 1989). Cannon (1929) argued that all the excited emotions such as anger and fear are actually accompanied by the following set of responses characteristically "increased respiratory volume, constriction of the blood vessels in the skin (pallor), dilation of pupils, arrest of gastro-intestinal activity, decreased salivation (dry mouth), and increased action of the sweat glands" (as cited in Parkinson, 1997, p. 7).

Ekman (1984) reported that among emotions there are differential activities not only in skin temperature but also in heart rate. ANS activity shows differences both between positive and negative emotions, and in patterns of ANS (see Figure 2.1).

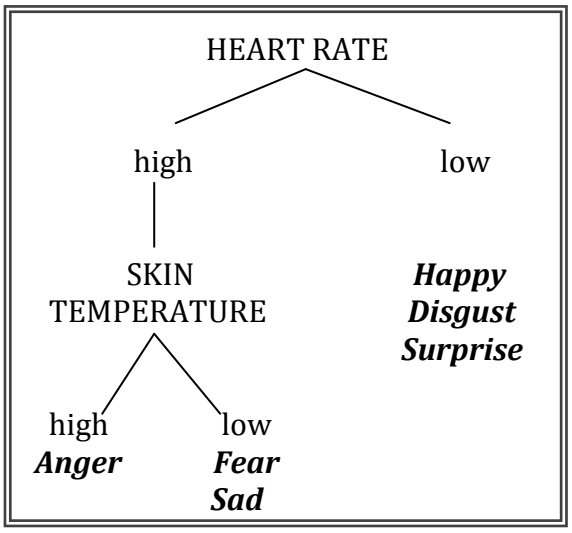


Figure 2.1. ANS activity differences between particular emotions. (Ekman, 1984, p. 326)

3. *Emotional expression*:

Expressive behaviour is one of the most obvious indicators of emotional experience (Parkinson, 1997). Expression refers to movement and sounds made by someone indicating the presence of emotion to someone else. These movement and sounds are expressive to the extent that they communicate emotional information either be deliberate or intentional. Because of face is capable of a wide variety of subtly patterned movements, it is the most important channel of emotional expression. Additionally, emotion can be expressed through tone of voice, bodily posture, and gestures (Dennis, 1989).

4. *Motivated action*:

Emotions include the impulse to act in certain ways that is appropriate for the particular emotion. One may feel a strong urge to hit out at someone in some

way when angry; to seek out for the company of your loved one and get as close as you possibly can to him or her when in love; and may feel the strong desire to run away, literally or metaphorically when afraid (Parkinson, 1997). In this perspective, emotions should be seen as inherently motivational states that serve to particular functions.

From the perspective of all given descriptions above, the components of an emotional experience can be summarized by Milton's (2007) explanation: Emotional episode begins with a stimulus (starting point of an evaluation process) and ends with an action motivated by feeling (see Figure 2.2). In this line, there are four elements that are involved in the stated episode. As an example, seeing a snake causes the stomach to tighten and the heart starts to beat more quickly, resulting with being afraid, motivated to take an action such as to throw a stone or to run away (Milton, 2007).

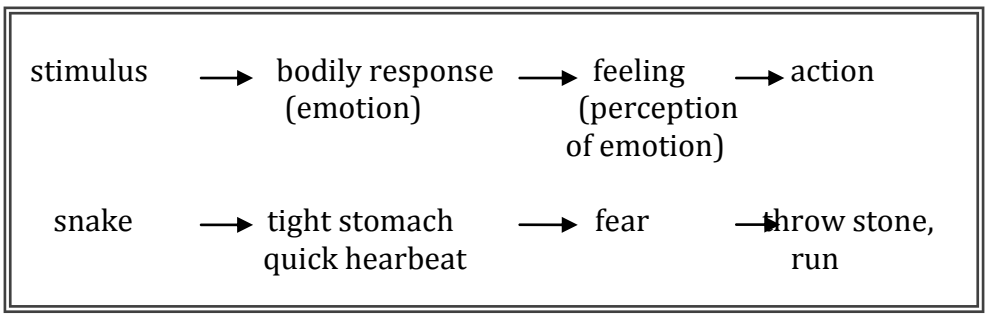


Figure 2.2. An illustration of an emotional experience episode. (Milton, 2007)

2.2.3. The Sequence of Emotion

The sequence of emotions involves 4 main factors that are appraisal, arousal, facial expression and action readiness. This sequence refers to the internal structure of emotional experience and it explains how emotional experience is produced.

Factor 1: Appraisal:

The process of appraisal involves setting criteria and evaluating the outcome of coping efforts (Leventhall, 1984). It is defined as "the perception and evaluation of the emotional event, with regard to its valence and its relevant properties for dealing with it" (Frijda, 1994, p. 61).

It is the first and most central factor in the generation of emotion (Parkinson, 1997). Appraisals theorists suggested that emotions are not always the direct reactions to stimulus qualities; rather, what gives an object emotional impact is its relevance to the individual's personal concerns. Smith and Lazarus (1993) maintained an appraisal role as combining emotional responses to environmental conditions on one side, and personal goals and beliefs on the other side.

The process of appraisal can be considered as the key in understanding that emotions are distinguishable for different individuals (Frijda, 1993). Appraisal illustrates that an emotionally charged event that elicits this specific emotion, in this specific individual, under this specific condition. It works as a clue not only

in understanding the conditions for the criterion of various emotions, but also in distinguishing emotions from each other.

Factor 2: Arousal:

State of arousal involves diverse processes that control activation, wakefulness, motor behaviour, and alertness. In physiological patterns, it contains autonomic activation, hormonal events, mechanisms in the brainstem and events in the cerebral cortex (DeCatanzaro, 1999). Arousal happens " when the body releases chemicals into the brain that act to stimulate emotions, reduce cortical functioning and conscious control, and create physical agitation and 'readiness for action'" (changingminds, para . 4).

When we feel emotions, we sometimes enter a state of arousal, in which our bodies experience heightened physiological activity and extremes of emotion (changingminds, para. 1). States of arousal can be positive and negative. It involves fear, anger, curiosity and love that are felt with an overpowering intensity that led us to act in an unthinking way. This acting process affects human performance. If the quantity of arousal is too little, it leads to poor performance, if it is in a moderate level it optimizes performance, if it is in a very high level, it interferes with adaptive behaviour (DeCatanzaro, 1999) (see Figure 2.3). Therefore, our efficiency of performance can be affected by the level of arousal.

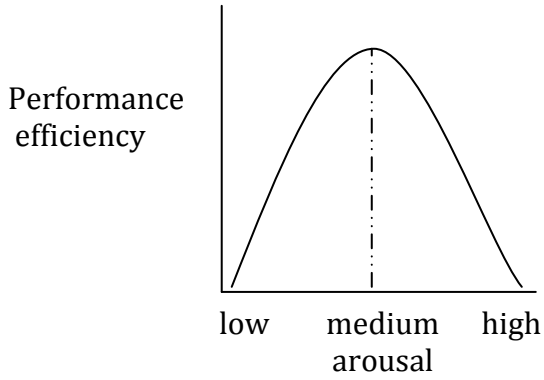


Figure 2.3. The U-shape relation relating efficiency of performance to level of arousal. (DeCatanzaro, 1999, p. 174)

Factor 3: Facial expression:

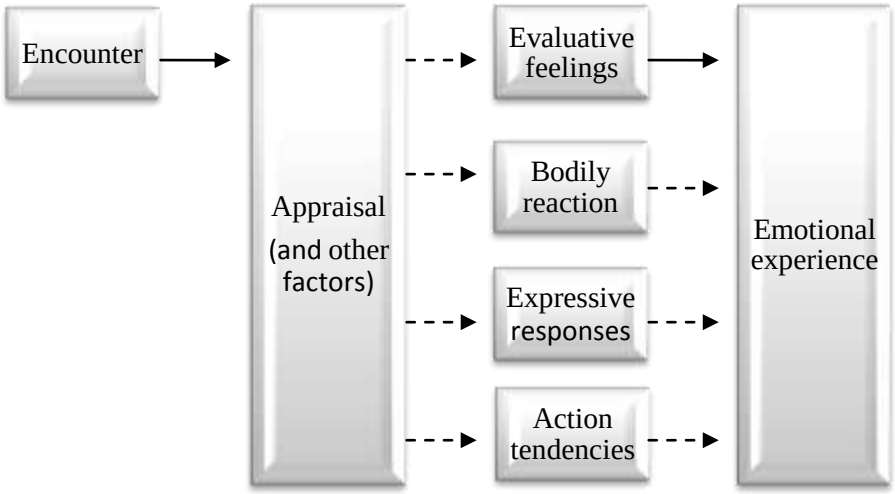
Unlike the signals available from the autonomic nervous system, the facial expressive patterns show some consistent relations with specific emotions (Parkinson, 1997). Ekman (1992) illustrated that every facial expression that has been precisely identified for each of the emotions occurs with an attempt to fabricate the appearance of emotion. More than one muscle movement is necessary for a clear signal of a single emotion. However, to signal disgust clearly only one muscle that is the "levator labii superiors, alque nasi, which raises the nares, pulls up the infraorbital triangle, and wrinkle the sides of the nose" (p. 551) is needed and in any other emotion that muscle action does not occur systematically. "The zygomatic muscle, which pulls the lip corners upward, can alone signal enjoyment, while in combination with other muscles signal sadness" (p. 551).

Factor 4: Action readiness:

In the experience of emotion, there exist some tendencies to carry out expressive behaviour. Readiness to carry out an action can exist with respect to

behaviour and have a sense or intent similar to that expressive behaviour (Frijda, 1986). These behaviours involve full-fledged actions like attack in which called expression often is a part. In addition, there are more or less instrumental actions like crying out when faced by danger, or constantly thinking of a person when seriously in love.

Parkinson (1997) considered several possible causal routes to the production of an emotional experience, with different theorists assigning priority to different categories of variable from the four factors of emotion (see Figure 2.4). The simple answer to the question of "which of these sequences is the correct one" is the appraisal sequence: Emotion is determined mainly by our evaluations and interpretations of the personal significance of events. Feedback from any of the four factors of the patterned emotional response may sometimes contribute to the strength or quality of the experience (Parkinson, 1997, p. 16).



Note: Broken lines represent linkages that are possible rather than necessary.

Figure 2.4. A four-factor theory of emotion (Parkinson, 1997, p. 17).

2.3. Influences of Emotion on Human Beings

The emotion affects people in many different ways. It tends to affect all aspects of the individual such as the body, perception, cognition, actions, personality development, sex, even marriage and parenthood.

1. *Emotions and the Body*: As part of an integrated whole, both the face and the body, contribute to convey the emotional state of the individual (Shan, Gong, & McOwan, 2007). Simonov (as cited in Izard, 1977) reported that in the electrical activity of the brain, in the circulatory system, and the respiratory system changes occur.

   Due to such dramatic changes in bodily functions occurring during a strong emotion, it can be suggested that in greater or lesser degree in emotion states virtually all of the neurophysiological systems and subsystems of the body are involved (Izard, 1977). These changes unavoidably affect the perceptions, thoughts, and actions of the person and in addition may also contribute to medical and mental health problems.

2. *Emotion and Perception:* Emotions like some other motivational states influence perception (Izard, 1977). He attributed that "the joyful person is more likely to see the world through 'rose-colored glasses'; the distressed or sad individual is more likely to interpret others' remarks as critical; the fearful person is inclined only to see the frightening object (tunnel vision)" (Izard, 1977, p. 10).

3. *Emotion and Cognition:* Emotion affects the person's memory, thinking, and imagination (Izard, 1977). According to him "the frightened person has difficulty considering the whole field and examining various alternatives; the person in anger is inclined to have only "angry thoughts"; the person in a high state of interest or excitement, the individual is curious, desirous of learning and exploring" (Izard, 1977, p. 10).

4. *Emotions and Actions:* Emotions play an important role in people's explanation of action (Zhu & Thagard, 2002). The concept of emotion deserves a distinctive and central place in philosophical theories of action. Izard (1977) claimed that the emotions and patterns of it have an influence on everything the person does-work, study, play. One is eager to study and to pursue a subject in depth when really interested in it. On the other hand, he wants to reject the subject if he is disgusted with it.

5. *Emotions and Personality Development:* The person's genetic makeup and the individual's experiences and learning related to the emotion sphere are the factors that are important in considering emotion and personality development (Izard, 1977). The first factor plays an important role in establishing emotion traits or the thresholds for the several emotions. The second factor is important in a way that emotion expressions and emotion-related behaviour are socialized.

Especially in infancy and childhood, the social development of an individual is significantly influenced by the emotion traits (Izard, 1977). He asserted that "the infant who has frequent temper tantrums, the one who frightens easily, and the one who often wears a smile, will reach invite and receive different responses from peers and adults" (Izard, 1977, p. 11).

6. *Emotions and Sex:* Virtually the sex drive always interacts with some emotion (Izard, 1977). The sex drive interacting with anger and contempt may result in sadism or rape; with guilt may produce impotence or masochism; with excitement and joy may produce love and marriage and produce peak experiences of sensory pleasure and emotion.

7. *Emotion, Marriage, and Parenthood:* In the selection of a partner in marriage, an individual's emotion expressiveness is a factor (Izard, 1977). A person may select a partner whose emotion experiencing and expressiveness complements his or her own; or he may select a partner whose emotion experiencing and expressiveness has a similar profile-similar threshold.

   It affects parenthood in a way that an individual's threshold for excitement, joy, disgust, or fear may influence his or her response to the child's interest, joy, disgust, or fear (Izard, 1977).

2.4. Universals of Emotion

Every facet of emotion such as the control of expressions, the symbolic representation of emotional experience, the evaluation of emotion-relevant situations, the attitudes to one's own emotions, and coping with emotion is influenced by culture and social learning processes (Ekman, 1992).

In widely different cultures, the fundamental emotions have the same expressions and experiential qualities. Even though, the fundamental emotions are subserved by innate neural programs, this does not mean that no aspect of an emotion can undergo a change through experience. By means of different social backgrounds and different cultures, people may learn quite different facial movements for modifying innate expressions (Izard, 1977).

Findings of Ekman and Friesen's (1971) study supported that particular facial behaviors are universally associated with particular emotions. They reported that experience within a culture, the kinds of events that elicit particular emotions, may act to influence the ability to discriminate particular pairs of emotions. The reason for not differentiating the fear faces from surprise faces may be due to fearful events are almost always also surprising in this culture such as the sudden appearance of a hostile member of another village, the unexpected meeting of a ghost or sorcerer, etc. Ekman (1992) reported that emotions of happiness, surprise, fear, sadness, anger and disgust are the consistent emotions that have universally accepted facial expressions.

2.5. Measuring Emotion

Emotion is a fact of human experience. Though it seems to be possible to describe it accurately and measure it adequately as a fact, it has not lent itself to satisfactory measurement (Arnold, 1960). Researchers offered various approaches for the ideal measurement of emotion as there is no single method.

Desmet (2003) maintained that psychologists have offered various definitions in which each focuses on different components of the emotions. As a solution for specifying more accurate definition of emotion, he stated that "emotions are best treated as a multifaceted phenomenon consisting of the following components: Behavioural reactions (e.g. approaching), expressive reactions (e.g. smiling), physiological reactions (e.g. heart pounding), and subjective feelings (e.g. feeling amused)" (Desmet, 2003, p. 113). Each instrument that measures emotion in fact measures one of the stated components.

According to Scherer (2005) ideally, it is needed to measure:

> The continuous changes in appraisal processes at all levels of central nervous system processing; the response patterns generated in the neuroendocrine, autonomic, and somatic nervous systems; the motivational changes produced by the appraisal results, in particular action tendencies; the patterns of facial and vocal expression as well as body movements; and the nature of subjectively experienced feeling state that reflects all of these component changes. (p. 709)

To compensate all approaches to ideal measurement of emotion, various instruments are developed. Today instruments range from simple pen-and-paper rating scales to dazzling high-tech equipment that measures brain waves or eye movements (Desmet, 2003) (see Figure 2.5).

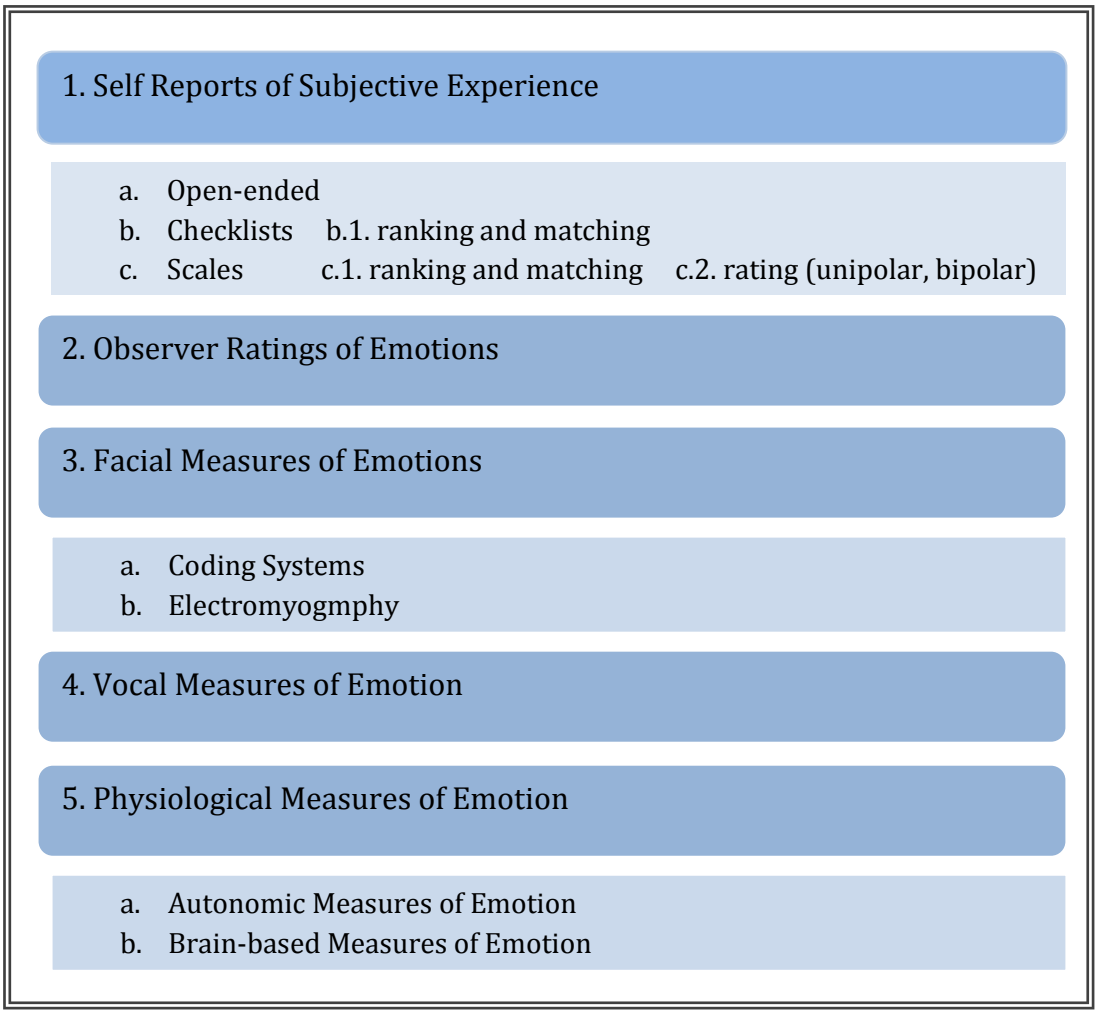


Figure 2.5. Emotion Measurement Instruments.

(Formed in the light of the previous works from Schubert, 1999; Larsen & Fredrickson, 1999; Desmet, 2003; Scherer, 2005)

Desmet (2003) classified emotion measurement tools as non-verbal and verbal instruments. Non-verbal instruments measure the expressive and the physiological component of emotion. An expressive reaction like smiling or frowning comprises the facial, vocal and postural expression of emotion. A physiological reaction such as activation or arousal like increases in the hearth rate refers to the change in activity in the Autonomic Nervous System (ANS). Verbal instruments on the other side comprise self-report instruments that typically decide on the subjective feeling component of emotion.

2.5.1. Self Reports of Subjective Experience

Self-report measures of emotion are used widely and have a broad range of assessment instruments (Larsen & Fredrickson, 1999). Subjective feelings such as feeling happy or feeling inspired are the conscious awareness of the emotional state one is in (Desmet, 2003). The only way of measuring such subjective feelings can be done through self-report, thus it gives the participant the opportunity to express a good deal of information that only he or she has access to, with the use of a set of rating scales, verbal protocols and adjective checklists (Singh, 1984; Larsen & Fredrickson, 1999; Desmet, 2003). Self reports are involving open-ended measures, checklist measures, matching measures, ranking measures, and rating scales (Schubert, 1999):

a. *Open-ended measures*: To avoid the problem of forcing the participant to respond with a category that is not provided in the list, free response format as open-ended instruments are generated (Scherer, 2005). It is a way of asking participants to respond with freely chosen labels or short expressions of what is in their mind that most suitably characterize the nature of the state they experience.

b. *Checklist measures*: It allows participant to select a word or several words from a list that describes best the emotions that s/he is/was feeling (Schubert, 1999; Larsen & Fredrickson, 1999) (see Figure 2.6). In many cases, participants have the opportunity of adding their own terms if they wish.

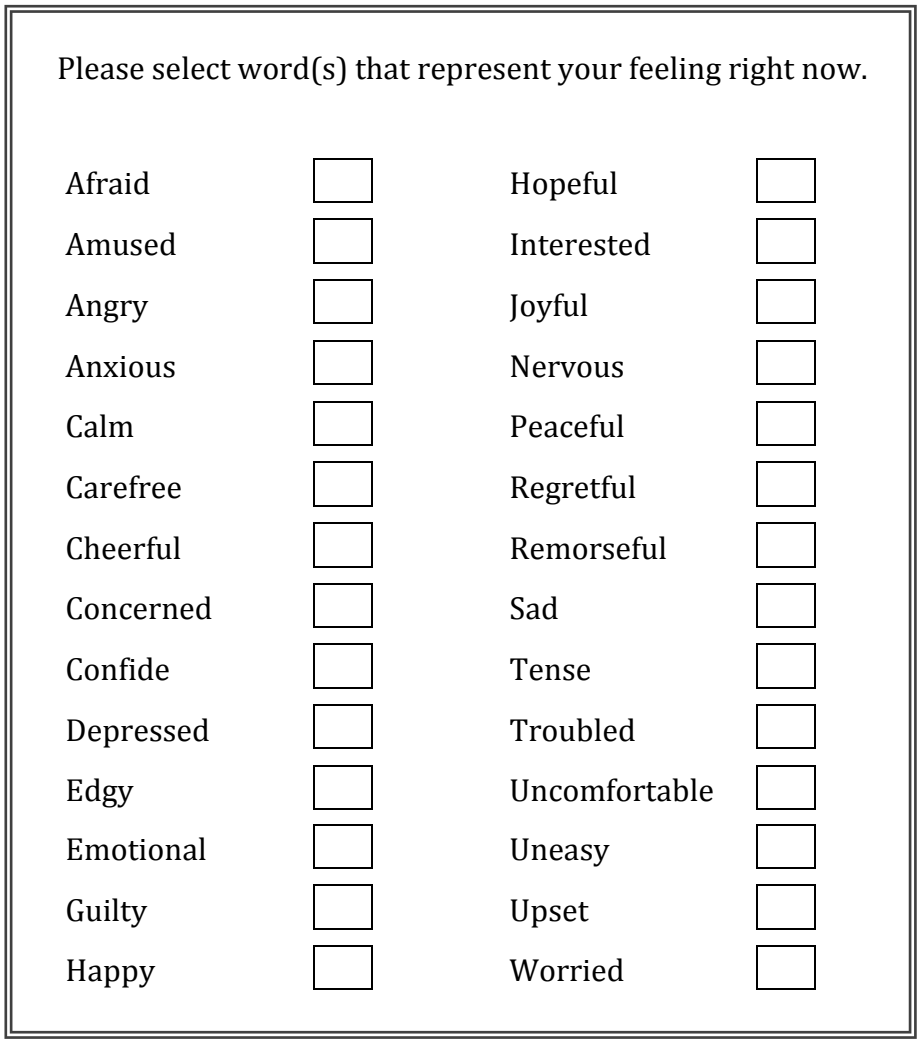


Figure 2.6. An illustration of a checklist measure.
(Emotion terms from the adjective checklist measures are taken from Luce, Bettman, & Payne (1997) studies.)

c. *Matching measures*: These are similar to checklists except when a selection from the given list is made –generally matched with the stimulus-, the item selected is removed. Until all the options in the list have been matched, the process usually continues (Schubert, 1999) (see Figure 2.7).

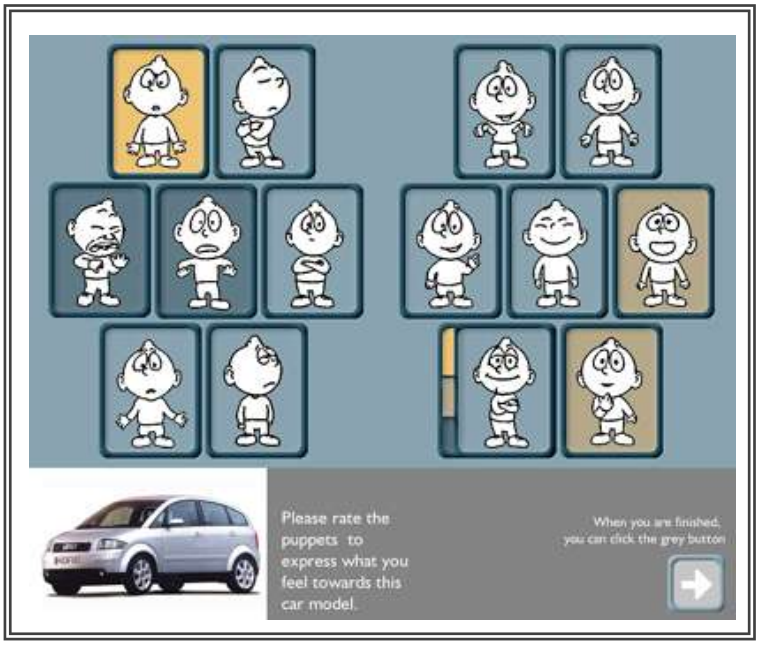


Figure 2.7. An illustration of a matching measure. (http://studiolab.io.tudelft.nl/desmet/PrEmo)

d. *Ranking measures*: It allows the participant a series of options and asks to rank them in accordance to a predetermined criterion, relative to one another like from highest to lowest (Schubert, 1999).

e. *Rating scales*: It is the most commonly used self-report scale. It asks research participants to rate how they are/were feeling on an emotional construct. The construct might be a global affective dimension like 'how unpleasant are you feeling?' or a specific emotion like 'how angry do you feel?' (Larsen & Fredrickson, 1999). The purpose of rating scales is to understand the kind of impressions objects or persons have made upon rates (Singh, 1984). Thus, it is important that the participant have an experience of the stimuli. Usually rating scale has two, three, five, seven, nine or eleven points on a line with descriptive categories at both ends

followed sometimes with a descriptive category in the middle of the continuum (see Figure 2.8).

Positive End:	Middle:	Negative End
Strongly agree	Neutral	Strongly disagree

Figure 2.8. An illustration of a rating scale. (Singh, 1984)

There are different kinds of rating scales namely, *numerical scales, graphic scales, percentage rating, standard scales, scales of cumulated points* and *forced choice scales*. In addition, the response scale might be unipolar in which the measurement is based on a single concept per scale like 'not at all angry to extremely angry' or bipolar in which the scale is anchored at either end by terms with opposing meaning like 'unpleasant to pleasant' (Schubert, 1999). The most common manifestation of bipolar rating scale is the *semantic differential*.

The Semantic Differential (SD) measures people's reactions to stimuli for rating on bipolar scales that specified with contrasting adjectives at each end (Heise, 1970) (see Figure 2.9). Singh (1984) defines SD scale as "a collection of scales in which absolute ratings of concepts are done; the concept refers to the object which is to be rated" (p. 256). A concept to be differentiated is provided to the participant in addition to a set of bipolar adjectival scales against which to do it (Osgood, Suci, & Tannenbaum, 1978). The only task is to indicate for each item, the direction of his association and its intensity on a seven-step scale. It is important for the participant to be as representative as possible of all the ways

in which meaningful judgements can vary. The aim of the instrument is to measure different facets of meaning of the concept, the different facets of meaning that is being represented by adjectives (Singh, 1984).

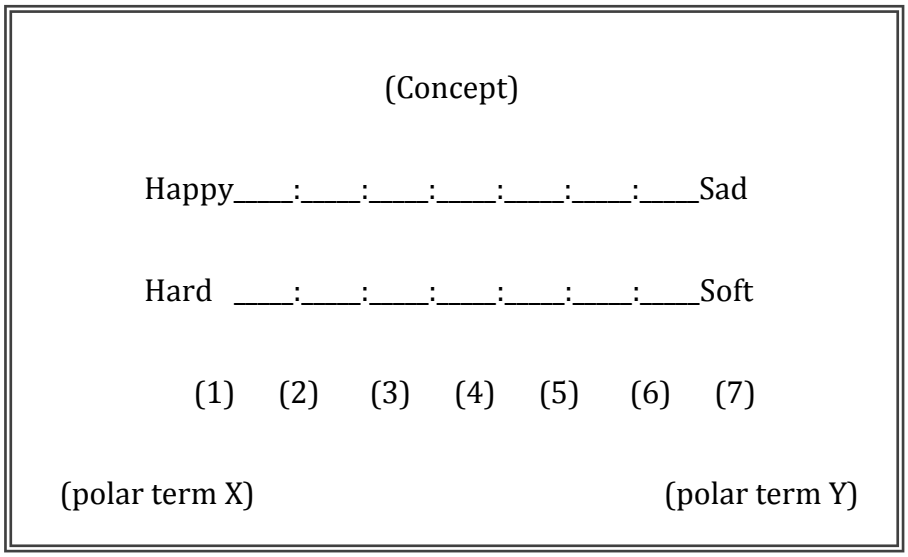


Figure 2.9. An illustration of Semantic Differential (SD).
(Osgood, Suci, & Tannenbaum, 1978)

The position marked 4 is labelled 'neutral; neither X nor Y'; the 3 and 5 positions are labelled 'slightly X and slightly Y' respectively; the 2 and 6 positions 'quite X and quite Y', and the 1 and 7 positions 'extremely X and extremely Y' (Heise, 1970; Osgood, Suci, & Tannenbaum, 1978). A scale like the Figure 4 measures directionality of a reaction like happy versus sad, hard versus soft and the intensity from slight through extreme.

There are other various constructed instruments that are used in self-report measurements. One of them is a questionnaire measure called the Affect Grid which is designed to assess two dimensions of affect: Pleasure-displeasure and arousal-sleepiness (Russell, Weiss, & Mendelson, 1989). It is composed of

a nine-by-nine matrix and the emotion adjectives are placed at the midpoints of each side of the grid (Larsen & Fredrickson, 1999) (see Figure 2.10). The research participant reads firstly the general instructions and then is given specific instructions, such as "Please rate how you are feeling right now" and then places one checkmark somewhere in the grid (Russell, Weiss, & Mendelson, 1989).

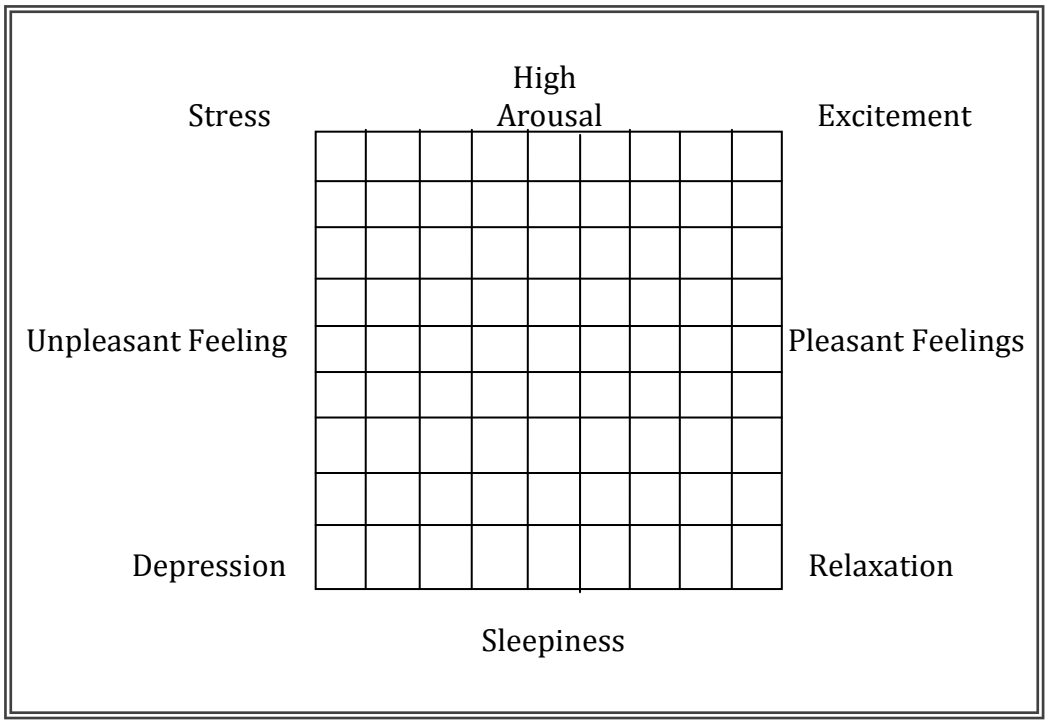


Figure 2.10. The Affect Grid. (Russell, Weiss, & Mendelson, 1989)

The other scale used in self-report is Mood Adjective Check List (MACL) in which the participant is asked to rate how s/he felt, during when the emotion adjective was read on a specific scale such as 'definitely felt it', 'slightly', 'cannot decide', 'definitely not' (Larsen & Fredrickson, 1999). Another important response scale is Visual Analog Scales (VAS) in which two opposing adjectives

are separated in a horizontal line. It is an instrument that tries to measure a characteristic and emotion that is believed to range across a continuum of values and cannot easily be directly measured (Gould, Kelly, Goldstone, & Gammon, 2001) (see Figure 2.11). There are various ways in which VAS have been represented, involve vertical lines and lines with extra descriptors.

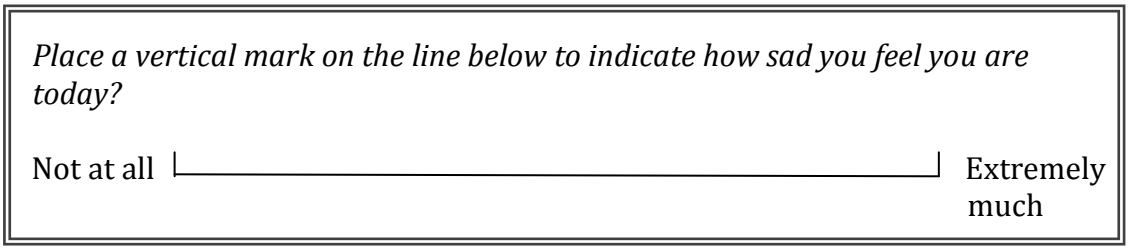


Figure 2.11. An illustration of Visual Analog Scale (VAS). (Gould, Kelly, Goldstone, & Gammon, 2001)

The advantages of self reports are that rating scales can be confederates to designate any set of emotions, and can be used to measure not only individual emotions but also mixed emotions (Desmet, 2003). They are assumed to be the best sources of information about an individual's emotional experience (Larsen & Fredrickson, 1999), and they are simple, straightforward and generally quite reliable (Scherer, 2005). On the other hand, the main disadvantage of self-reports is their difficult application between cultures due to translation (Desmet, 2003). In emotion studies, it is difficult to translate emotion words as straight translation is not available. Usage of colour emotion words and their characteristics change with languages (e.g. Nakamura, Sakolnakorn, Hansuebsai, Pungrassamee, & Sato, 2004). To overcome the problem of between-culture comparisons, a handful of non-verbal self-report instruments have recently been developed in which pictograms are used

instead of words to designate emotional responses. The Self-Assessment Manikin (SAM) is an example for that kind of instruments.

The SAM is a non-verbal pictorial scale instrument that directly measures the arousal, valence and dominance associated with a participants' affective reaction to various types of stimuli (Bradley & Lang, 1994; Oliveira, Fonseca, Teixeira, & Simões, 2005). Participants point out the puppets that they think best portray their emotions in a specific moment (see Figure 2.12). However, there is an important limitation for it's application in between-culture studies: They do not measure distinct emotions but only generalised emotional states (Desmet, 2003). Like SAM, there are some other non-verbal pictorial scale instruments in which universally accepted facial expressions of emotion are used (see Figures 2.13 and 2.14). Karadoğaner (2010) generated one neutral and six basic emotions (happiness, sadness, anger, fear, surprise, and disgust) by using Poser Software according to the Facial Action Coding System (FACS) descriptions and the results of the Action Units (AU) (see Appendix A2) (see Figure 2.15).

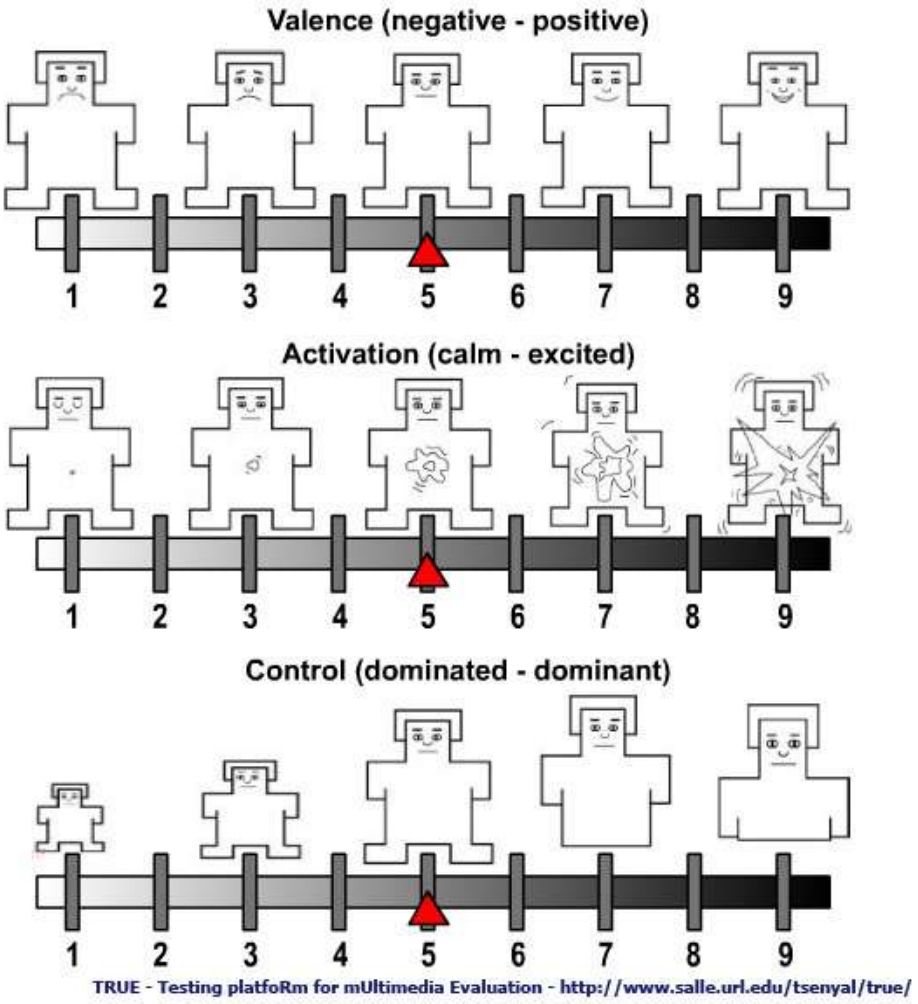


Figure 2.12. Self Assessment Manikins (SAM).
(http://www.salle.url.edu/tsenyal/true/imatgesTRUE/plugins/pluginSAM.jpg9)

Figure 2.13. Paul Ekman's facial expressions of emotion. (Cardinal, 2004)

Figure 2.14. Paul Ekman's facial expressions of emotion. (Evans, 2002)

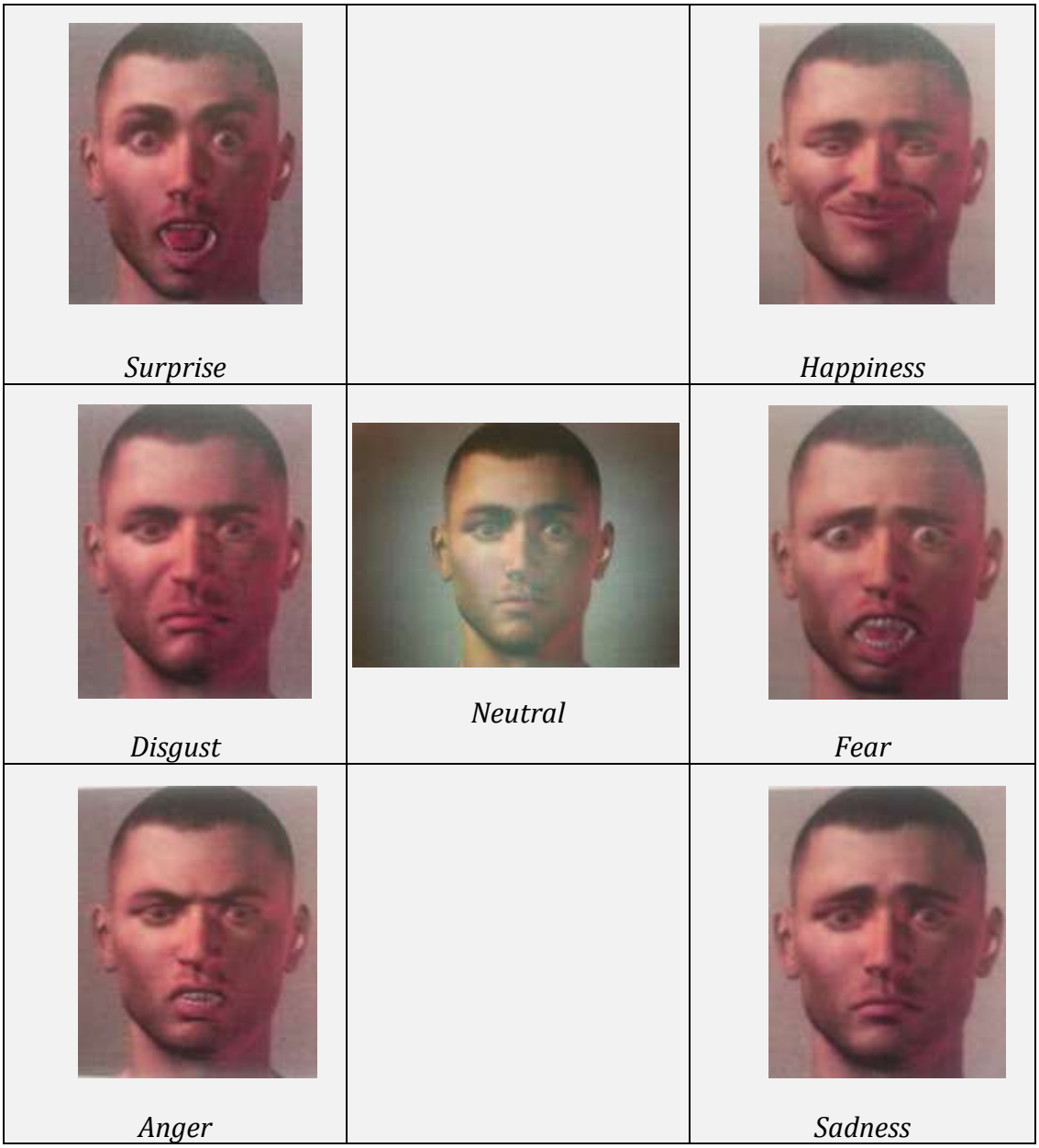


Figure 2.15. Karadoğaner's facial expressions of emotion. (Karadoğaner, 2010)

One of the most important measurement issues of emotion is the timing (Larsen & Fredrickson, 1999). Emotions take time and they are "dynamic processes that unfold, linger, and then dissipate over time-sometimes gradually, other times rapidly" (p. 42). They consist of cascade of discrete response systems that have its own time of onset and duration. Therefore, it is critical to capture the

dynamic aspects of the concept under study. Self-report measures may increase the chance of capturing the dynamic moments of the emotional effect (Larsen & Fredrickson, 1999).

2.5.2. Observer Ratings of Emotion

Any self-report measure can also be collected from a third person perspective with available sufficient information. Observer reports may be received from expert observers of a target person's emotional experiences such as a best friend, a therapist or from strangers without a special training (Larsen & Fredrickson, 1999). The crucial point in the observer rating is to supply the observer-rater with emotion-relevant information about the target person's experiences. Written accounts, videotape, photographs of facial behaviour or their combinations are used for data (Arnold, 1960; Larsen & Fredrickson, 1999). In reviewing process of the collected data, a specially trained observer makes judgement about the emotional state of the target person.

2.5.3. Facial Measures of Emotion

Facial expression instruments are on the basis of theories that link expression features to distinct emotions (Desmet, 2003). The measurements are done by using Coding Systems or Electromyogmphy.

a. *Coding System:* Facial Action Coding System (FACS) is one of the most expansive and extensively used instruments for coding emotion in the face (Larsen & Fredrickson, 1999). It involves forty-six anatomically based 'action units' (AUs) in which each represent a specific observable change in the face such as AU 1 raises the inner brows, and AU 9 wrinkles

the nose (see Appendix A). This instrument illustrates all possible movements in the skin of the face observable to the naked eye and can support by photographs and videotape.

Other important instrument is Maximally Discriminative Facial Moving Coding System (MAX) in which the analyses are based on the visible expressions that are captured on stills or short video sequences (Desmet, 2003).

b. *Electromyogmphy:* Subtle expressions refer to expressions invisible to the naked eye. They can also be measured because the facial muscle activities result in electrical potentials (Desmet, 2003). The neural activation of the striated muscles in the face generates action of muscle that can be detected by using Facial Electromyographic Activity (EMG). The recordings are gained by using two electrodes placed over the muscle bundle of interest, and the electrical signal given off by the muscle (Larsen & Fredrickson, 1999). Training in electophysiological measurement and collaboration with appropriate expertise is required.

2.5.4. Vocal Measures of Emotion

Vocal expression instruments can measure the influence of emotion in multiple vocal cues such as average pitch, pitch changes, intensity colour, speaking rate, voice quality, and articulation (Desmet, 2003). Vocalization is a bodily process that is sensitive to emotion-related changes in the broader bodily context (Larsen & Fredrickson, 1999). Vocal changes have been assessed by using both

low-tech means which refers to listen with or without training, to audiotape speech samples and evaluating them on emotional terms. In some *high-tech means,* the same audiotapes are digitized and analyzed by electro-acoustic equipment or digital computers.

2.5.5. Physiological Measures of Emotion

Physiological reactions refer to activation or arousal such as increases in the hearth rate. They signify changes in activity in the Autonomic Nervous System (ANS) that is associated with emotions. Various manifestations of emotions can be measured by using different array of techniques such as instruments that measure blood pressure responses, skin responses, papillary responses, brain waves, and heart responses (Desmet, 2003).

a. *Autonomic Measures of Emotion:* Emotions are frequently oriented to act in specific ways like to strike out against a competitor, to escape from imminent danger, or to be near a loved one (Larsen & Fredrickson, 1999). An autonomic measure is the link between emotions and such action tendencies of the Autonomic Nervous System (ANS).

b. *Brain-Based Measures of Emotion:* It refers to the neurophysiological measures of emotion (Larsen & Fredrickson, 1999). Scalp-recorded brain electrical activity, or electroencephalogram (EEC), can index the layout of anterior asymmetries that differentiate specific emotion states.

The major advantage of the facial, vocal and physiological measures of emotions (non-verbal instruments) is that, they are language-independent. Thus they can be used in between-cultures studies (Desmet, 2003). Additionally, they are unobtrusive as they do not disturb participants during the measurement. However, the most obvious limitation of these instruments is that, they can only reliably assess a limited set of 'basic' emotions such as anger, fear, and surprise; they cannot assess mixed emotions.

"Colour, like features, follow the changes of the emotions."

Pablo Picasso

3. COLOUR BASICS

3.1. Colour: A Definition

With no doubt, colour has potency in every side of life. From birth to death, our life scenario covers colour notionally and perceptibly. We perceive and experience them, thus we become more aware of them. Day starts with the sunrise colour and ends with the sunset colour, and in between we also witness various colours with different tones and shades in the natural environment. We design our personal environments and feel sense of belonging with the use of favourite and suitable colours in the design process. Each colour has its own meaning. Thus, each of them evokes different feelings. This suggests that with its potency, it may affect human beings psychologically, physiologically and behaviourally.

It is important to define colour and its dimensions to understand the reason behind its effectiveness. Colour definitions in the literature have different approaches. Scientifically, colour is defined as "a specific visual sensation produced by visible radiation, or colour stimulus that occurs when light from a natural or artificial source is interrupted by an object or a dust particle" (Meervein, Rodeck, & Mahnke, 2007, p. 4). A broader definition might be more suitable for this dissertation as colour being "an inherent property of all

materials and surfaces including everything from light and paint to art, from aesthetics to functionality and as an inseparable element of design" (Dalke, Little, Niemann, Camgöz, Steadman, Hill, & Stott, 2005, p. 343).

3.2. Basic Colour Terminology

To explain the 'sensation' of colour, the three distinct qualities that are hue, brightness (lightness, value) and saturation (chroma, purity) are important. These qualities are also known as dimensions of colour as they can be independently measured (Munsell, 1988; Fehrman & Fehrman, 2000). Without changing any of the other dimensions, it is possible to change one quality. For instance, without changing the brightness and hue rate, a colour may be strengthened or weakened in saturation; without changing the brightness or saturation, the hue may be modified; without influencing the hue or saturation, the brightness may be changed (Munsell, 1988).

Hue is the name of a colour and represents the chromatic aspect. It allows us to differentiate one colour from another such as red from yellow, or green from blue (Fehrman & Fehrman, 2000). White, gray and black as being achromatic colours are considered to be colours without hue (Raskin, 1986).

Brightness, also known as lightness and value, represents the lightness or darkness of a colour (Fehrman & Fehrman, 2000). Thus, it allows us to differentiate a light colour from a dark one (Munsell, 1988). Wyszecki and Stiles (1982) defined lightness as "the attribute of a visual sensation according to

which the area in which the visual stimulus presented appears to emit more or less light proportion to that emitted area perceived as a white stimulus" (p. 494). In making contrast more effective, the attribute of brightness becomes an important aspect. Colour values are also called *shades*. Raskin (1986) defined these terms with the explanations of "adding black to a colour decreases its brightness and produces a shade" (p. 7).

Saturation also known as chroma and colourimetric purity is the strength and vividness of a hue. Thus, it represents the amount of pigment in a colour (Fehrman & Fehrman, 2000). It allows us to distinguish a strong colour from a weak one by representing the distance of a colour sensation from that of white or gray (Munsell, 1988; Saunders, 1998). It is related with the intensity of colour. Saturation is also related with *tints*. Raskin (1986) defines this as "while adding white to a colour decrease its saturation and produces a tint" (p. 7).

3.3. Colour Order Systems

The human eye can differentiate ten million colours (Fehrman & Fehrman, 2000). For differentiating colour from each other fairly accurately, colour order systems were developed. Different systems systematize colour in various ways, each being convincing of its own rightness (Holtzchue, 2006). However, a single colour order system cannot be truly inclusive as colour is a huge topic. Munsell Colour System, NCS, CIELAB and RGB colour model are the most widely used colour order systems in different research areas. The primary objectives of colour ordering systems are to give order to the dimensions of colour

(hue, brightness and saturation), and to differentiate and use colour in a systematic way (Fehrman & Fehrman, 2000; Holtzchue, 2006).

3.3.1. Munsell Colour System

The Munsell system is originated by the artist A. H. Munsell in 1905 and it is one of the most widely used colour order systems (Hunt, 1987). It identifies surface colours in terms of three attributes; hue, value and chroma (Agoston, 1987; Fehrman & Fehrman, 2000). "These attributes of colour are arranged into orderly scales of equal visual steps; the scales are used as dimensions or parameters for the accurate specification and description of colour under standard conditions of illumination and viewing" (Munsell Colour Corporation, 1980, p. 1).

There are ten major hues in the hue circle of the Munsell System that appear in an order (clockwise) (Agoston, 1987; seen in Figure 3.1). Five principal hues are red (5R), yellow (5Y), green (5G), blue (5B), and purple (5P). Five intermediate hues are yellow-red (5YR), green-yellow (5GY), blue-green (5BG), purple-blue (5PB), and red-purple (5RP). These five intermediate hues are after-images of the principal hues, forming the basis for Munsell's complementaries (Hunt, 1987). After-imaging "is an optical reaction that occurs after staring intensely at a hue and then shifting our eyes to a white surface; this second hue is termed the after-image" (Feishner, 2006, p. 11).

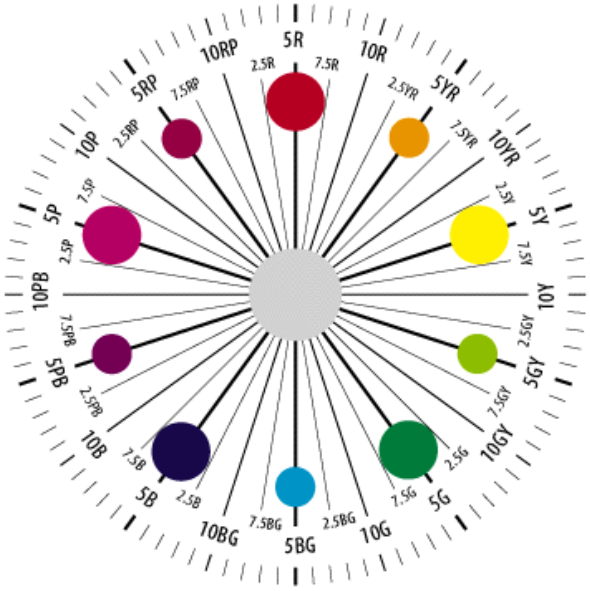


Figure 3.1. A view showing the Munsell hue circle.
(http://www.uwgb.edu/heuerc/2D/ColourSystm.html)

The hue circle is subdivided by a scale including 100 equally spaced *Hue radii.* A *hue range* (for example R) consists of eleven hue radii; 0-10. For each hue range there is a major hue that is located at the middle of each hue range, along *hue radius* 5. The numbering of radii works clockwise from 0 to 10 in each range (Agoston, 1987).

The divisions between 5R and 5YR are designated as; 6R, 7R, 8R, 9R, 10R, YR, 2YR, 3YR and 4YR with similar designations between other hues (Hunt, 1987). Other divisions are represented by using decimals; 2.5 YR is intended to be perceptually midway between samples having hues of 2YR and 3YR.

The Value (V) notation is defined on a scale from 0-10 and refers to the lightness of perceived colour much as the luminance factor (Agoston, 1987). It includes ten main steps, with white designated 10 and black 0, grays from 1 to 9 as they

become lighter (Hunt, 1987). Thus, it shows the lightness or darkness of a colour in relation to neutral gray scale. The value symbol 0/ represents absolute black; the symbol 10/ represents absolute white; the symbol 5/ represents middle gray (Munsell Colour Corporation, 1980). In addition, these symbols are used for all chromatic colours that appear half-way in value between absolute black and absolute white (see Figure 3.2). The Munsell value of a sample in between other samples is designated by using decimals (Hunt, 1987). For instance, a value of 7.5 would be intended to be perceptually midway in lightness from samples having values of 7 and 8.

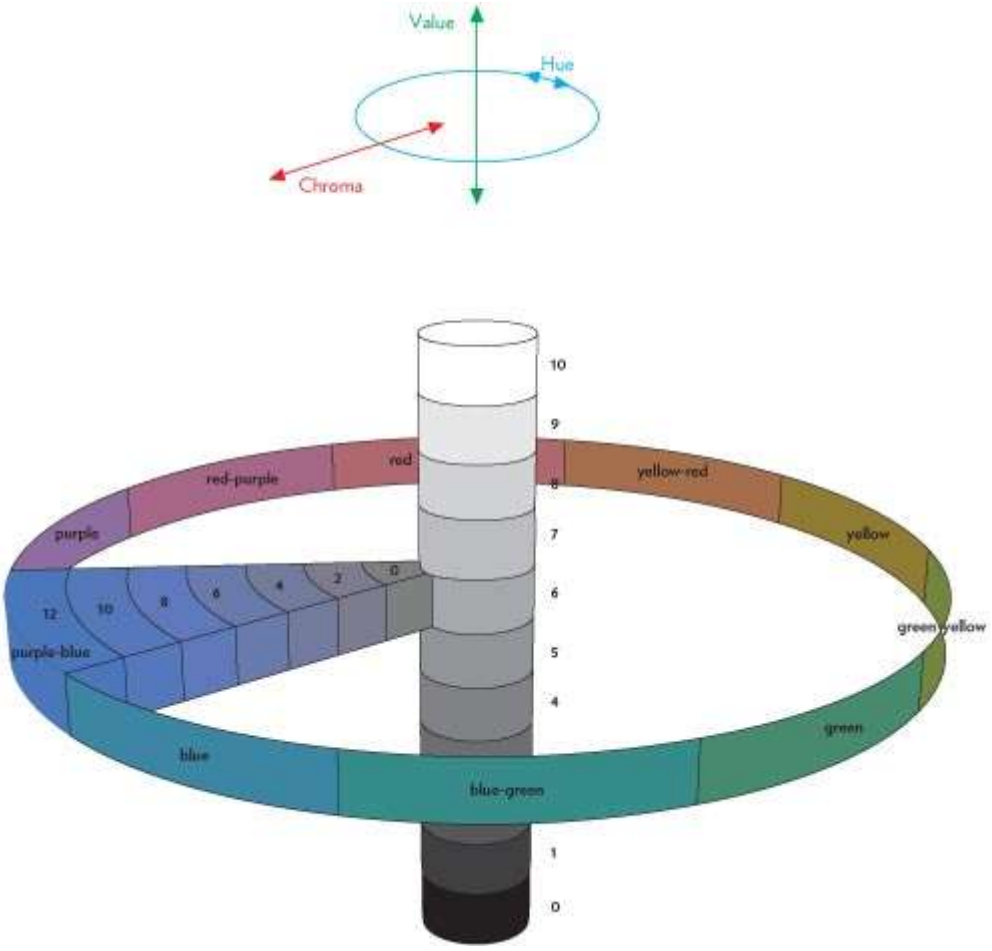


Figure 3.2. A view showing hue, value and chroma scales arranged in colour space.
(http://www.aadip9.net/flavie/2010/02/munsells-color-system-document.html)

The Chroma (C) notation is considered to be the perceived saturation and is defined with its difference from neutral gray of the same value (Agoston, 1987). The scales of chroma are from /0 represent neutral gray out of /10, /12, /4 or farther (Munsell Colour Corporation, 1980). The chroma scale is open-ended (Kuehni, 2000; see Figure 3.2). It is measured along a hue-radius that means the chroma is zero at the centre (neutral gray) and increases outward progressionally to a maximum chroma (Agoston, 1987).

By a colour solid or colour space, Munsell scales of hue, value and chroma can be visualized (see Figure 3.2). The central vertical axis steps from black at the bottom to white at the top. Chroma scales radiate in equal visual steps from the neutral axis outward to the periphery of the colour space (Munsell Colour Corporation, 1980). Hues are positioned on vertical axis showing values from light to dark (Feishner, 2000).

The full Munsell notation for a chromatic colour is always given in the order of H/V/C. The rotation for a neutral (achromatic) colour is written as NV/ (Munsell Colour Corporation, 1980). For instance, 2.5 Y 6/8 indicates that the hue is half way between 10YR and 5Y (slightly orange to yellow) that the lightness is slightly lighter than a medium grey and it has a fairly strong chroma (Hunt, 1987, p. 80).

The physical samples were arranged to form an atlas and Munsell Books of Colour were established by visual means. It displays approximately 150 colour standards arranged in slots on charts for forty different hues. “Each constant

hue chart is printed with a V/C grid and labelled with its hue notation" (Munsell Colour Corporation, 1980, p. 5; see Figure 3.3). The Munsell hue chips are arranged on a square grid to show variations of Munsell value vertically and Munsell chroma horizontally (Agoston, 1987; Hunt, 1987).

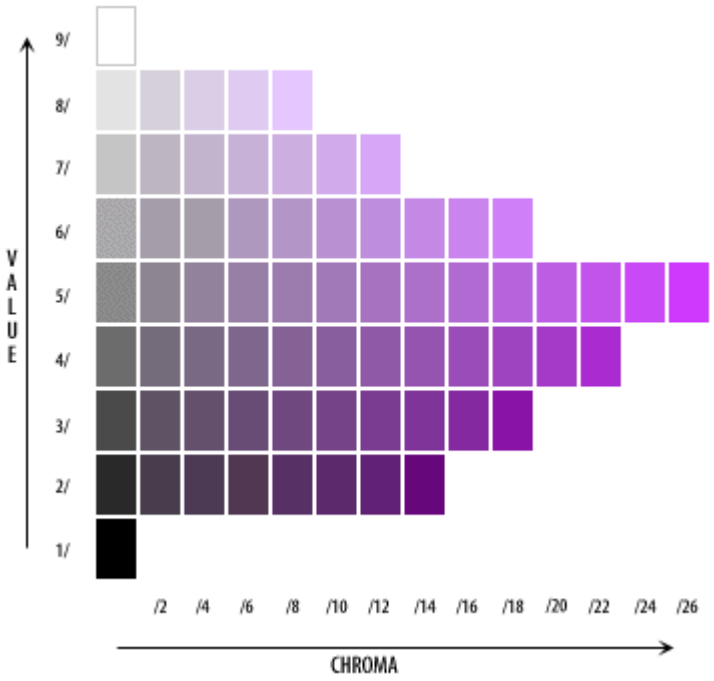


Figure 3.3. A view showing a sample page from Munsell Book of Colour. (http://dba.med.sc.edu/price/irf/Adobe_tg/models/munsell.html)

The Munsell Colour System has various applications because of its simple use. It enables artist to determine the components of a colour without experimentation and provides pigment specifications that are precise (Hunt, 1987). It is used by colour-scientists in government and industry throughout the world. In development and specification of colour designs and the communication of colour information between sales, engineering and production departments, the Munsell notations and colour standards are used (Munsell Colour Corporation, 1980).

3.3.2. Natural Colour System (NCS)

NCS has been developed as an implementation of the Ewald Hering opponent colour system conducted in the nineteenth century (Wyszecki, 1975; Kuehni, 2000; Fehrman & Fehrman, 2000). To describe NCS effectively it is necessary to understand the idea behind the Hering colour system.

According to Hering colour system the hues red, yellow, green and blue are unique hues because they cannot be described in terms of any combinations of other colours (Hunt, 1987). For instance, yellowish red or a reddish yellow is one way to describe orange. However, red cannot be described as such. These four unique hues include two pairs as red and green, and yellow and blue where the colours in each of these pairs are opponents. Having reddish green or a yellowish blue is impossible although yellowish reds as orange or reddish blues as purple are possible.

Together with white and black, these four unique hues make six basic colours that constitute one additional colour pair; white and black (Hunt, 1987). This new colour pair is different from the unique-hue pairs in its opponency, in that blackish white or whitish blacks are possible, experienced as the colour *gray* (p. 86).

These ideas of Hering were developed and revived by the Swedish physicist Tryggue Johansson since 1964 and produced the Natural Colour System (NCS) (Hunt, 1987; Agoston, 1987). NCS allows everyone with normal colour vision to make colour evaluations without the use of colour-measuring instruments or of

colour samples for comparison (Agoston, 1987, p. 133). It describes the formal basic elements of the colour language and it provides the ability to identify characteristic similarities and relations between colours (Hard and Sivik, 2001). It is used directly to determine the perceived colour of surface. A colour is determined in this way as an absolute measure based on colour perception.

NCS is the recognition of six psychological primaries that are six basic colours of Hering colour system: Yellow, red, blue, green, white and black (Wyszecki, 1975; Agoston, 1987; Fehrman & Fehrman, 2000). The first step in judging a colour by the NCS is the determination of its hue. The binary compositions of hues Y, R, B, and G, are presented systematically in NCS colour circle (see Figure 3.4). The NCS hue circle is divided into four quadrants (Y/R, R/B, B/G, and G/Y) by unitary hues that are Y, R, B, G. "The scale that is read clockwise shows standard NCS hue designations" (Agoston, 1987, p. 134). The dashed lines separate hue ranges such as; the hues between G50Y and Y50R are the yellows; the hues between Y50R and R50B are the reds, continuing in the same manner around the circle. In this terminology with yellowish reds and bluish reds, common hue terms such as orange and purple are excluded (Agoston, 1987).

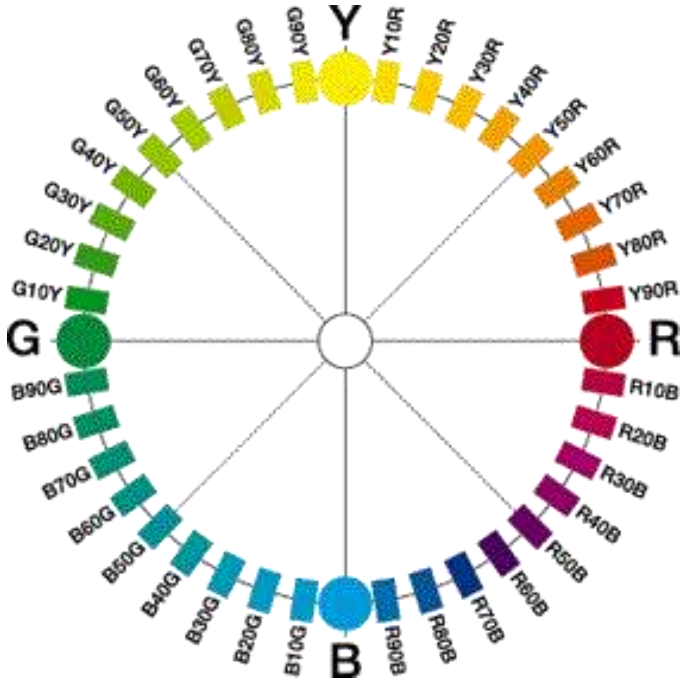


Figure 3.4. A view showing NCS colour circle.
(http://www.ncscolour.co.uk/information/ncs_system.html)

In the NCS, colours are defined by the relative amounts of the basic colours that are perceived presented by percentages (Hunt, 1987). For instance, a medium grey which includes equal amounts of whiteness and blackness is defined as having a whiteness of 50% and a blackness of 50%. A pure red colour with no mark of yellowness or blueness or whiteness or blackness is defined as having a redness of 100%. Therefore, the notation of Y50R in the colour circle represents a 50/50 mixture of unitary yellow and unitary red. Similarly R50B, B50G, and G50Y represent 50/50 mixtures (Agoston, 1987).

To judge hue, two unitary hues and the quadrant of the circle in which the hue is located needs to be identified (Hunt, 1987). For instance, for the mixture of yellow and red, the location is Y/R quadrant. If the hue has 10% unitary yellow and 90% unitary red, then the NCS notation for this hue is Y90R. This notation

represents the chromatic component *C*. If the relative amounts of whiteness (*W)* are 40% and blackness (*S*) 10% and *C* 50% then its NCS specification is S1050-Y90R (see Figure 3.5). In the hue triangle, by the relative amounts of S, W, and C, the perceived colour can be represented (see Figure 3.6).

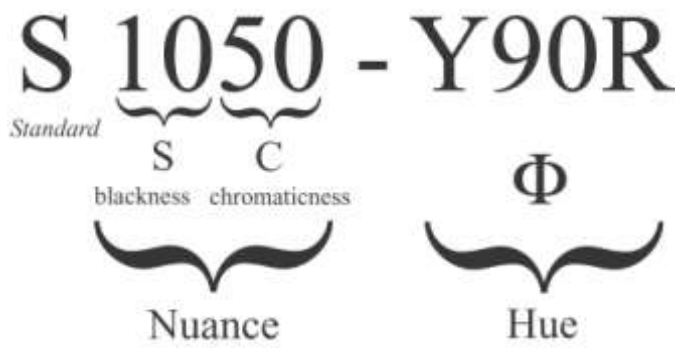


Figure 3.5. One NCS specification.
(http://leopon.co.kr/wp-content/uploads/2007/12/ncs3.jpg)

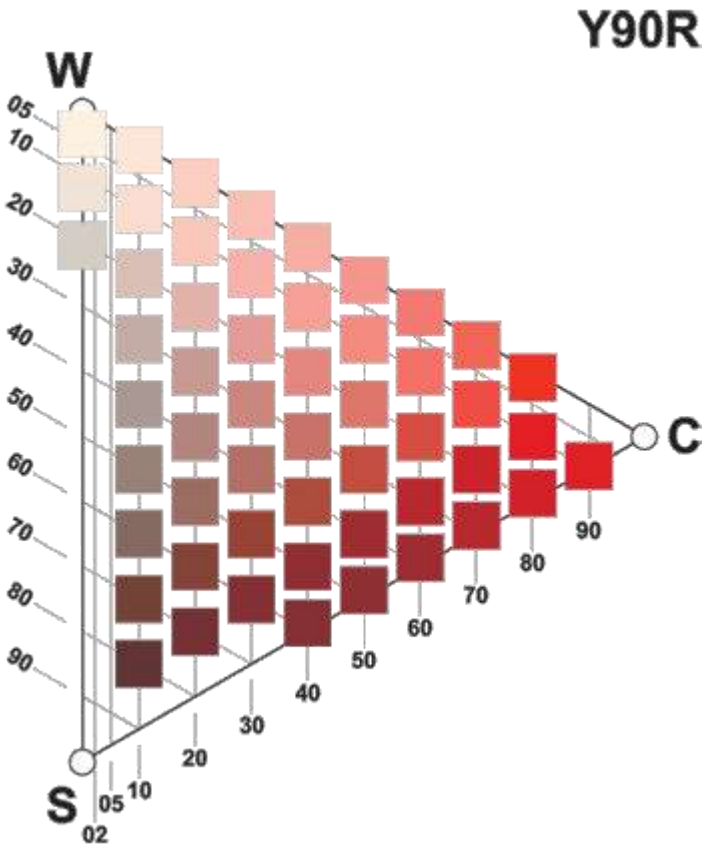


Figure 3.6. One of the NCS hue triangles.
(http://www.ncscolour.co.za/index.php/about/the_natural_colour_system/how_the_system_works)

The Swedish Standard Institution (SIS) has adapted the NCS as a Swedish Standard for colour notation and colour atlas. The NCS colour atlas includes 42 pages and 1750 colour samples (Swedish Standards Institution, 1996). The first page shows the NCS colour circle with 40 colour samples of high chromaticness (saturation), showing the hues selected for the atlas (see Figure 3.4). The second page of the atlas includes colour samples for non-chromatic (purely gray) and slightly-chromatic (near-gray) colours. The other 40 pages include NCS triangles that show different hues and relationships to white and black of a specific hue in each page (see Figure 3.6). In the NCS colour atlas "the chromatic hues are arranged in a circle with nine intermediate steps between each, totalling to forty hues. Then, for each hue, a triangular chart is developed showing the pure hue and its relationship to white and black"
(Fehrman & Fehrman, 2000, p. 205).

To conclude, NCS can be used by people with no particular knowledge about colour and with no previous experience on colour specification or colour measurement (Agoston, 1987). It is the only colour system in the psychology domain; all the descriptions are directly related to the properties of colour percepts (Tonnquist, 1988). The notation is easily understood when compared with the other systems and verbal description of the appearance of a colour is possible. The human brain is the instrument besides a specialized physical instrument. Thus, it is used for describing and ordering by means of psychometric methods, the characteristic relationships between all possible colour percepts of the surface (Hard, Sivik, & Tonnquist, 1996). It is intended to help colourists, manufacturers and users of different kinds of coloured products

to communicate about colour in the sense of colour percepts (Swedish Standards Institution, 1996).

3.3.3. CIELAB

In 1931, the Commission Internationale de l'Eclairage, (the International Lighting Commission; referred as the CIE) an international standardizing body, recommended a system of colourimetric (Padgham & Saunders, 1975). The system is "based on spectrophometric measurements of colour samples illuminated by specific types of lighting and related to the visual response of a *standard observer*" (Fehrman & Fehrman, 2000, p. 209). As an example; it is probable for a sample to reflect green light and to look green under a northern skylight, but it may appear slightly more yellow under artificial light.

The dimensions of colour which are hue, saturation and brightness are the CIE tristimulus values X, Y, Z (red, green, blue) (Yılmaz, 2002) or three independent quantities reproduced from them like x, y and Y (Agoston, 1987). CIE has a chromaticity diagram that companion with x and y. As recognizant of the wavelength and degree of saturation of a given colour, this diagram is used. The spectral pure colours and non-spectral colours that are physically possible to realize are situated inside the diagram (Grandis, 1986). In the centre, there is white light supplied by the source (see Figure 3.7). The chromaticity diagram allows locating the position of every colour arising from the mixture of two or more colours within the given space. Therefore, the chromaticity, purity, and saturation of a colour can be specific in the CIE triangle (Grandis, 1986).

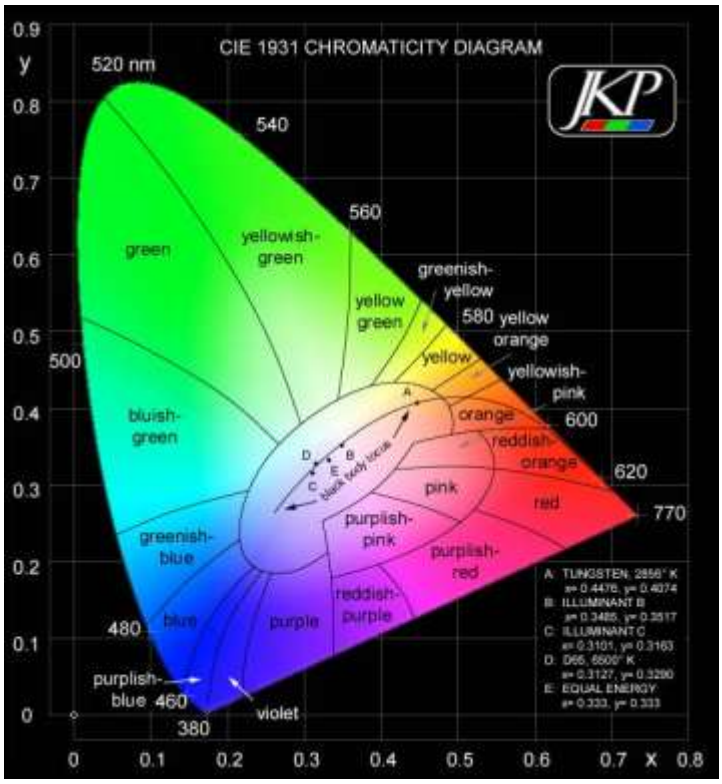


Figure 3.7. The CIE chromaticity diagram.
(http://www.cs.berkeley.edu/~sequin/CS184/TOPICS/ColourSpaces/Colour_0.html)

For introducing three-dimensions of x, y and Y graphically and to plot the points, CIE (x, y, Y) colour space is used. Colour space involves a series of two dimensional chromaticity diagrams in which one is placed above another. Each chromaticity diagram in the series would accommodate points that represent colours of a single luminance Y (Agoston, 1987; see Figure 3.8). The bottom Y=0 represents only one colour: Black.

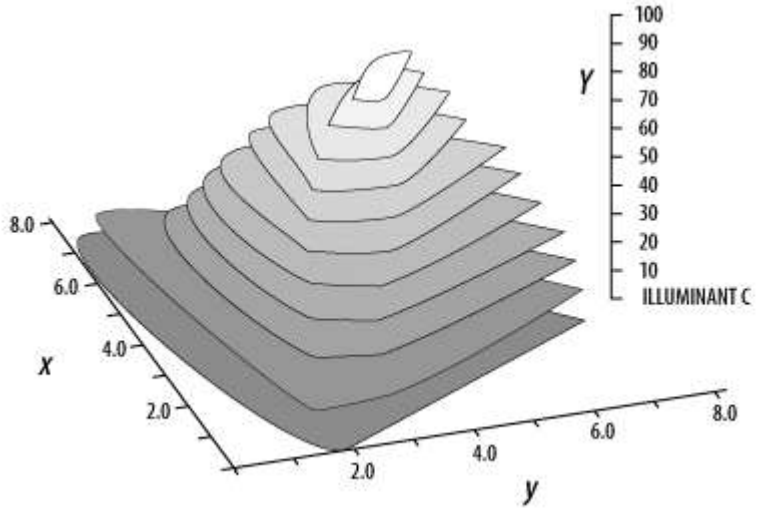


Figure 3.8. The three-dimensions of x, y and Y.
(http://dba.med.sc.edu/price/irf/Adobe_tg/models/ciexyz.html)

The measurement of colour is an important issue. On the other hand, the measurement of colour differences is another important issue. In industry, "in the production of large amount of paint, fabrics and other coloured materials and objects, colours are usually required to match the standards within a stated tolerance of variation; the smaller the tolerance, the more difficult the task of manufacture" (Agoston, 1987, p. 90). CIE system is limited in that; it does not uniformly express differences between colours. For designating colour differences by providing a standard approximately uniform colour scale, CIE recommended CIELAB in 1976 (HunterLab, 2008). It provides an approximate uniform colour space for the judgment of colour differences by mathematical calculation of two sets of tristimulus values X, Y and Z (Agoston, 1987).

" There is a vertical metric lightness *L* axis in the basic structures of the CIELAB that passing centrally through evenly spaced horizontal planes that are subdivided into square grids containing coordinates *a* and *b* which are the tristimulus values"(Agoston, 1987, p. 107; see Figure 3.9). The mathematical calculations that convert tristimulus values to CIELAB colour space values allow colours to be considered as existing in an approximately uniform three-dimensional space (Weatherall & Coombs, 1992). In that space, each specific colour has a unique location defined in terms of its cartesian coordinates with respect to the axes L, a, b (see Figure 3.10). The metric-lightness axis L shows hueless colours ranging upwards from black, through the neutral gray to white. Points in colour space apart from those on the metric-lightness axis shows chromatic colours (Agoston, 1987). *L* represents the lightness coordinate, *a* represents the red/green coordinate and *b* represents the yellow-blue coordinate.

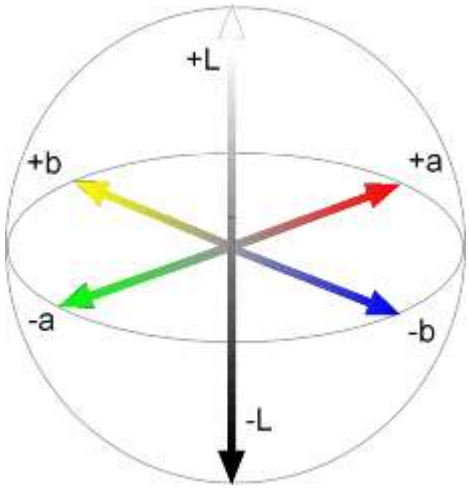


Figure 3.9. The CIELAB colour space.
(http://www.iffo.nl/temp/index.php/en/technicalphotography/colourmanagement/59-adobergbvssrgb.html)

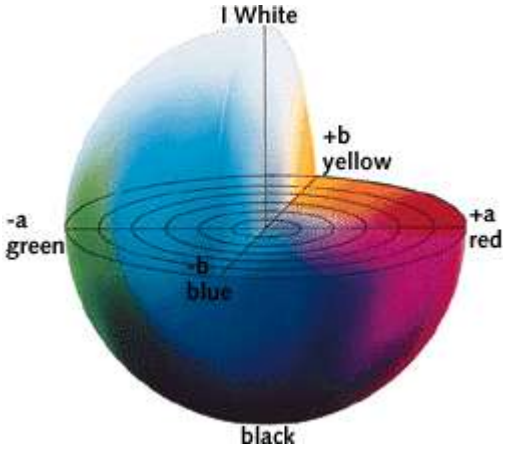


Figure 3.10. The CIELAB uniform three-dimensional colour space. (http://www.sapdesignguild.org/resources/glossary_colour/index1.html)

CIELAB was developed to accommodate a standard, uniform colour scale for the measurement of colour differences. As it was mentioned, CIELAB was recommended especially for matching the standards in the production of material and objects and it is mostly used in industrial colour difference evaluations (Grandis, 1986; Agoston, 1987; Melgosa, 2000; Feishner, 2000). With an objective standard, it eliminates differences in human interpretation, as well as problems caused by the fading of painted or coloured products. Additionally, it has been used by image processing researchers (Connolly & Fliess, 1997) and by researchers who conduct scientific experiments by using a specified instrument for the measurement (Grandis, 1986).

The NCS and the Munsell system collections present various samplings of the same colour (Agoston, 1987). Because of that, a simple relationship exists between them. "NCS judgments of surface colours viewed in daylight could be translated into Munsell notation and then into CIE (x, y, Y) notation without the use of colour measuring instruments" (p. 137). The samples are measured

instrumentally and the CIE data can be converted into Munsell notation or Munsell notations can be converted into CIE by conversion programs (Munsell Colour Corporation, 1980).

3.3.4. RGB Colour Model

RGB colour model is based on creating colours by mixing various proportions of coloured light. The mixing of coloured light is called *additive colour mixture*. Three basic colours are producing white light: Red, green and blue. These colours make up what is called the additive or spectral, primary colours (Raskin, 1986; Ladau, Smith, & Place, 1988).

Mixing red, green and blue light not only creates a white or colourless light but also, by varying the intensities of colours almost any other colour can be obtained (Helen, 1983) (see Figure 3.11). In Figure 3.11, red and blue are mixed to generate magenta; red and green are mixed to generate yellow, while cyan results from the mixture of green and blue. The lights may be mixed by placing coloured filters in front of a projected light ray (Feisner, 2006) (see Figure 3.12).

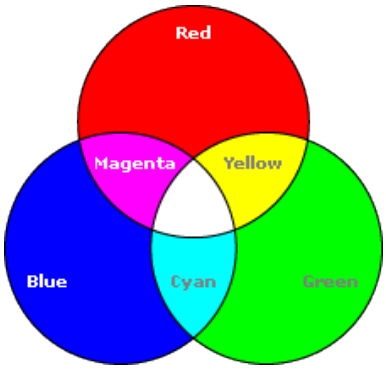


Figure 3.11. RGB chromaticity chart.
(http://www.redminibox.com/products/colourpicker/RGB.php)

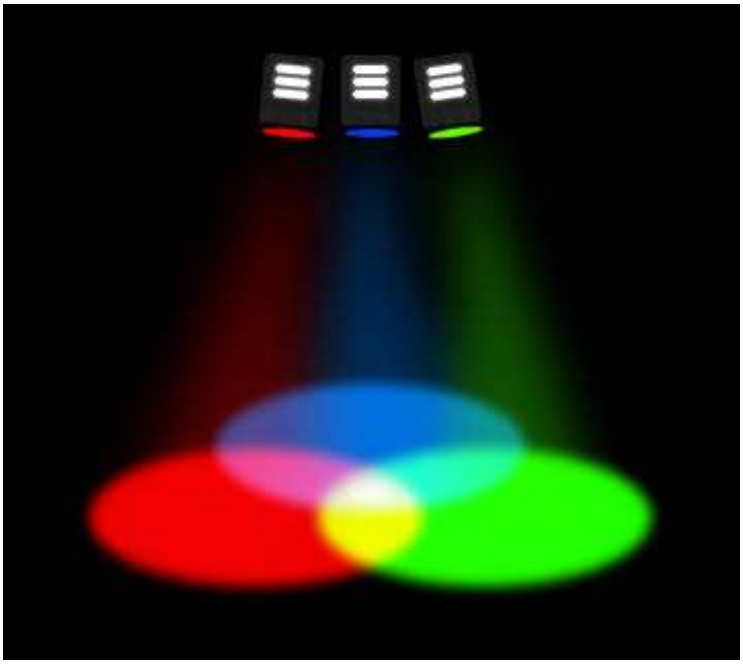


Figure 3.12. A view showing RGB lights together.
(http://vladek.ehion.com/xchange/hsi/colmodels.html)

With the projection of two primary coloured light beams onto a white surface, they will partially overlap (Pile, 1997) (see Figures 3.11 and 3.12). This overlapping area will be brighter than the primaries and if the intensities of the beams are equally balanced, a clear secondary colour will result. For instance,

when projecting red and green coloured light beams, they will overlap and this area will be brighter than either the red or the green area. A clear yellow will result if the intensities of these beams are equally balanced. However, if the red beam is stronger than the green or if the green is dimmed an orange will result. If the green is stronger than the red, than it will produce a yellow-green mix (Pile, 1997). The white that is produced by three additive primaries can be tinted by increasing or reducing one of the three colours.

In RGB colour model, the primary colours are red, green and blue. In between each primary is a secondary colour that is the mixture of two primaries and two tertiary colours that are the mixtures of a primary and a secondary colour (http://blulob.com) (see Figure 3.14). Thus, yellow, cyan and magenta are the secondary colours while orange, yellow-green[1], cyan-green[2], cyan-blue[3],

[1] Yellow-green is also known as *spring green* (http://blulob.com), *chartreuse green* (http://infoacrs.com/nm/design.html), and *lime* (http://eportfolio.pdht.ca/w11_eportfolio/zeliger_isabella/portfolio/print/rgbcolourwheel.php)

[2] Cyan-green is also known as *turquoise* (http://blulob.com), *and aqua* (http://eportfolio.pdht.ca/w11_eportfolio/zeliger_isabella/portfolio/print/rgbcolourwheel.php).

[3] Cyan-blue is also known as *ocean* (http://blulob.com), *azure* (http://infoacrs.com/nm/design.html), and *indigo* (http://eportfolio.pdht.ca/w11_eportfolio/zeliger_isabella/portfolio/print/rgbcolourwheel.php).

blue-magenta[4] and red magenta[5] are the tertiary colours in RBG colour mode. These hues are arranged in RGB colour circle with 12 steps as in Figure 3.13.

There are degrees around the RGB colour wheel, beginning from the top being 0˚ (red) and with a full rotation clockwise being 360˚ and each degree represents a specific colour. Additionally, there are three values that indicate the RGB values and can be anywhere from zero to 255 (http://blulob.com). Zero value to red colour means that there is no red in the selected colour. On the other side, 255 values to red colour means that red is as strong as it can possibly be in the selected colour. This formula is the same for green and blue. Therefore, a 255-0-0 value represents the *pure red* – there are no other hues in the selected colour.

[4] Blue-magenta is also known as *violet* (http://bllob.com; http://infoacrs.com/nm/design.html), and *purple* (http://eportfolio.pdht.ca/w11_eportfolio/zeliger_isabella/portfolio/print/rgbcolourwheel.php).

[5] Red-magenta is also known as *raspberry* (http://blulob.com) and *rose* (http://infoacrs.com/nm/design.html; http://eportfolio.pdht.ca/w11_eportfolio/zeliger_isabella/portfolio/print/rgbcolourwheel.php).

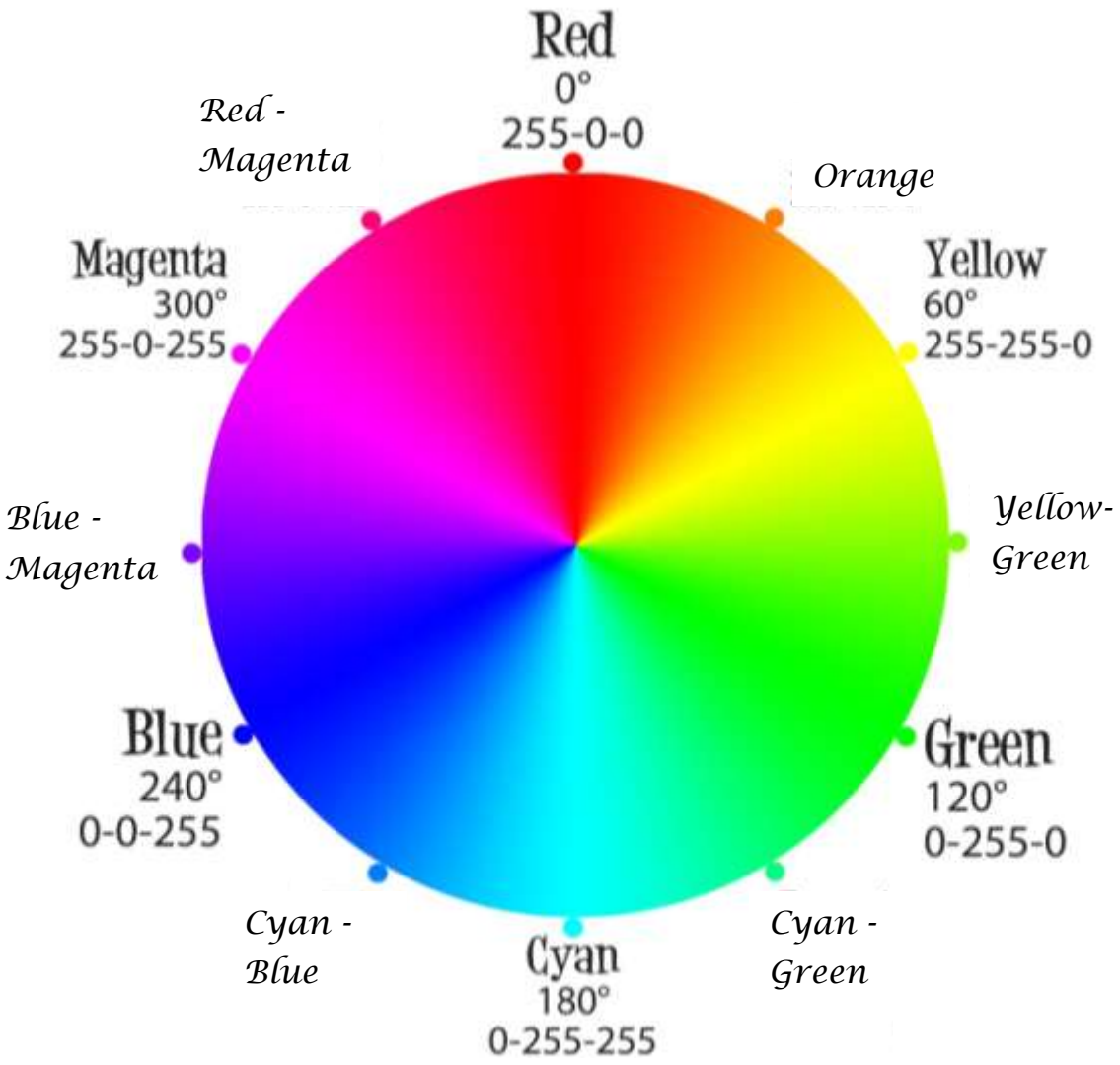


Figure 3.13. RGB colour wheel.
(synthesis of http://blulob.com/2009/03/08/the-rgb-colour-wheel/ and http://www.chainstyle.com/tutorials/colwheel.html)

3.4. The Nature of Colour

Colour is one of the most dominant elements that affect every part of our lives. It works as a guide for making sense of our environment and affects our behaviour by its informational and cultural role (Martinson & Bukoski, 2005). In addition, as it is a phenomenon of a wavelength of light that is transmitted through our eyes, it also has an influence on the quality of our lives. Thus, colour influences us both psychologically and physiologically (Jin et al., 2009).

3.4.1. Colour in Physiology

Each colour and colour combination has its own sensation. They individually or as in relation to each other have a potential of becoming eye irritants and causing headaches. Their appropriate usage can maximize productivity and relax the whole body (Shehata, 2000). It could affect not only people's emotions but also their brain waves, hearth rates, blood pressures and respiratory rates (Kaiser, 1984; Martinson & Bukoski, 2005), secretions of hormones, reactions to stresses, the autonomic nervous system and the cerebral cortex where emotions are located (Jin et al., 2009). In their study, Jin et al. (2009) reported that the red colour appeared to have the most effect on emotional changes and directly affected subjects' parasympathetic nerve system activity which adjusted the blood pressure, the heart rate and the respiratory rates below the normal level. The effect of colours on physiological functions of the body has been effectively used as colour therapy in various medical fields such as depression and cancer.

There is an ancient and widespread faith in the healing power of colour (Helen, 1983). Therefore, colour is suggested to be used as a treatment tool as regard to

colour healing. Colour healers believe in chakras that are evaluated as being energy centres within the human body (O'Connor, 2011). These energy centres are formed by seven chakras. If there is too much or too little energy in each chakra in other words no balance in the energy of chakras then emotional well-being and personality are influenced (Mahnke, 1996). Each chakra gets along with one of the spectral colours that is illustrated below and proper balance in the energy of chakras is restored through colour therapy.

1. Vertex chakra (violet) stands for wisdom, and spiritual energy. It influences the pituitary gland.
2. Forehead chakra (indigo) stands for intuition (third eye) and influences the pineal gland.
3. Larynx chakra (blue) stands for religious inspiration, creativity, language and communication. It influences the thyroid gland.
4. Heart chakra (green, pink) stands for love, sympathy and harmony. It influences the heart and the thymus gland.
5. Solar plexus chakra (yellow) stands for knowledge, intellect and is also the seat of tension. It influences the solar plexus and the adrenal body.
6. Spleen chakra (orange) stands for energy, and it influences the spleen and pancreas.
7. Basis chakra (red) stands for life and reproduction. It influences the sex glands and sexual organs. (Mahnke, 1996, p. 35-36)

Kopacz (as cited in O'Connor, 2011) associated colours with body functions and dysfunctions within each chakra area, such as:

> Red: Activates the circulation system and benefits the five senses; used to treat colds, paralysis, anaemia, ailments of the bloodstream and ailments of the lung;
> Blue: Raises metabolism; is used to stabilize the heart, muscles and bloodstream; used to treat burns, skin diseases, glaucoma, measles and chicken pox, and throat problems;
> Green: Strengthens bones and muscles, disinfects bacteria and virus, and relieves tension; used to treat malaria, back problems, cancer, nervous disorders, and ulcers, and to manage heart problems and blood pressure. (O'Connor, 2011, p. 231)

3.4.2. Colour in Psychology

The physical influences of colour on human beings provoke psychological reactions and psychological manners towards colour impress bodily responses (Birren, 1988). This means colour pervades all aspects of the whole man, his body, mind, spirit, and emotion.

Many psychiatrists and psychologists have noted that reactions to colour are more impulsive and emotional (Birren, 1988). Therefore, colour can have strong influences on people's moods and emotions. Helen (1983) explained emotional reactions to colour as:

> Light of different colours entering the eye can indirectly affect the centre of the emotions in the hypothalamus, which in turn affects the pituitary gland. This 'master' gland controls the entire endocrine system, including the thyroid and sex glands, and so controls the hormone levels of this system and the moods consequents upon them. (p. 44)

In light of the given reasoned chain, medical circles are using colour as an effective method of treatment by stimulating psychological emotion with colour (Jin et al., 2009). The psychological responses to colour are generally studied with their qualitative descriptions in the literature such as anxiety, aggression, and happiness.

"Emotions are the colours of the souls."
W.M. Paul Young, The Shack

4. COLOUR AND EMOTION

The symbolism of colour has been a longstanding subject of study. It is highly intermixed with physiological and psychological responses. Symbolic associations indicate a base pattern for emotional colour approach.

People's mood and emotions are influenced by colour. It individually or in combination might evoke both positive feelings such as happiness, energy, excitement, calmness and negative feelings such as anger, disgust, and sadness. The evaluations of emotional responses of colour are called colour emotion studies.

4.1. Symbolic Associations of Colour – Colour Meanings

Colour symbolism has been stated for centuries from body painting to heraldry (Fehrman & Fehrman, 2000). Colour can transmit meaning from emotional or cognitive messages. Some reactions to colour are inborn, intuitive, and universal to everyone while others lay in the body of learned associations that are dependent both on realities known to everyone and to meanings learned within a particular society in a particular time and place (Pile, 1997). Thus, human beings accept certain colour meanings as facts based on cultural heritage and family values (Fehrman & Fehrman, 2000).

Every colour has a particular set of meanings. Not only physical but also emotional characteristics can be related to any given colour (Ladau, Smith, & Place, 1988). However, there are universally agreed meanings for red, orange, and yellow which are associated with fire, also for blue, green, and violet which are associated with cool oceans, deep forests, and shadows (Fehrman & Fehrman, 2000) (to see the range of colour samples of red, green, blue, yellow, purple, violet and orange from Munsell Book of Colour for Turkish culture, see Şahin Ekici, Yener, & Camgöz's (2006) study).

Colour Analysis

RED

Red is one of the oldest colour names. It is the first colour with a defined wavelength (Petru, 2006). It is assumed to be the colour of blood and fire. These early associations charged red with passionate emotions. It has a primary implication of excitement, heat, intensity, and force (Pile, 1997).

Red's positive connotation involves love (red roses, red heart), luck, passion (red-blood), sexiness (red lipstick), importance (red carpet), dynamism, excitement, richness, royalty and courage (Ladau, Smith, & Place, 1988; Feisner, 2006). Red's negative connotations involve war (red uniforms to disguise blood), blood, fire, the devil, revolution and anarchy (red flag), revolution, danger, fire and bureaucracy.

The term red contains many hues in languages that have only a few terms for colour. Red may include hues of all reds, and hues from the range of oranges,

most yellows, browns, pinks, and even purples (Petru, 2006). Red becomes *pink* when it is reduced to a tint and loses some of its saturation and psychological intensity (Pile, 1997). It becomes gentle and feminine with milder warmth, with charm and delicacy. Pink is associated generally with positive emotions: Being 'in the pink' means 'everything is fine', as when everything is rosy (Fehrman & Fehrman, 2000). Its positive connotations contain health, sweetness, prettiness and femininity (Feisner, 2006).

GREEN

Green has ambivalent connotations, because it is the largest colour family distinguishable to the human eye (Feisner, 2006). It has its own meanings, although it is made from blue and yellow (Ladau, Smith, & Place, 1988). Yellow supplies it some pleasant characteristics while blue makes it seem more calm (Pile, 1997). It is associated with grass, trees and other vegetations and all these make it to be calming and restful to the eyes. This is also commonly related with health and well-being and makes green the most restful colour.

Green's positive connotations include environment, growth, and renewal in spring, fertility, freshness, nature, youth, health, peace and calm, things that are cool and refreshing and wealth, and money (Ladau, Smith, & Place, 1988; Morton, 1997; Freisner, 2006). Green's negative connotations contain witch-craft, jealousy, envy, poison, immaturity, rawness, and sourness.

BLUE

It is the coolest of the cool colours and has no inclusion of warmer tones (Pile, 1997). It symbolizes infinity and serenity in relation to the sky and the sea that surrounds human beings (Fehrman & Fehrman, 2000). On the other hand, it also symbolizes depression, sadness, and isolation. Additionally, bright blue can be a lively colour but it can also lower the body temperature, pulse rate, and blood pressure which stands in opposition to red in its physical effects (Pile, 1997).

Blue's positive connotations involve heaven, coolness, truth, tranquillity, conservatism (in appeal), loyalty and dependability, security, sky water and eyes (Ladau, Smith, & Place, 1988; Morton, 1997; Freisner, 2006). Blue's negative connotations involve introversion, sadness, depression (the winter blues), things that are cold like frost or ice (blue with cold), drowning or illness (turning blue), and melancholy.

YELLOW

It has the highest luminosity after white and this makes it the most easily perceived hue (Feisner, 2006). It can be easily seen before other colours especially when placed with black. This combination –yellow placing against black- is used as a warning sign (to signal hazardous situations in industry).

It has an important role in interior design of being sometimes rated as a more attractive artificial lighting source colour (Pile, 1997). Creams, beiges, and light

tans that are some of the most popular background colours all constitute of yellow tints.

Yellow's positive connotations involve cheerfulness, sun, gold, happiness, vitality, hope, warmth, optimism and serenity. Caution (traffic light), sickness, betrayal, treason, cowardice and fever are the negative connotations of yellow (Ladau, Smith, & Place, 1988; Morton, 1997; Freisner, 2006).

PURPLE and VIOLET

The terms *violet* and *purple* is often confused. Violet is a spectral hue, on the other hand purple is a mixed colour (Fehrman & Fehrman, 2000). Purple is the hardest colour for eye to discriminate (Feisner, 2006). Thus, when using violets and purples, it is critical to approach with caution. In many contexts, they are avoided as being disturbing to many people (Pile, 1997). Violet and purple's associations are conflicting because in the colour circle they are falling in between red and blue which are associated with two opposing values of warmness and coolness. In the electromagnetic spectrum violet does not stand in between two neighbours like orange and green (Pile, 1997). It falls at the end of farthest from red and closest to the blue. On the other hand, purple is simply a mixture of red and blue. In addition to negative approaches, violet is also associated with liveliness, calmness, sensitivity and artistic expression. The positive connotations of purple are aristocracy, spirituality, mystery, luxury, loyalty, awareness, inspiration and passion. Negative connotations of purple are pomposity, mourning, death and rage (Morton, 1997; Freisner, 2006).

ORANGE

Orange is a mixture of red and yellow and is a warm colour (Fehrman & Fehrman, 2000). It shares some of the qualities of its neighbours in the colour circle such as the intensity of excitement attended by red and the sense of cheer association with yellow (Pile, 1997). The brown tones of orange are associated with comfort and security (Fehrman & Fehrman, 2000), and signifies earth, wood, and chocolate (Feisner, 2006). Orange's positive connotations are warmth, fruitfulness, brightness, autumn, energy, activity, excitement; while negative emotions contain danger (fire) and brashness (Morton, 1997; Feisner, 2006).

THE NEUTRALS

Black, white and gray are the achromatics or neutral colours, constituting only of brightness and saturation, without having the hue dimension.

BLACK

Black is a total absence of any chromatic colour (Feisner, 2006) as it absorbs almost all the light of any colour (Ladau, Smith, & Place, 1988). By the addition of some chromatic colours, black can be perceived as warm or cool, because it becomes no longer pure black (Pile, 1997). Dark tones such as dark gray or very dark blues like midnight blue can have the expressive qualities of black.

Black's positive connotations are sophistication especially in fashion, power, strength, seriousness, dignity, formality, and luxury (Pile, 1997; Feisner, 2006).

Most of the associations with black are negative such as death, emptiness, fear, depression, disapproval, mystery and bad luck.

WHITE

White is the opposite of black. A white surface reflects all light in theory, thus it represents maximum lightness (Fehrman & Fehrman, 2000). Although it is defined as a non colour, it results as a combination of all chromatic colours (Pile, 1997). In the modern movement, the colour white has been used extensively. This has made white one of the symbolic attributes of modernism. In addition, manufacturers use a various range of whites with blue, red, yellow and green undertones because it is the best-selling paint (Fehrman & Fehrman, 2000). Together with black, they create a very powerful and sharp contrast of non chromatic colours (Pile, 1997).

White is positively associated with purity, cleanliness, sterility, simplicity, clarity, peacefulness, innocence, angels, brides and snow (Ladau, Smith, & Place, 1988; Pile, 1997; Freisner, 2006). It is negatively associated with emptiness, blackness, boredom, surrender, cowardliness, cover-up, perversion of justice and ghosts.

GRAY

Gray is the mixture of black and white. It is a neutral that can range not only from light to dark but also from totally neutral (non chromatic) tones to warmer tones that are the mixture of chromatic tones with white and black (Pile, 1997).

Light gray does not have strong associative implications as dark gray. Gray in darker tones shares the positive and negative characteristics of black.

Gray is associated with technology, machines, aircraft, concrete, cement and the urban environment (Fehrman & Fehrman, 2000). It implies confusion, loss of distinction (gray area), intelligence, shadow and work (people in gray suits) (Feisner, 2006). It also represents the wisdom of age (gray hair). Light gray especially in warm toned versions are useful as background tones (Pile, 1997).

4.2. Empirical Implementations of Colour and Emotion

Studies on the symbolic association of colour were and are still essential for empirical colour emotion studies. A great deal of research was conducted on the relationship between human emotions and colour and other factors as illustrated in this section. The most common method used for the measurement of emotion is that of the psychological measurement method, the subjective evaluation.

Boyatzis and Varghese (1994) studied children's emotional responses to colours. They reported their emotional reactions depending on the brightness of colours. Children had positive reactions to bright colours, which were pink, red, yellow, blue, purple and green, and had negative reactions to dark colours, which were brown, black and gray. Children stated their positive emotions by mentioning happiness, strength and excitement, and their negative emotions by mentioning sadness, anger and boredom. The colour red created the highest

number of emotional responses where pink the lowest. Colour not only effects human psychological feelings but also effects human physiological responses.

Emotional reactions to colour hue, brightness, and saturation were investigated by using the Pleasure-Arousal-Dominance emotion model (Valdez & Mehrabian, 1994). Red, yellow, green, blue, purple, yellow-red, green-yellow, blue-green, purple-blue, and red-purple were used as colour samples. Brighter and more saturated colours were found more pleasant; less bright and more saturated colours were found more arousing and induced greater feelings of dominance in viewers. In addition, short wavelength hues (e.g. blue) were rated as being the most pleasant, with intermediate wavelength hues (e.g. green) being low levels of pleasantness. The long wavelength hues such as yellow-red and red showed an increase in pleasure ratings. Suk and Irtel (2009) also studied the emotional responses to hues red, yellow, green, blue, and violet by using SAM. Based on SAM ratings the blue colour rated as less exciting, and more dominant than the other hues.

Terwogt and Hoeksma (1995) and Zentner (2001) studied colour and emotion combinations by using matching measures with children and adults. In Terwogt and Hoeksma (1995) study used colours were the primary colours red, blue, yellow, and green supplemented with black and white. The emotions involved were six basic emotions anger, happiness, sadness, fear, surprise, and disgust. For each emotion, participants were asked to point at the colour that they thought best fitted to the feeling given. Children aged 7-years-old combined the colour blue with the emotion happiness, red with surprise and happiness, white

with surprise, fear, and sadness, black with anger; aged 11-year-old combined the colour yellow with the emotion anger, red with happiness and surprise, white with fear and surprise, green with aversion, and black with anger and sadness; adults combined the colour blue with the emotion surprise, yellow with happiness and anger, red with sadness, white with surprise, green with happiness, and black with fear, anger, sadness, and aversion.

The effect of colour hue on emotion is studied by Odom and Sholtz (2000) by using rating scales. The colours used were red, yellow, blue, and a lighter shade of each with the words exciting, calm, and cheerful. Each word had a continuum from one to ten scales. The participants were asked to circle a number on the continuum next to each adjective representing an emotion. Primary colours (red, yellow, blue) were seen as more cheerful and exciting than non primary colours, while non primary colours were seen as more calming than primary colours. In addition, yellow was found both cheerful and exciting while blue was associated with being calm.

In Zentner (2001) study participants were shown three faces displaying a happy, a sad and an angry expression and were asked to match the colours red, yellow, green, blue, brown and black. A bright colour (yellow, red, green) for the happy expression and a dark colour (blue, brown, black) for the sad expression are chosen by children. Mostly red and yellow are chosen for the happy expression; blue and brown for the sad expression. On the other hand, red is rarely matched with happiness and becomes the colour of anger in adults'

colour emotion matches. In addition, sadness is associated with black rather than blue, yellow with happiness, and the non-emotionality of the colour green.

Pos and Green-Armytage (2007) investigated the pairing of six universally representative facial expressions of basic emotions that are anger, surprise, disgust, sadness, happiness and fear with colour samples from Natural Colour System (NCS) by the use of matching measure. Participants were asked to choose from the NCS collection colour samples that they considered best fit the faces. Happiness, surprise, and fear integrated with very light colours (lightness value more than 63); sadness and disgust with colours of intermediate lightness (lightness value in between 50 and 60); and anger with rather dark colours (usually red and black). Anger is characterised by redness and blackness; surprise by yellowness/redness; happiness by yellowness/redness; sadness by whiteness/blackness; fear by whiteness/blackness and some redness/blueness; and disgust appears a little more heterogeneous. Thus, colours relative to sadness and fear are very desaturated, while happiness, surprise and anger are associated with highly chromatic colours as the results agree the idea of considering *active* these last three emotions (happiness, surprise, anger) and *passive* the other three (sadness, disgust, fear). The authors maintain that the colour choices were influenced simply by the emotions conveyed by the facial expressions.

In Manav's study (2007) participants were asked to match the given adjective list with the colour samples from the catalogue according to the emotional response they associate. The responses indicated that the feelings of enjoyment,

cheerfulness, and warmness were attained to the colour samples of pink and yellow; both green and blue samples were favoured for calmness, peacefulness, relaxation, and modernism; green samples on the other hand were associated with boredom, fearfulness, mystery, anxiety, annoyance; blue samples were considered as calming but also were expressed by being cold and dull; yellow samples were indicated as dynamic, warm and cheerful.

Kaya and Epps (2004) investigated the reason for colour emotion associations with open-ended self-report measure. They reported that how individuals associate colours with specific emotions are highly related with the way they associate emotions with things, objects or the physical space. Thus, colour related emotion is dependent on personal preference and ones past experience with that particular colour. For instance, in their study, the colour green attained the highest number of positive emotions, including the feelings of relaxation, followed by happiness, comfort, peace, and hope; and it was associated with nature and trees that create a feeling of comfort and accompanying soothing emotions. As another example, yellow was seen to be energetic and elicited positive emotions as it was associated with the sun and the summer time.

Individuals' colour associations with different building types were studied with college students between ages 18 to 25 years old (Kaya & Crosby, 2006). It was indicated that, colour associations were based on individual and emotional aspects. It was reported that red represented energy, vitality, power, happiness and joy, purple represented fun and creativity, and blue represented truth,

serenity, harmony, relaxation and calmness. Shehata (2000) claimed that orange represented energy, yellow was used for mental stimulation, and green represented harmony and balance.

Gao and Xin (2006) investigated human emotional responses on colours with a psychophysical experiment. Totally 218 colour samples that are a textile version of the Munsell Colour Order System, covering a wide range of hue, lightness, and chroma were used in the study. Subjects were asked to match a more suitable word from 12 word pairs to describe the colour, after viewing a colour sample. Contrary to previously stated studies, it was reported that hue had less influence on basic emotion variables while people were more sensitive to colours with low chroma and high lightness.

A new method for emotional connotations of colour was extended by Clarke and Costall (2008). Unlike the conducted studies in the same field, the participants were not given actual colour samples, thus they were free to imagine their own examples. A semi-structured interview –covering red, orange, yellow, green, blue, purple, black, white, pink, brown and grey- supplied participant freedom to respond in their own terms of descriptions. Red, orange and yellow did evoke the more active emotions and were related to love, anger, passion (red), warmth, sunshine, and sadness (yellow); green and blue to peacefulness, calmness, relaxation, neutral, and sadness; purple to calming and passive nature; pink to femininity; black to power, badness, strength, and death. Grey was mostly regarded as lacking emotion. Most of the participant did not make any comment about emotive qualities, but referred to un-emotive qualities.

Qu, Luo, Sun, Hu, and Chen (2011) examined the impact of age on colour emotion responses. 30 single colour stimuli covered a wide range of hue, lightness and chroma; and 190 colour pairs were used. For each colour stimuli, participants were asked to select words that best describe the shown stimuli. For single colours; older participants had ratings as less active, less liked, and cooler than for younger participants. For colour pairs; light colour pairs were rated as less active and cooler while achromatic colour pairs were rated as cooler, less liked and less harmonious.

Table.4.1. Emotional associations of colour in the literature.

COLOUR	EMOTION	
	Positive emotions	*Negative emotions*
CHROMATIC COLOURS		
RED	happiness, surprise, energetic, powerfulness, enjoyment, passionate	sadness, anger, fear
PINK	enjoyment, cheerfulness, warmness, femininenes	
GREEN	happiness, calmness, peacefulness, hopefulness, relaxation, comfort, modernism	aversion, boredom, fearfulness, anxiety, sadness, annoyance, mystery, neutral, non-emotional
BLUE	happiness, surprise, calmness, peacefulness, relaxation, modernism, harmony, serenity	sadness, fear, dull, cold
YELLOW	happiness, cheerfulness, excitement, surprise, enjoyment, warmness, dynamism, energetic	anger, sadness
PURPLE	creativity, fun, creativity, excitement	
NEUTRALS		
BLACK	powerfulness	sadness, anger, fear, boredom, aversion
WHITE	surprise	sadness, anger, boredom, fear
GRAY	-	sadness, anger, boredom, un-emotive

(Based on the studies by Boyatzis & Varghese (1994); Terwogt and Hoeksma (1995); Odom and Sholtz (2000); Zentner (2001); Kaya and Epps (2004); Kaya and Crosby (2006); Pos and Green-Armytage (2007); Manav (2007); Clarke and Costall (2008)).

"Space is the breath of art."
Frank Lloyd Wright

5. COLOUR, INTERIOR SPACE AND EMOTION

Colour and emotion studies investigate the affinity of these two phenomena mostly by the use of two dimensional stimuli to draw a frame on colour emotion associations. However, colour may also be an efficient tool in interior spaces to cause impressions for various emotions. It is intended for any living environment to be pleasing regarding to its colour, both psychologically and emotionally. To analyze colour emotion associations in interior spaces, it is necessary to identify what an interior space is and the impact of colour on its limits.

5.1. Interior Space

Human beings spend most of their lives in interior spaces that are created by the structures and shells of buildings (Ching, 1987). These interior spaces supply the physical context that involves facts of what we do, and give life to the architecture that houses them.

Space is formed by the relationships of elements in a specific field and humans who perceive it (Ching, 1987). Formulation of a space involves several basic steps; when an element is placed in a field, a visual relationship is constituted; by intruding another element into the field some relationship are accomplished

between the space and the elements as well as among the elements themselves. Thus, we sense shelter and enclosure upon entering a building due to the surrounding columns, walls, floors and ceilings of an interior space that are the major elements of interior spaces (Ching, 1987; Krier, 1992). These architectural elements draw the boundaries of spaces. Windows and doors are used to provide connection with the exterior. Besides the major architectural elements, furniture is another important category of design that acts as an intermediary between architecture and people (Ching, 1987). The selection and arrangement of furniture within the spaces are major tasks of interior design, while walls, floors, ceilings, windows and doors are established in the architectural design of a building.

5.2. Emotional Response to Colour in Interior Spaces

Colour is a flexible and powerful design element. It plays an essential role in design and it touches everything. Colours work as a kind of language and serve as tools of communication between people and the objects surrounding those (Hard & Sivik, 2001). The colour-person-environment relationship is an important theoretical concept for not only designers but also environmental colour researchers. By integrating the concept of colour and the person-environment, more sensitive and relevant environmental design may be achieved. It is important to consider the way people exist in different forms of relationships with the built or physical environment when colouring the buildings and associated environments (Smith, 2008). Colour can be used for breaking the monotony and enhancing different spaces with their colour schemes (Helvacıoğlu & Olguntürk, 2010). However, the colour scheme should

not override the overall atmosphere. Careful settings of colour can make warm environments than they actually are or an appropriate usage can make cool environments to feel warmer (Danger, 1987). Moreover, colour provides legible spaces in terms of spatial perception (Helvacıoğlu & Olguntürk, 2011). Therefore, colours should be used to give the right message to people through the built environment (Kaya & Crosby, 2006).

Even though it has an active role in the relationship between people and their surrounded environment, colour emotion studies fail to concentrate on colour emotion associations in indoor spaces. Studies related with spaces in the framework of colour emotion mainly focus on influences of colour on user performances and also preferences of colour on in environment.

The effect of interior office colours on participants clerical task performance, mood, and colour preferences were studied by Kwallek, Lewis, Lin-Hsiao, and Woodson (1998). It is reported that participants made significantly more proofreading errors in the white office than in the blue and red offices. They scored highest in the orange office, and lowest in the blue and purple offices after the white office. The subjects in the lower saturated office colours made significantly more errors than those in the higher saturated office colours. Overall, they liked the green and red office colours the best and the orange office the least. Additionally, gender differences were found in the preference of the office colour. Males like white, green, blue, and gray colours the most, and gave yellow, purple, and orange colours the lowest score; while females liked green, red and beige the most, and gray and orange the least.

The impact of the colour red on performance in achievement context was examined as the colour red is often associated with danger of failure and evokes avoidance motivation (Elliot, Maier, Moller, Friedman & Meinhardt, 2007). Achievement contexts were evaluated with positive outcomes like success and negative outcomes like failure. The results of the study showed that the participants who viewed the colour red performed worse on the test than those who viewed green or black. Additionally, participants who viewed green performed comparably to those who viewed black.

In Manav's study (2007) individuals were asked to match a colour sample from the catalogue to different areas in residences by stating the reason of preference. They were asked to offer a colour sample from the catalogue as the finishing coating of various areas in residences. Pink sample was preferred for the sleeping room and children's room as it was associated with warmth, romance and enjoyment; blue sample was selected for the living room as it was associated with calmness, peacefulness, being modern and relaxation; yellow sample was selected for the dining area as it was associated with simplicity, being classic and plainness; samples that were close to white were preferred for kitchen, bathroom, entrance, and stair hall as they were associated with purity and hygiene.

6. THE EXPERIMENT

6.1. Aim of the Study

Colour as a design element has influence on human psychological and physiological responses for as much as it evokes discrete feelings. On this account, it constitutes a key factor in the relationship between people and their surroundings. Consequently, environments that enclose people should be carefully and systematically analyzed in association with colour use in order to design environments willing to reduce possible threats on their users. However, though quite a few researches on the relationship between human emotions and colour have been carried out, there are still not enough studies concentrating on specific emotion associations with colour use in interior spaces.

The main objective of this study is to examine the relationship between two crucial phenomenon of design *colour* and *emotion* in interior spaces. While analyzing this issue, the main focuses are on:

- *How individual colours affect human emotional reactions in interior spaces*,
- *Whether human emotional reactions to individual colours differ in a distinctive way in the same interior space,*
- *In what way colours emotional influences are distinguished from each other*,

- *Whether emotional reactions to individual colours in interior spaces differ according to gender.*

In addition to the stated focuses, the other objective of the study is to develop a matrix between colours and emotions associations in interior spaces that would visualize the colours and their associations with different emotions. Thus, it is expected to find out the influence of the use of different colours in interior spaces on human emotions.

6.1.1. Research Questions

1. Do emotional reactions shown to different colours in an interior space differ?
2. Do emotional reactions to a colour in interior space differ according to gender?

6.1.2. Hypotheses

1. Emotional reactions shown to different colours in an interior space differ.
2. Gender effects emotional reactions to a colour in interior space.

6.2. Method of the Study

6.2.1. Sample Group

The study is comprised of a hundred and eighty people who are students enrolled in the İhsan Doğramacı Bilkent University. They were chosen by stratified quota sampling on the basis of their design background and sex. Providing a sample that does not have a design past is thought to be important to be able to supply information to designers and interior architects specifically from user perspective. Thus, a person who had a relation with design such as being a student in the Faculty of Art, Design and Architecture was excluded from the study (see Table 6.1 for the distribution of departments).

Table 6.1. Distribution of the departments.

DEPARTMENT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Computer Science (CS)	47	26,1	26,1	26,1
	Industrial Engineering (IE)	47	26,1	26,1	52,2
	Law (LAW)	11	6,1	6,1	58,3
	Electrical and Electronics Engineering (EEE)	9	5,0	5,0	63,3
	Molercular Biology and Genetics (MBG)	4	2,2	2,2	65,6
	Economics(ECON)	14	7,8	7,8	73,3
	Psychology (PSYC)	4	2,2	2,2	75,6
	Computer and Instructional Technology Teacher Education (CTE	3	1,7	1,7	77,2
	Chemistry (CHEM)	2	1,1	1,1	78,3
	Music (MUS)	2	1,1	1,1	79,4
	Business Administration (BA)	9	5,0	5,0	84,4
	Tourism and Hotel Management (THM)	3	1,7	1,7	86,1
	Mathematics (MATH)	4	2,2	2,2	88,3
	Mechanical Engineering (ME)	3	1,7	1,7	90,0
	International Relations (IR)	5	2,8	2,8	92,8
	Archaeology (HART)	4	2,2	2,2	95,0
	American Culture and Literature (AMER)	2	1,1	1,1	96,1
	Banking and Finace (BF)	5	2,8	2,8	98,9
	Translation and Interpretation (TRIN)	2	1,1	1,1	100,0
	Total	180	100,0	100,0	

The group needed to be balanced as to sex (ninety females and ninety males) to explore gender differences in colour emotion association in interior spaces. The age of the sample group varies in between 17 and 26, and the majority of the subjects were between 19-22 in age (75,63%). The mean age of the sample group is 21,08 (see Appendix B for the detailed information on age distribution of the sample group).

All of the participants were familiar with the computer. 47,2% of them have been using computer for five to ten years, while 52,8% have been using for more than ten years. 67,2% of the participants stated that they use computer a few times a day, 30% of them everyday and a minority 2,8% of them use computer for every other day (see Appendix B, Table B.3 and B.4).

6.2.2. Setting Description

The experiment was conducted at İhsan Doğramacı Bilkent University Library Multimedia Room where covers of music and film collections (see Appendix C, Figures C.1 and C.2). There are seventeen private booths in Multimedia Room which can be used for listening to music, watching films and documentaries and a bigger public study area. As the booths provide private spaces, students are generally using these areas for studying as individuals or as a group. The booths supply an isolated area in which there is not any obvious interaction between inside and outside. This is one of the reasons for the Multimedia Room chosen as an experiment setting. The second reason is related with the sample group. Library is has a collection of sources, resources, and services and is an access

point for print, audio, and visual materials. For this reason, library is frequently used by students who are studying in different departments. Thus, it has a power of gathering diverse people. The sample group for this study includes students who have not got a design past. As the library provides this opportunity and the Multimedia Room supplies a special space for conducting the experiment, it was decided to be used as the setting.

The permission for conducting the experiment was taken from the Directory Department of the Library. The Multimedia Room was open between 08:30-23:00 during the week and 09:00-17:00 at weekends. Thus, the study was conducted during these hours.

The booths had both artificial and daylight illumination. To fix the variables in the experiment setting, one booth without any daylight illumination was selected. However, one side of the selected booth had a window pane. Therefore, during the experiment participants might be affected or disturbed by the outside view. In order to control the potential problem, the window pane was made passive by covering it with a black curtain (see Figure 6.1).

Figure 6.1. A view showing the experiment booth from outside.

The illuminance level was measured with Minolta Illuminance Meter T-10 to understand the lighting situation in the booth after the black curtains were mounted and it was kept the same during the experiment. The illuminance level was fixed to 219 lux. A Philips Master TLD-18W/840 fluorescent lamp was used in the coves for lighting the experiment booth.

The sitting arrangement in the booth was organized to supply the best control of possible veiling reflections[6] on the computer screen (see Figures 6.2 and 6.3). In addition, participants were faced to an unobstructed surface by this interior arrangement.

[6] Veiling reflections occur when the incident light angle on the horizontal work surface is within the observer's viewing zone (Egan, 2002).

Figure 6.2. A view showing the interior organization of the experiment setting.

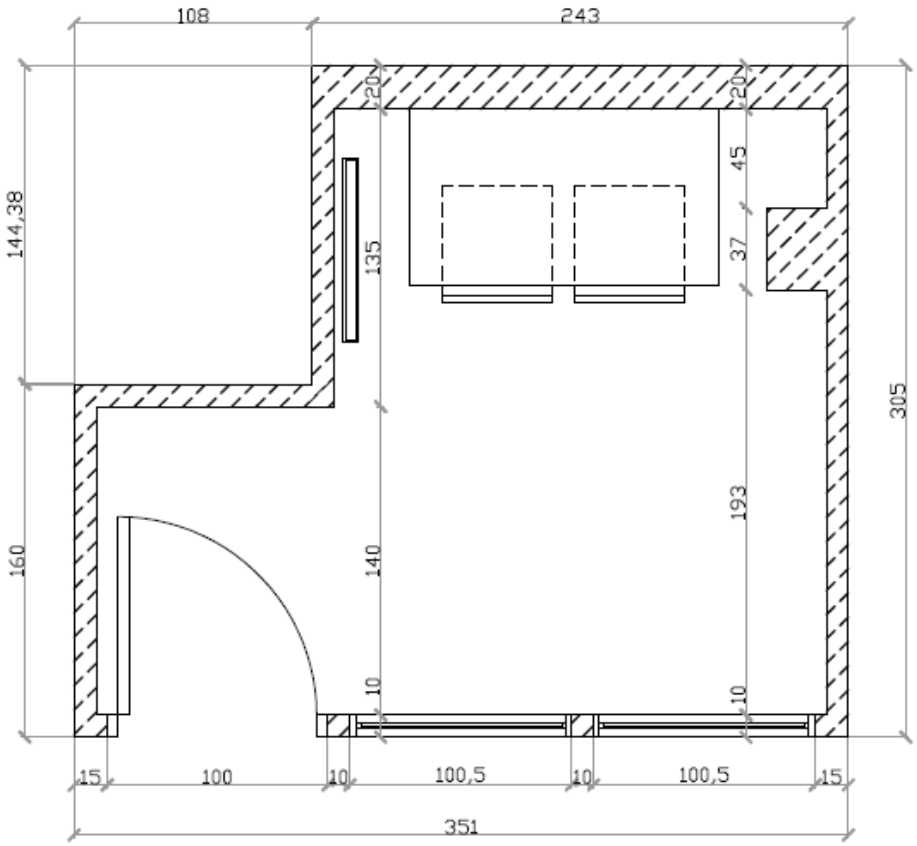


Figure 6.3. Drawing showing the interior arrangement of the booth.

6.2.3. Procedures

6.2.3.1. Selecting the Function

In this study the main goal is to discover human emotional reactions to individual colours in an interior space. In order to specify the kind of space, the user requirements and human needs are analyzed carefully and translated into spatial context.

As regard to human needs, love-belonging needs involve feelings of belonging that involve emotionally based relationships such as friendship and family (Maslow, 1943). When it comes to user identification requirement it is critical to analyze if the space is used by an individual or a group – if a group how many?- of people (Ching, 1987). In territorial requirements it is significant to design spaces that also provide their users personal space, privacy and interaction intentional spaces (Ching, 1987).

In this research, a *living space* was studied. A living space satisfies belonging needs as one has the opportunity to socialize with one's family and friends, refers to large group of user identification, and provides a public space where interaction is possible.

The layout of spaces as physical settings should also satisfy the stated needs in relation with their function. All functions that are taking place in living rooms such as conversing and watching television are analyzed and the required furniture – a bookcase, a TV unit, couches, and a coffee table are selected and arranged (see Figures 6.4). The main concern in configuration of the living room

layout was to provide a seating arrangement that is ideal for creating an intimate chatting space. The book case with the TV unit works as a focal point. Thus, the focal attention will be towards the one area in which by the arrangement of the furniture eyes will naturally be drawn to. Additionally, the furniture arrangement does not create an obstacle for the circulation.

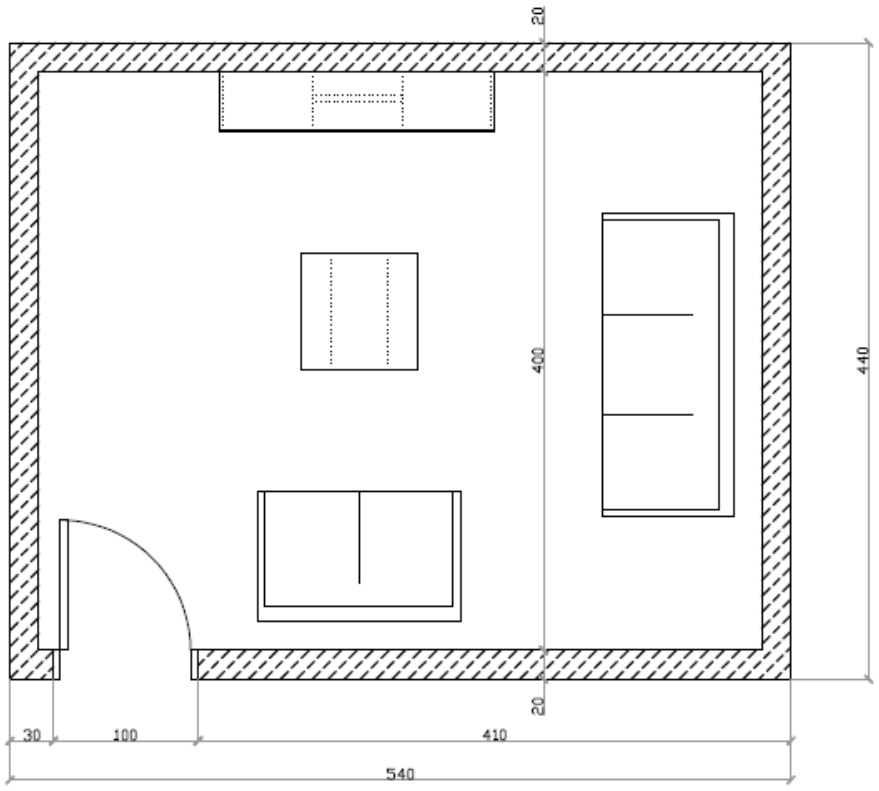


Figure 6.4. Layout of the living room viewed.

In this study, it is critical to distinguish the emotional response to colour thus; other stimulations should be minimal. In order to achieve this intent some design ideas are generated:

- Furniture, floor and ceiling colours are decided to be nearly the same – grey serve as lack of hue- in all spaces as the main variable is the wall colour,

- Simplicity to be another design criteria in decor, line and style of furnitures and textures,
- Spaces to be generic and conventional to eliminate the role of design in itself,
- Natural light or any other special lighting products not to be used to remove the lighting effect.

6.2.3.2. Specifying the Colours

In this experiment, the interior spaces were shown to participants from a computer screen. Computer monitors are using RGB colour model as their method to manage colours. Thus, a computer monitor may allow a wide range of RGB colours. As RGB colour model is based on the way light mixes on a computer screen, Additive Colour Synthesis –RGB Colour Model- was used in specification and selection of colours in this study. The same computer screen was used in the experiment as different monitors may display the RGB different.

In the experiment the colours chosen are primary additive colours (Red, Green, Blue) and an achromatic colour as a control tool for being lack of hue. In experiments concerning colour, it is important to use the colours with the same brightness (value, lightness) and saturation (chroma, chromaticness) for controlling the variables. The aim is to change only the hues, while keeping the perceived lightnesses and saturations of colours the same, in order to understand the effect of hue. Therefore, the lightness (B value) and saturation

(S value) rates were kept the same for each four colours (see Table 6.2). According to Illuminating Engineering Society of North America (IESNA, 2000) guideline, 50 % is the recommended reflectance value[7] for wall surfaces (Egan, 2002). In the light of this information, lightness of colours was adjusted to 50 as they were used for wall surfaces.

To eliminate possible effects of furniture, ceiling and floor colours within the same interior space, these elements were also coloured in grey as being lack of hue. To discriminate furniture, floor and ceiling from each other, they needed to be different in their colour; therefore three different greys were used in the space for those elements. They were chosen according to IESNA recommendations. IESNA recommends 70% reflectance value for ceiling and 20% reflectance value for floor in indoor spaces. Thus, the brightness level for the ceiling was adjusted to 70 and for the floor to 20. For the furniture it was adjusted to 60 (see Table 6.2).

[7] Reflectance is the percentage of light which is reradiated from a surface (Egan, 2002).

Table 6.2. Selected colours from RGB additive colour model.

Groups	Colours	RGB values	HSB values
Wall Colour		R: 255 G: 0 B: 0 *PURE RED*	H: 0 S: 100 B: 50
Wall Colour		R: 0 G: 255 B: 0 *PURE GREEN*	H: 120 S: 100 B: 50
Wall Colour		R: 0 G: 0 B: 255 *PURE BLUE*	H: 240 S: 100 B: 50
Wall Colour		R: 128 G: 128 B: 128 *GRAY*	H: 0 S: 0 B: 50
Floor Colour		R: 51 G: 51 B: 51 *GRAY*	H: 0 S: 0 B: 20
Ceiling Colour		R: 179 G: 179 B: 179 *GRAY*	H: 0 S: 0 B: 70
Furniture Colour		R: 153 G: 153 B: 153 *GRAY*	H: 0 S: 0 B: 60

6.2.3.3. Creating the Interior Space

Interior spaces for the experiment were created in Virtual Environment (VE). The VE were four different coloured living rooms and they were designed in Second Life (see Appendix D, Figures D.1, D.2, D.3, and D.4). The reason for using SL is its closeness to real-world perceptual experience.

Second Life (SL) is a 3D virtual world imitating the real world. It provides a space that people have an opportunity to experience real-world or SL games that are simulations of the world, including a whole simulated ecosystem (Helmer, 2007). The SL is populated with avatars which refer to virtual representations of SL members. Almost all of the objects and places in SL have been created by SL citizens (Rymaszewoski, Wallace, Winters, Ondrejka & Batstore-Cunningham, 2007). It supplies a user-friendly interface (Hendaoui, Limayem, & Thompson, 2008). Users are able to navigate by walking, flying and teleporting between spaces.

After creating the four different wall coloured interior spaces in SL, videos for all those spaces were generated by CamStudio 2.6 Beta program. Each video lasts for 35 seconds starting from the entrance (door) of the space and ending again at the same point.

6.2.3.4. Phases of the Experiment

The study was conducted in two phases;

In the first phase, subjects were asked to fill in a brief questionnaire about themselves (see Appendix E) where they were asked of their gender, age, department of study in the University, usage of computers.

The subjects were asked if they had any eye or vision deficiencies. Subjects who have any vision deficiencies were asked to take the experiment with their correction equipments such as contact lenses or eyeglasses, which they wore

regularly. There were no subjects with severe eye or vision damage who needed to be excluded from the experiment.

Subjects were also given *Ishihara's Tests for Colour-Blindness* (Ishihara, 1975) in the very same room with the experimental setup, under the same lighting conditions. It is a series of plates that are designed to provide a test giving a quick assessment of colour vision deficiency (Camgöz, 2000). It is used to designate the commonest form of colour vision disturbances among them being red-green deficiency the most common. "The test controls whether the subject has a red-green deficiency, which may be of two types: A protan (that may be complete (protanopia) or partial (protanomalia)) and a deutan (which may be complete (deuteranopia) or partial (deuteranomalia))" (Camgöz, 2000, p. 77). After this test, participants were informed about the main objective and procedure of the experiment both written and oral (see Appendix F).

In the second phase, there was a 3D living space with four versions. For each space, all walls as one of the major element of an interior space were coloured with four selected colours (red, green, blue, and gray) separately. Thus, there were same 3D interior spaces with four different wall colours.

Each participant was shown the same space with two different colours. It is critical to eliminate the possible effect of a definite sequence of seeing colours. To control that effect, the sequences of showing the colours were changed systematically (see Table 6.3). According to this strategy, there were six different experiment sets and in each the sequences were different. For each set

there were thirty subjects (15 female, 15 male). Thus hundred and eighty subjects were used in the study in respect to gender and different experiment sets.

Table 6.3. Experiment sets showing the number of participants with the sequence of colours.

		Sequence of Colour	**Participants**	
EXPERIMENT SETS	*SET 1*	Gray, Red	30 (15 female, 15 male)	60 (30 female, 30 male)
	SET 2	Red, Gray	30 (15 female, 15 male)	
	SET 3	Gray, Green	30 (15 female, 15 male)	60 (30 female, 30 male)
	SET 4	Green, Gray	30 (15 female, 15 male)	
	SET 5	Gray, Blue	30 (15 female, 15 male)	60 (30 female, 30 male)
	SET 6	Blue, Gray	30 (15 female, 15 male)	
TOTAL			**180 (90 female, 90 male)**	

Self report measure of emotion was used in the experiment to give the participant the opportunity to express information that only s/he has access. A matching measure in between coloured interior spaces and expressive emotional faces was used in addition to an open-ended measure.

Coloured interior space and emotion matching task constituted of four coloured stimuli and seven faces expressive of six basic emotions and one neutral that include anger, disgust, surprise, happiness, fear, sadness, and representative of

the neutral face expression (see Appendix G, Figure G.1). Firstly, the participant was seated in front of the computer individually and was shown one 3D interior space video with one specific wall colour. Then, s/he was shown the seven faces with no written name of the emotion. S/he was asked to choose a single face representing a specific emotion that best fit the shown coloured interior space. The age and sex of the stimulus face shown in the photographs were held constant with the seven faces. To reduce the influence of coloured photographs on emotion, photographs were used in black and white chosen from Ekman's universal representativeness of basic emotions. Secondly, after choosing a face s/he was encouraged to state the reason for choosing the specific face. No time limit was stipulated. One participant was shown two spaces and did the matching scale two times.

7. FINDINGS

To analyze the data, Statistical Package for the Social Sciences (SPSS) 13.00 was used. Through the analyzing process, Independent Samples *t*-Test, Paired Samples t-Test, Chi-Square Goodness-of-Fit Test and frequency tables were used.

For each coloured room firstly, the effect of sequence of showing coloured rooms (red, green and blue as chromatic, gray as achromatic) and secondly, the gender influence on emotional associations to coloured room was analyzed. Statistical analyses indicated that the showing order of the coloured rooms and gender has no effect on emotional associations to red room and blue room. Thus, final emotional associations to red room and blue room are given without regarding the sequence of showing coloured rooms and gender differences. On the other hand, contrary to red room and blue room, showing order of the green room and gray room effects the emotional associations to green room. However, there is no influence of gender on emotional associations to green room. Thus, final emotional associations to green room are given without regarding gender differences.

Within the scope of the stated aspects, findings from the statistical analyses are given in respect of the experiment sets involving coloured rooms created by the primary additive colours (red, green and blue) and gray colour sequentially. For each coloured room, findings are beginning with the effect of sequence of showing coloured rooms; continue with the effect of gender on emotional associations to coloured rooms and ends with the frequencies that indicate the distribution of emotions on coloured rooms (see Table 7.1 for the overview of frequencies). Additionally, for each experiment set, the comparison of red, green and blue wall coloured room with gray room is given separately in order to understand if there is a difference in their emotional associations.

Table 7.1. The frequency distribution of emotions on the coloured rooms.

	EXPERIMENT SETS						
	1st Experiment Set		**2nd Experiment Set**		**3rd Experiment Set**		
EMOTIONS	RED ROOM	GRAY ROOM	GREEN ROOM	GRAY ROOM	BLUE ROOM	GRAY ROOM	GRAY ROOM IN TOTAL
Anger	3	1	2	0	3	0	1
Disgust	21	22	9	23	8	15	60
Neutral	9	20	15	18	25	23	61
Surprise	4	1	2	0	4	0	1
Happiness	20	0	27	2	8	2	4
Fear	2	2	3	0	6	0	2
Sadness	1	14	2	17	6	20	51
Number of Participants	60		60		60		180

7.1. 1st Experiment Set – Red Room

The first experiment set embodied the rooms with red and gray colours. In this set, there were 60 participants (30 female, 30 male) in total. The sequences of experiencing the coloured room were changed systematically in order to control the effect of showing order (see Table 6.3). The first 15 females and 15 males first experienced the gray room and secondly the red room. The following 15 females and 15 males experienced the red room, then the gray room.

7.1.1. Red Room

To determine the effect of sequence of showing coloured rooms on emotional reactions to red room, Independent Sample (Two-Sample) *t*-Test was conducted. It is used "to determine whether the unknown means of two populations are different from each other based on independent samples from each population" (Elliott and Woodward, 2007). If the means of the two-sample are significantly different from each other, the population means are declared to be different. In Independent Samples Test, the first result is on *F*-test (Levene's test) to evaluate the equality of variance. If the ρ-value on Levene's Test is 0.05 or below, than the value on the bottom line that is 'equal variances not assumed' should be considered; if the ρ-value on Levene's Test is more than 0.05, than the value on the top line that is 'equal variances assumed' should be considered. The *t*-test points out that there is not a significant effect of seeing red room before or after gray room on the emotional reactions to red room (F=1.620, df=58, ρ=.359) (see Appendix H, Tables H.1 and H.2).

The effect of gender on emotional reactions to red room was analyzed by Independent Sample *t*-Test. The test shows that there is not a significant difference between gender groups in their emotional reactions to red room (F=3.242, df=55.682, ρ=.803) (see Appendix H, Tables H.3 and H.4). Thus, gender has no influence on human emotional reactions to red room (see Figure 7.1, Appendix H, Tables H.5 and H.6).

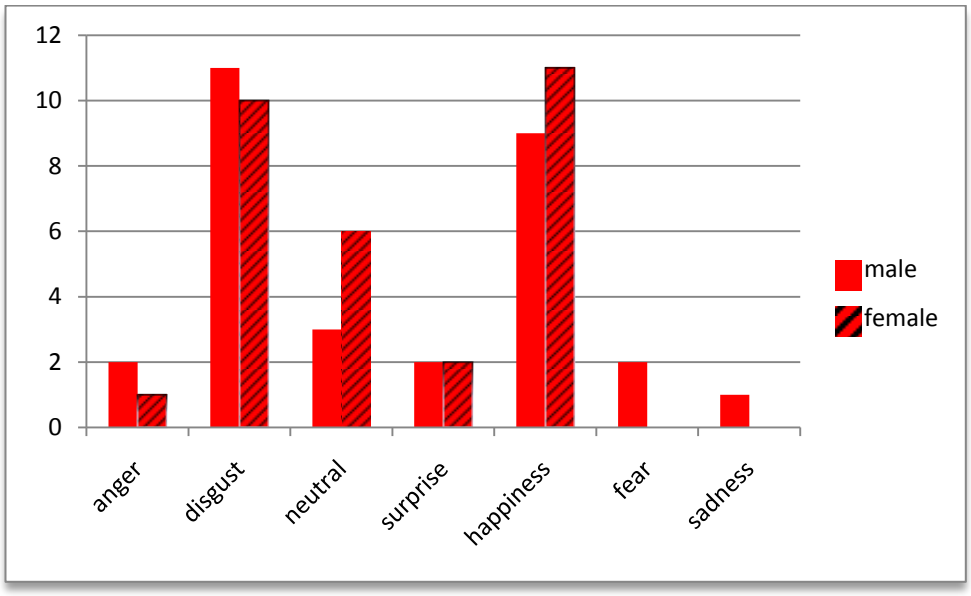


Figure 7.1. The distribution of emotions on the red room in respect to gender group.

The findings for emotional associations to red room are given without regarding the gender differences and sequence of showing the gray room and red room. The findings involve 60 participant's responds who experienced the red room.

The equality of parameters of multinomial probability distribution of seven emotions was tested by the use of Chi-square goodness-of-fit test. It is a non-parametric test that is used for multinomial frequency distribution in cases of

more than two points on the scale (Argyrous, 2005). It is used "to ascertain whether the distribution of observed counts in the various categories of a categorical variable matches the expected distribution of counts under a hypothetical model for the data" (Elliott & Woodward, 2007, p. 143). In this study, the attention is on the frequency of distribution of seven emotions used in the experiment. According to the analyses, the parameters are not equal (χ^2=51.067, df=6, ρ=.000) and this indicates that for the red room, the proportion of participants with seven emotions are not the same (see Appendix H, Table H.7). In other words, the distribution of emotions for 60 participants is different. The figure 7.2 illustrates that the number of participants who associate the emotions of *disgust* and *happiness* are significantly larger than the other emotions. According to the figure, red room was associated with each six basic emotion that is universally accepted and neutral emotion. The percentages from the highest to lowest are as follows: *Disgust* (35%), *happiness* (33.3%), *neutral* (15%), *surprise* (6.7%), *anger* (5%), *fear* (3.3%), and *sadness* (1.7%) (see Appendix H, Table H.8).

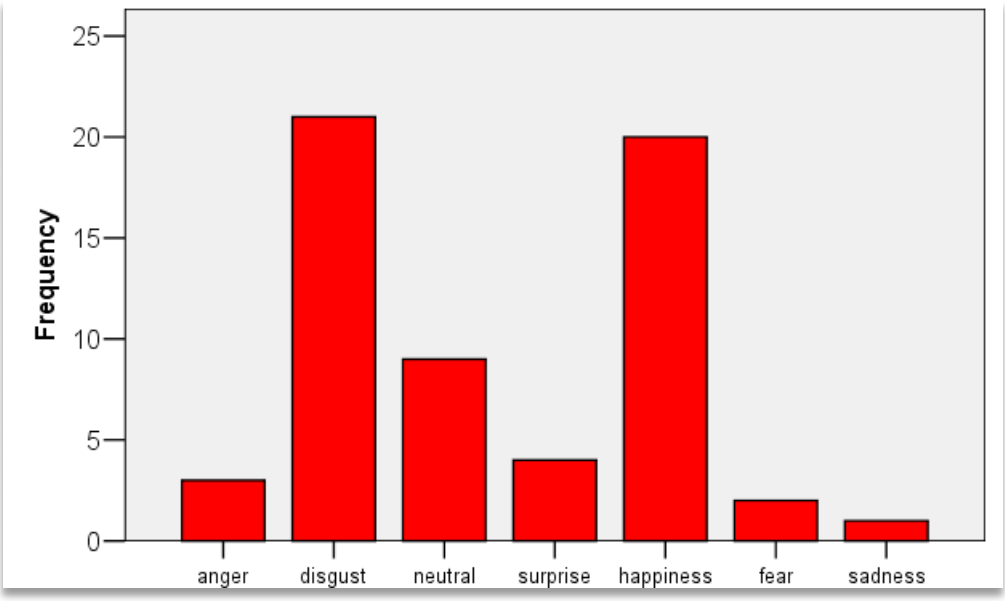


Figure 7.2. The distribution of emotions on the red room.

7.1.2. Gray Room

The impact of sequence of showing coloured rooms on emotional reactions to gray room was tested by Independent Sample *t*-Test. According to the analysis, there is not a significant effect of seeing gray room before or after red room on the emotional reactions to gray room (F=6.363, df=55.214, ρ=.414) (see Appendix H, Tables H.9 and H.10).

To determine the effect of gender on emotional reactions to gray room, Independent Sample *t*-Test was conducted. The test points out that there is not a significant difference between gender groups in their emotional reactions to gray room (F=7.863 df=54.849, ρ=.345) (see Appendix H, Tables H.11 and H.12). Thus, gender has no influence on human emotional reactions to gray coloured room in the first experiment set (see Figure 7.3, Appendix H, Tables H.13 and H.14).

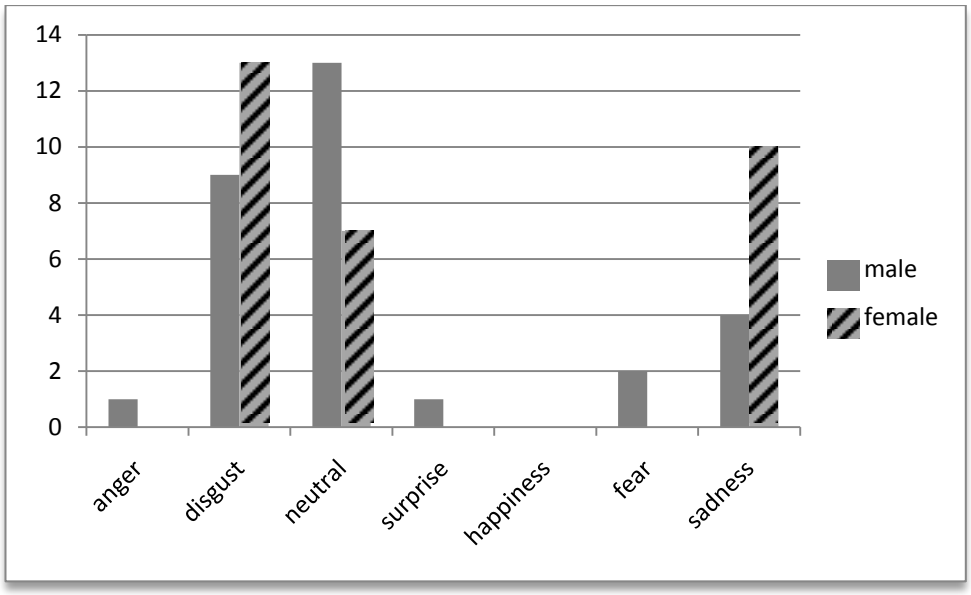


Figure 7.3. The distribution of emotions on gray room in respect to gender group.

The equality of parameters of multinomial probability distribution of seven emotions was tested. The test points out that the parameters are not equal (χ^2=48.600, df=5, ρ=.000) (see Appendix H, Table H.15). The number of participants who match the gray room with the emotions of *disgust*, *neutral* and *sadness* are larger than the other emotions (see Figure 7.4). The gray room was associated with basic emotions that are universally accepted except *happiness* without regarding the gender differences and sequence of showing the spaces. The gray room was not associated with *happiness*. The percentages from the highest to lowest are as follows: *Disgust* (36.7%), *neutral* (33.3%), *sadness* (23.3%), *fear* (3.3%), *surprise* (1.7%), and *anger* (1.7%) (see Appendix H, Table H.16).

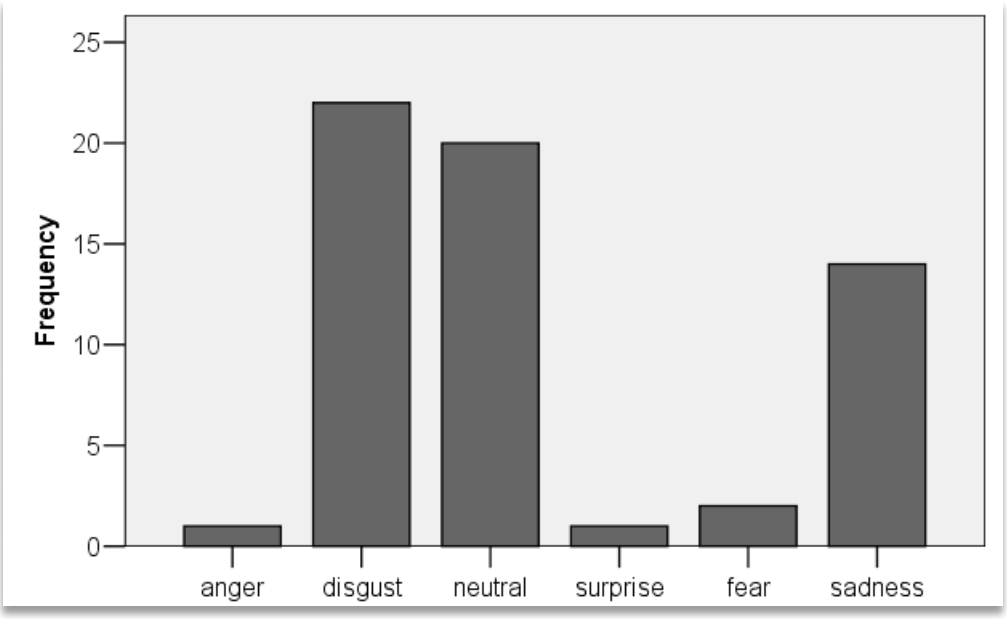


Figure 7.4. The distribution of emotions on the gray room in the first experiment set.

In the first experiment set emotional association to red room and gray room was tested. Emotional associations to red room and gray room were compared with Paired Samples *t*-Test. The analysis points out that there is a significant difference between red room and gray room in terms of their associations with emotional reactions (*df*=119, ρ=.000) (see Appendix H, Tables H.17).

7.2. 2nd Experiment Set - Green Room

The second experiment set involved the rooms with green and gray colours. In this set, there were 60 participants (30 female, 30 male) in total. The sequences of experiencing the coloured room were changed systematically in order to control the effect of showing order (see Table 6.3). The first 15 females and 15 males first experienced the gray room and secondly the green room. The following 15 females and 15 males experienced the green room, then the gray room.

7.2.1. Green Room

The effect of sequence of showing coloured rooms on emotional reactions to green room was analyzed by Independent Sample *t*-Test. The *t*-test points out that there is a significant effect of seeing green room before or after gray room on the emotional reactions to green room (*F*=.019, *df*=57.549 *ρ*=.012) (see Appendix H, Tables H.18 and H.19). 30 participants who experienced green room after gray room associated green room with all seven emotions tested. The percentages from the highest to lowest are as follows: *Happiness* (56.7%), *neutral* (13.3%), *disgust* (10%), *fear* and *sadness* (6.7% for each) and *anger* and *surprise* (3.3% for each) (see Figure 7.5; see Appendix H, Table H.20).

30 participants who experienced green room before gray room associated green room with all emotions except *sadness*. The percentages from the highest to lowest are as follows: *Neutral* (36.7%), *happiness* (33.3%), *disgust* (20%), *anger, surprise,* and *fear* (3.3% for each) (see Appendix H, Table H.21).

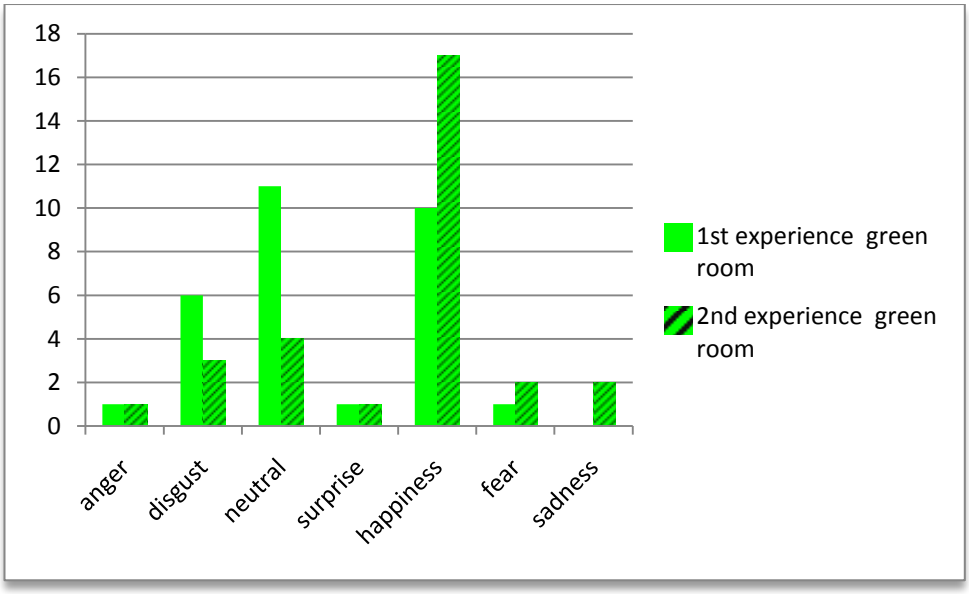


Figure 7.5. The distribution of emotions on the green room in respect to showing order.

The effect of gender on emotional reactions to green room was analyzed by Independent Sample *t*-Test. The test shows that there is not a significant difference between gender groups in their emotional reactions to green room (F=4.513, df=54.048, ρ=.727) (see Appendix H, Tables H.22 and H.23). Thus, gender has no influence on human emotional reactions to green room (see Figure 7.6, Appendix H, Tables H.24 and H.25).

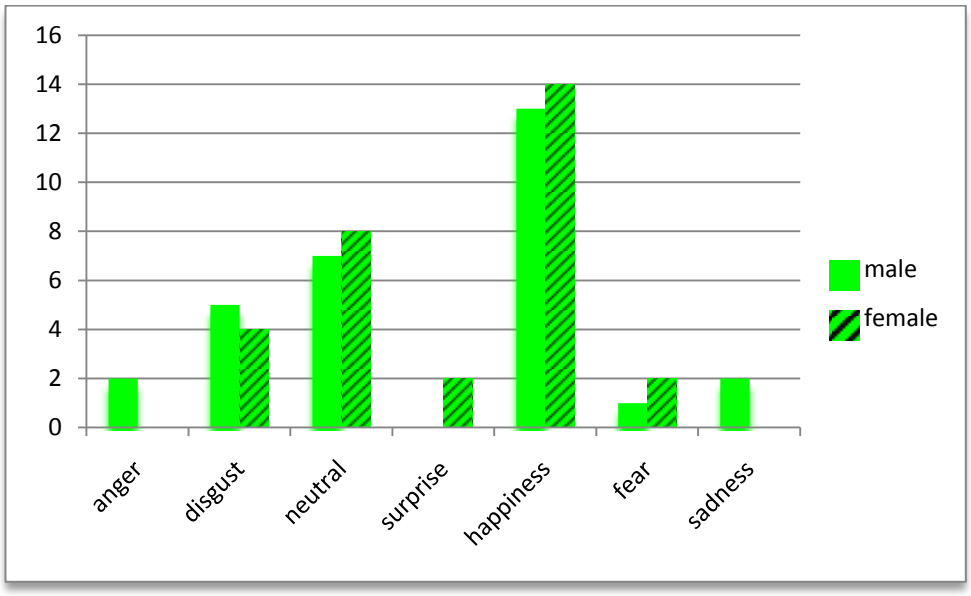


Figure 7.6. The distribution of emotions on the green room in respect to gender group.

As the sequence of showing the rooms has an effect on associations, the findings from 30 participants who first viewed green room are reported for emotion associations. The equality of parameters of multinomial probability distribution of seven emotions was tested. The test points out that the parameters are not equal (χ^2=22.000, df=5, ρ=.001) (see Appendix H, Table H.26). The number of participants who matched the green room with the emotion of *neutral*, *happiness* and *disgust* are larger than the other emotions (see Figure 7.7).

The percentages from the highest to lowest are as follows: *Neutral* (36.7%), *happiness* (33.3%), *disgust* (20%), *fear*, *anger* and *surprise* (3.3% for each) (see Appendix H, Table H.21).

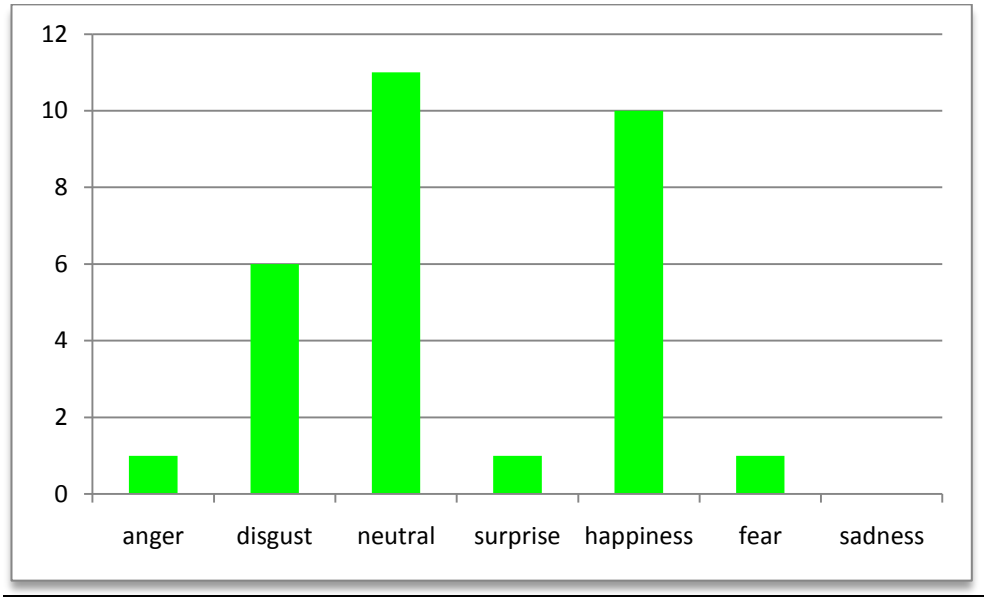


Figure 7.7. The distribution of emotions on the green room.

7.2.2. Gray Room

The effect of sequence of showing coloured rooms on emotional reactions to gray room was tested by Independent Sample *t*-Test. According to the analysis, there is not a significant effect of seeing gray room before or after green room on the emotional reactions to gray room (F=8.825, df=55.461, ρ=.303) (see Appendix H, Tables H.27 and H.28).

For establishing the effect of gender on emotional reactions to gray room in the second experiment set, Independent Sample *t*-Test was conducted. The test points out that there is not a significant difference between gender groups in

their emotional reactions to gray room (F=2.266, df=58, ρ=.431) (see Appendix H, Tables H.29 and H.30). Thus, gender has no influence on human emotional reactions to gray coloured room in the second experiment set (see Figure 7.8, Appendix H, Tables, H.31 and H.32).

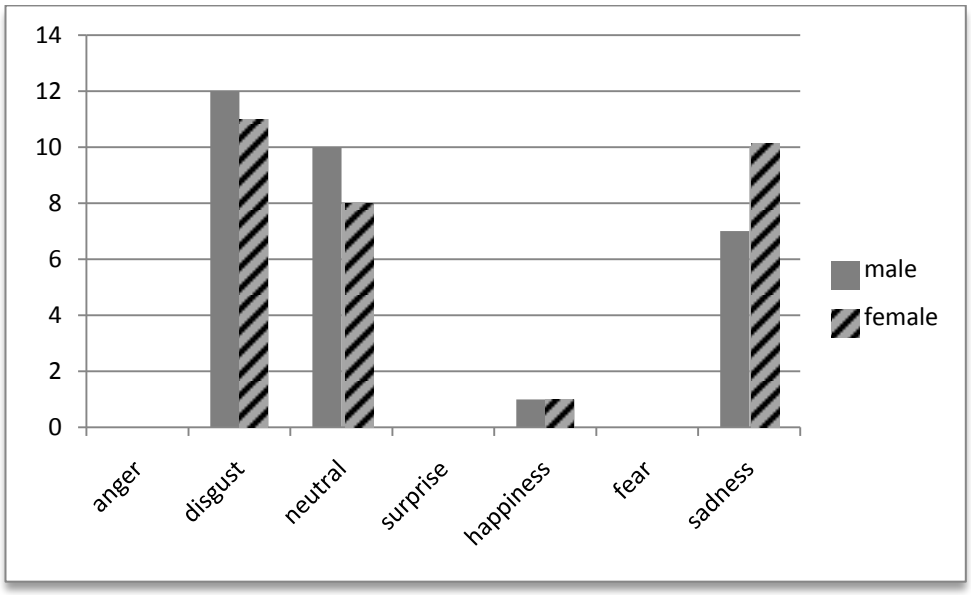


Figure 7.8. The distribution of emotions on the gray room in respect to gender group in the second experiment set.

The findings for emotional associations to gray room are given within the responds of 60 participants involved in the second experiment set. The equality of parameters of multinomial probability distribution of seven emotions was tested. The test points out that the parameters are not equal (χ^2=16.400, df=3, ρ=.001) (see Appendix H, Table H.33). The number of participant who match the gray room with the emotions of *disgust, neutral* and *sadness* are larger than the other emotions (see Figure 7.9). The gray room was associated with basic emotions that are universally accepted except *anger, surprise* and *fear* without regarding the gender differences and sequence of showing the spaces.

The percentages from the highest to lowest are as follows: *Disgust* (38.3%), *neutral* (30%), *sadness* (28.3%) and *happiness* (3.3%) (see Appendix H, Table H.34).

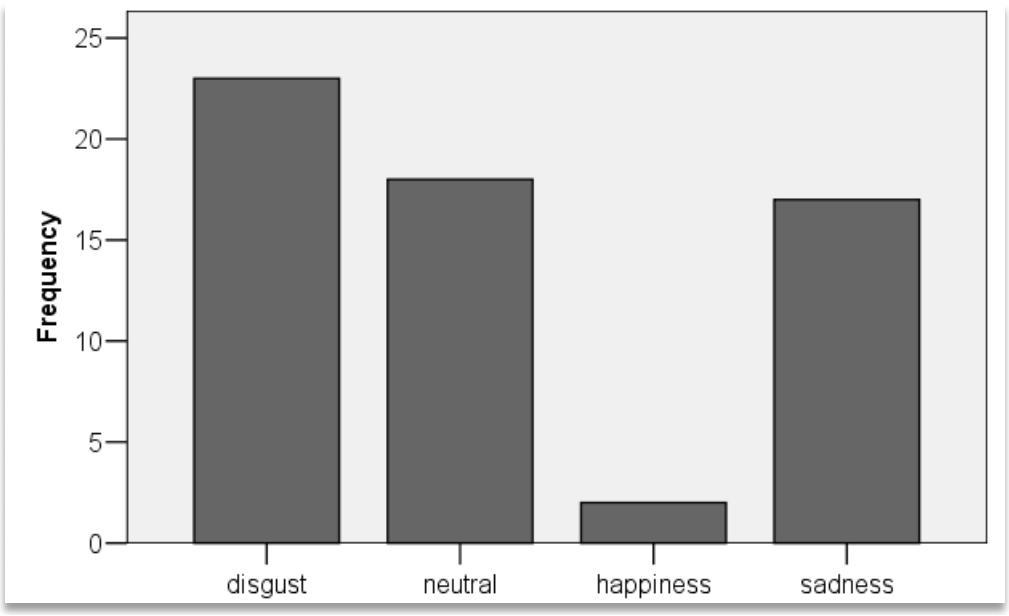


Figure 7.9. The distribution of emotions on the gray room in the second experiment set.

In the second experiment set emotional association to green room and gray room was investigated. Emotional associations to green room and gray room were compared with Paired Samples *t*-Test. The analysis points out that there is a significant difference between green room and gray room in terms of their associations with emotional reactions (df=119, ρ=.000) (see Appendix H, Table H.35).

7.3. 3rd Experiment Set - Blue Room

The third experiment set involved the rooms with blue and gray colours. In this set, there were 60 participants (30 female, 30 male) in total. The sequences of experiencing the coloured rooms were changed systematically in order to control the effect of showing order (see Table 6.3). The first 15 females and 15 males first experienced the gray room and secondly the blue room.
The following 15 females and 15 males experienced the blue room, then the gray room.

7.3.1. Blue Room

The influence of sequence of showing coloured rooms on emotional reactions to blue room was investigated by Independent Sample *t*-Test. The *t*-test points out that there is not a significant effect of seeing blue room before or after gray room on the emotional reactions to blue room (F=.000, df=58, ρ=.880) (see Appendix H, Tables H.36 and H.37).

To determine if there is a significant difference between gender and the emotional reactions to blue room, Independent Sample *t*-Test was used. According to the statistical analyses, there is not a significant difference between gender groups in their emotional reactions to blue room (F=1.870, df=58, ρ=.092) (see Appendix H, Tables H.38 and H.39). Thus, gender has no influence on human emotional reactions to blue room (see Figure 7.10, Appendix H, Tables H.40 and H.41).

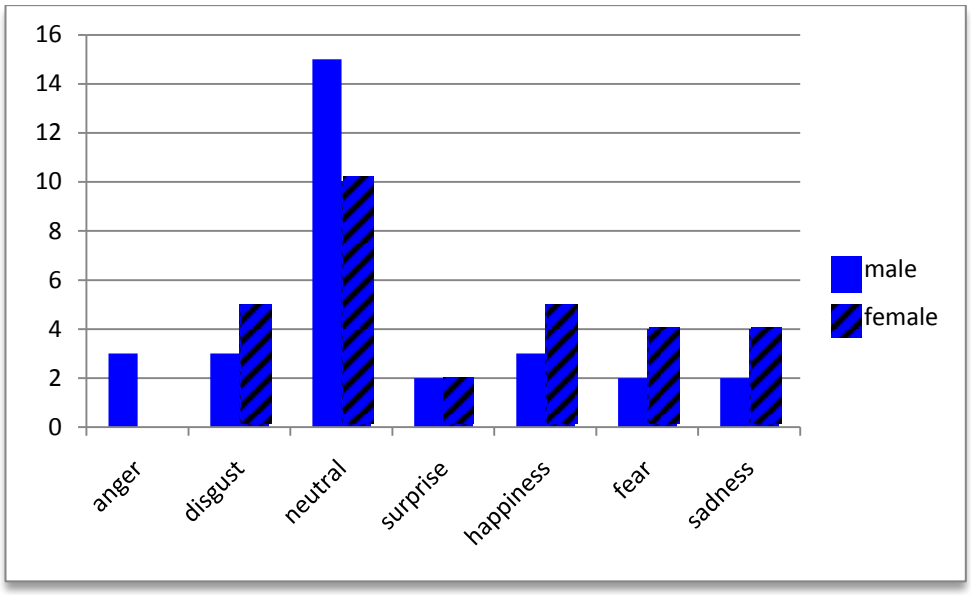


Figure 7.10. The distribution of emotions on the blue room in respect to gender group.

The equality of parameters of multinomial probability distribution of seven emotions was tested. The test points out that the parameters are not equal (χ^2=39.167, df=6, ρ=.000) (see Appendix H, Table H.42). The number of participant who match the blue room with the emotion of *neutral* are larger than the other emotions (see Figure 7.11). Blue room was associated with each six basic emotion that is universally accepted and a large number of associations was with *neutral* emotion. The percentages from the highest to lowest are as follows: *Neutral* (41.7%), *disgust* and *happiness* (13.3% for each), *fear* and *sadness* (10% for each), *surprise* (6.7%) and *anger* (5%) (see Appendix H, Table H.43).

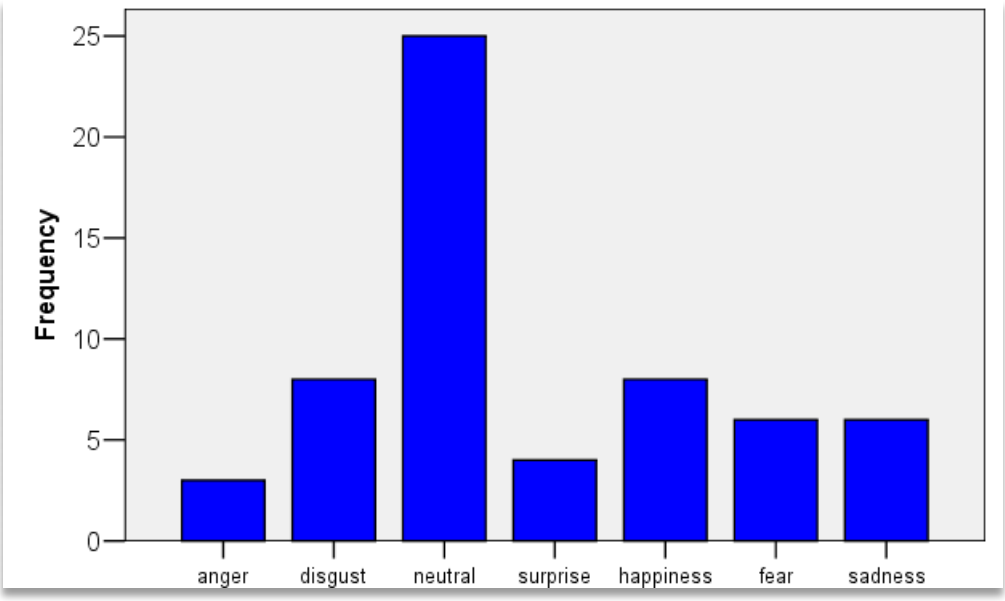


Figure 7.11. The distribution of emotions on the blue room.

7.3.2. Gray Room

The effect of sequence of showing gray room before or after blue room on emotional reactions to gray room was tested by Independent Sample *t*-Test. According to the analysis, there is not a significant effect of seeing gray room before or after blue room on the emotional reactions to gray room (F=2.765, df=58, ρ=.202) (see Appendix H, Tables H.44 and H.45).

The effect of gender on emotional reactions to gray room in the third experiment set was analyzed by Independent Sample *t*-Test. According to the analyses, there is not a significant difference between gender groups in their emotional reactions to gray room (F=.370, df=58, ρ=.364) (see Appendix H, Tables H.46 and H.47). Thus, gender has no influence on human emotional reactions to gray coloured room in the third experiment set (see Figure 7.12, Appendix H, Tables H.48 and H.49).

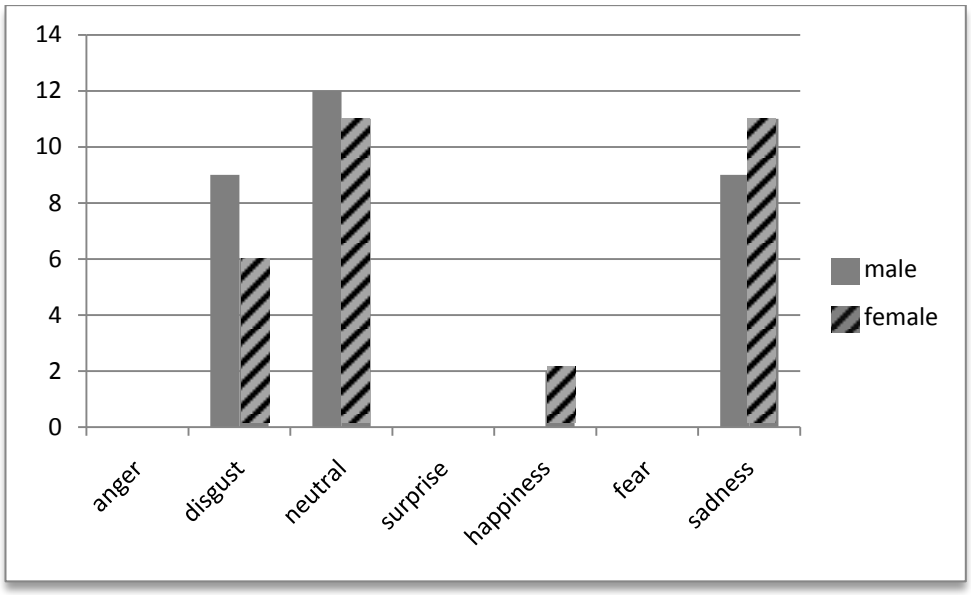


Figure 7.12. The distribution of emotions on the gray room in respect to gender group.

The equality of parameters of multinomial probability distribution of seven emotions was tested. The test points out that the parameters are not equal (χ^2=17.200, df=3, ρ=.001) (see Appendix H, Table 50). The number of participant who matched the gray room with the emotion of *neutral, sadness and disgust* are larger than the other emotions (see Figure 7.13). The frequencies from highest to lowest are as follows: *Neutral* (38.3%), *sadness* (33.3%), *disgust* (25%) and *happiness* (3.3%) (see Appendix H, Table H.51). The gray room was not associated with *anger*, *surprise* and *fear*.

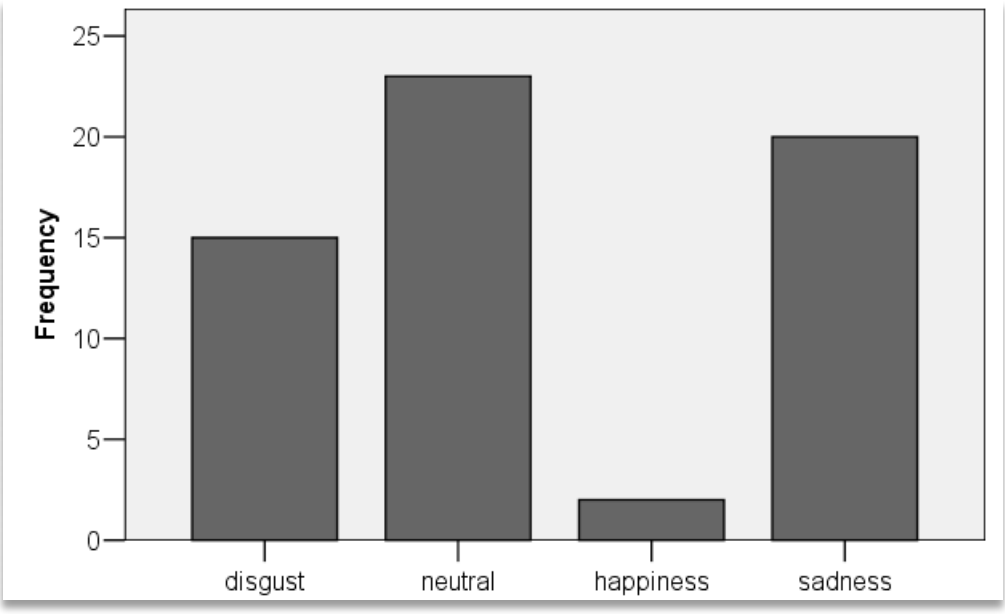


Figure 7.13. The distribution of emotions on the gray room in the third experiment set.

In the third experiment set emotional association to blue room and gray room was investigated. Emotional associations to blue room and gray room were compared with Paired Samples *t*-Test. The analysis points out that there is a significant difference between blue room and gray room in terms of their associations with emotional reactions (*df*=119, *ρ*=.000) (see Appendix H, Table H.52).

8. DISCUSSION

This study comprises three major phenomenons that are '*colour'*, '*emotion'* and *'interior space'*. The main objective is to investigate the influence of different colours in interior space on human emotional reactions. Emotional associations with four different colours were tested in the study. It was hypothesized that emotional reactions shown to different colours in an interior space differ. Thus, an inequality on the number of people who associate a specific emotion with a specific colour was expected. Additionally, this study investigated gender differences on colour-emotion associations. The selected colours for the study were *red*, *green* and *blue*. *Gray* was also tested as being an achromatic "neutral" colour as a control tool. The colours and their associations with emotions were analyzed individually.

Findings of the study were analyzed according to the experiment sets involving coloured rooms of red, green and blue. The first experiment set embodied the red room. The equality of parameters of multinomial distribution of seven emotions that covered anger, disgust, neutral, surprise, happiness, fear and sadness was tested. It was indicated that for the red room, the proportions of participants with emotions are not the same (ρ=.000; see Appendix H, Table H.7). The frequency distributions pointed out that the participants who

associated the emotions of *disgust* and *happiness* are larger than the other emotions.

Red is one of the powerful colours with its associations with passionate emotions such as love, blood and fire (Pile, 1997). Furthermore, it is the colour that creates the highest number of emotional responses (Boyatzis & Varghese, 1994). It is associated with surprise, happiness and sadness (Terwogt & Hoeksma, 1995), energy, vitality and power (Kaya & Crosby, 2006), fear and anger (Pos & Green-Armytage, 2007). Thus, red evokes emotions in a range from the negatives (anger, fear and sadness) to positives (happiness, energy, power).

In this study it was the same, as disgust and happiness were mostly associated with red. That shows the ironic side of this colour. The number participants who matched the red room with happiness were 20 and 14 of them found the red interior space active and energetic. On the other hand, the ones who associated the red room with disgust were 21 and 9 of them mentioned about its discomforting side. Helen (1983) stated the same approach with the explanation of 'red wall in a space can be reassuring and discomforting'. Some expressions recorded after the experiments regarding participants' feelings for the association of disgust with red room are as follows:

> "[...] I do not want to spent time in a space with red walls. It is a very powerful colour, thus I think that after a while I may feel tired [...]".
>
> "I hate the idea of a red room".

"[...] In my estimation, red colour is more appropriate for leisure spaces, not for home".

"Red background can be disturbing especially while trying to focus on something".

The second experiment set involved the green room. The equality of parameters of multinomial probability distribution was tested and pointed out that the parameters are not equal (ρ=.000; see Appendix H, Table H.26). The numbers of participant who match the green room with neutral and happiness are larger than the other emotions. Disgust was also associated with green. The green room was thought to be neutral when it is first experienced. It is interesting to note that when participants experienced the green room after the gray room, they thought by a large number that it was inducing happiness rather than being neutral. Neutral is being allocated to the gray room. Most of the participant who matched green room with neutral wanted to change their responds with happiness after seeing gray room. They stated that after seeing gray, they started to perceive the green room as being a happier environment.

Green is associated with nature and trees which creates a feeling of comfort (Kaya & Epps, 2004). These connotations make it attain the highest number of positive emotions such as feelings of relaxation, happiness, comfort, peace and hope (Kaya & Epps, 2004). Similar to previously done studies, green attained the positive emotion of happiness and neutral. 11 participants over 15 who matched the neutral with green room mentioned that they chose it as it represented calmness and relaxation more than the other facial expressions. Thus neutral was thought to be an outcome of calmness and relaxation, being

a rather positive state. On the other hand, green room was associated with disgust the participants who indicated that colour green was their least favourite colour in their daily lives.

The third experiment set covered the blue room. According to the equality of parameters of multinomial probability distribution of seven emotions, the number of participants who matched the blue room with neutral was larger than the other emotions. 9 participants from 25 who matched the blue room with neutral mentioned that it represented calmness and 8 of them with relaxation same as the green room, again neutral being a rather positive state of emotion. This was expected from the connotations of blue with infinity and serenity in relation to the sky and the sea that represents peacefulness and relaxation (Fehrman & Fehrman, 2000). The previous studies that were done without any reference to interior space reported that blue was associated with happiness (Terwogt & Hoeksma, 1995), calmness, peacefulness, relaxation and modernism (Manav, 2007). Thus, the blue colour is generally associated with these emotions whether the fundamental is interior space or not. On the other hand, in the previous studies blue was also associated with sadness (Zentner, 2001), with being cold and dull (Manav, 2007). In this study participants who associated the room with negative emotions generally complained about the tone of the blue. They found its brightness and saturation values high.

In each experiment set, in addition to chromatic wall coloured rooms, the same interior space was also assessed with an achromatic wall colour. The concern was to control the emotional reactions to chromatic wall coloured rooms. It was

assumed that if the approaches to chromatic room and gray room were the same than hue (colour) of a room was not asserting any emotions. However, emotional reactions for each chromatic room were differed from achromatic spaces. Thus, hue (colour) was found to be significantly affecting emotions for a space.

Emotional reactions to red room and gray room in the first experiment set were compared and the analyses pointed out a significant difference between them (ρ=.000; see Appendix H, Table H.17). The number of participants who matched gray room with disgust, neutral and sadness was larger than the other emotions. As it is mentioned before, red room was mostly associated with disgust and happiness. Although the number of participant who match the interior spaces with disgust were almost the same, not any of them associated gray room with happiness contrary to red room. In addition, sadness was mostly associated with gray room while only one participant over sixty associated this emotion with red room.

Emotional associations to green room and gray room were investigated and the analyses showed a significant difference between these rooms (ρ=.000; see Appendix H, Table H.36). In the second experiment set, the number of participants who matched gray room with disgust, neutral and sadness was larger than the other emotions. Although green was mostly associated with neutral and happiness, only two participants over sixty associated happiness with gray room. Moreover, contrary to gray room sadness was an emotion

within the least associated with green room, while anger, surprise and fear were not associated with gray room in contrast to green room.

Gray room and blue room was also compared in terms of their emotional associations and a significant difference was found (ρ=.000; see Appendix H, Table H.53). According to multinomial probability distribution, the number of participants who matched gray room with the emotions of neutral, sadness and disgust were larger than the other emotions. Anger, surprise and fear were not associated with gray room, while they were associated with blue room. In addition, sadness was one of the most associated emotions with gray room, while that was the least associated one with blue room. The association of neutral with blue and gray room was almost the same. However, the interpretation of neutral was different for gray and blue rooms. Participants matched the blue room with neutral, because they felt that neutral had the most representative facial expressions for relaxation, calmness and peacefulness. On the other hand, for participants who matched gray room with neutral indicated that they did not feel anything towards gray room.

An achromatic wall colour of gray, which did not have any hue in it, was assumed to be a neutral interior with no strong emotional associations. This study showed that in isolation the achromatic gray acted as a colour (as in chromatic colours) on its own right. Gray was associated with neutral as expected as having no feelings towards that colour, but it was also associated with negative emotions that are disgust and sadness (see Table 4.5). Chromatic colours were associated more with positive emotions as being more active

colours than gray (see Table 4.6). Some participants' comments on gray room were:

"It looks like somebody who is pessimistic is living here"

" I hate it"

" I do not feel anything towards that room".

From these perspectives, it is possible to mention that users desire colour in space in order to feel something or in order to create a psychological bond with it.

Table 8.1. Mostly associated emotions with gray room.

	Emotions	
Gray (1st experiment set-red)	Disgust, neutral, sadness	
Gray (2nd experiment set-green)	Disgust, neutral, sadness	
Gray (3rd experiment set-blue)	Neutral, sadness, disgust	

Table 8.2. Mostly associated emotions with chromatic rooms.

Chromatic Rooms	*Emotions*	
Red room	Disgust and happiness	
Green room	Neutral, happiness and disgust	
Blue room	Neutral	

The effect of gender on colour-emotion associations was also examined in this study. It was expected that female and male groups had different approaches to and associations with colours. Previous studies about individual differences in preferences of colour supported that gender played an important role in personal interpretation of colour (Boyatzis & Varghese, 1994; Shehata, 2000). However, contrary to the literature, gender differences were found in the emotional associations of colours.

Pile (1997) claims that a living room should be in colour tones ranging from mildly warm to neutral. Stronger tones should just be used in smaller areas or as accents. According to Pile, although the idea of a *red room*, *green room* and *blue room* may seem attractive, they should be used in a situation where there are a number of living spaces available to give the occupants the opportunity of choosing among the alternatives (1997). According to Helen (1983), in hospitals blue walls have a calming effect. However, in a cafe, the same colour causes employees to complain about a cold environment. Thus, it is fundamental to become aware of the power of colour and design built environments a respect for users' emotional and physiological health.

9. CONCLUSION

Both emotion and colour have a central role in peoples' lives. People are always experiencing these phenomenons consciously or unconsciously in their daily lives. These experiences affect people psychologically and physiologically, thus, colour and emotion have an influence on the quality of our lives. Moreover, colour as one of the major design tools supplies more legible interior spaces to people. With an effective planning in the integration process of colour and space, more sensitive and relevant designs may be achieved. These kinds of spaces become more user friendly and they reduce the possible stress levels of users. Therefore, in a manner, all these three important concepts –colour, interior space, emotion- are related to each other.

A great deal of research on the relationship between human emotions and colour has been carried out. In these studies generally the subjects were asked to match colours with emotion words (Terwogt & Hoeksma, 1995; Zenter, 2001; Manav, 2007), to rate colours with emotional reactions (Kaya & Crosby, 2006; Suk & Irtel, 2009), to match colours with given facial expressions (Pos & Green-Armytage, 2007). However, none of these studies were conducted with any reference to interior space. Thus, there are not enough research dealing with the association of emotion and interior space, and also there is a lack of research

combining both the concepts of colour and emotion in the scope of interior design.

Within the scope of the stated aspects, the main objective of this study was to examine the association between colour and emotion in interior space. Furthermore, it was aimed to develop a general discussion in respect to colour and emotion associations within the framework of interior space to understand the impacts of colours used in interior space on its inhabitants.

Colour and emotion associations in a living room providing conversing, resting and watching functions, were investigated by using self report matching measure. Red, green and blue as chromatic colours, in addition gray as an achromatic colour were chosen to be examined in the study. The study was conducted at Bilkent University, Ankara, Turkey with hundred and eighty participants from various ages and departments. They first watched a short video of a 3D model of a living room with different specified wall colours. Secondly, they were asked to match the coloured living rooms with facial expressions of emotions that were anger, disgust, neutral, surprise, happiness, fear and sadness.

As in all experimental research this study also has its own limitations. These limitations give space for future research to understand more about colour. The limitations are due to the selection of colour, selection of function to interior space and selection of the sample group. This study was limited with four colours out of the available millions. Since the number of colours to be

investigated is increased, the required time for conducting the study would be increased as well. However, the permission taken from the directory department of the library for conducting the study was limited. Future studies can continue on different colours. These approaches allow creating and improving a guideline for designers and interior architects that may be used as a dictionary to illustrate which colour in interior space is associated with which specific emotion.

In this study colour-emotion associations were investigated in a living room. As regard to human needs, a living space provides to fulfil the belonging need as one has an opportunity to socialize with family and friends. It also provides a semi-public space where an interaction is possible. The same study could be repeated and tested with different kinds of spaces. For instance, sleeping room could be tested as being a different kind of space. This would answer the physiological needs by providing sleeping, resting and private area for users. Moreover, spaces serve for diverse functions such as dining, or working, thus cafes, restaurants, bars and offices could also be examined with the cooperation of discrete colours in terms of their associations with emotions.

Gender differences in emotional associations to a colour were examined in the study. The analyses showed that, there were no gender differences in emotional association to any of the used colours. Different demographics such as age, education and socio-cultural factors could be tested in future studies. Additionally, this study was conducted with participants who do not have

a design background in order to provide information to designers and researchers from user perspective. However, future studies could be concentrated on supplying information from participants with design education to draw the possible different approaches.

For future studies that will comprise the issues on colour and emotion in interior spaces, it is critical to point out some suggestions for improving the strength of the study. When studying with colour, in the selection process of colours that are planning to be used in the experiment, at least one of the dimensions of colour should be kept the same. Hue, brightness and saturation generate the identity of a colour. Controlling these variables are important to clarify and analyze whether any effect from a colour takes its source from the hue, brightness or saturation.

Right along with the function, it is also important to decide on the layout of the space. In order to specify the design of a layout, user requirements and human needs for specific function should be analyzed and translated into spatial contexts carefully. Furthermore, the spaces should be generic and conventional; the decoration should be simple in terms of the line and style of furnitures and textures to eliminate the effect of design in itself.

Table 9.1. Mostly associated emotions with living rooms.

	Emotions						
Living Rooms	Anger	Disgust	Neutral	Surprise	Happiness	Fear	Sadness
RED room		■			■		
GREEN room					■		
BLUE room			■				
GRAY room		■	■				■

Pile (1997) claimed that a space generates favourable reactions if it presents a pleasant and proper impression with the use of colour. However, the same space will be depressing and disappointing with an unpleasant use of colour. In order to form some design judgements on the use of colour in spaces, it is utmost to experience colour through exercises and planned experiments. In this study, according to the statistical analyses, the room with red walls was mostly associated with the emotions of disgust and happiness, green room was mostly associated with happiness, blue room was mostly associated with neutral and gray room was mostly associated with neutral, disgust and sadness (see Table 9.1). All these results and the suggestions should be taken into account by architects, interior architects, designers and researchers to obtain more pleasant and healthy spaces.

REFERENCES

Agoston, G. A. (1987). *Colour theory and its application in art and design*. Berlin: Springer-Verlag.

Argyrous, G. V. (2005). *Statistics for research: With a guide to SPSS*. London: SAGE Publications.

Arnold, M. B. (1960). *Emotion and personality: Neurological and physiological aspects*. New York: Columbia University Press.

Ben-Ze'ev, A. (2001). *The subtlety of emotions*. London: The MIT Press.

Birren, F. (1988). *Light, colour and environment*. Pennslvania: Schiffer Publishing Ltd.

Bradley, M. M., & Lang, P.J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behaviour Therapy & Experimental Psychiatry*, *25* (1), 49-59.

Boyatzis, C. J., & Varghese, R. (1994). Children's emotional associations with colors. *The Journal of Genetic Psychology*, *155* (1), 77-85.

Camgöz, N. (2001). Effects of hue, saturation, and brightness on attention and preference. (Published doctoral dissertation). Ann Arbor: UMI Dissertation Services, A Bell & Howell Company.

Cardinal, R. N. (2004). Emotion and motivation [PDF document]. Retrieved from http://egret.psychol.cam.ac.uk/psychology/2003-4/PDF_HANDOUT_MRCPsych_2004_Emotion_Motivation.pdf

Ching, F. D. K. (1987). *Interior design: Illustrated*. New York: Van Nostrand Reinhold Company.

Clark, M. S., & Isen, A. M. (1982). Toward understanding the relationship between feeling states and social behavior. In A. H. Hastorf & A. M. Isen (Eds.), *Cognitive social psychology* (pp. 73-108). New York: Elseiver.

Clarke, T., & Costall, A. (2008). The emotional connotations of colour: A qualitative investigation. *Colour Research and Application*, *33* (5), 406-410.

Connoly, C., & Fliess, T. (1997). A study of efficiency and accuracy in the transformation from RGB to CIELAB colour space. *IEEE Transactions on Image Processing*, *6* (7), 1046-1048.

Dalke, H., Little, J., Niemann, E., Camgöz, N., Steadman, G., Hill, S., & Stott, L. Colour and lighting in hospital design. *Optics & Laser Technology*, *38*, 343-365.

Danger, E. P. (1987). *The colour handbook: How to use colour in commerce and industry*. England: Gower Technical Press.

DeCatanzaro, D. A. (1999). *Motivation and emotion: Evolutionary, physiological, developmental, and social perspectives.* New Jersey: Prentice-Hall.

Dennis, C. (1989). *Introduction to psychology, exploration and application*. St.Paul: West Publishing Company.

Denton, H. G., McDonagh, D., Baker, S., & Wormald, P. (2004). In D. McDonagh, P. Hekkert, Introducing the student designer to the role of emotion in design. J. Van Erp & D. Gyi (Eds.), *Design and emotion: The experience of everyday things* (pp. 415-420). New York: Taylor & Francis.

Desmet, P. M. A. (2003). Measuring of emotion: Development and application of an instrument to measure emotional responses to products. In M. A. Blythe, A.F. Monk, K. Overbeeke & P.C. Wright (Eds.), *Funology: From usability to enjoyment* (pp. 111-123). Dordrecht: Kluwer Academic Publishers.

Egan, M.D. (2002). *Architectural lighting*. New York: McGraw-Hill.

Ekici, Ş. E., Yener, C., & Camgöz, N. (2006). Colour naming. *Optics & Laser Technology*, *38*, 466-485.

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology*, *17* (2), 124-129.

Ekman, P., & Friesen, W. V. (1978). *Facial action coding system (FACS).* Palo Alto: Consulting Psychologist Press.

Ekman, P. (1984). Expression and the nature of emotion. In K. R. Scherer & P. Ekman (Eds.), *Approaches to Emotion* (pp. 319-343). London: Lawrence Erlbaum Associates, Publishers.

Ekman, P. (1992). Are there basic emotions? *Psychological Review*, *99* (3), 550-553.

Ekman, P. (1994). Moods, emotions, and traits. In P. Ekman & R.J. Davidson (Eds.), *The Nature of Emotion: Fundamental Questions* (pp. 56-58). New York: Oxford University Press.

Elliot, A. J., Maier, M. A., Moller, A. C., Friedman, R., & Meinhardt, J. (2007). Colour and psychological functioning: The effect of red on performance attainment. *Journal of Experimental Psychology*, *136* (1), 154-168.

Elliot, A. C., & Woodward, W. A. (2007). *Statistical analysis: Quick reference guidebook with SPSS examples*. London: SAGE Publications.

Evans, D. (2002). *Emotion: The science of sentiment*. New York: Oxford University Press.

Fehrman, K. R., & Fehrman, C. (2000). *Colour: The secret influence*. New Jersey: Prentice-Hall.

Feisner, A. (2000). *Colour: How to use colour in art and design*. London: Laurence King Publishing.

Feisner, A. (2006). *Colour: How to use colour in art and design* (2nd ed.). London: Laurence King Publishing.

Frijda, N. H. (1986). *The emotions*. Cambridge: Cambridge University Press.

Frijda, N. H. (1993). Appraisal and beyond. *Cognition and Emotion*, *7* (3/4), 225-231.

Frijda, N. H. (1994). Varieties of affect: emotions and episodes, moods, and sentiments. In P. Ekman & R. J. Davidson (Eds.), *The Nature of Emotion: Fundamental Questions* (pp. 59-67). New York: Oxford University Press.

Gao, X. P., & Xin, J. H. (2006). Investigation of human's emotional responses on colours. *Colour Research and Application*, *31* (5), 411-417.

Gould, D., Kelly, D., Goldstone, L., & Gammon, J. (2001). Examining the validity of pressure ulcer risk assessment scales: developing and using illustrated patient simulations to collect the data INFORMATION POINT: Visual Analogue Scale. *Journal of Clinical Nursing*, *10* (5), 697-706.

Grandis, L. D. (1986). *Theory and use of colour*. New York: Harry N. Abrahams, Inc.

Hard, A., Sivik, L., & Tonnquist, G. (1996). NCS, Natural Colour System –from concept to research and applications, Part I. *Colour Research and Application*, *21* (3), 180-205.

Hard, A., & Sivik, L. (2001). A Theory of colours in combination – A Descriptive model related to the NCS colour-order system. *Colour Research and Application*, *26* (1), 4-28.

Heise, D. R. (1970). The semantic differential and attitude research. In F. S. Gene (Ed.), Attitude measurement (pp. 235-253). Chicago: Rand McNally.

Helen, V. (1983). *Colour*. London: Marshall Editions.

Helmer, J. (2007). Second life and virtual worlds. *Learning Light Limited*, 1-29.

Helvacıoğlu, E., & Olguntürk, N. (2011). Colour contribution to children's wayfinding in school environments. *Optics & Laser Technology*, *43* (1), 410-419.

Helvacıoğlu, E., & Olguntürk, N. (2010). Colour and wayfinding. In Zennaro, P. (Ed.), *Colour and light in architecture: Proceedings of an international conference held at the Universita Luav di Venezia, Verona, 11-12 November 2010* (pp. 464-468). Knemesi, Verona (Italy).

Hendaoui, A., Limayem, M., & Thompson, C. W. (2008). 3D Social virtual worlds: Research issues and challenges*, IEEE Internet Computing,* 88-92.

Holtzchue, L. (2006). *Understanding colour: An introduction for designers*. New York: John Wiley & Sons.

Hunt, R. W. G. (1987). *Measuring colour*. New York: John Wiley & Sons.

HunterLab. (2008). CIE Lab colour scale. *Insight on Colour*, *8* (7), 1-3. Retrieved from http://www.hunterlab.com/appnotes/an07_96a.pdf

Illuminating Engineering Society of North America. (2000). The IESNA lighting handbook: Reference & application. Illuminating Engineering Society of North America.

Ishihara, S. (1975). *Ishihara's tests for colour-blindness*. Japan: Kanehara Medical Publishing Co. Ltd.

Izard, C. E. (1977). *Human emotions*. New York and London: Plenum Press.

Izard, C. E. (1992). Basic emotions, relations among emotions, and emotion-cognition relations. *Psychological Review*, *99* (3), 561-565.

Jin, H. R., Yu, M., Kim, D. W., Kim, N.G., & Chung A. S. W. (2009). Study on physiological responses to colour stimulation*. International Association of Societies of Design Research: Proceedings of an international conference held in COEX, Seoul, 18-22 October 2009*, (pp. 1969-1979). Korea: Korean Society of Design Science.

Kaiser, P. K. (1984). Physiological response to colour: A critical review. *Colour Research and Application*, *9* (1), 29-36.

Karadoğaner, A. (2010). The effect of emotional facial expressions of a virtual character on people's performance for interactive digital tasks [Unpublished master thesis]. Middle East Technical University, Ankara, Turkey.

Kaya, N., & Epps, H. N. (2004). Relationship between colour and emotion: A study of college students. *College Student Journal*, *38* (3), 396-405.

Kaya, N., & Crosby, M. (2006). Colour associations with different building types: An experimental study on American College students. *Colour Research and Application, 31* (1), 67-71.

Krier, R. (1992). *Elements of architecture* A. C. Papadakis, (Ed.). London: Academy Editions.

Kuehni, R. G. (2000). A comparison of five colour order systems. *Colour Research and Application, 25* (2), 123-131.

Kwallek, N., Lewis, C.M., Lin-Hsiao, J. W. D., & Woodson, H. (1998). Effects of nine monochromatic office interior colours on clerical tasks and worker mood. *Colour Research and Application*, *21* (6), 448-458.

Ladau, R. F., Smith, B. K., & Place, J. (1988). *Colour in interior design and architecture*. New York: Van Nostrand Reinhold.

Larsen, R. J., & Fredrickson, B. L. (1999). Measurement issues in emotion research. In D. Kahreman & N. Schwarz (Eds.), *Wellbeing: Foundations of Hedonic Psychology* (pp. 40-50). New York: Russell Sage.

Lazarus, R. S. (1968). Emotions and adaptation. In W. J. Arnold (Ed.) *Nebraska symposium on motivation* (vol.16. pp. 175-265). Lincoln, NE: University of Nebraska Press.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Leventhall, H. (1984). A perceptual motor theory of emotion. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 271-291). London: Lawrence Erlbaum Associates, Publishers.

Levy, R. I. (1984). The emotions in comparative perspective. In K.R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 397-412). London: Lawrence Erlbaum Associates, Publishers.

Luce, M. F., Bettman, J. R., & Payne, J.W. (1997). Choice processing in emotionally difficult decisions. *Journal of Experimental Psychology*: *Learning, Memory, and Cognition*, *23* (2), 384-405.

Lupton, D. (1998). *The Emotional Self: A Sociocultural exploration*. London: SAGE Publications.

Mahnke, F. H. (1996). *Colour, environment, and human response*. New York: Wiley.

Manav, B. (2007). Colour-emotion associations and colour preferences: A case study for residences. *Colour Research and Application*, *32* (2), 144-150.

Martinson, B., & Bukoski, K. (2005). Implication: Seeing colour. *Informe Design, 3* (5), 1-5. Retrieved from http://www.informedesign.umn.edu/_news/may_v03r-p.pdf

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, *50*, 370-396.

Meervein, G., Rodeck, B., & Mahnke, F. H. 2007. *Colour: communication in architectural space*. Switzerland: Birkhauser Verlag.

Melgosa, M. (2000). Testing CIELAB -based colour- differences formulas. *Colour Research and Application*, *25* (1), 49-55.

Milton, K. (2007). Emotion (or life, the universe, everything). In H. Wulff (Ed.), *The emotions: a cultural reader* (pp. 61-76). New York: Berg Publishers.

Morton, J. (1997). *A guide to colour symbolism* [PDF Document]. Colour Voodoo. Retrieved from http://www.colorvoodoo.com/cvoodoo1.html

Munsell, A. H. (1988). *A colour notation*. Baltimore, Maryland: Macbeth.

Munsell Colour Corporation. (1980). *Munsell Book of Colour – Glossy finish collection.* Baltimore, Maryland.

Nakamura, T., Sakolnakorn, O. P. N., Hansuebsai, A., Pungrassamee, P., & Sato, T. (2004). Emotion induced from colour and its language expression. *AIC- Colour and Paints, Interim Meeting of the International Colour Association: Proceedings of an international conference held at the Convention Centre of the Pontificia Universidade Catolica de Rio Grande do Sul, 3-5 November 2004* (pp. 328-332). Porto Alegre: Brazil.

Norman, D. A. (2002). Emotion & design: Attractive things work better. *Interactions*, *9* (4), 36-42.

Norman, D. A., & Ortony, A. (2003). Designers and users: Two perspectives on emotion and design. *Foundations of interaction design: Symposium held in Ivrea, Italy, Interaction Design Institude, November 2003.*

Norman, D. A. (2004). Beauty, goodness, and usability: Introduction to the special section. *Human-Computer Interaction*, 19 (4), 311-318.

O'Connor, Z. (2011). Colour psychology and colour therapy: Caveat emptor. *Colour Research and Application*, *36*, 229-234.

Odom, A. S., & Sholtz, S. S. (2000, November 30). The reds, whites, and blues of emotion: Examining colour hue effects on mood tones [PDF document]. Retrieved from http://clearinghouse.missouriwestern.edu/manuscripts/184.php

Oliveira, A., Fonseca, I., Teixeira, M., & Simões, F. (2005). A functional measurement approach to the Self-Assessment Manikin. In J. S. Monahan, S. M. Sheffert & J. T. Townsend (Eds.). Fechner Day 2005. *Proceedings of the Twenty-First Annual Meeting of the International Society for Psychophysics* (pp. 251-256). Mt. Pleasant, MI: The International Society for Psychophysics.

Orthony, A., Clore, G.L., & Collins, A. (1988). *The cognitive structure of emotions*. New York: Cambridge University Press.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1978). *The measurement of meaning*. USA: University of Illinois Press.

Padgham, C. A., & Saunders, J. E. (1975). *The perception of light and colour*. New York: Academic Press.

Parkinson, B. (1997). Emotion. In B. Parkinson & A.M. Colman (Eds.), *Emotion and motivation* (pp. 1-21). New York: Addison Wesley Longman Publishing.

Parkinson, B., & Colman, A.M. (1997). *Emotion and motivation*. New York: Addison Wesley Longman Publishing.

Petru, S. (2006). Red, black, or white?: The dawn of colour symbolism. *Documenta Praehistorica*, *33*, 203-208.

Pile, J. (1997). *Colour in interior design*. New York: McGraw-Hill.

Pos, O., & Green-Armytage, P. (2007). Facial expressions, colours and basic emotions. *Colour: Design & Creativity*, *1* (1):2, 1-20.

Qu, L. C., Luo, M. R., Sun, P. L., Hu, N. C., & Chen, H. S. (2011). Age effects on colour emotion, preference, and harmony. *Colour Research and Application*, 1-14. doi: 10.1002/col.20672

Raskin, R. (1986). *Colour: An outline of terms and concepts.* Denmark: Aarhus University Press.

Russell, J. A., Weiss, A., & Mendelson, G. A. (1989). Affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology*, *57* (3), 493-502.

Rymaszewoski, M., Wallace, M., Winters, C. Ondrejka, C., & Batstore-Cunningham, B. (2007). *Second Life: The official guide*. New Jersey: John Wiley & Sons.

Saunders, B. (1998). *What is colour?.* British Journal of Psychology, *89* (4), 697-704.

Scherer, K. R. (2005). What are emotions? And how can they be measured?. *Social Science Information*, *44*, 695-729.

Schubert, E. (1999). Measurement and time series analysis of emotion in music (Unpublished doctoral dissertation). University of New South Wales, Sydney, Australia.

Shan, C., Gong, S., & McOwan, P.W. (2007). Beyond Facial Expressions: Learning Human Emotion from Body Gestures. *In Proc. Of British Machine Vision Conference (BMVC'07)*. Warwick, UK.

Shehata, (2000). Colour: Use in design [PDF document]. Retrieved from http://www.hodgemony.com/pages/HCI/Color_Use_In_Design.pdf

Singh, A. K. (1984). *Tests measurements and research methods in behavioural sciences*. New Delhi: Tata McGraw-Hill Publishing Company Limited.

Smith, D. (2008). Colour-person-environment relationship. *Colour Research and Application*, *33* (4), 312-319.

Smith, C. A., & Lazarus, R. S. (1993). Appraisal components, core relational themes, and the emotions. *Cognition and Emotion*, *7* (3/4), 233-269.

Sorrentino, R. M., & Yamaguchi, S. (2008). *Handbook of motivation and cognition across cultures*. USA: Elseiver.

Suk, H. J., & Irtel, H. (2009). Emotional response to colour across media. *Colour Research and Application*, *35* (1), 64-77.

Swedish Standards Institution. (1996). *Natural Colour System Atlas*. Stockholm, Sweden.

TenHouten, W. D. (2007). *A general theory of emotions and social life*. New York: Routledge, Taylor & Francis Group.

Terwogt, M. M., & Hoeksma, J. B. (1995). Colours and emotions: Preference and combinations. *The Journal of General Psychology*, *122* (1), 5-17.

Tonnquist, G. (1988). Aspects of colour (percept, valence, stimulus, colorant), what do they mean and how can they be used? *AIC Symposium, Colour in Environmental Design, 7-11 August 1988. Switzerland.*

Valdez, P., & Mehrabian, A. (1994). Effects of colour on emotions. *Journal of Experimental Psychology, 123* (4), 394-409.

Weatherall, I. L., & Coombs, B. D. (1992). Skin colour measurements in terms of CIELAB colour space values. *Journal of Investigative Dermatology*, 99, 468-473.

Wyszecki, G., & Stiles, W. S. (1982). *Colour science: Concepts and methods, quantitative data and formula*. New York: John Wiley & Sons.

Yılmaz, İ. (2002). Renk sistemleri, renk uzayları ve dönüşümler. *Selçuk Üniversitesi Jeodezi ve Fotogrameti Mühendisliği Öğretiminde 30. Yıl Sempozyumu, October 2002*. Konya, Türkiye.

Zentner, M. R. (2001). Preferences for colours and colour-emotion combinations in early childhood. *Developmental Science*, *4* (4), 389-398.

Zhu, J., & Thagard, P. (2002). Emotion and action. *Philosophical Psychology*, *15* (1), 19-36.

http://changingminds.org/explanations/emotions/emotion_arousal.htm

http://studiolab.io.tudelft.nl/desmet/PrEmo

http://www.salle.url.edu/tsenyal/true/imatgesTRUE/plugins/pluginSAM.jpg9

http://www.uwgb.edu/heuerc/2D/ColourSystm.html

http://www.aadip9.net/flavie/2010/02/munsells-color-system-document.html

http://dba.med.sc.edu/price/irf/Adobe_tg/models/munsell.html

http://www.ncscolour.co.uk/information/ncs_system.html

http://leopon.co.kr/wp-content/uploads/2007/12/ncs3.jpg

http://www.ncscolour.co.za/index.php/about/the_natural_colour_system/how_the_system_works

http://www.cs.berkeley.edu/~sequin/CS184/TOPICS/ColourSpaces/Colour_0.html

http://dba.med.sc.edu/price/irf/Adobe_tg/models/ciexyz.html

http://www.iffo.nl/temp/index.php/en/technicalphotography/colourmanagement/59-adobergbvssrgb.html

http://www.sapdesignguild.org/resources/glossary_colour/index1.html

http://www.redminibox.com/products/colourpicker/RGB.php

http://vladek.ehion.com/xchange/hsi/colmodels.html

http://blulob.com

http://infoacrs.com/nm/design.html

http://eportfolio.pdht.ca/w11_eportfolio/zeliger_isabella/portfolio/print/rgbcolourwheel.php

http://blulob.com/2009/03/08/the-rgb-colour-wheel/

http://www.chainstyle.com/tutorials/colwheel.html

APPENDICES

APPENDIX A

DESCRIPTIONS AND IMAGES OF ACTION UNITS DEFINED IN THE FACIAL ACTION CODING SYSTEM (FACS) by Paul Ekman, Wallace V. Friesen.

(retrieved from http://www.cs.cmu.edu/afs/cs/project/face/www/facs.htm)

APPENDIX A1. Descriptions and Images of Action Units

Table A.1. Descriptions and images of action units

Action Unit	Description	Example Image
AU 1	Inner brow raiser	
AU 2	Outer brow raiser	
AU 4	Brow lowerer	
AU 5	Upper lid raiser	
AU 6	Cheek raiser	
AU 7	Lid tightener	
AU 9	Nose wrinkler	

Table A.1. *(cont'd)*

Action Unit	Description	Example Image
AU 10	Upper lip raiser	
AU 11	Nasolabial deepener	
AU 12	Lip corner puller	
AU 13	Cheek puffer	
AU 14	Dimpler	
AU 15	Lip corner depressor	

Table A.1. *(cont'd)*

Action Unit	Description	Example Image
AU 16	Lower lip depressor	
AU 17	Chin raiser	
AU 18	Lip puckerer	
AU 20	Lip stretcher	
AU 22	Lip funneler	

Table A.1. *(cont'd)*

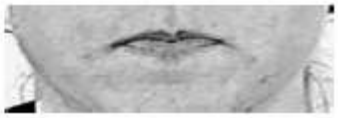
Action Unit	Description	Example Image
AU 23	Lip tightener	
AU 24	Lip pressor	
AU 25	Lips parts	
AU 26	Jaw drop	
AU 27	Mouth stretch	

Table A.1. *(cont'd)*

Action Unit	Description	Example Image
AU 28	Lip suck	
AU 41	Lid droop	
AU 42	Slit	
AU 43	Eyes closed	
AU 44	Squint	
AU 51	Head turn left	
AU 52	Head turn right	

Table A.1. *(cont'd)*

Action Unit	Description	Example Image
AU 53	Head up	
AU 54	Head down	
AU 55	Head tilt left	
AU 56	Head tilt right	
AU 57	Head forward	

Table A.1. *(cont'd)*

Action Unit	Description	Example Image
AU 58	Head back	
AU 61	Eyes turn left	
AU 62	Eyes turn right	
AU 63	Eyes up	
AU 64	Eyes down	

APPENDIX A.2. Prototypical Patterns of Facial Expressions of Basic Emotions

Table A.2. Prototypical patterns of facial expressions (Ekman and Friesen, 1978)

Emotions	**Prototypical Patterns of Facial Expressions by Action Units (AU)**
Happiness	AU 6 +AU 12 AU 12
Anger	AU 4 + AU 5 + AU 7 + AU 10 + AU 22 + AU 23 + AU 25,26 AU 4 + AU 5 + AU 7 + AU 10 + AU 23 + AU 25,26 AU 4 + AU 5 + AU 7 + AU 23 + AU 25,26 AU 4 + AU 5 + AU 7 + AU 17 + AU 23 AU 4 + AU 5 + AU 7 + AU 17 + AU 24 AU 4 + AU 5 + AU 7 + AU 23 AU 4 + AU 5 + AU 7 + AU 24
Sadness	A1 + AU 4 + AU 11 + AU 15 with or without AU 54 + AU 65 A1 + AU 4 + AU 15 with or without AU 54 + AU 65 A6 + AU 15 with or without AU 54 + AU 65 AU 25 & AU 26 may occur with all prototypes
Fear	AU 1 + AU 2 + AU 4 + AU 5 + AU 20 + AU 25 + AU 26 or AU 27 AU 1 + AU 2 + AU 4 + AU 5 + AU 25 + AU 26 or AU 27
Surprise	AU 1 + AU 2 + AU 5 + AU 26 AU 1 + AU 2 + AU 5 + AU 27
Disgust	AU 9 AU 9 + AU 16 + AU 25,26 AU 9 + AU 17 AU 10 AU 10 + AU 16 + AU 25,26 AU 10 + AU 17

APPENDIX B

DESCRIPTIONS OF THE SAMPLE GROUP

Table B.1. Descriptive statistics showing the mean age of the sample group.

	N	Minimum	Maximum	Mean	Std. Deviation
age	180	17,00	26,00	21,0833	1,74930
Valid N (listwise)	180				

Table B.2. Sample's distribution on the basis of age.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	17,00	2	1,1	1,1	1,1
	18,00	8	4,4	4,4	5,6
	19,00	21	11,7	11,7	17,2
	20,00	39	21,7	21,7	38,9
	21,00	43	23,9	23,9	62,8
	22,00	33	18,3	18,3	81,1
	23,00	15	8,3	8,3	89,4
	24,00	12	6,7	6,7	96,1
	25,00	6	3,3	3,3	99,4
	26,00	1	,6	,6	100,0
	Total	180	100,0	100,0	

Table B.3. Computer usage of the sample group.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Five to Ten Years	85	47,2	47,2	47,2
	More than Ten Years	95	52,8	52,8	100,0
	Total	180	100,0	100,0	

Table B.4. Computer Usage Frequency of the sample group.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A few times a day	121	67,2	67,2	67,2
	Everyday	54	30,0	30,0	97,2
	Every other day	5	2,8	2,8	100,0
	Total	180	100,0	100,0	

APPENDIX C

SETTING OF THE EXPERIMENT

Figure C.1. A view showing the public study area next to the Multimedia Room.

Figure C.2. A view showing the booths for using audio and visual materials.

APPENDIX D

INTERIOR SPACES USED IN THE EXPERIMENT

Figure D.1. A view from red wall-coloured living room.

Figure D.2. A view from blue wall-coloured living room.

Figure D.3. A view from green wall-coloured living room.

Figure D.4. A view from gray wall-coloured living room.

APPENDIX E

THE QUESTIONNAIRE

APPENDIX E.1. The Questionnaire (in Turkish)

ANKET

AŞAĞIDAKİ SORULARI SİZİN İÇİN EN UYGUN ŞEKİLDE CEVAPLAYINIZ:

Kişisel Bilgiler

1. Cinsiyet: Kız ☐ Erkek ☐

2. Yaş: _____

3. Bölüm: _____

4. e-mail: _____

Göz ve Renk Görme Bozukluğu

1. Herhangi bir göz bozukluğunuz var mı? Varsa açıklayınız lütfen.

_____

2. Bu göz bozukluğunuzu giderecek herhangi bir araç (lens, gözlük, v.b. gibi) kullanıyor musunuz? Bu araç şu an üzerinizde mi?

_____

3. Renk Görme Kusuru **(Ishihara Renk Körlüğü Testi)**

Var ☐ Yok ☐

Bilgisayar Kullanımı

1. Bilgisayar kullanıyor musunuz? Evet ☐ Hayır ☐

2. Kaç yıldır bilgisayar kullanıyorsunuz?

1 yıldan az ☐

1 - 2 yıl ☐

2 - 5 yıl ☐

5 – 10 yıl ☐

10 yıldan fazla ☐

3. Ne sıklıkla bilgisayar kullanıyorsunuz?

Günde birkaç kere ☐

Hergün ☐

Gün aşırı ☐

Haftada bir ☐

Ayda birkaç kere ☐

Ayda bir ☐

Diğer _____

APPENDIX E.2. The Questionnaire (in English)

QUESTIONNAIRE

ANSWER THE QUESTIONS APPROPRIATE TO YOUR SITUATION:

Personal Information

1. Gender: Female ☐ Male ☐

2. Age: _____

3. Department: _____

4. e-mail: _____

Eye and Colour Vision Deficiency

1. Do you have any eye or vision deficiencies? If yes, please explain.

_____

2. Do you use any correction equipment (contact lenses, eyeglasses, etc.) for any eye or vision deficiency you have? Are you wearing this equipment at the moment?

_____

3. Colour Deficiency (**Ishihara's Test for Colour Blindness)**

Has ☐ Has Not ☐

Computer Usage

1. Do you use a computer? Yes ☐ No ☐

2. About how long have you been using a computer?

Less than one year ☐
One to Two Years ☐
Two to Five Years ☐
Five to Ten Years ☐
More than Ten Years ☐

3. How often do you use a computer?

A few times a day ☐
Every day ☐
Every other day ☐
Once a week ☐
A few times a month ☐
Once a month ☐
Other _____

APPENDIX F

INFORMATION ABOUT THE STUDY

APPENDIX F.1. Information About the Study (in Turkish)

Bu veriler Bilkent Üniversitesi, İç Mimarlık ve Çevre Tasarımı Bölümü'nde yürütülen "İÇ MEKÂNLARDA RENK-DUYGU İLİŞKİSİ" konulu doktora tezi çalışması için kullanılacaktır.

Bu çalışma yaklaşık olarak **5 dakikanızı** alacaktır.

Bu çalışmada size 7 farklı duyguyu temsil eden yüz ifadeleri verilecektir ve size 2 farklı iç mekânda çekilmiş video görüntüleri izletilecektir. Lütfen gördüğünüz videolardaki iç mekânları ve onu en iyi temsil eden yüz ifadesini eşleştiriniz.

Bu çalışmada doğru veya yanlış cevap yoktur.

TEŞEKKÜR EDERİZ

Araştırmacının adı: Elif Helvacıoğlu

Yer: Bilkent Üniversitesi Kütüphanesi, Multimedya odası, 8 numaralı kabin, Ankara-Türkiye.

APPENDIX F.2. Information About the Study (in English)

This study is designed to gather data for a Ph.D. Dissertation entitled "Colur-Emotion Associations in Interior Environments" prepared at Bilkent University, Department of Interior Architecture and Environmental Design.

This study takes about **5 minutes** to complete.

In this study seven faces, each representing different basic emotions, and videos of two different interior spaces will be shown to you. Please match the shown interior space with a single face representing a specific emotion that best fit with each other.

There is no true or wrong answer in this study.

THANK YOU

Name of the researcher: Elif Helvacıoğlu

Location: Bilkent University Library, Multimedia room, 8th booth, Ankara-Turkey.

APPENDIX G

FACIAL EXPRESSIONS OF BASIC EMOTIONS USED IN THE EXPERIMENT

Figure G.1. The facial expressions of six basic emotions used in the study.

APPENDIX H

DATA ANALYSES

Table H.1. Statistics of the sequence of showing coloured room for red room.

	SEQUENCE	N	Mean	Std. Deviation	Std. Error Mean
RED ROOM	Participants first experience gray room	30	3,6333	1,42595	,26034
	Participants first experience red room	30	3,2667	1,63861	,29917

Table H.2. Independent Samples t-Test results for sequence differences on emotional reactions to red room.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RED	Equal variances assumed	1,620	,208	,925	58	,359	,36667	,39659	-,42718	1,16052
	Equal variances not assumed			,925	56,914	,359	,36667	,39659	-,42751	1,16084

Table H.3. Statistics for gender differences for red room.

	GENDER TOTAL	N	Mean	Std. Deviation	Std. Error Mean
RED ROOM	Female	30	3,4000	1,37966	,25189
	Male	30	3,5000	1,69685	,30980

Table H.4. Independent Samples *t*-Test for gender differences on emotional reactions to red room.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RED	Equal variances assumed	3,242	,077	-,250	58	,803	-,10000	,39928	-,89925	,69925
	Equal variances not assumed			-,250	55,682	,803	-,10000	,39928	-,89996	,69996

Table H.5. Frequency of emotions associated with red room in respect to male gender group.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	2	3,3	6,7	6,7
	disgust	11	18,3	36,7	43,3
	neutral	3	5,0	10,0	53,3
	surprise	2	3,3	6,7	60,0
	happiness	9	15,0	30,0	90,0
	fear	2	3,3	6,7	96,7
	sadness	1	1,7	3,3	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.6. Frequency of emotions associated with red room in respect to female gender group.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	1	1,7	3,3	3,3
	disgust	10	16,7	33,3	36,7
	neutral	6	10,0	20,0	56,7
	surprise	2	3,3	6,7	63,3
	happiness	11	18,3	36,7	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.7. Chi-square goodness-of-fit test for emotion association to red room.

	Observed N	Expected N	Residual
anger	3	8,6	-5,6
disgust	21	8,6	12,4
neutral	9	8,6	,4
surprise	4	8,6	-4,6
happiness	20	8,6	11,4
fear	2	8,6	-6,6
sadness	1	8,6	-7,6
Total	60		

Test Statistics

	RED
Chi-Square(a)	51,067
df	6
Asymp. Sig.	,000

a 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 8,6.

Table H.8. Frequency of emotions associated with red room.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	3	5,0	5,0	5,0
	disgust	21	35,0	35,0	40,0
	neutral	9	15,0	15,0	55,0
	surprise	4	6,7	6,7	61,7
	happiness	20	33,3	33,3	95,0
	fear	2	3,3	3,3	98,3
	sadness	1	1,7	1,7	100,0
	Total	60	100,0	100,0	

Table H.9. Statistics of the sequence of showing gray room.

	SEQUENCE	N	Mean	Std. Deviation	Std. Error Mean
GRAY ROOM	Participants first experience gray room	30	3,4333	1,79431	,32759
	Participants first experience red room	30	3,8667	2,25501	,41171

Table H.10. Independent Samples *t*-Test results for sequence differences on emotional reactions to gray room.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GRAY	Equal variances assumed	6,363	,014	-,824	58	,414	-,43333	,52614	-1,48651	,61984
	Equal variances not assumed			-,824	55,214	,414	-,43333	,52614	-1,48764	,62098

Table H.11. Statistics for gender differences for gray room in the first experiment set.

	GENDER TOTAL	N	Mean	Std. Deviation	Std. Error Mean
GRAY ROOM	Female	30	3,9000	2,26442	,41342
	Male	30	3,4000	1,77337	,32377

Table H.12. Independent Samples t-Test for gender differences on emotional reactions to gray room in the first experiment set.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GRAY	Equal variances assumed	7,863	,007	,952	58	,345	,50000	,52512	-,55113	1,55113
	Equal variances not assumed			,952	54,849	,345	,50000	,52512	-,55242	1,55242

Table H.13. Frequency of emotions associated with gray room in respect to male gender group in the first experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	1	1,7	3,3	3,3
	disgust	9	15,0	30,0	33,3
	neutral	13	21,7	43,3	76,7
	surprise	1	1,7	3,3	80,0
	fear	2	3,3	6,7	86,7
	sadness	4	6,7	13,3	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.14. Frequency of emotions associated with gray room in respect to female gender group in the first experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	13	21,7	43,3	43,3
	neutral	7	11,7	23,3	66,7
	sadness	10	16,7	33,3	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.15. Chi-square goodness-of-fit test for emotion association to gray room in the first experiment set.

	Observed N	Expected N	Residual
anger	1	10,0	-9,0
disgust	22	10,0	12,0
neutral	20	10,0	10,0
surprise	1	10,0	-9,0
fear	2	10,0	-8,0
sadness	14	10,0	4,0
Total	60		

Test Statistics

	GRAY
Chi-Square(a)	48,600
df	5
Asymp. Sig.	,000

a 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 10,0.

Table H.16. Frequency of emotions associated with gray room in the first experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	1	1,7	1,7	1,7
	disgust	22	36,7	36,7	38,3
	neutral	20	33,3	33,3	71,7
	surprise	1	1,7	1,7	73,3
	fear	2	3,3	3,3	76,7
	sadness	14	23,3	23,3	100,0
	Total	60	100,0	100,0	

Table H.17. Paired Samples t-Test for emotional association differences between red room and gray room.

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair	COLOUR - EMOTION	-2,05000	1,89138	,17266	-2,39188	-1,70812	-11,873	119	,000

Table H.18. Statistics of the sequence of showing coloured rooms for green room.

	SEQUENCE	N	Mean	Std. Deviation	Std. Error Mean
GREEN ROOM	Participants first experience gray room	30	4,4667	1,45586	,26580
	Participants first experience green room	30	3,5333	1,33218	,24322

Table H.19. Independent Samples *t*-Test results for sequence differences on emotional reactions to green room.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GREEN	Equal variances assumed	,019	,890	2,591	58	,012	,93333	,36029	,21214	1,65453
	Equal variances not assumed			2,591	57,549	,012	,93333	,36029	,21202	1,65465

Table H.20. Frequency of emotions associated with green room in respect to showing order (viewed after gray room).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	1	1,7	3,3	3,3
	disgust	3	5,0	10,0	13,3
	neutral	4	6,7	13,3	26,7
	surprise	1	1,7	3,3	30,0
	happiness	17	28,3	56,7	86,7
	fear	2	3,3	6,7	93,3
	sadness	2	3,3	6,7	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.21. Frequency of emotions associated with green room in respect to showing order (viewed before gray room).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	1	1,7	3,3	3,3
	disgust	6	10,0	20,0	23,3
	neutral	11	18,3	36,7	60,0
	surprise	1	1,7	3,3	63,3
	happiness	10	16,7	33,3	96,7
	fear	1	1,7	3,3	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.22. Statistics for gender differences for green room.

	GENDER TOTAL	N	Mean	Std. Deviation	Std. Error Mean
GREEN ROOM	Female	30	4,0667	1,25762	,22961
	Male	30	3,9333	1,65952	,30299

Table H.23. Independent Samples *t*-Test for gender differences on emotional reactions to green room.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GREEN	Equal variances assumed	4,513	,038	,351	58	,727	,13333	,38016	-,62764	,89430
	Equal variances not assumed			,351	54,048	,727	,13333	,38016	-,62882	,89549

Table H.24. Frequency of emotions associated with green room in respect to male gender group.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	2	3,3	6,7	6,7
	disgust	5	8,3	16,7	23,3
	neutral	7	11,7	23,3	46,7
	happiness	13	21,7	43,3	90,0
	fear	1	1,7	3,3	93,3
	sadness	2	3,3	6,7	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.25. Frequency of emotions associated with green room in respect to female gender group.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	4	6,7	13,3	13,3
	neutral	8	13,3	26,7	40,0
	surprise	2	3,3	6,7	46,7
	happiness	14	23,3	46,7	93,3
	fear	2	3,3	6,7	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.26. Chi-square goodness-of-fit test for emotion association to green room (first experience green room).

	Observed N	Expected N	Residual
anger	1	5,0	-4,0
disgust	6	5,0	1,0
neutral	11	5,0	6,0
surprise	1	5,0	-4,0
happiness	10	5,0	5,0
fear	1	5,0	-4,0
Total	30		

Test Statistics

	GREEN
Chi-Square	22,000[a]
df	5
Asymp. Sig.	,001

a 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 15,0.

Table H.27. Statistics of the sequence of showing coloured room for gray room.

	SEQUENCE	N	Mean	Std. Deviation	Std. Error Mean
GRAY ROOM	Participants first experience gray room	30	3,5333	1,87052	,34151
	Participants first experience green room	30	4,1000	2,32453	,42440

Table H.28. Independent Samples *t*-Test results for sequence differences on emotional reactions to gray room.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GRAY	Equal variances assumed	8,825	,004	-1,040	58	,303	-,56667	,54474	-1,65709	,52375
	Equal variances not assumed			-1,040	55,461	,303	-,56667	,54474	-1,65815	,52482

Table H.29. Statistics for gender differences for gray room in the second experiment set.

	GENDER TOTAL	N	Mean	Std. Deviation	Std. Error Mean
GRAY ROOM	Female	30	4,0333	2,22033	,40538
	Male	30	3,6000	2,01032	,36703

Table H.30. Independent Samples *t*-Test for gender differences on emotional reactions to gray room in the second experiment set.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GRAY	Equal variances assumed	2,266	,138	,792	58	,431	,43333	,54685	-,66130	1,52797
	Equal variances not assumed			,792	57,437	,431	,43333	,54685	-,66153	1,52820

Table H.31. Frequency of emotions associated with gray room in respect to male gender group in the second experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	12	20,0	40,0	40,0
	neutral	10	16,7	33,3	73,3
	happiness	1	1,7	3,3	76,7
	sadness	7	11,7	23,3	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.32. Frequency of emotions associated with gray room in respect to female gender group in the second experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	11	18,3	36,7	36,7
	neutral	8	13,3	26,7	63,3
	happiness	1	1,7	3,3	66,7
	sadness	10	16,7	33,3	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.33. Chi-square goodness-of-fit test for emotion association to gray room in the second experiment set.

	Observed N	Expected N	Residual
disgust	23	15,0	8,0
neutral	18	15,0	3,0
happiness	2	15,0	-13,0
sadness	17	15,0	2,0
Total	60		

Test Statistics

	GRAY
Chi-Square(a)	16,400
df	3
Asymp. Sig.	,001

a 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 15,0.

Table H.34. Frequency of emotions associated with gray room in the second experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	23	38,3	38,3	38,3
	neutral	18	30,0	30,0	68,3
	happiness	2	3,3	3,3	71,7
	sadness	17	28,3	28,3	100,0
	Total	60	100,0	100,0	

Table H.35. Paired Samples t-Test for emotional association differences between green room and gray room.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair	COLOUR - EMOTION	-2,47500	2,02074	,18447	-2,84026	-2,10974	-13,417	119	,000

Table H.36. Statistics of the sequence of showing coloured room for blue room.

	SEQUENCE	N	Mean	Std. Deviation	Std. Error Mean
BLUE ROOM	Participants first experience gray room	30	3,7667	1,67504	,30582
	Participants first experience blue room	30	3,8333	1,72374	,31471

Table H.37. Independent Samples *t*-Test results for sequence differences on emotional reactions to blue room.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
BLUE	Equal variances assumed	,000	1,000	-,152	58	,880	-,06667	,43882	-,94507	,81174
	Equal variances not assumed			-,152	57,952	,880	-,06667	,43882	-,94508	,81175

Table H.38. Statistics for gender differences for blue room.

	GENDER TOTAL	N	Mean	Std. Deviation	Std. Error Mean
BLUE ROOM	Female	30	4,1667	1,72374	,31471
	Male	30	3,4333	1,59056	,29040

Table H.39. Independent Samples *t*-Test for gender differences on emotional reactions to blue room.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
BLUE	Equal variances assumed	1,870	,177	1,713	58	,092	,73333	,42822	-,12384	1,59051
	Equal variances not assumed			1,713	57,629	,092	,73333	,42822	-,12396	1,59062

Table H.40. Frequency of emotions associated with blue room in respect to male gender group.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	3	5,0	10,0	10,0
	disgust	3	5,0	10,0	20,0
	neutral	15	25,0	50,0	70,0
	surprise	2	3,3	6,7	76,7
	happiness	3	5,0	10,0	86,7
	fear	2	3,3	6,7	93,3
	sadness	2	3,3	6,7	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.41. Frequency of emotions associated with blue room in respect to female gender group.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	5	8,3	16,7	16,7
	neutral	10	16,7	33,3	50,0
	surprise	2	3,3	6,7	56,7
	happiness	5	8,3	16,7	73,3
	fear	4	6,7	13,3	86,7
	sadness	4	6,7	13,3	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.42. Chi-square goodness-of-fit test for emotion association to blue room.

	Observed N	Expected N	Residual
anger	3	8,6	-5,6
disgust	8	8,6	-,6
neutral	25	8,6	16,4
surprise	4	8,6	-4,6
happiness	8	8,6	-,6
fear	6	8,6	-2,6
sadness	6	8,6	-2,6
Total	60		

Test Statistics

	BLUE
Chi-Square(a)	39,167
df	6
Asymp. Sig.	,000

a 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 8,6.

Table H.43. Frequency of emotions associated with blue room.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	anger	3	5,0	5,0	5,0
	disgust	8	13,3	13,3	18,3
	neutral	25	41,7	41,7	60,0
	surprise	4	6,7	6,7	66,7
	happiness	8	13,3	13,3	80,0
	fear	6	10,0	10,0	90,0
	sadness	6	10,0	10,0	100,0
	Total	60	100,0	100,0	

Table H.44. Statistics of the sequence of showing coloured room for gray room in the third experiment set.

	SEQUENCE	N	Mean	Std. Deviation	Std. Error Mean
GRAY ROOM	Participants first experience gray room	30	3,8000	2,00688	,36641
	Participants first experience blue room	30	4,5000	2,19325	,40043

Table H.45. Independent Samples *t*-Test results for sequence differences on emotional reactions to gray room in the third experiment set.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GRAY	Equal variances assumed	2,765	,102	-1,290	58	,202	-,70000	,54277	-1,78647	,38647
	Equal variances not assumed			-1,290	57,549	,202	-,70000	,54277	-1,78665	,38665

Table H.46. Statistics for gender differences for gray room in the third set.

	GENDER TOTAL	N	Mean	Std. Deviation	Std. Error Mean
GRAY ROOM	Female	30	4,4000	2,12700	,38834
	Male	30	3,9000	2,10664	,38462

Table H.47. Independent Samples *t*-Test for gender differences on emotional reactions to gray room in the third set.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
GRAY	Equal variances assumed	,370	,545	,915	58	,364	,50000	,54657	-,59407	1,59407
	Equal variances not assumed			,915	57,995	,364	,50000	,54657	-,59408	1,59408

Table H.48. Frequency of emotions associated with gray room in respect to male participants in the third experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	9	15,0	30,0	30,0
	neutral	12	20,0	40,0	70,0
	sadness	9	15,0	30,0	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.49. Frequency of emotions associated with gray room in respect to female participants in the third experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	6	10,0	20,0	20,0
	neutral	11	18,3	36,7	56,7
	happiness	2	3,3	6,7	63,3
	sadness	11	18,3	36,7	100,0
	Total	30	50,0	100,0	
Missing	System	30	50,0		
Total		60	100,0		

Table H.50. Chi-square goodness-of-fit test for emotion association to gray room in the third experiment set.

	Observed N	Expected N	Residual
disgust	15	15,0	,0
neutral	23	15,0	8,0
happiness	2	15,0	-13,0
sadness	20	15,0	5,0
Total	60		

Test Statistics

	GRAY
Chi-Square(a)	17,200
df	3
Asymp. Sig.	,001

a 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 15,0.

Table H.51. Frequency of emotions associated with gray room in the third experiment set.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disgust	15	25,0	25,0	25,0
	neutral	23	38,3	38,3	63,3
	happiness	2	3,3	3,3	66,7
	sadness	20	33,3	33,3	100,0
	Total	60	100,0	100,0	

Table H.52. Paired Samples t-Test for emotional association differences between blue room and gray room.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair	COLOUR - EMOTION	-2,40833	1,85389	,16924	-2,74344	-2,07323	-14,231	119	,000