To my beloved parents

WARMTH PERCEPTION IN ASSOCIATION WITH COLOUR AND MATERIAL

The Graduate School of Economics and Social Sciences
of
İhsan Doğramacı Bilkent University

by

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In Partial Fulfilment of the Requirement for the Degree of
DOCTOR OF PHILOSOPHY

in

THE DEPARTMENT OF
INTERIOR ARCHITECTURE AND ENVIRONMENTAL DESIGN İHSAN
DOĞRAMACI BİLKENT UNIVERSITY
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August 2016

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ABSTRACT

WARMTH PERCEPTION IN ASSOCIATION WITH COLOUR AND MATERIAL

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August 2016

Warmth perception is physical, emotional, semantic, and sensorial bond between people and their environments. Warmth is a prominent characteristic of interior architecture and is related to colours and materials. Although the effects of single colours and single materials on warmth have been explored, colours and materials rarely appear alone in interiors and there has been no research on how paired colours and paired materials affect warmth perception in interiors. Therefore, the main aim of this study is to investigate their effects through a seven-point semantic differential scale and open ended questions.192 different participants assessed three different colours (red, white, and green), and their pairs or three different materials (fabric, timber, and plasterboard), and their pairs under controlled conditions. Findings demonstrated that single colours and paired colours both affect warmth perception in interiors. The effects of single colours in interiors are subtle in warmth perception: red is perceived warmer than green and green is perceived warmer than white. All single colours have a moderate level of warmth in interiors as pairs, consequently red (warm colour) appears to increase and white (achromatic colour) appears to decrease the warmth perception of their pairs. Furthermore, as single materials timber and fabric have the same level of warmth and are warmer than plasterboard whereas there is not any difference between pairs. Findings indicated that natural materials are perceived warmer than artificial one.

Keywords – Colour, Interior Architecture, Material, Warmth Perception.

ÖZET

RENK VE MALZEME ÇİFTLERİNİN SICAKLIK ALGISIYLA İLİŞKİSİ

Ulusoy, Begüm

Doktora, İç Mimarlık ve Çevre Tasarımı Bölümü

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Ağustos 2016

Sıcaklık algısı bireylerle çevreleri arasında fiziksel, duygusal, anlamsal ve duyusal bir bağ kurar. Kavram iç mimarinin öne çıkan bir özelliğidir, renkler ve malzemelerle yakın ilişkidedir. Her ne kadar tek renkler ve tek malzemelerin kavram üzerindeki etkisi araştırılmış olsa da renkler ve malzemeler iç mekânlarda nadiren tek başlarına bulunurlar. Renk çiftlerinin ve malzeme çiftlerinin iç mekânda sıcaklık algısını nasıl etkilediğine dair bir çalışma henüz yapılmamıştır. Bu nedenle bu çalışmanın temel amacı renk ve malzeme çiftlerinin konu üzerindeki etkisini anlamsal farklılık ölçeği ve serbest çağrışım yöntemleri ile araştırmaktır. 192 farklı katılımcı üç farklı rengi (kırmızı, beyaz ve yeşil), ve çiftlerini veya üç farklı malzemeyi (kumaş, ahşap ve alçı levha) ve çiftlerini kontrollü koşullar altında değerlendirmiştir. Sonuçlar hem tek renklerin ve hem de renk çiftlerinin iç mekânda sıcaklık algısını etkilediğini göstermiştir. Tek renklerde kırmızı yeşilden yeşil ise beyazdan daha sıcak algılanmaktadır. Tüm renk çiftleri kendi tek renklerinin ortalama sıcaklık değerine sahiptirler ve sonuç olarak, çiftler için, kırmızı (sıcak renk) sıcaklık algısının artmasına, beyaz (akromatik renk) ise azalmasına neden olmaktadır. Tek malzeme olarak kumaş ve ahşap aynı sıcaklık değerine sahip ve alçı levhadan daha sıcakken çiftler arasında hiçbir fark yoktur. Buna ek olarak sonuçlar çalışmada kullanılan doğal malzemelerin yapay malzemeden daha sıcak olduğuna dikkat çekmektedir.

Anahtar Kelimeler: Renk, İç Mekân, Malzeme, Sıcaklık Algısı

ACKNOWLEDGEMENTS

I would like to thank my supervisor Assoc. Prof. Dr. Nilgün Olguntürk for her support and motivation throughout my Ph.D. study. Without her invaluable guidance my research, Ph.D. study and this thesis could not be embodied. I am also honoured to thank my committee members Assit. Prof. Dr. Çağrı İmamoğlu, Assit. Prof. Dr. Owain Pedgley and Assit. Prof. Dr. Elif Güneş for their contributions and critical comments during the preparation of this thesis. I am grateful to Assit. Prof. Dr. Yaprak Öz and Assit. Prof. Dr. İpek Memikoğlu for their contribution and invaluable comments for the finalization of the thesis.

I would like to show my appreciation to İnci Apaydın (Bilkent University) for their contribution throughout statistical analyses and Dr. Geraint Ellies (Queens University Belfast) and Dr. Gül Kaçmaz Erk (Queens University Belfast) for their support during the experimental study.

I would like to thank for two years long financial support to TUCEV and for their kindly permission to use their facilities to School of Planning, Architecture and Civil

Engineering of Queens University Belfast, the Department of Politics, International Studies and Philosophy of Queens University Belfast, and Red Barn Gallery, Belfast.

I am also thankful to my beloved parents Serap Günay Ulusoy and İsmail Orhan Ulusoy for their support and patience which make me feel lucky. Without them this thesis and my research studies could not be completed. In addition, special thanks to my dear friends Segah Sak and Seden Odabaşıoğlu for their encouragement, moral support and advices.

TABLE OF CONTENTS

ABSTRACT…………….…………………………………………………………….....iii

ÖZET…...………………………………………………………………………….....iv

ACKNOWLEDGEMENTS…………………………………………………….......v

TABLE OF CONTENTS…………………………………………………...…..vii

LIST OF TABLES……………………………………………………………...…xii

LIST OF FIGURES…………………………………………………………….xvi

CHAPTER 1: INTRODUCTION…...…………………………………………………1

1.1. Aim of the Study……………………………………………….....…3

1.2. The General Structure of the Thesis…….……………………………………4

CHAPTER 2 WARMTH PERCEPTION…………………….…………………………7

2.1. A Definition……………………………………………………………....11

2.2. Aspects of Warmth Perception……………………………………………...12

2.2.1. Physical Aspects……………………………………………...14

2.2.2. Sensorial Aspects……………………………………………..19

2.2.3. Emotional Aspects……………………………………………26

2.3. Perceiving Warmth……………………………………………………….27

2.3.1 Through Colour Information……………………………….....28

2.3.2 Through Material Information………………………………...…34

CHAPTER 3: COLOUR AND MATERIAL IN THE BUILT ENVIRONMENT...…...40

3.1. Colour in the Built Environment……………………………...………….40

3.1.1. Colour and User Interaction……………………..………………..41

3.1.2. Colour in Interior Architecture………………………….............47

3.2. Material in the Built Environment………………………………………......51

3.2.1. Material and User Interaction……………………………………...52

3.2.2. Material in Interior Architecture………………………..........…53

CHAPTER 4: WARMTH AND MEANING THROUGH COLOUR AND MATERIAL………………………………………………………………………….…61

4.1. Figurative Meaning…………………………………………………..….68

4.1.1. Associations of Warm…..…………………………………………71

4.1.2. Associations of Intimacy……………………………………......72

4.1.3. Associations of Energy……………………………………........73

4.2. Literal Meaning………………………………………………………......74

CHAPTER 5: EXPERIMENTAL STUDY…………………………………….........75

5.1. Aim of Study…………………………………………………………......75

5.1.1. Research Question…………………………………......….76

5.1.2. Hypotheses…………………………………………………...77

5.2. Methodology…………………………………………………………...77

5.2.1. Sample Group……………………………………………......79

5.2.2. The Experiment Box and Measurement Equipment…...……..…..80

5.2.3. Preparing the Models……………………………………………88

5.2.3.1. Specifying the Colours…………………………………...91

5.2.3.2. Specifying the Materials……………………………………93

5.3. Conducting the Experiment………………………………………………96

CHAPTER 6: DATA ANALYSIS OF THE EXPERIMENTAL STUDY……….......104

6.1. Data of Open-Ended Questions for Colour Set……………………………106

6.1.1. Red and White Colour Pair………………………………………107

6.1.2. Red and Green Colour Pair………………………………………108

6.1.3. White and Green Colour Pair……………………………………110

6.1.4. Overall Results……………………………………………...…112

6.2. Data of Semantic Differential Scale Questions for Colour Set…………....113

6.2.1. Red and White Colour Pair………………………………………114

6.2.2. Red and Green Colour Pair………………………………………116

6.2.3. White and Green Colour Pair…………………………………....117

6.2.4. Comparison of Colour Pairs…………………………..….119

6.3. Data of Open-Ended Questions for Material Set…………………...…....120

6.3.1. Fabric and Timber Material Pair……………………………...…….120

6.3.2. Fabric and Plasterboard Material Pair……………………………122

6.3.3. Timber and Plasterboard Material Pair…………………………...124

6.3.4. Overall Results…………………………………………………...126

6.4. Data of Semantic Differential Scale Questions for Material Set……….....127

6.4.1. Fabric and Timber Material Pair…………………………...….128

6.4.2. Fabric and Plasterboard Material Pair…………………...…….130

6.4.3. Timber and Plasterboard Material Pair…………………………...132

6.4.4. Comparison of Colour Pairs…………………………...………134

CHAPTER 7: DISCUSSION……………………………………………………................136

7.1. Colour Pairs…………………………………………………….……......137

7.1.1. Warm……………………………………………………………......138

7.1.2. Energy…………………………………………….…………139

7.1.3. Intimacy……………………………………………..…………140

7.1.4. Discussion of Free-Associations…………………………………141

7.1.5. Overall Discussion……………………………….…………144

7.2. Material Pairs………………………………………………………………149

7.2.1. Warm………………………………………………………………..150

7.2.2. Energy………………………………………………………………151

7.2.3. Intimacy……………………………………………………………..152

7.2.4. Discussion of Free-Associations……………………....………153

7.2.5. Overall Discussion………………………………………………..155

CHAPTER 8: CONCLUSION……………………………………………...………161

REFERENCES…………………………………………………………………….....168

APPENDICES

APPENDIX A: DICTIONARY MEANINGS OF WARM, INTIMACY AND ENERGY…………………………………………………………..179

APPENDIX B: QUESTIONNAIRE SHEET (IN ENGLISH)………………...181

APPENDIX C: DEMOGRAPHIC RESULTS……………………………….....183

APPENDIX D: PHILIPS MASTER TL-D 90 GRAPHICA…………………..189

APPENDIX E: KONICA MINOLTA ILLUMINANCE METER T-10A…….192

APPENDIX F: ARTIPAN STANDARD PLASTERBOARD……….………..195

APPENDIX G: ASSESSMENT SHEET OF FIRST PILOT STUDY (IN TURKISH)………..……………………………………….….198

APPENDIX H: ASSESSMENT SHEET OF SECOND PILOT STUDY (IN TURKISH)…………………………………………..…..199

APPENDIX I: ASSESSMENT SHEET OF SECOND PILOT STUDY (IN ENGLISH)…………………………………………….....200

APPENDIX J: INFORMATION SHEET (IN ENGLISH)……………………202

APPENDIX K: CONSENT FORM SHEET (IN ENGLISH)……..………….204

APPENDIX L: RESULTS OF 'PHYSICAL WARM' SEMANTIC SCALE QUESTION……………………………………..……205

APPENDIX M: POST TESTS……………………………...………………209

APPENDIX N: NUMBER OF PARTICIPANT………………………………213

LIST OF TABLES

1. Fundamental studies related to colours……………….………………………...33

2. Fundamental studies related to materials…………….………………………39

3. Emotional associations of colours – (Adapted from Helvacıoğlu, 2011: 83)…..48

4. Positive and negative meanings of red, green and white (adapted from Ladau, Smith, & Place, 1988; 69-71)……………………………………………...49

5. Associations of red, green and white (adapted from Mahnke, 1996: 67-70)…...50

6. Warmth perception through user and design perspectives……………………...64

7. Similarities and differences of figurative and literal meanings of warmth……..67

8. Colour set and material set……………………………………………………...79

9. Number of participants…………………………………………………………80

10. Procedure of colour differences (Set-1)…………………………………………89

11. Procedure of material differences (Set-2)………………………………………89

12. NCS Codes, brands and required proportions of colours………………………92

13. Brands and proportions of red colour for each material type…………………...93

14. NCS code of each materials……………………………………………………96

15. NVivo word frequency table of the red and white set…………………………107

16. NVivo word frequency table of the red and green set…………………………109

17. NVivo word frequency table of white and green set…………………………..111

18. Overall results of colours and colours pairs………………………………...113

19. Symbols of the colours used in the tables 20, 22, 24, and 26………………….114

20. Red and white pair models and their statistical relations……………………...115

21. Contingency table of red and white colour pair……………………………….115

22. Red and green pair models and their statistical relations……………………...116

23. Contingency table of red and green colour pair……………………………….117

24. White and green pair models and their statistical relations……………………118

25. Contingency table of white and green colour pair……………………………..118

26. Colour pairs and their statistical relations……………………………………..119

27. NVivo word frequency table of the fabric and timber pair……………………121

28. NVivo word frequency table of fabric and plasterboard pair………………….123

29. NVivo word frequency table of the timber and plasterboard pair……………..125

30. Overall results of materials and materials pairs…………………………….....127

31. Symbols of the materials used in the tables 32, 34, 36, and 38………………..128

32. Fabric and timber pair models and their statistical relations…………………..129

33. Contingency table of fabric and timber material pair………………………….129

34. Fabric and plasterboard pair models and their statistical relations…………….131

35. Contingency table of fabric and plasterboard material pair…………………...132

36. Timber and plasterboard pair models and their statistical relations…………...133

37. Contingency table of timber and plasterboard material pair…………………..133

38. Material pairs and their statistical relations……………………………………134

39. The relationship between three colours and three colour pairs with 'warm'….138

40. The relationship between three colours and three colour pairs with
‘energetic’…………………………………………………………………...140
41. The relationship between three colours and three colour pairs with
‘intimate’……………………………………………………………………141
42. Comparison of overall results with previous studies…………………………..143
43. Overall results of single colours….……………………………………………145
44. Overall results of paired colours……………………………………………….146
45. The relationship between three materials and three material pairs with
‘warm’………………………………………………………………………151
46. The relationship between three materials and three material pairs with
‘energetic’…………………………………………………………………...152
47. The relationship between three materials and three material pairs with
‘intimate’’…………………………………………………………………...153
48. Overall results of single materials……………………………………………..157
49. Overall results of paired materials…………………………………………….157
C1. Red and white colour pair……….……………………………………………183
C2. Red and green colour pair……….……………………………………………184
C3. Green and white colour pair……….………………………………………….185
C4. Fabric and timber material pair……….………………………………………186
C5. Fabric and plasterboard material pair………….……...………………………187
C6. Timber and plasterboard material pair.……………………...………………...188
L1. Red and white pair and their statistical relations……………………….....……205
L2. Red and green pair and their statistical relations………………………….....…205

L3. White and green pair and their statistical relations……………………………206

L4. Colour pairs and their statistical relations……………………………………..206

L5. Fabric and timber pair and their statistical relations…………………………..206

L6. Fabric and plasterboard pair and their statistical relations…………………….207

L7. Timber and plasterboard pair and their statistical relations…………………...207

L8. Material pairs and their statistical relations……………………...…………208

M1. Results in terms of warmth, energetic and intimacy (Wilcoxon Test Results)..……………………..…211

M2. Results in terms of warmth, energetic and intimacy (Wilcoxon Test Results)...212

N1. Number of participants, for each model, who assessed the models as the first one……………………………………………………….……………..……….213

LIST OF FIGURES

1. Comparison of classical view and Green and Akirav's (2007) findings about warmth-cold perception…………………………………………………………......8
2. Interior of a sauna (personal archive of Begüm Ulusoy)…….……………………..9
3. Multiple colours and materials used in the interior of Sevda Cenap And Vakfı at Ankara Castle (personal archive of Begüm Ulusoy)…………...…………………10
4. Some randomly selected objects with two or more materials (personal archive of Begüm Ulusoy)……………………………………………………………………10
5. Velvet covered car (personal archive of Begüm Ulusoy)………………………10
6. Product experience's framework (Adapted from Desmet & Hekkert, 2007: 60)………………………………………………………………………………13
7. Understanding warmth…………………………………………………………15
8. Findings of the previous study (Ward et al., 2006) "illustrates the colours selected for the 10 single piano, 10 single string and 10 single sine waves on two occasions (the synaesthete LHM and a control participant)" (Ward et al., 2006: 269)……………………………………...23
9. Researches that have demonstrated the effects of colour to gustatory sense. (Adapted from Piqueras- Fiszman, & Spence, 2012: 326)……………………………………….…………………………..25

10. Relationship of warm perception with both ‘natural perception’ and ‘thermal measure’ (Chen et al., 2009: 4307)…………………………………………...36
11. Basic representation of the human eye (Holtzschue, 2006: 36)………………...43
12. Afghan, Belgian and French flags (https://en.wikipedia.org/wiki/Timeline_of_national_flags 15.02.2016: 18:31)...45
13. Texture of a fabrics (%100 cotton) (personal archive of Begüm Ulusoy)……...57
14. Different textures of timber in the Malaysian Timber Industry Board catalogue (personal archive of Begüm Ulusoy)……………………………………………58
15. Texture of red painted plasterboard surface (http://www.juliancassell.com/934/painting-a-room)...................................…...60
16. The relation between language and vision (adapted from Jackendoff, 1996: 2)……………………………………………………………………………...62
17. Artefacts in language and communication (adapted from Krippendorff, 2006: 149)…………………………………………………………………………...63
18. Components of warmth perception (Fenko et al., 2010a)……….……………...68
19. The red and green colour pair models in the experiment box (Table 10, Colour pair 2)……………………………………………………………………………78
20. Room-1…………………………………………………………………………82
21. Room-2…………………………………………………………………………82
22. Room-3…………………………………………………………………………82
23. Drawings of the experiment box (side view and top view)…………...………...83
24. Drawings of the experiment the model (front view, top view, and perspective)..84

25. Models (red-white colour pair models) inside of the experiment box. (Table 10, Colour pair 1)…...87
26. NCS Colour meter (left) and Konica Minolta Illuminance Meter T-10A in the experiment box (right) (personal archive of Begüm Ulusoy)…..87
27. Model of first pilot study…..98
28. NVivo word clouds of red and white pair…..108
29. NVivo word clouds of the red and green pair….110
30. NVivo word clouds of the white and green pair….112
31. NVivo word clouds for the fabric and timber pair….122
32. NVivo word clouds of fabric and plasterboard pair…...124
33. NVivo word clouds of the timber and plasterboard pair….126
34. Overall relationship chart for single colours and paired colours….148
35. Overall relationship chart for single materials and paired materials…..159
36. Colour associations with related adjectives….163
37. Material associations with related adjectives….163
M1. Human figure at left and right sides of red fabric model…..210
M2. Virtual test conditions…...212

CHAPTER - 1

INTRODUCTION

Interiors are not only shelters in which we spend our lives in, but also a source of pleasure and comfort for their users. When an user walks in an indoor, they are metaphorically included in a new world and in a novel experience. In order to create satisfying interiors for this fresh encountering, interior architects should understand the perception of users and be capable of manipulating it. Warmth perception is essential, welcoming and vivid notion (of interiors) which provides environments to embrace their users, and could be manipulated by colours and materials, as key interior design elements.

Warmth perception is a powerful concept, which is important in interiors for user and that importance leads designers and architects to look at how it relates to colours and how it relates to materials. Although the concept is mentioned by many disciplines such as industrial design, psychology etc., it is one that is the least understood as an aspect of perception in interiors. Describing the concept proved to be a complex task thus a basic model demonstrating aspects and components of warmth perception and effects of colour pairs and material pairs on this concept is devised.

Colours are substantial elements of interiors as they affect every part of our daily life. Colour not only affects the perception of interiors (Odabaşıoğlu & Olguntürk, 2015), but is also a powerful element for different professions. Colours have key role for consumers in decision making process (Seimiene & Kamarauskaite, 2014), and they have impact on psychology and physiology of human beings (Helvacıoğlu, 2011). Early psychological studies (Wright, 1962; Hogg, 1969) which focused on effects of single colours on the warmth perception in the context of physical aspects stated that hue has a primary influential effect on the perception of warmth.

Materials are substantial design decision elements in interior architecture. "Understanding how materials are selected, composed and assembled is an essential skill for interior design" (Brown & Farrelly, 2012: 6). Materials are chosen by the designer for every surface and each design object, and are used by the users or consumers. Their existences and their meanings contribute to the perception of warmth as well.

There are some psychology and design studies about colour, material and warmth perception; however, studies that explore associations of colour pairs and material pairs in interiors are lacking. Although many studies associate colour with warmth perception, these studies mostly focus on single colours. Two psychology studies, which explored colour pairs in small scale of colour chips, did not elicit their effects in interiors as three dimensional design elements (Ou, Luo, Woodcook & Wright, 2004; Hogg, 1969). In addition, single materials' effects on warmth perception were studied by different disciplines such as industrial design, material studies and textile studies (Karana, Hekkert & Kandachar, 2009; Fenko, Schifferstein & Hekkert, 2010a; Chen, Barnes, Childs, Henson & Shao, 2009; Schneider & Holcombe, 1991). These studies focused on the single materials and their associations with the design objects. There is one study of Wastiels, Schifferstein, Heylighen and Wouters (2012a) that investigated the relationship between single materials and the concept on indoor wall materials. In fact, there has been no research on how colour pairs and material pairs affect the warmth perception in interiors.

1.1. Aim of the Study

The main aim of this study is to investigate how colours pairs and materials pairs affect warmth perception in interiors. As colours and materials are rarely viewed in isolation, pairs are chosen as stimuli in this study, thus three colour pairs and three material pairs are used. Determining the influence of colour and material offerings in a design context would encourage designers to create more effective spaces and designs for their clients, and will contribute to the understanding of the concept. In addition, warmth as a concept might have implications for well-being and satisfaction of users.

The main objective of the study is to investigate the relationship between warmth perception and colour pairs or material pairs. The research questions of the study are:

- Does users' warmth perception change with different colour pairs in the same interior?
- How can colours be used in interiors to induce the effective perception of warmth?
- In what ways user's free associations differ with different colour pairs in interiors?
- Does users' warmth perception change with different material pairs in the same interiors?
- How can materials be used in interiors to induce the effective perception of warmth?
- In what ways user's free associations differ with different material pairs in interiors?

Most of the studies on warmth perception are about the effects of a single colour or a single material. There is not any research about how warmth perception is affected by colour pairs or material pairs. There is lack of knowledge in the literature about how colour pairs and material pairs affect the concept in interiors. Therefore, effects of colour pairs and material pairs on warmth perception of users are still unrecognized. The present study aims to focus on the warmth perception of colour pairs and material pairs.

1.2. The General Structure of the Thesis

This thesis consists of eight sections. The first section draws general structure of the thesis and includes the descriptions of each section.

The second section of the thesis presents the notion of warmth. Definition of the concept, its aspects, and each component of warmth perception with their definitions are presented in this section. In addition, the relationship between warmth perception and colours, and warmth perception and materials are presented with prior experimental studies. In addition, the section presents the measurement methodologies for warmth perception that were used by previous researches.

The third section presents colour and material in the built environment. Firstly, user and colour interaction is defined. Next, colour existence in interior architecture is revealed. Then, the section continues with material and user interaction. Finally, material existence in interior architecture is presented.

The fourth section presents meaning aspects of warmth perception. The section firstly defines the meaning aspects of the concept. Then it reveals literal and figurative meanings of warmth. The section ends with three basic components of the figurative meaning for the concept of warmth.

The fifth section describes the experimental study with its aim, pilot studies, methodology, and procedure. This section defines the hypotheses and research questions of the study and elicits the reasons of the colour and material choices. The section finishes with the elaborated explanation of procedure of the experiment.

The sixth section includes the results and their data analysis with Statistical Package for the Social Sciences (SPSS) 20.0 and Nvivo. This section reports both qualitative and quantitative statistical results. Qualitative results such as grouping lists and word clouds are also analysed.

Discussion of the results and their relation to previous studies are stated in the seventh section. These discussions include both colour and material pairs. The eighth section as the last section of the thesis reveals the major conclusion of the study and suggestions for further research. All visual and written documents and detailed statistical charts of the study are included in the appendices.

CHAPTER - 2

WARMTH PERCEPTION

Warmth perception is a physical, emotional, semantic and sensorial bond between people and their environments. It has significant attributes that affect the experience and usage of designs; however, there are only a few studies available. The concept also has connotations related to well-being and satisfaction. In interiors and product design, people are affected by warmth, and colours and materials are prominent properties for the concept. For instance, when people experience their environments, they first perceive it with their visual sensory even if they have little left. For this reason, visual quality of their environment such as colours and materials becomes important.

Warmth perception was studied by different disciplines; medicine (for example see Harju, 2002; Green & Akirav, 2007) and neuroscience (for example see Michael, Galich, Relland, & Prud'hon, 2010; Michael & Rolhion 2008). Findings of these researches are useful. These studies defined the concept with its physical attributes. Green and Akirav (2007) determined in which way central nervous system perceives warmth and cold stimulus. Their findings conflicted with classical view that claimed cold sensation and warm sensation “are sensed with different sensory systems” (see Figure 1). They found out both warm and cold sensations are detected by same pathways in the central nervous system. They concluded that cold and warm are not separate sensations.

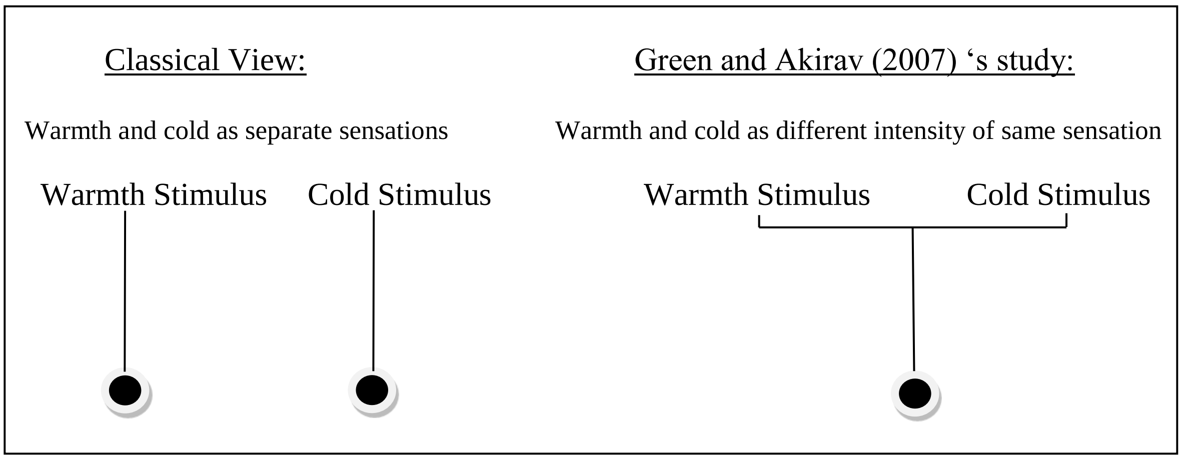


Figure 1. Comparison of classical view and Green and Akirav’s (2007) findings about warmth-cold perception

According to Wright (1962), who conducted one of the initial studies that concentrated on warmth perception of colours, hue has primary influential effect on the perception of warmth. However, in this study the researcher judged the colours by their own existences. Colours do not usually appear alone, they often emerge together (Hard & Sivik, 2001). Kueppers (1982) mentioned ‘effect of surrounding colours’ with an experiment. He placed light brown coloured banana shaped paper on yellow and dark blue coloured papers to observe the differences of peoples’ perceptions and found that same light brown coloured banana shaped paper “looks darker, dirtier and more unappetizing” (Kueppers, 1982: 22) on yellow coloured paper than dark blue one. This study, which proved that colours are perceived differently according to their accompanying colour, is an example of how colour pairs affect overall perception of users. Although warmth perception researches studied whether isolated single colours have an effect, there is not any research to elicit the effects of colour pairs on warmth perception in interiors. Similar to colours, materials also do not usually appear alone. Both in interiors and design objects, people see and perceive materials with some other materials. Except in spaces like saunas, it is quite difficult to find any interior that consists of the same type of material (see Figure 2). There are also some design objects such as post-it, which are produced by only one type of material (e.g. cellulose). But most of the time people do not encounter with a single colour or a single material (see Figures 3, 4 and 5).

Figure 2. Interior of a sauna (personal archive of Begüm Ulusoy)

Figure 3. Multiple colours and materials used in the interior of Sevda Cenap And Vakfı at Ankara Castle (personal archive of Begüm Ulusoy)

Figure 4. Some randomly selected objects with two or more materials (personal archive of Begüm Ulusoy)

Figure 5. Velvet covered car (personal archive of Begüm Ulusoy)

2.1. A Definition

Holoien and Fiske (2013: 33) stated that "warmth reflects traits related to other-profitable intent, such as friendliness, communion, morality, and trustworthiness". In parallel, according to Williams and Bargh (2008: 606-607) warm is a "constellation of traits related to perceived favourability of the other person's intentions toward us, including friendliness, helpfulness and trustworthiness" and "is so central to interpersonal perception and behaviour". These definitions cooperate that warmth perception consists of traits that evoke positive emotions/feelings. Andersen and Guerrero (1997: 304) indicated that interpersonal warmth is "one of the most common, most important and perhaps least understood emotions". According to Heflick, Goldenberg, Copper and Puvia (2011: 572) "the stereotype content model[1]"'s, researchers discuss perception of warmth being essential to perceiving "others as fully human". The previous study stated that "things that were once alive and warm, like the fur of a polar bear rug or the leather of a chair, may carry an association with previous life" (Schifferstein & Wastiels, 2014). In parallel, some colours and some materials carry a meaning of warmth in interiors. Warmth is one selection criteria for interiors, and is used by architects and non-architects to define an interior environment (Wastiels et al., 2012a). For this study, warmth perception is defined as a physical, semantic, emotional, and sensorial bond between people and their environments. The concept not

[1] The stereotype content model (SCM) (Fiske, Cuddy, & Glick, 2007; Fiske, Cuddy, Glick& Xu, 2002) assesses person's behavioural and emotional reactions to others based on perceptions of two dimensions: warmth and competence

only includes physical warmth but also emotional and semantic features, which are perceived through the five senses. In the light of these definitions 'warmth perception' is described as a multisensory concept, consisting of physical, semantic, and emotional aspects. These aspects and their relationship constitute an overall perception of warmth. The concept is perceived by sensorial information which is analysed by the cognitive process of human brain. Warmth is defined as a kind of percept that is affected not only by physical features of the environment, but also affects and is affected by emotions of individuals and meanings that are assigned to physical features. The concept is also constituted by these assigned meanings as semantic aspect which has fundamental effects on interior.

2.2. Aspects of Warmth Perception

Product experience consists of three components: aesthetic experience, experience of meaning and emotional experience (see Figure 6) (Desmet & Hekkert, 2007: 60). In this study, the framework of Desmet and Hekkert (2007) for product experience is embraced in order to clarify aspects of 'warmth perception' and their relations. In the context of warmth perception in interiors; aesthetic experience corresponded with physical and sensorial aspects, experience of meaning corresponded with meaning (semantic) aspect and emotional experience corresponded with emotional aspect.

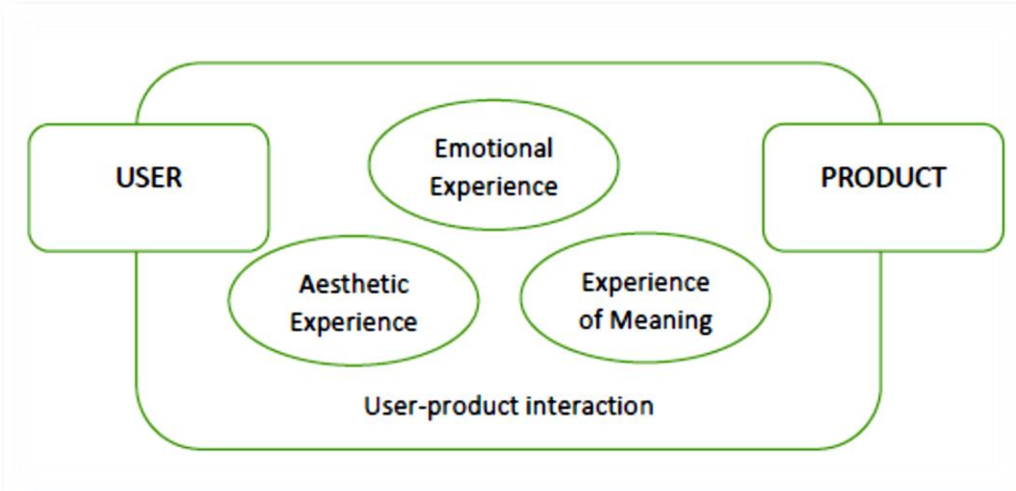


Figure 6. Product experience's framework (Adapted from Desmet & Hekkert, 2007: 60)

Warmth perception is a multisensory experience of physical environments that includes meanings and emotions (see Figure 7). Definition of the concept consists of four parts; physical aspect, sensorial aspect, emotional aspect and meaning aspect. These four parts and their relations constitute an overall warmth perception. Firstly, aesthetic experience, which was defined as a physical appearance of product by the previous study (Desmet & Hekkert, 2007) corresponded with physical and sensorial aspects of warmth perception that is described by physical existence and properties of interior. Physical aspect, which are inherent properties of interiors, affects the actual warmth independently from both cognitive process and personal or cultural differences. These conditions are scrutinized by five senses, which constitute sensorial aspect; however, emotional and meaning aspects of the concept dominate the overall perception of warmth. Emotional experience was defined as "the feelings and emotions that are elicited" (Hekkert, 2006: 160), thus emotional aspect of warmth reveals occupants' feelings that are associated with an interior's property. Experience of meaning, which was presented as "the meaning we attached to the product" (Hekkert, 2006: 160) corresponded with meaning aspect of warmth perception in interiors. Emotional aspect is defined by human social cognition and emotions; however, meaning aspects include literal and figurative meanings (see Figure 7). Physical aspects are related to interiors and environments, sensorial aspects are about sensations of users, however, meaning and emotional aspects are outcomes of cognitive process in users` minds and brains. In interior architecture, meaning aspects have influential effects on warmth perception because physical and sensorial aspects are absolute realities which cannot be interpreted and emotional aspect is more related to personal differences; however, meaning aspect has universal consensus as well as culture dependent diversity of meanings that are shared by majority.

2.2.1. Physical Aspects

The concept includes physical aspects of objects, surfaces and environments. The definition of warm as it is indicated in Merriam-Webster is given in Appendix A (see Appendix A for the definition of warm). Physical aspects consist of two parts. The first part includes thermal properties and other properties such as thermal conductivity or ambient temperature that affect actual warmth of an environment. However, in the second part, surface properties such as colours, pattern and roughness affects other aspects of warmth perception (see Figure 7).

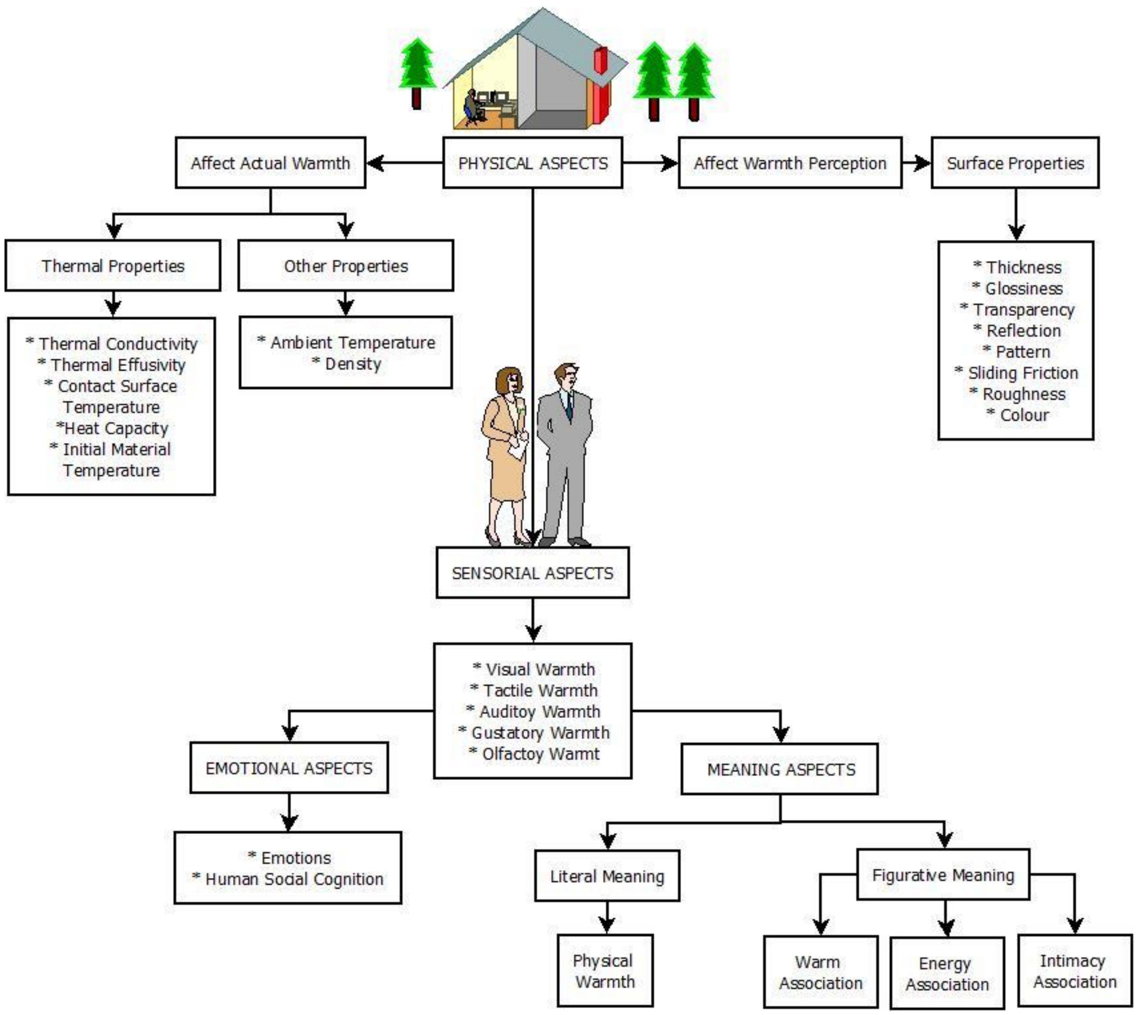


Figure 7. Understanding warmth

Some researches associated warmth with physical attributes. Fay and Maner (2012) correlated the distance between the object and the participants with the temperature of the object. They measured the perceived distance by a self-report test and physical distance with an objective measurement. They found out that perceived physical proximity of the objects increase with objects' physical warmth. In parallel, Bargh and Shalev (2012) claimed that physical warmth substitutes to social warmth. They found out people feel socially warmer at physically warm environments. According to Kang, Williams, Clark, Gray and Bargh (2011) people tend to feel more "interpersonal trust" in warmer environments. In this study, they defined warmth as "physical temperature" and indicated that "insula" [2] has key role about warmth perception. Although this study defined the concept as physical warmth, they were still studying 'interpersonal trust'.

The physical aspect of warmth includes all physical features of the environment, namely thermal properties, surface properties, density, and ambient temperature, regardless of an individual's perception. Thermal properties include thermal conductivity, thermal effusivity, contact surface temperature, heat capacity, and initial material temperature (Obata, Takeuchi, Furuta, & Kanayama, 2005; Fenko et al., 2010a; Wastiels et al., 2012a, Wastiels, Schifferstein, Heylighen and, & Wouters, 2012b). These properties are related to actual warmth of an environment or an object. Thermal conductivity means that "the rate of conduction of heat through a material over unit length per unit area per unit temperature gradient" (Clugston, 1998: 759). "Thermal effusivity is defined with the square root of the product of thermal conductivity, specific heat and density" (Obata et al., 2005). Contact surface temperature is arithmetic calculation of temperature when human hand touches a surface; for instance, "when a person with a skin temperature of 35°C touches an aluminium block and then a timber block both at 15°C, the contact surface temperature will be 15.9°C in the case of aluminium and 30°C in the case of timber" (Kanoğlu, 2011). Basic equation of contact surface temperature is (Obata et al., 2005: 1321):

[2] Insula: the lobe in the center of the cerebral hemisphere that is situated deeply between the lips of the sylvian fissure—called also central lobe, island of Reil.

$$T_{cs} - T_{ini\mathrm{M}} = \frac{T_{ini\mathrm{H}} - T_{ini\mathrm{M}}}{1 + \eta_{\mathrm{M}} / \eta_{\mathrm{H}}} \quad (1)$$

In which, T_{CS} represents contact surface temperature, T_{ini} is an initial temperature, and η is thermal effusivity. H and M means hand and material respectively. Heat capacity (specific heat) is "the heat transferred to a system per unit in temperature, defined in terms of the conditions imposed on the system at the time" (Clugston, 1998: 350). Warmth perception has positive linear relationship with thermal conductivity (temperature resistance) (Wastiels et al., 2012b), contact surface temperature (Obata et al., 2005) and heat capacity (specific heat) (Fenko et al., 2010a). Also warmth perception has negative linear relationship with thermal effusivity (Obata et al., 2005). Initial material temperature is initial temperature of material before any interaction with human hand or other surfaces, and has positive linear relationship with the concept.

Surface properties include thickness, glossiness, transparency, reflectance, pattern, colour (hue, saturation and lightness), roughness (also means average roughness and mean square roughness) (Wastiels et al., 2012a, 2012b), and sliding friction (Chen et al., 2009). Thickness is "the quality or state of being thick" that means "having or being of relatively great depth or extent from one surface to its opposite". Glossiness is defined as "having a surface luster or brightness". Transparency is "the quality or state of being transparent" that is defined as "having the property of transmitting light without appreciable scattering so that bodies lying beyond are seen clearly". Reflectance is "the fraction of the total radiant flux incident upon a surface that is reflected and that varies according to the wavelength distribution of the incident radiation". Pattern is "a form or model proposed for imitation" and sliding friction is "the friction between two bodies that are in sliding contact". Roughness is "a measure of the fine, closely-spaced random irregularities of a surface that caused by production process" (Wastiels et al., 2012a: 442). Definitions of all these variables are cited from Merriam-Webster. Visual texture may embrace all these components of surface properties. Colour has three attributes; hue, saturation and lightness. Hue is defined as "the quality or characteristic by which one color is distinguished from another" (Mahnke, 1996: 84). Saturation "designates the purity of a given color, the quality that distinguishes it from a grayed, or weaker color" (Mahnke, 1996: 85). Lightness "is the quality that differentiate a dark color from a light one" (Mahnke, 1996: 85). Roughness and thickness have positive linear relationship with warmth perception (Wastiels et al., 2012b). Relationship of colour variables are not explicit in the literature. However, hue affects the warmth perception independent from other colour variables (Wright, 1962).

Ambient temperature and density are other variables that affect warmth perception of materials (Wastiels et al., 2012b). Ambient temperature, which is measured in °C, is temperature of environment or surrounding in which the material exists. Density is defined as "the mass of material per unit volume" (Clugston, 1998: 350) and is measured in kg/m^3. Both have a linear positive relationship with the concept (Wastiels et al., 2012b).

2.2.2. Sensorial Aspects

People can perceive warmth with their five senses, therefore, sensorial aspects are constituted by five senses in human body. Visual warmth, tactile warmth, auditory warmth, gustatory warmth, and olfactory warmth independently exist, but are also affected by each other and create a multi-sensorial and overall perception of warmth. Wastiels and Wouters (2012: 585) indicated that because of its “smaller scale and shorter develop-to-market” characteristics, industrial design might detect material experience faster than interior architecture and architecture. Therefore, in this study, interpretation of some industrial design studies is presented. Karana et al. (2009) is one important research that embraces all five senses. They conducted their study to determine how meanings are attributed to materials in relation to sensorial properties (13 sensorial properties such as roughness, odorous, transparency, etc.) and manufacturing process (33 manufacturing process such as polishing, moulding, decorative joining, etc.). They stated that people tend to differentiate sensorial properties more than the manufacturing process. For instance, in overall ranking, roughness, softness, glossiness, colourfulness, colour intensity, strength and weight of products are important than polishing for products. This study shows that type of a product determines which sense has dominance on the concept.

Gifford (2002) stated that people are primarily visual creatures. Numerous studies reported the importance of vision for perception and experience in the context of design disciplines (Hekkert, 2006; Schifferstein, 2006; van Kesteren, 2008; Fenko, Schifferstein, Huang, & Hekkert, 2009; Fenko, Schifferstein & Hekkert, 2010b). In addition, Hay, Pick and Ikeda (1965) proved dominance of vision over all other senses and overall sensation. Crilly, Moultrie and Clarkson (2004) demonstrated that people mostly use their visual information while they are studying products. Bloch (1995) stated that for consumer response and product success, visual property is important. Fenko et al. (2009: 372) reported that:

> … smell dominated the judgments of freshness for soft drinks and dishwashing liquids. However, for scented candles smell and colour were equally important in determining freshness. This suggests that the dominant sensory modality for the product experience of freshness depends on the characteristics of the particular product.

Schifferstein (2006: 41) investigated evaluation process of products and concluded that vision is the most important sense, “followed by touch, smell, and taste”. A similar study was conducted by Fenko et al. (2010b) with products (scarves and breakfast trays) to investigate what properties make products warm. Their results revealed that visual warmth is associated with figurative meaning of the products, which means people relate visual warmth with “social interaction, intimacy and friendly atmosphere” (Fenko et al., 2010b: 1325).

In the context of interiors, when users enter somewhere, they firstly see their surroundings with colours, materials, etc. While experiencing an interior, people firstly activate their visual sense. This experience is followed by other senses. But vision is the first sense which people experience, perceive and understand their environment and construct their first impression. Interiors could be assumed as a kind of product that is initially consumed by visual sense, and visually perceived by users more than other products. Although, there is not a vast amount of studies about visual sense and interiors relationship, Wastiels et al. (2012a) conducted one study with two senses (visual sense and tactile sense) in order to investigate warmth perception. According to their study, the visual sense dominated one's overall warmth perception within the context of indoor walls in interiors. In addition, innate properties of materials; heat capacity, thermal effusivity, colour, roughness, softness, polishing, elasticity, etc. had effects on the perception of warmth. Also they demonstrated that colour is a powerful determinant for warmth perception in interiors for vertical elements which is related with visual sense. Wastiels, Schifferstein, Wouters and Heylighen (2013) conducted another experimental study in which participants experienced building materials with only their visual sense or only their tactile sense or both. Participants assessed materials with both semantic differential scale and free association, and they were asked to write down three keywords for each sample. The results proved that architecture students, who were participants of the study, were dominated by vision during their material selection process in fact they were not aware of tactile properties of materials and could not identify them by barely their tactile sense. Therefore, in the current study, the researcher investigate the visual warmth of interiors.

Tactile sense is mentioned by myriad studies as the second important sense for experiencing objects and designs (Klatzky, Lederman & Metzger, 1985; Schifferstein, 2006; Fenko et al., 2010b). Schifferstein (2006) demonstrated that tactile sense is the second important sense after vision for product evaluations. Similar results were reported by Fenko et al. (2010b) which show that while consumers buying a product, they firstly see it, then touch it and after that hear, smell and taste it. Klatzky et al.(1985: 301) stated that "…the haptic system is well equipped to identify familiar objects; we do not mean to claim that the perception of form through touch is generally accurate and efficient". Touch is an effective way to identify and understand the materials and designs but it cannot inform the user without other senses (especially vision), if the user does not have any former experience with it. Fenko et al.(2010b) conducted a study in order to investigate what properties make products warm and found out tactile warmth is associated with literal meaning of the products, which mean people relate tactile warmth with physical properties. Wastiels et al. (2012a: 359) investigated the concept within the context of interiors as "separate effects of vision and touch". Their results reveal that "the senses used for evaluation have a major impact on the warmth perception" and "the overall perception of warmth was shown to correspond to its visual perception" (Wastiels et al., 2012a: 359). Although, visual sense dominates the perception of warmth in interiors, tactile sense has prominent effect on the experience of interiors. Users tend to touch walls, sit on furniture, touch a furniture and feel the temperature that surround them by their tactile sense. For the case of visually impaired users, it defines limits of interiors. Nevertheless, as commonly known, vision still is the dominant sense for perception for all people.

Auditory warmth is the least investigated part of the sensorial aspects. There is no study on how sounds affect the warmth perception. However, synaesthesia phenomenon has revealed some relationship between colours and sounds. "Synaesthesia is a broadly defined neural phenomenon in which stimulation of a sense or concept triggers a second perception not normally associated with the stimulus" (Novich, Cheng & Eagleman, 2011: 353). Ward, Huckstep and Tsakanikos (2006) conducted three experiments to elicit how people associate colours with sounds. They reported that "both synaesthetes and nonsynaesthetes display a tendency to associate low pitch notes with dark colours and high pitch notes with light colours" (Ward et al., 2006: 268) (see Figure 8).

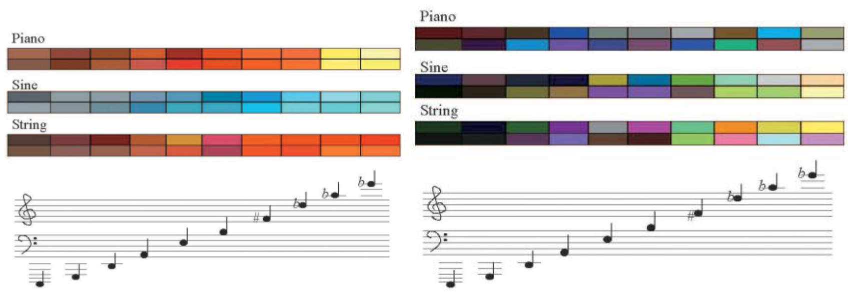


Figure 8. Findings of the previous study (Ward et al., 2006) "illustrates the colours selected for the 10 single piano, 10 single string and 10 single sine waves on two occasions (the synaesthete LHM and a control participant)" (Ward et al., 2006: 269).

Gustatory sense is multimodal perception (Verhagen & Engelen, 2006). To taste a product, people touch it with their oral cavity, use olfactory receptors for smell and their gustatory receptors for taste. Even auditory sense affects the perception of foods, potato chips are perceived fresher when their sound of biting has amplified (Zampini & Spence, 2004). The previous study demonstrated that even non-human primates (squirrel monkeys and spider monkeys) utilize olfactory, gustatory and tactile senses together (Laska, Freist & Krause, 2007). Temperature related characteristics of foods and beverages are the most important ones (Fenko et al., 2009), thus gustatory sense is used to define warmness and coldness of these products. Researches related 'cold' with oral 'freshness' (Zellner & Durlach, 2002; Westerink & Kozlov, 2004). Temperature has an influential effect on taste (Talavera et al., 2005), so gustatory warmth affects people's perception. Also cold stimulus is preferred to warm ones and this situation is product dependent; cold beverages are perceived as thirst quencher even if they have same quality with warm ones (Eccles, Du-Plessis, Dommels & Wilkinson, 2013). Williams and Bargh (2008)'s study that showed that a cup of hot coffee is associated with 'warmer' personalities which reveals people experience warmth perception with gustatory sense. In addition, colours affect the sense of taste (see Figure 9). Piqueras-Fiszman and Spence (2012) investigated perception of hot beverage and colour of their plastic cups and proved that colour of the cup manipulates the perception of beverage (likening, chocolate beverage, sweetness and chocolate flavour). "Cold colours (blue and green) were considered as the most thirst-quenching beverages whereas warm colours (red and yellow) were considered as the lower thirst-quenching beverages" (Guéguen, 2003: 4).

Nasal properties are not considered as being directly related to the concept. However, there are few studies indicating how colours affect the perception with olfactory senses (Zellner & Kautz, 1990; Zellner, Bartoli, & Eckard, 1991; Zellner & Whitten, 1999). These three studies probed the influence and effects of colours on odour intensity, odour identification and liking, and colour appropriateness respectively. Fenko et al. (2009) investigated relationship between colour and two different modalities: vision and smell. They showed that dominancy of the modality depends on the characteristics of the product. For instance, olfactory sense is more influential for soft drinks and dishwashing liquids; however, both smell and colour of the candles have the same effect on products for perceiving freshness. There are two more studies which elicited the effects of colours on warmth perception by olfactory sense. The first study was conducted by Michael et al. (2010: 419) which conducted an experiment with odourless coloured water, reported "cooling was more frequently associated with green and warming with red". The second study, which investigated how colours affect the nasal activities in four experiments, reported similar results with the former one and they concluded that even when there is not any change for thermal stimuli, red coloured odourless water is perceived warmer than green coloured odourless water (Michael et al., 2010).

Author(s) (year)	**Receptacle**	**Product**	**Characteristics studied**	**Main Findings**
Dichter (1964)	Packaging	Coffee	Color	The majority of respondents associated the brown packet with a strong flavored coffee, red with richness, blue with mildness/smoothness and yellow with an excessively mild flavor.
Favre and November (1979)	Jars	Coffee	Color	The coffee from the brown jar was rated as too strong, that from the red jar had a richer, fuller aroma, that from the blue jar a milder aroma and that from the yellow jar appeared to have come from a weaker blend.
Guéguen (2003)	Cups	Soft drink	Color	Drinks from "colder-colored" cups were judged as more thirst-quenching than those from warm colors
Krishna and Morrin (2008)	Cups	Water	Flimsiness (touch – not touch)	Touching the flimsy cup decreased the perceived quality of the water.
Schifferstein (2009)	Cups	Soft drink and tea	Materials (and color)	Drinks from cups were perceived similarly as the cups were perceived when empty.
Harrar *et al.* (2011)	Bowls	Popcorn	Color	The sweet popcorn, in addition to being sweet, was perceived as saltier when eaten out of a colored (as compared with a white) bowl, and vice versa for the salty popcorn.
Piqueras-Fiszman *et al.* (2012a)	Plates	Sweet strawberry mousse	Color (black and white)	When the mousse was served from a white plate, it was perceived as significantly more intense and sweeter. It was also liked more than when served from a black plate.

Figure 9. Researches that have demonstrated the effects of colour to gustatory sense. (Adapted from Piqueras- Fiszman & Spence, 2012: 326).

2.2.3. Emotional Aspects

Emotional aspects of warmth perception include emotions and human social cognition. Emotions are defined as feelings and “affective aspect of consciousness” by Merriam and Webster online dictionary. Human social cognition is related to social abilities and intensions that are constituted by cognitive process (Jacob, 2008; Adolphs, 1999). Warmth is mentioned as an emotion and is associated with positive consequences. Aaker, Stayman and Hagerty (1986: 365) defined the emotional aspects as:

> Warmth has been used as an emotion in a number of contexts, appearing in the literature as a part of lists of emotions (Bush, 1972), as an experience associated with emotional terms (Davitz, 1969), and as a part of em-pathetic emotional response (Coke, Bateson, & McDavis, 1978)

Interpersonal warmth is “one of the most common, most important” but “perhaps least understood emotions” and consists of variables of intimacy, relationship closeness, bonding, attachment, and involvement (Andersen & Guerrero, 1997: 304). The emotional aspects of warmth are related with interpersonal warmth that is defined as individuals’ emotions to each other. However, when emotions are studied in the context of interior architecture, there has not been any research to clarify the relationship of emotions and warmth in interiors.

Human social cognition is a human centred concept between individuals such as mother-child relation, friendship, intimacy, etc. In human social cognition, warmth perception is the most essential dimension which is followed by competence (Fenko et al., 2010a). In parallel Lin, Wang, Lin, Lin, and Johnson (2011) indicated that warmth with competence are essential dimensions to assess other individuals and their behaviours. This cognitive process is important to perceive and judge our social environment. For human social cognition, warmth is one of the essential dimensions for assessing other individuals and their behaviors (Lin et al., 2011). The stereotype content model, as aforementioned, focused on the concept to assess behaviors and emotions of people (Fiske et al., 2007). This cognitive process is important for how people perceive and judge their social and built environment. Hekkert and Karana (2014) demonstrated that emotional experience is hard to investigate without meaning experience in the context of product design.

2.3. Perceiving Warmth

Users in interiors perceive warmth through key design elements of environments by their five senses. In the context of interior architecture, two prominent key design elements are colours and materials that have influential effect on the perception of warmth. These two design elements should be studied separately in order to clarify their effects on the concept as single colours, single materials, paired colours and paired materials.

2.3.1. Through Colour Information

Warmth perception was studied by many researchers from different disciplines. This subject was first studied in the context of psychology. "The Apparent Warmth of Colours" was conducted by Meryl F. Mogensen and Horace B. English in 1926 as one of the first studies and it was mentioned by Benjamin Wright (1962) in his fundamental work about the concept. Definition of warm is associated with colour (see Appendix A), therefore, since these initial studies, warmth perception has always been associated with colour. Wright (1962) mentioned: " the influence of hue, lightness and saturation on apparent warmth and weight" in his fundamental study about the subject. He focused on colour and sought which feature of colour has dominant effect on apparent warmth. Wright (1962) found out that hue of colour has effect on warmth perception independent of saturation and brightness.

Newhall (1941) probed the warmth and coolness of 50 colours with 297 participants. He stated that yellow-reds are assessed as warm. Nordvik and Broman (2009) conducted the focus group study to investigate reactions and perceptions of human beings to interior wood's computer visualization. This study is a rare example that investigates visual warmth perception of wood through a computer screen. They found out "colour and contrast gave life and warmth to the material on the screen.

One of the earliest studies about interior architecture and warmth perception was conducted by Morgan, Goodson and Jones (1975). They aimed to find how age differences influence the association between felt temperature (subjective assessment of temperature) and colour choices. The result of the study demonstrated that 6 years olds did not have any association, whereas 12 years olds could only associate ‘hot’ and ‘red’ and 18 years old associated all colours (red, yellow, green and blue) with the felt temperature. The researchers concluded that association between colour and felt temperature is learned by age and is related with culture. They found out elder children associate colour with traditional pairing more than younger children. Itten (1973) mentioned an unreferenced study about the concept in the context of colour and art. Also Mahnke and Mahnke (1987) mentioned same type of study in a different published book of Itten (1970). In this study, Itten (1970) revealed that participants felt cold in blue-green room of 15˚C, whereas they felt cold at 11.1˚C in red-orange room (as cited in Mahnke & Mahnke, 1987). Clark (1975) (as cited in Mahnke & Mahnke, 1987) and Porter and Mikellides (1976) investigated the same subject in interiors. Clark (1975) proved that users prefer 1.8 degree higher indoor environment temperature in a blue room than in an orange room. Users felt cold in the 22.2˚C blue room; however, they preferred orange 22.2˚C in the room because they felt warm at 24˚C (as citied in Mahnke & Mahnke, 1987). Similarly, Porter and Mikellides (1976) found people prefer to decrease indoor temperature 4 degrees lower in a red room than a blue one. These earlier studies focused on only the effects of isolated single effect of hue on warmth perception. They confined their experimental settings by difference between blue and red or blue and orange.

Michael and Rolhion (2008: 141) conducted their study to investigate how visual perception of objects can affect “nasal thermal sensation”. The participants felt cold in their nasal nostril while smelling green coloured water and felt warm in their nasal nostril while smelling red coloured water. They found out visual sense affect warmth perception of olfactory sense. They also borne out the participants’ sense cool with their right nostril and warm with their left nostril. Michael and Rolhion (2008) conducted their study to elicit how colour (visual sense) of a bottle of distilled water affects the nasal warmth perception (olfactory sense). They used four different coloured waters. Participants were asked to assess their nasal warmth after smell (without touch). The participants were only allowed to asses ‘cooling’, ‘warming’ or ‘none’ sensation; on a subjective scale. This study is an essential example to prove how different senses can affect each other while people perceive warmth and how subjective scales are used for experimental settings.

There are two studies that are associated with interior architecture. These were conducted by the same group of researchers. Both studies focused on the warmth of materials in interiors. In the first study, the authors aimed to define how colour and roughness of materials can affect the warmth perception of the participants (Wastiels et al., 2012b). They investigated both tactile and visual warmth. The researchers found out both colour and roughness have effect on warmth perception and the effect of colour is larger than the effect of roughness on warmth perception. They also determined warm colours are perceived warmer than cold colours, and rough surfaces are perceived warmer than smooth surfaces. The second study concentrated on how the concept is affected by technical material parameters (thermal effusivity, thermal conductivity, specific heat, density, material colour, surface gloss and roughness), "the effect of non-colour materials on warmth perception" and "what extent do the senses of vision and touch contribute to the perception of warmth for building materials" (Wastiels et al., 2012a: 361). The researchers used both materials' technical parameters and sensorial measurements. The measurements of the materials' parameters were done in four ways. Firstly; they gathered data about thermal measurements. Thermal conductivity, the specific heat, the density and the thermal effusivity data of the materials were ensured from "different sources": Bone, Kemps, Peters and Post (2003), Braeckman, De Cock and Drugmand (1987), Leijendeckers, Fortuin, van Herwijnen and Schwippert (2002), Simpson and TenWolde (1999) and Wilkinson (2008) (as cited in Wastiels et al., 2012a: 362). Secondly, average roughness (Ra) and mean square roughness (Rq) were measured by Wyko NT2000 non-contact profiler. These were surface measures of the materials. Thirdly, gloss (20˚/60˚/80˚ geometry) was measured by BYK-Gardner Micro-Tri-Glossmeter. Finally; lightness, red-green value (a*), Yellow-Blue value (b*) and colour intensity (I*) were measured by Minolta CR-310 colorimeter, with a D/8 geometry and D65/10˚ illuminant. These were colour measurements of the materials. On the other hand, the meaning aspects were measured by 9-point itemized semantic differential scale that included 'cold-warm' with 14 accompanying adjectives with their opposing adjectives (unpleasant-pleasant, simple pattern-complex pattern, not fragile at all-extremely fragile, not lively at all-very lively, intense colour-pale colour, not fresh-very fresh, mat-glossy, soft-hard, not denting-denting, dark colour-light colour, not massive-massive, obtrusive-neutral, smooth-rough, and textured-flat) (Wastiels et al., 2012a:

363). All these adjective pairs were defined by the researchers. Both tactile and visual warmth perception were assessed by the participants. They found that visual perception dominates overall perception of warmth in interiors, technical parameters can be used as good indicators of warmth perception and colour is a powerful determinant for warmth perception. They demonstrated that red and yellow induce the perception of warmth in interiors and white is the coolest colour.

Table 1 presents fundamental studies about the concept with their criteria and findings. Studies of warmth perception preferred to use two types of measurements: physical measurements and subjective assessments. For measuring physical aspect of warmth, equipments and physical measurements were used. However, for measuring meaning and emotional aspects of warmth perception ‘semantic differential scales’ were used. Also interviews could be utilized to explore the concepts’ meaning and emotional aspects.

Table 1. Fundamental studies related to colours

References	Criteria	Findings
Newhall (1941)	Colour and coolness Colour and warmth	Yellow-reds are assessed as warm
Wright (1962)	Colour and warm	Hue of colour has effect on warmth perception independent of saturation and brightness
Itten (1970) (as cited in Mahnke & Mahnke, 1987)	Indoor wall colour and felt temperature	Red-orange rooms are felt approximately 4 ˚C warmer than blue-green rooms
Morgan, Goodson and Jones (1975)	Colour and felt temperature according to age	Associations between colour and felt temperature is learned by age. Hot and red association started after 12.
Clark (1975) (as cited in Mahnke & Mahnke, 1987)	Indoor wall colour and felt temperature	Orange room is felt approximately 2.2 ˚C warmer than blue room.
Porter and Mikellides (1976)	Indoor wall colour and felt temperature	Red room is felt 4 ˚C warmer than blue room.
Michael and Rolhion (2008)	Colour and nasal thermal sensation (olfactory warmth perception)	Visual sense affects olfactory sense.
Nordvik and Broman (2009)	Woods computer visualization (visual warmth perception)	Colour and contrast create warmer wood on the screen more than its actual warmth
Wastiels et al., 2012b	Colour of material and warmth Roughness of material and warmth	Colour and roughness have effect on warmth perception and the effect of colour is larger than the effect of roughness on warmth perception. Warm colours are perceived warmer than cold colours, and rough surfaces are perceived warmer than smooth surfaces
Wastiels et al., 2012a	Visual and tactile warmth and technical parameters of materials	Visual perception dominates overall perception of warmth in interiors. Colour is a powerful determinant for warmth perception. Red and yellow induce the perception of warmth in interiors and white is the coolest colour.

2.3.2. Through Material Information

Warmth perception and material concept were usually mentioned in terms of colour. Some essential studies concentrated on material-warmth relationship without the effects of colour (Obata et al., 2005; Chen et al., 2009; Fenko et al., 2010a; Karana et al., 2009). More than a few decades ago, the subject was studied by Tinker (1938). In this study, the researcher aimed to investigate how two different materials (paper and cloth) and 11 different colours can affect the affective value and apparent warmth. He found out that the influence of colour is higher than the influence of material type on the affective value and apparent warmth.

Textile and textile products were studied about their warmth perception. These studies about textile and textile products focused on tactile attributes (Bacci et al., 2012, Chae, Lee, & Cho, 2011; Schneider & Holcombe, 1991) and effects of their physical properties (Gürcüm, 2010). Therefore, materials` tactile warmth was an essential concern in these studies. Bacci et al. (2012) investigated different types of wool fabrics and their tactile properties. They found out high positive correlation between warmth and thickness of wool fabric. Chae et al. (2011) evaluated tactile sensory perceptions of coloured organic cotton (NaCOC) and related mechanical properties (seventeen mechanical properties were defined by authors) to these sensory evaluations. Their findings gave much useful data for many aspects of a material (e.g. thickness, weight) but not so much for warmth. Schneider and Holcombe (1991) investigated which properties of fabric affect coolness to touch and found out outer layers' thickness is the property that affects cool sensation on fabric. Gürcüm (2010) investigated how subjective perception is related with physical attributes of woven fabric (fiber contents, weight, weave type, fiber count, tensile properties and bending properties). Participants were asked to assess five fabrics with different properties (the softness, fullness, tightness, drape, flatness, thickness, warmth, elasticity, tearing strength and resistance to ironing properties) (Gürcüm, 2010: 101). The researcher used 7-point itemized semantic differential scale to measure subjective perception. They found negative correlation between smoothness of fabric and warmth perception and positive correlation between toughness of fabric and warmth perception.

Also warmth perception of wood or timber products was concern of researchers such as Obata et al. (2005), Shida and Koike (1996), and Chen et al., (2009). Obata et al. (2005) conducted a quantitative study with thermal attributes (thermal effusivity, contact surface temperature). They defined effects of thermal attribute of the wood on tactile warmth of the wood, and used equations and calculations to conclude the results. Obata et al. (2005) found positive correlation between warmth of wood and contact surface temperature and negative correlation between warmth of wood and thermal effusivity. Shida and Koike (1996) investigated “the radiant heat varied according to difference in emissivity of the materials”. They concluded that “wood will have a medium efficiency to the radiant thermal sensation” (Shida & Koike, 1996: 881). As textile studies, timber and timber product studies frequently investigated the tactile warmth perception of the material. In addition to these material related studies, product design was of concern in warmth perception studies. Chen et al. (2009: 4299) investigated the relationship between 37 packaging materials' physical properties (sliding friction, heat transfer and compliance) and users' assessment with their tactile sense and affective judgments ("how pleasure, exciting, indulgent the sample felt"). Sliding friction, heat transfer and compliance were measured "with equipment based on a piezo-electric force platform" (Chen et al., 2009: 4301). The participants assessed sensorial properties and affective judgments about these packing materials with 7-point itemized semantic differential scale. The researchers performed 2 separate self-report experiments. They found out roughness and sliding friction are useful determinants for affective packaging design, and perception of warmth is related to thermal measure and natural perception. (see Figure 10) (Chen et al., 2009: 4307).

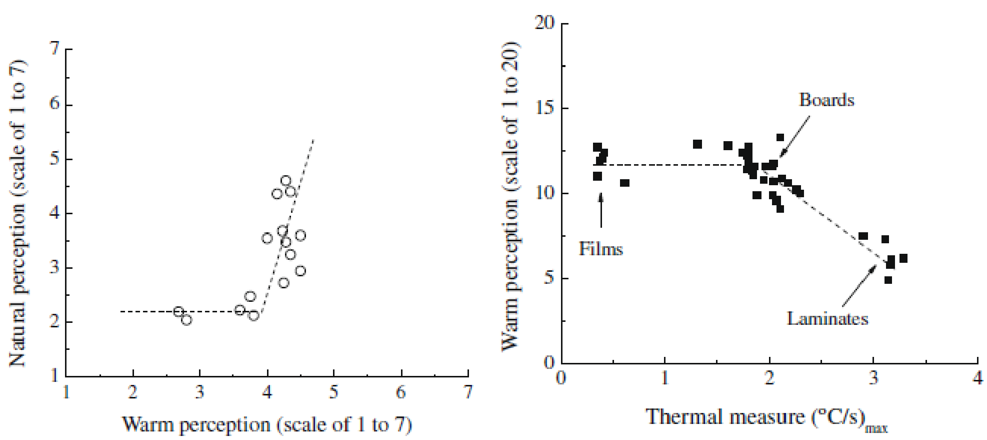


Figure 10. Relationship of warm perception with both 'natural perception' and 'thermal measure' (Chen et al., 2009: 4307).

Fenko et al. (2010a) and Karana et al. (2009) investigated warmth perception of materials of different products. Fenko et al. (2010a) defined warmth as "thermal properties of product" and related to tactile perception. However, Fenko et al. (2010a) stated that warmth is "a multisensory product experience that may also include visual, olfactory and in some case, also gustatory and auditory components" (Fenko et al., 2010a: 1325). They used Munsell code, which is an objective measurement of the surface attribute, to determine which colour they used for each object. Moreover, Fenko et al. (2010a) used both questionnaire and interview. They asked the participant to assess the warmth of object with questionnaire that included 10 point itemized semantic differential scale (1- 'very cold' and 10- 'very warm'). In addition, they used a semi-constructed interview that included the questions: "what sensory properties of the products mentioned are relevant for the experience of warmth" and "the environment and the activities that participants associate with the experience of warmth and what emotions they have in such environments and during such activities" (Fenko et al., 2010a: 1329). These questions were used to measure the meaning and emotion aspects of the concept. They found that colour and material have the same magnitude of influence on the perception of warmth. Also it can be interpreted from the results that people tend to overestimate the impact of the literal meaning of the warmth and underestimate the impact of the figurative meaning of the concept.

On the other hand, Karana et al. (2009) demonstrated warmth as one of the variables that affect how people attribute a meaning to the materials. Karana et al. (2009) preferred to use a different procedure that increases the practical results of the study. They conducted the study with objects that were selected by the participants. They did not determine the products and did not control the properties of the products. Participants were asked by a letter to bring five products that they attributed the five given meanings (aggressive, nostalgic, professional, sexy and toy-like) to the test room. 125 products were classified by the meaning they attributed. They used a 5-point itemized semantic differential scale for assessment of sensorial properties and conducted interviews to assess the materials of the products. People brought products for the meaning of aggressive and sexy, and they tended to associate these products with warm, which supported that warmth has the meaning of energetic as an exciting and reactive arousal. As a result, people tended to differentiate sensorial properties more than the manufacturing processes. They mentioned glossiness, roughness, transparency and softness more often than others. Metal and plastic were associated with all five given meanings, glass was associated with the meanings of sexy and timber was associated with the meaning of nostalgic.

The researches that investigated the relationship between materials and warmth perception demonstrated that roughness is a determinant. Table 2 presents fundamental studies with their criteria and findings. Except roughness; thickness, toughness, sliding friction, glossiness and softness were mentioned by different researchers. However, there is not any agreement about these properties. These studies used same measurement methods as the studies which associate colour and warmth perception.

Table 2. Fundamental studies related to materials

References	Criteria	Findings
Schneider and Holcombe (1991)	Properties of fabric affect coolness to touch	Outer layers' thickness is the property that affects cool sensation on fabric
Shida and Koike (1996)	The radiant heat and emissivity of the material	Wood has a medium efficiency for the radiant thermal sensation
Obata et al. (2005)	Tactile warmth of wood and thermal attributes	Positive correlation between warmth of wood and contact surface temperature; and negative correlation between warmth of wood and thermal effusivity.
Chen et al., (2009)	Packaging materials' physical properties and users' assessment with their tactile sense and affective judgments	Roughness and sliding friction are useful determinants for affective packaging design, and warmth perception is related to thermal measure and natural perception.
Karana et al. (2009)	Meaning of materials (tactile sense and warmth)	People tend to differentiate sensorial properties more than the manufacturing processes. Timber is associated with the meaning of the nostalgic, however, warm meaning is related to aggressive and sexy,
Gürcüm (2010)	Subjective perception and physical attributes of woven fabric	Negative correlation between smoothness of fabric and warmth perception; and positive correlation between toughness of fabric and warmth perception.
Chae et al. (2011)	Tactile sensory perceptions of coloured organic cotton	Their findings give much useful data for many aspects of a material (e.g. thickness, weight) but not so much for warmth
Bacci et al. (2012)	Wool fabrics and tactile properties	High positive correlation between warmth and thickness of wool fabric
Fenko et al. (2010a)	Thermal properties and tactile perception	Colour and material have same magnitude of influence on the perception of warmth. People tend to overestimate the impact of the literal meaning of the warmth and underestimate the impact of the figurative meaning of the concept.

The next chapter will present colours and materials in the context of build environment. Firstly, colours and materials will be presented in the context of user interaction and then their existence in interior architecture will be discussed.

CHAPTER – 3

COLOUR AND MATERIAL IN THE BUILT ENVIRONMENT

Colours and materials as fundamental elements of every environment, have influential effect in the built environments. They not only constitute environments, but also function as a media between user and environment. Their existences contribute to user-designer and user-design relationships (Baker, 2002) which reveal the importance of perception. In the context of interior architecture, colours and materials are both key design elements that are perceived by users and these key design elements create an environment that embrace users. In the scope of the thesis, their relationships between users and their existence in interior architecture are presented.

3.1. Colour in the Built Environment

Human beings, like their ancestors, utilize colours to select eligible or tastier foods, sense danger, detect changes and select their partners. These basic functions of colours still accompany our modern lives thus create traffic lights or cosmetic industry of today.

Colour has fundamental effects on our everyday life and creates vivid, enjoyable and safe environments. However, colours have more function and pleasure in the context of built environments of the 21th century contemporary cities. In the context of contemporary environments, colours are more complicated that they have never been before. That is why Umberto Eco started his fundamental article, which was entitled ‘How Culture Conditions the Colour We See’, with the phrase: “Colour is not easy matter” (Eco, 1985: 157).

3.1.1. Colour and User Interaction

Colour is defined as “non-verbal communication” (Ambrose & Harris, 2005: 6), not only a feature of a surface or an object, but also a sensation (Mahnke, 1996) and “first sensory event” (Holtzschue, 2006: 2); which defines individuals’ identities and everyday life (Ormiston & Robinson, 2007). Colour “arouses definite emotional and aesthetic associations” (Mahnke, 1996: 18), and “profoundly affects our emotional state” (Gregory, 1990: 127). In the Futurist Manifesto colour was embraced as the most important part of the life (Ormiston & Robinson, 2007).

Many different disciplines define colour from physics to art studies. The concept of colour is always related to light (Ladau, Smith, & Place, 1988; Mahnke & Mahnke, 1987; Wong, 1987). Ladau et al. (1988: 41) defined colour as "shattered light" which "can be perceived through dispersion" (Ladau et al.,1988: 43). Mahnke and Mahnke

(1987: 1) said that "colour is created by light, is therefore a form of energy, and this energy affects body function just as it influences mind and emotion". Colour is mentioned by different disciplines, with its physical and mental effects on people (Birren, 1978; Mahnke & Mahnke, 1987; Ladau et al., 1988; Fehrman & Fehrman, 2000 Mausfeld & Heyer, 2003).

People need light and their eyes to see (Gregory, 1990). Without light, we cannot see colour and also colours cannot exist (Ladau et al., 1988) therefore colour is defined as energy (Birren, 1961). Colour as an energy need to be seen by a human eye to affect human emotions, psychology, thoughts, etc. Ladau et al. stated that (1988: 47).

> We do not actually see color until the light waves that enter the eye stimulate the receptive cones located in the back of the eye. This stimulation causes an electrical disturbance that is transferred to the optical nerves behind the eyeball and is in turn fed to the optical area at the base of the brain. The brain then turns this information into color.

Pythagoras (c. 582-507 BC) related colour to musical scales and to planets' and stars' position, then Aristotle (383-322 BC) revealed contrasts of colours and he associated colour with time of the day; however, these preliminary definitions were changed after Sir Isaac Newton (1642-1727) discovered white light includes all the colours of the spectrum (Ladau et al.,1988; Ormiston & Robinson, 2007). Newton proved that white light includes all colours and each colour is identified by wavelengths (red has the longest and purple has the shortest) (Gregory, 1990). Goethe contradicted to Newton and indicated that "the eye perceiving colour, rather than Newton's theory on light as the source" (Ormiston & Robinson, 2007:15). With that statement, Goethe put the user with their eyes in the core of the concept. After Goethe, colours were defined by Albert

Munsel (1858-1918) according to their colour attributes: hue, saturation and lightness (Ormiston & Robinson, 2007). In the short duration of time, Johannes Itten (1888-1967) embodied how individuals react and are affected by colour with his fundamental studies (Ormiston & Robinson, 2007).

Users' first interaction with colours occurs in their eyes, which collect the information about their environment (see Figure 11). Human eye is a measurement equipment which provides data to the brain that analyse and define these data with cognitive process. Our associations, emotions and connotations about colours are end products of these activities of the eye and the brain. Holtzschue (2006: 35) defined

> The eye is an organ that is adapted to detect light. Light enters the eye through the pupil and falls on the retina, the inside back of the eye. The retina is made up of two kinds of light-sensitive receptor cells, rods and cones. Both rods and cones connect to the optic nerve, which transmits the sensory message from the eye to the brain.

During these physiological process, the eye sees and the brain analyses the environment, after that they start to affect human physiology and psychology.

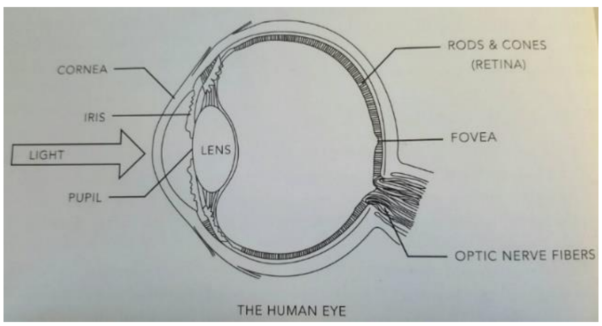


Figure 11. Basic representation of the human eye (Holtzschue, 2006: 36).

Mahnke (1996: 3) stated that colour has “great impact on our psychological reactions and physiological well-being”. In addition to these physical, physiological, psychological and cognitive processes, colours are used to cure some illnesses for centuries. Birren (1961) suggested that colours are used as a diagnosis and healing, such as red being associated with magic healing, yellow curing jaundice, etc. He also stated that people may associate some colour with some disasters, such as jaundice causing yellow colour. O'Connor (2011) defined colour therapy and how it is related to popular culture (for instance, 284,000 websites were accessed by the researcher). Kopacz (2003), which indicated that red is "used to treat colds, paralysis, anaemia, ailments of the bloodstream and ailments of the lung "and green "strengthens bones and muscles, disinfects bacteria and virus, and relieves tension; used to treat malaria, back problems, cancer, nervous disorders and ulcers" (citied by O'Connor, 2011: 231). These physical and psychological effects of colours on human beings occur when physiology of the eye and colour vision are healthy and function accurately.

Fehrman and Fehrman (2000) stated that colour symbolism has been important to people for centuries and differs according to cultural background: for example, British people prefer green apples; Americans prefer red ones. Colour associations are learned in childhood (Ekici, Yener, & Camgöz, 2006) and are constituted by both universal elements (such as the physiology of the human eye, evolution, nature, etc.) and culture. The colour-culture relationship is not only about what people see but also about how they associate colours with objects or experiences. Some colour associations are universal: red-orange-yellow colours are considered warm and green-blue-purple colours are considered cool (Ou et al., 2004). Red is often associated with fire, sun and/or blood therefore people tend to apply similar associations to it (Ekici et al., 2006). However, other colour associations are cultural: white symbolizes purity in Western culture, but mourning in India (Holtzschue, 2006). And noting the same pattern but different colours on some countries' national flags [e.g., the tri-coloured vertical bands of the Afghan flag (black-red-green), the Belgian flag (black-yellow-red) and the French flag (blue-white-red)] (see Figure 12), Holtzschue (2006) further showed that colours have different cultural meanings and associations. Hutchings (2004: 57) stated that "green above all colours has a special significance both in the UK and Ireland". Hutching (2004) stated that wearing green is related to unluckiness in Ireland and Britain, and that this folkloric concept passed to North America with immigration. On the other hand, green, as a substantial colour for both Ireland and Britain, has positive meanings and is associated with springtime and life in Britain, and the shamrock and St. Patrick in Ireland (Hutchings, 2004).

Figure 12. Afghan, Belgian and French flags (http://en.wikipedia.org/wiki/Timeline_of_national_flags)

Birren (1988) stated that "psychological attitudes toward colour will affect bodily responses" and "red may seem exciting and blue subduing" (1988: 27). In everyday life, colours lead us to understand important elements of our environment, such as water temperature and traffic lights. Colours affect people's perceptions and behaviours either consciously (as with traffic lights) or unconsciously (as with brand colours). Brand colours are designed according to the associations that colours carry, such as expensiveness and power related to black, dependence and trust associated with blue, love and high quality related to red, and honesty, sincerity, and warmth related to green, and light colours, for instance, white, are preferred for cheaper products' package which are manufactured for low classes (Seimiene & Kamarauskaite, 2014). In addition, these colour associations are carried by products as well. Na and Suk (2014) showed that, in the context of product design, white was defined as the most elegant colour when they compared white with other colours in their study that was conducted to find emotional characteristics of white. In fact, meanings, associations and emotions of colours differentiate according to their context and scale. Some disciplines may share a few same or similar meanings, associations and emotions for the same colour, even when they have different scales. But they also have a lot of different meanings, associations and emotions as well. Therefore, these properties of colours should be studied in their own contexts, independently. In the following part, meanings, associations and emotions of colours will be discussed through previous studies both in generic context and in interior architecture context in order to clarify them.

3.1.2. Colour in Interior Architecture

Colour is an important visual bond that constitutes emotional, physical and sensorial relations between people and their environment, and is a fundamental element of interiors which it affects every part of our daily lives. According to Aloumi, Noroozi, Eves, and Dupac (2013: 233) “colour has the power to support or inhibit the design intention”. Colour not only affects the perception of interiors (Odabaşıoğlu & Olguntürk, 2015), but is also a powerful element in different professions. For example, colour plays a key role in consumers' decision-making processes (Ou et al., 2004) and has impacts on psychology and physiology of human beings (Helvacıoglu, 2011).

Baker (2002: 170) defined colour as “an interface between a product and the designer; a product and the buyer”, similarly, colours are an interface in interiors. Colours are also an interface between the designer and an interior, and the user and an interior. Therefore, their appearances change the perception and experience in interiors. As people associate some colours with some meanings, they, as users, tend to associate them with some meaning and emotion in interiors as well. However, meanings and emotions of colour are defined by different researches; their meanings are more 'sui generic' and should be studied in the context. In the context of interior architecture, there are few studies that were conducted to investigate meanings of colours in interiors. Helvacıoğlu (2011) provided a list of emotions that shows colours and emotions relationships which were demonstrated by different researchers (see Table 3). In this study, emotive faces were used and participants matched these faces with the virtual presentations of an interior (an ordinary living room) (Helvacıoğlu, 2011). Helvacıoğlu (2011) utilized Second Life and CamStudio 2.6 Beta programs to prepare the virtual presentation. Their study showed, in a living room, that red colour (on a wall) was related to happiness and disgust, and green colour (on a wall) was related to happiness and neutral. Although both red and green are associated with happiness, red may related to disgust and may have some negative associations in some of the population. In this previous study, red was related to ‘happiness’ as a common point with the list of emotions, which was prepared by the author (see Table 3). ‘Disgust’ was not mentioned by these emotion studies so the author did not include it in the list of emotions; however, it appeared in Helvacıoglu’s study in the context of interior architecture. Although, they have some common points with other disciplines, the study revealed that colours of interiors carry different meanings in their own context, independently.

Table 3. Emotional associations of colours – (Adapted from Helvacıoğlu, 2011: 83).

COLOUR	EMOTION	
Chromatic Colours	Positive Emotions	Negative Emotions
Red	Happiness, Surprise, Energetic, Powerfulness, Enjoyment, Passionate	Sadness, Anger, Fear
Green	Happiness, Calmness, Peacefulness, Hopefulness, Relaxation, Comfort, Modernism	Aversion, Boredom, Fearfulness, Anxiety, Sadness, Annoyance, Mystery, Neutral, Non-emotional
White	Surprise	Sadness, Anger, Boredom, Fear

Another study, which mentioned the meanings of colours in interiors was conducted by Ladau et al. (1988). They stated that each colour has a set of meaning due to its history and existence, and particularly "the basic spectral colours (red, blue, yellow and green, as well as black and white)" are associated with physical and emotional characteristics (Ladau et al., 1988: 69). These meanings have both physical and cultural roots. In the scope of the thesis, common meanings, which are universally associated with three colours (red, green, and white) are presented (see Table 4). These semantic findings of the previous study were related to interiors by the author; however, they did not reveal any specific meaning and emotion in the context of interior architecture.

Table 4. Positive and negative meanings of red, green and white (adapted from Ladau et al., 1988; 69-71).

	Red	Green	White
Positive Meanings	Excitement, Apples, Richness, Royalty, Roses, Love, Sex, Valentines, The Red Cross, A red carpet, Bishops' robes, Red velvet.	Grass, Trees, Spring, Fertility, Freshness, Salads, Gardens, Money.	Purity, Angels, Nurses, Cleanliness, Brides, Virginity, Snow, Chalk.
Negative Meanings	Fire, Blood, Blushing, The devil, Prostitution, Adultery, Revolution, Stop signs, Danger.	Mold/Decay, Illness, Witchcraft, Jealousy.	Ghosts, A death pallor, Iceberg, Sterility.

Their results demonstrated that red, which has the longest wavelength, takes attention and arouses excitement (Ladau et al., 1988). Red stands for good luck in China (Hurlbert & Ling, 2007) and has a special nature that always has prominent meanings for different culture, such as Red Square, Turkish flag, etc. Green, which is the restful colour, is associated with "nature and tranquillity" (Ladau, Smith, & Place, 1988: 71). White, is usually associated with positive meanings; however, in eastern countries it is funeral and mourning colour (Ladau et al., 1988; Holtzschue, 2006).

The influential study of Mahnke (1996) defined some basic associations of colour in interior walls. In this study, the researcher revealed some associations of basic hues and achromatic colours on wall, on ceiling and on floor. In the scope of the study, only red, green and white as a wall colour are presented (see Table 5).

Table 5. Associations of red, green and white (adapted from Mahnke, 1996: 67-70).

	Associations of Colour for Interiors' Walls
Red	Aggressive, Advancing
Green	Cool, Secure, Calm, Reliable, Passive, Muddy
White	Neutral to empty, Sterile, Without energy

Mahnke (1996) demonstrated some specific meanings, associations and arousals of colours in interiors, and exemplified two influential studies about surrounding colours and arousals. The first study was conducted by Louis Cheskin with four entirely painted rooms. Their results showed that red room increased blood pressure and pulse and caused to decrease concentration because of overstimulation, some participants even could not tolerate to stay in. However, green room did not arouse any negative or positive effects, it caused monotony (as cited in Mahnke, 1996). Additionally, Mahnke (1996) mentioned overstimulated and understimulated interiors as unaccepted experiences which might appear because of exaggerated surfaces applications of colours, materials, patterns, etc. The second study was conducted by Frank Gebert in 1977 with chambers (2.5m x 2.5m x 2.5m.) and observed physiological measurements. This study revealed that red chamber was arousing and stimulating; however, green chamber was calming (as cited in Mahnke, 1996). These two studies concentrated on physical changes of human body against surrounding colours in interiors and they measured physical changes of participants such as blood pressure, pulse and physical activities which presented effects of these single coloured interiors. Although, both researchers conducted their studies with four hues: red, yellow, green, and blue, they did not investigate other hues, achromatic colours, or colour pairs. These studies are based on single surrounding colours in the context of psychology; however, they are inspirational experiments for multi-coloured experimental studies in interiors.

3.2. Material in the Built Environment

As human eyes see colours, they see materials as well. However, while the physiology of the eyes during this process are the same, their perception and affects are different. Materials are inherently features of design objects and environments in everyday life. Even completely natural environments are constituted by a group of materials. Karana (2009) stated that materials are common points which are shared by all living creatures and non-living things. The experience of materials was mostly studied by industrial design and product design disciplines (Karana et al., 2008; Karana, 2009; Karana & Herkkert, 2009; Fenko et al., 2010a; Fenko et al., 2010b; Wastiels & Wouters, 2012; Schifferstein & Wastiels, 2014; Karana, Pedgley, & Rognoli, 2014; Karana, Pedgley, & Rognoli, 2015), which concentrated on how people perceive, experience and are affected by products' materials. Riggs (1996), Wastiels et al. (2012a), Gagg (2012), and Brown and Farrelly (2012) investigated some materials and their perception, experience and effects in interiors. However, these concepts, in interior architecture context, need further investigation.

3.2.1. Material and User Interaction

In the context of user interaction, the most basic difference between colour and material concept is sensation. In fact, colours are only perceived by sense of vision; however, materials are perceived by both vision and tactile senses. In addition, except synaesthesia phenomenon, colours are not perceived by olfactory, gustatory and auditory senses whereas materials are almost perceived by five senses. People tend to associate some colours with smells, tastes and sounds, but these associations are based on semantic roots and needs accompaniment of vision. For instance, Fenko et al. (2009) conducted a study in order to investigate the effects of smell (olfactory sense) and colour (visual sense) on the freshness of some products. Their findings demonstrate that sensorial experience of freshness depends on product type and properties of products. For soft drinks and dishwashing liquids smell (olfactory sense) dominate the experience of freshness; however, for scented candles both smell (olfactory sense) and colour (visual sense) are equally effective. These results demonstrated that colours have effects on the experience and assessment of other senses such as gustatory sense, olfactory sense, etc.; however, colours cannot be perceived through these senses. Eventually, materials have some visual and haptic properties as roughness, texture and weight because of their physical existence which colours do not have.

Material studies, which are concern of different disciplines such as physics, chemistry, architecture etc., have been existing since early eras of humankind and are “related to civilization, to technology and to scientific knowledge” (Keller, 1988: 1). In the context of interior architecture, material studies mostly concentrate on surfaces of materials. Surfaces are separating substances from the environment in which they exist (Gibson, 1979). Therefore, users understand and perceive the features of materials through their surface properties. Gibson (1979: 23) revealed the importance of light for the quality of surfaces and stated “the way in which light is absorbed and reflect at surfaces and the way this action depends on the composition of the substance…”. Substances of materials define the appearance of surfaces such as marbles reflecting light more than plastics, because of their nature. Consequently, users interact with materials’ surfaces and their features, which are designated by their substance and environment.

Human and material interaction have been evolving for long centuries, and twentieth century is threshold for new materials, new interpretation of old materials and invention of material properties (Brown & Farelly, 2012). Even nano materials are about to add another dimension for human material interaction (Leydecker, 2008). Basic materials and users’ interactions, in interiors, have not been investigated extensively yet.

3.2.2. Material in Interior Architecture

Materials are important design elements of interior architecture similar to colours. They affect the perception of users, carry meaning and constitute designed environment.

Materials define how forms will be shaped, which colours can be used and which construction techniques can be utilized. Technological improvements and innovative approaches in material science provide variety of materials, material colours and construction techniques, but interior architecture is still limited by the constraints of these materials' natures. Although new materials are used in interiors, more natural and conventional materials, such as fabric, marble, tiles, glass etc. still dominate interiors. Gagg (2012) mentioned the endless possibility for the choice of interiors. These endless possibilities are not only because of diversity of material types, but also due to variety of colours, manufacturing techniques, contexts and combinations of materials.

Materials are design decision elements in interiors which are important for both users and designers. "Understanding how materials are selected, composed and assembled is an essential skill for interior design" (Brown & Farrelly, 2012: 6). Su and Yang (2015) stated that human needs have changed throughout the history and basic survival needs evolved to more-complicated ones. For example, materials that were used to satisfy basic and survival needs are longer adequate for today's society and people. That forced designers to study and consider about new demands and needs of users and investigate new materials and material experiences while creating interiors. Some material properties, such as thermal effusivity (Wastiels et al., 2012a), roughness (Wastiels et al., 2012b) and sliding friction (Chen et al., 2009) have influential effects on the perception of designs and their existence contributes to how interiors are perceived. Hekkert and Karana (2014: 8-9) stated that materials carry "universal" and "learned" meanings. 'Universal meanings' are associated with common characteristics that would be similar across cultures. For instance, the authors found that timber is ascribed cosy because it has a warm tactile sensation regardless of culture (Hekkert & Karana, 2014). Karana et al. (2009) investigated the same concept and demonstrated that, in the context of product design, natural materials and timber are related to nostalgia; however, textiles are related with sexy. However, 'learned meanings' are associated with subtle characteristics of materials. Karana and Hekkert (2010) stated that Chinese participants assessed plastic products as more elegant than metal products when they were compared to Dutch participants.

Material experiences and how material experiences affect design were studied by many researchers (Karana, Hekkert, & Kandachar, 2008; Wastiels & Wouters, 2012; Schifferstein & Wastiels, 2014). Wastiels and Wouters (2012) studied the material selection process in different stages of design. Wastiels and Wouters (2012) indicated that there is not a lot of knowledge about the concept; however, its experimental quality is important. Materials' social, cultural, and personal aspects and how interior experience is affected by them were stated by Brown and Farrelly (2012). Their study reported that people related some materials to specific emotions and meanings. For instance, because of its expensiveness, stone is related to prestige, wealth and power in Europe. Timber is regarded as warm material because of its texture and colour (Farrelly, 2009). Gagg (2012), reported that timber, as one of the initial material for humans' shelter, has been used as interior architecture material for a long time and that causes people related it to home. In the current study, three basic materials, which are mostly used in interiors, are investigated. Fabric and timber as natural materials and plasterboard with paint as artificial material are subjects of this investigation. Therefore, in addition to generic understanding of materials in interiors, characteristics of these three materials will be presented.

There has been a relationship between clothes and interiors since the early era of humankind; both body and interiors were covered with textiles (Brown & Farrelly,2012). Therefore, people tend to dress their environment as they dress their bodies. Fabrics which cover and protect the body (human body or interior wall) create a perception that is related to warm and safe associations. Fabrics are used not only for their texture and appearance, but also for their acoustical qualities (Riggs, 1996). However, fabrics are not only basic elements for domestic interiors and furniture, but they also have been used for many different interiors such as concert halls or offices. Gagg (2012) stated that fabrics, which are believed to provide warmth and comfort in interiors, have been used until 16th century, and have not lost its popularity because they are light and can be easily modified according to tastes or trends. Today patterns and designs, which have been used by 16th century's people are not preferred anymore. However, fabrics with contemporary patterns and designs are still popular because of their warm, cosy and comfortable textures, and easy to modify surface properties. There are natural and artificial fabrics; however because of environmental concerns, todays' designers and users tend to prefer natural and biodegradable fabrics to ensure healthy environments and sustainability (Gagg, 2012). Nevertheless, fabrics are widely used as wall coverings (Riggs,1996), they are utilized for other vertical design elements in interiors such as, furniture, upholstery, curtain, etc. Although, trends and fashion have changed, fabrics have been used for interior architecture throughout history. Their texture (see Figure 13) and meaning will convey through interiors. In addition, their prevalence for all cultures are interesting that almost each culture prefers to use fabrics for their interiors.

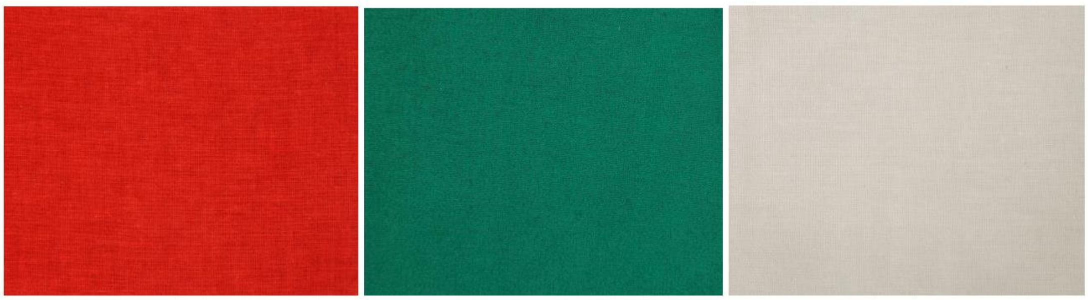


Figure 13. Texture of fabrics (%100 cotton) (personal archive of Begüm Ulusoy)

Timber, aforementioned, was the first material for human shelter after caves. Timber did not only cover and protect the early interiors, but also provided physical warmth when it was combined with fire. Therefore, its associations and connotations have positive and historical roots. Even the modern environments include a lot of horizontal, vertical surfaces and forms with different appearances of timber. Throughout the human history, timber has been used as a material in interior architecture and today, it still does not lose its dominance on constructions (Ashcroft, 1992). Farrelly (2009) defined timber as an efficient, sustainable, practical and variable material, which grows older gracefully and beautifully. A whole building can be constructed by only timber without using any other material or assembly (Farrelly, 2009); however, these types of buildings and interiors are rare and mostly are associated with country houses or hunting lodges. Because of its mortal nature (Gagg, 2012), timber is related to living beings. Due to its efficient usage (Farrelly, 2009), high insulation property (Riggs,1996), and renewable characteristic

(Vezzoli, 2014), timber is in the agenda of designers from different disciplines. Timber has a huge variety of patterns (see Figure 14), for instance, timber of oak, willow and walnut have different patterns and colours, but each timber have a common point, you feel warm when you touch them (Gagg, 2012). This haptic characteristic of the material, due to its thermal property, reveals associations and connotations in interiors. Today, since timber as a solid wood is expensive and less stable (Ashcroft, 1992), designers and users tend to prefer wood veneer laminated boards that are covered with a thin natural timber layer on top of mdf/chipboard. Wood veneer laminated board, which are covered with timber, provide the same surface quality with solid wood; however, they have lower costs, faster production, and easy usage. For example, wood veneer laminated boards are not affected by water or humidity as much as solid wood. Therefore, both cleaning and usage of wood veneer laminated boards are more easy and adequate than solid wood in interiors.

Figure 14. Different textures of timber in the Malaysian Timber Industry Board catalogue (personal archive of Begüm Ulusoy)

In the context of this study, plasterboard was investigated as an artificial material, which is widely used in interiors. Since 3000 B.C. plaster or stucco have been used to cover the walls (Gagg, 2012) in order to protect and create surfaces and ornaments. The Ancient Egypt and Greek civilizations mostly used the material for vertical elements of interior architecture (Riggs,1996). Riggs (1996) exemplified how plaster is hard to use and expensive for modern interiors due to its high cost and labour intensive application. In contemporary interior architecture, it is preferred by some special interior applications such as commercial installations and luxury home interiors. However, both plaster and plasterboard share some chemical and physical characteristics, plasterboard is a popular interior architecture element due to its surface, assembly and construction properties, in addition to its low prices. It ensures different functions and surfaces in interior architecture such as walls, ceilings, built-in furniture, furniture, etc. It is easily assembled, modified and its surface is easy to change in to different textures. Riggs (1996) demonstrated that plasterboard is not only a substantial material for insulation, acoustic requirements and fire safety, but also it has a smooth surface that can be used with its natural form with paints or can be textured with other applications. Brown and Farrelly (2012) revealed obtaining similar rigid surface characteristic with plasterboard, which is suitable for many different applications. In the context of this study, the researcher preferred to investigate the most popular one: plasterboard and paint. In order to keep that rigid texture of plasterboard and investigate its own surface properties, water based paint was utilized (see Figure 15).

Figure 15. Texture of red painted plasterboard surface (http://www.juliancassell.com/934/painting-a-room)

The next chapter will show how the meaning aspect of warmth perception is constituted through colours and materials. The meaning aspect of the concept consists of two different meanings: figurative meaning, which has different associations, and literal meaning.

CHAPTER – 4

WARMTH AND MEANING THROUGH COLOUR AND MATERIAL

Perception and knowledge were dominated by seeing. People firstly see and recognize their environments with their visual abilities and after that they develop the ability to define them with words according to what they see (Berger, 2008). Family or network teach and define words by respective culture and society, and these words are related to surroundings, environments and objects. For any environment, colours and materials are important characteristics and are related to these semantic, cognitive, and perceptional processes. Individuals who have a full visual ability, see colours and materials and use colours and materials to define and depict their environments. For instance, the Stroop effect, which is a misreading of words because of their colour, shows dominant influence of visual stimuli on knowledge and perception. Visual sense has a dominance on people’s overall perception in interiors (Wastiels et al., 2012a; Wastiels et al., 2013). Language and vision are related to each other (see Figure 16) and people's associations between language and vision demonstrate how people experience and perceive interiors.

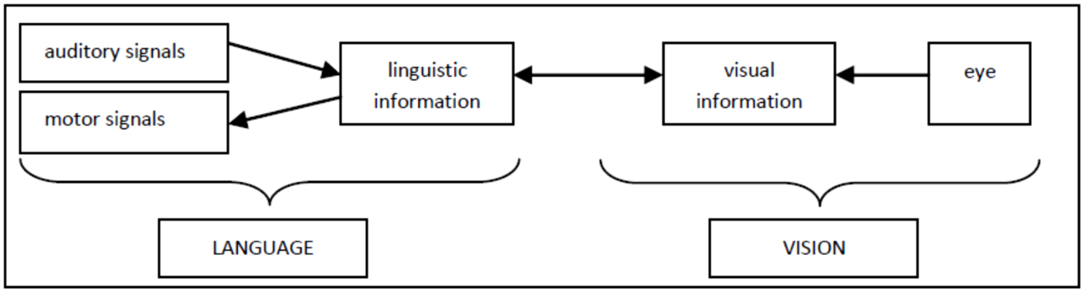


Figure 16. The relation between language and vision (adapted from Jackendoff, 1996: 2)

Colours and materials are important and fundamental visual elements of interiors. They have influential effects on the user's perception. In this study, User Conceptual Model that "constitute an inventory of the meaning that a community of users have available, can easily acquire, and are likely to enact, given the possibilities that artifacts suggest" (Krippendorff, 2006: 108) was used by the researcher in order to investigate associations of colours and materials as an important visual elements of interiors. This model "explains experiences that users bring to artifacts they intend to use" (Krippendorff, 2006: 105). When user or stakeholder are considered as the focus of design decisions, this consideration causes that knowledge that includes design elements' meanings should be obtained by designers. Users need to utilize words in order to define artefacts, therefore, identifying any interior or any design with its user or stakeholder also calls for linguistic elements (see Figure 17).

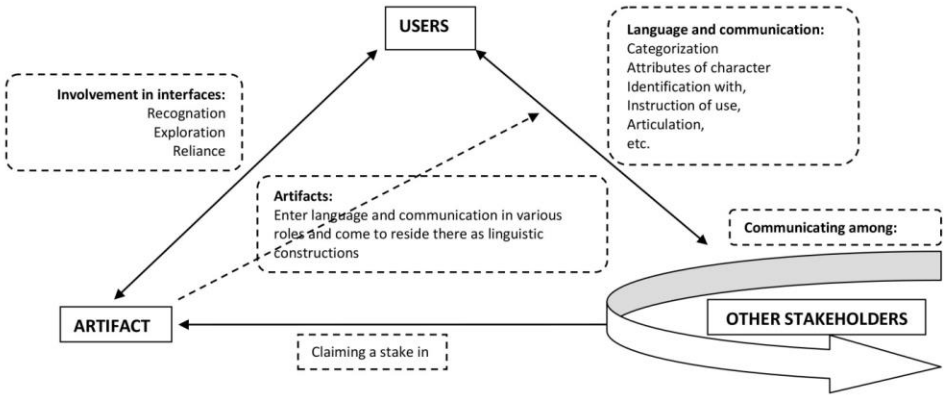


Figure 17. Artefacts in language and communication (Krippendorff, 2006: 149)

”Language is one of the core components of any culture" and is "closely related to thought" (Fenko, Otten, & Schifferstein, 2010: 3315). Rompay and Ludden (2015: 1) stated that “designers communicate affective meaning through their design” in their study, which they elaborately investigated the product experience. Khalaj and Pedgley (2014) investigated these meanings, which were intended to be given by designers and compare them to the meanings, which were realized by users, in the context of product design. Similarly, in the context of warmth perception, user and designer have two different perspectives (see Table 6). In the current study, user perception was investigated through the experimental setting. Product experience consists of three components: aesthetic experience, experience of meaning and emotional experience (Desmet & Hekkert, 2007). These components might correspond with sensory, symbolic, and affective descriptors respectively, that are investigated by the study of Fenko et al. (2010). In order to investigate and inquire meanings of interior architecture elements, these product design studies could be adopted to interior architecture. People use adjectives to explain their product experience and these adjectives have three categories:

sensory, symbolic and affective descriptors (Fenko et al., 2010). Sensory descriptors were related to five senses and were determined by using the five senses: visual, olfactory, tactile, auditory and gustatory; and included words such as colour, bitter, rough, etc. (Fenko et al., 2010). Symbolic descriptors were defined by words such as modern, complex and interesting (Fenko et al., 2010). Affective descriptors were defined by words such as exciting, cute and funny (Fenko et al., 2010). In order to investigate free association, in the current study, sensory descriptors are related to physical characteristics of interiors which are perceived by the five senses, symbolic descriptors are associated with the symbolic meanings of design and affective descriptors are related to emotions. In order to probe meaning aspect of warmth perception, the researcher investigated these descriptors as well.

Table 6. Warmth perception through user and design perspectives

USER PERSPECTIVE (is from the perspective of user experience)	**DESIGN PERSPECTIVE** (is from the perspective of design attribute)
Warmth perception and 'user perspective': Seeing warm by something (colour or material): Appraisal of an effect → the colour or material makes me warm, the interior makes me warm, etc.	**Warmth perception and 'design perspective':** Seeing the warmth of something (colour or material): Appraisal of a thing → the colour of the room is warm, the interior is warm, etc.
Warmth as a physical (real) increase in a person's body temperature	Warmth as a physical (real) increase in a sample's/object's temperature (e.g. black absorbs, white reflects light and also heat)
Warmth as physical (real) increase in a person's body temperature which are experienced by five sense, visual warmth, tactile warmth, auditory warmth, gustatory warmth, and olfactory warmth	Warmth as a perceived (not necessarily real) increase in a sample's/object's temperature (i.e. limitations/differences in people's sensorial discrimination)
Warmth as a perceived (not necessarily real) increase in a person's body temperature	
Warmth as a psychological affect such as a state of cosiness, comfort, familiarity, relaxation etc. which constitutes 'emotional warmth'	
Warmth as a figurative characterisation of a sample/object. Memories and associations are part of these warmth such as timber is warm in interiors (Farrelly, 2009)	

Warmth perception is used by architects and non-architects to define conditions of interior' environments and it is selected at the design stage (Wastiels et al., 2012b). Warmth perception comprises of physical, semantic and emotional aspects with sensorial experiences. Physical, meaning and emotional aspects with sensorial experiences and their variables affect each other and overall warmth perception. In the scope of this study, the framework of the previous study (Desmet & Hekkert, 2007) was embraced to define warmth perception in interiors: aesthetic experience correspondence to physical aspects, experience of meaning correspondence to meaning (semantic) aspects and emotional experience correspondence to emotional aspects. Hekkert and Karana (2014:6) stated that 'the experience of meaning' is more related to material (product) experience than 'aesthetic experience' and 'emotional experience'. Similarly, meaning aspect of the concept embrace all other aspects and constitute the core concept in interior architecture. Therefore, in the scope of this study, the researcher focused on the meaning aspects. Warmth, as a meaning, constitute a core for other aspects, meaning aspect is affected by physical aspects, and affect emotional aspects. These processes may constitute the notion of warmth in both literal and figurative meanings. Fenko et al. (2010a) demonstrated that people tend to relate visual sense with figurative meaning of warmth and tactile sense with literal meaning of warmth. Their study associated figurative meaning with visual sense (eye-vision) and colour. They related literal meaning to tactile sense (skin-touch) and roughness. Literal meaning of warmth perception embraces physical warmth; however figurative meaning includes some meanings, associations, feelings in the semantic context (Fenko et al., 2010a). For instance, sauna and wool winter coat is literally warm interior and product, whereas living room and home related objects such as breakfast tray, bed and toy are figuratively warm.

Meaning aspects of products, were defined by Desmet and Hekkert (2007: 57) as "our ability to assign personality or other expressive characteristics and to assess the personal or symbolic significance of product". They claimed that meaning "can elicit emotions, because product meaning can be appraised as beneficial or harmful for the individuals' concerns" (Desmet & Hekkert, 2007: 62). Interiors, as experienced products with greater scales, which surround their users, inherently arouse some meanings which are based on symbols, memories, cognitive process, etc. Literal meanings represent physical conditions in interiors, as people claim that some interiors are physically warm or physically cold. However, figurative meaning is more related to meanings and associations which affect the perception of warmth in interiors.

Meaning aspect of warmth perception includes two different types of meaning: literal and figurative which focus on two different features of the concept. Similarities and differences between literal and figurative meaning elicit the definition of warmth and warmth perception (see Table 7). Even both meanings are related to sensation, literal meaning presents physical warmth which is non-figurative meaning and can be measured by instruments. Temperature of an interior is a measurement of physical warmth and is related to physical aspects (thermal properties and other properties) which affect actual warmth of the interiors.

Gifford (2002) applied Brunswik’s lens model (Brunswik, 1956) to environmental perception. The researcher embraces the same model for an indoor environment to elicit the notion of warmth. In fact, the literal meaning is the actual warmth, which is also related to physical aspects, and the figurative meaning includes associations. Fenko et al. (2010a) stated that energy and intimacy associations affect warmth perception more than physical warmth does (see Figure 18). In their product design study, intimacy associations include love, being together, atmosphere, and memories. Energy associations are related to connotations of action, energy, excitement, and creativity (Fenko et al., 2010a).

Table 7. Similarities and differences of figurative and literal meanings of warmth

<table>
<tr><td rowspan="3">Similarities</td><td colspan="2">Warmth</td></tr>
<tr><td>Figurative Meaning</td><td>Literal Meaning</td></tr>
<tr><td colspan="2">• Is perceived by five senses and affected by sensorial aspects,
• Part of “warmth perception” for design, products and interiors,
• Is related to heat and temperature</td></tr>
<tr><td rowspan="8">Differences</td><td>Figurative</td><td>Nonfigurative</td></tr>
<tr><td>Metaphorical</td><td>Literal</td></tr>
<tr><td>Measured by semantic differential scales, free-associations and interviews</td><td>Measured by equipment</td></tr>
<tr><td>Perceived by all five human senses</td><td>Perceived by tactile sense or the skin</td></tr>
<tr><td>Is related to all aspects of warmth perception</td><td>Is related to physical aspects of warmth perception</td></tr>
<tr><td>Subjective</td><td>Objective</td></tr>
<tr><td>Evoke positive manner, emotions, feelings and etc.</td><td>May evoke either positive or negative approach accordingly to climate, season and indoor environment conditions</td></tr>
<tr><td>Associated with being fully human or alive</td><td>Does not have any associations about being fully human, animal or object.</td></tr>
</table>

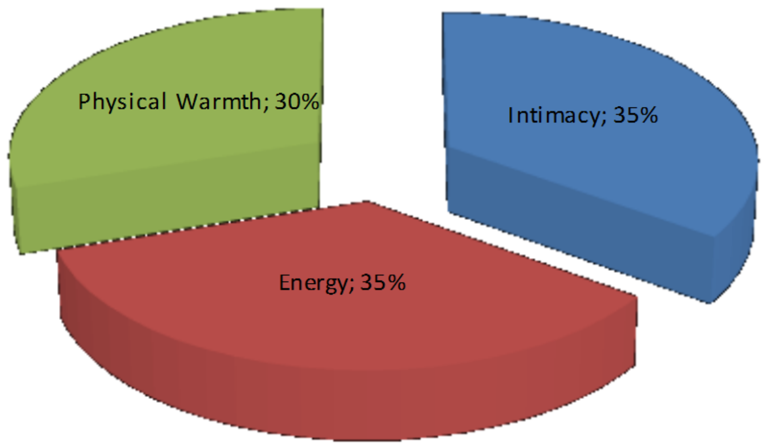


Figure 18. Components of warmth perception (Fenko et al., 2010a)

4.1. Figurative Meaning

Figurative meaning of the concept is constituted by semantic elements and is perceived by five senses. Different senses could participate in the concept, for instance, sound of fire could be related to the concept and may arouse warm, intimate, and energetic image through cognitive process of users in that interior. Although figurative meaning is a multi-sensorial notion, in this study, the researcher preferred to investigate visual sense independently, because it dominates the perception of warmth in interiors as previous studies recommended (Wastiels et al., 2012a; Wastiels, et al. 2012b).

Figurative meaning through colours and materials affect the concept in interiors. For instance, when users enter a room and go through it, they see colours and materials and associate these interior design elements with specific meanings. Hekkert and Karana

(2014) demonstrated that there were universal and learned meanings. Universal meanings also have some figurative concepts that are embodied by universal consensus such as timber being inviting and cosy. The authors stated that natural materials were associated with being alive and hard materials were related to being dead. Learning meanings are defined by their context, therefore there are both universal and some culture specific meanings of materials. In addition, the study revealed that previous lives of materials also affect the perception. For example, a fur or a cotton, as natural materials, are perceived warmer than metals or plastics due to their previous life as living creatures. People tend to associate their previous life with materials and those associations cause some changes on warmth perception.

Fenko et al. (2010a) stated that people associated breakfast tray with figurative warmth. Breakfast tray, as a product, does not create any physical warmth; however, it is related to warmth because of its figurative meanings such as home, lovely mornings, intimate relationships, waking up to a new morning with energy, etc. Similarly, interiors are related to some associations that are eventually not able to produce or create any physical warmth. Colour and materials, which are inevitably perceived together, affect overall perception of interiors and contribute to the experience of users. In the context of warmth perception, they have figurative meanings in interiors as well. Single colours, single materials, colour pairs and material pairs could change the perception of warmth with their figurative meanings in interiors. Holtzschue (2006) stated that human eye was the ultimate measurement equipment for colour studies: it was over tools and equipments of technology. Similarly, warmth perception is a concept in human brain, therefore these changes of meaning could be measured by semantic differential scales, free-associations and interviews.

Aforementioned studies were conducted in the context of product design. The meaning aspect of warmth perception through colours and materials have not been elicited extensively in interiors yet. Interiors are hard to change after their construction and have influential effects on user's perception without them realizing through surrounding colours and materials. Therefore, investigating the concept would contribute developments in interiors as well as increasing pleasure and satisfaction of users.

Definition of warmth has meaning aspects, except heat and temperature (See Appendix A for the definition), therefore figurative meaning aspect of warmth perception could be analysed under three headings; warm associations, intimacy associations and energy associations. These associations include different concepts and are related to each other in the context of perceived warmth. Fenko et al. (2010) clarified these three associations in their fundamental study as the following: warmth associations were related to affection, gratitude, ardent and interested; intimacy association that mean conducting a bond with surrounding includes loving, being together, atmosphere and memories; energy associations were an intensity of emotions which included active, energized, excited, creative, proud and healthy.

4.1.1. Associations of Warm

Warm is a cognitive association that evokes friendliness, communication, trustworthiness etc. It affects perception, experience, feelings, associations and evaluation of designs, products and interiors. The concept could not be measured by equipments and all process takes place in the human brain with its cognitive existence.

Dictionaries define warm with more figurative meanings than its literal meaning such as warm welcome (see Appendix A). As people judge others warm or not, they judge interiors and designs, as well. Their perception of warmth affects their experience in the built environment, interiors and designs objects. According to Wastiels et al. (2012b) non-architects use term of warmth to define environments. However, the researcher did not include meaning aspect of the concept to their study, they stated that "the way a space feels are related to its design and the feeling of warmth is one of the aspects important to the experience of constructed environment" (359). The previous studies proved that the concept of figurative warmth is not less influential than literal warmth in interiors (Itten, 1970; Clark, 1975; Porter & Mikellides, 1976; Mahnke & Mahnke, 1987). These previous studies elicited that perception of literal warmth of interiors could be manipulated by figurative meaning through colours. In fact, meaning of interiors can be manipulated by not only colours but also materials or other interior architecture elements such as form and shape. Previous studies stated that, in interiors, colours and materials are more dominant than other design elements (Wastiels et al., 2012a; Ladau et al., 1988; Mahnke, 1996). This manipulation of warmth perception through meanings of colours and materials could be core concept of the concept in interiors in order to create more vivid, welcoming and liveable interiors which are environmentally friendly. The concept of warmth perception also includes intimacy and energy associations concomitantly warmth associations.

4.1.2. Associations of Intimacy

Warmth consists of variables such as intimacy, relation closeness, bonding, attachment and involvement (Andersen & Guerrero, 1997). The concept of intimacy also includes warmth when it is mentioned in interiors: ‘the café’s intimacy’ is a quality about warmth perception in interiors (see Appendix A for the definition of intimacy). Warmth perception arouse the meaning of intimacy when an user interacts with an interior. These associations are important while perceiving interiors and designs because they constitute the bond between user and design.

Fenko et al. (2010a) conducted the study that consists of face-to-face interviews. These interviews explored the meaning aspect of warmth perception in the context of product design. In parallel to Andersen and Guerrero’s (1977) statement, 35% of participants associated warmth with the concept of intimacy. Their findings indicated that physical aspect of warmth is not more important than the intimacy of warmth perception (see Figure 18). The concept is related to intimacy associations in interiors as well, as in the context of product design. Warmth is associated with intimacy associations, that are related to “loving” (10%), “being together” (11%), “atmosphere” (10%), and “memories” (4%) (Fenko et al., 2010a: 1330).

4.1.3. Associations of Energy

Definition of warm is also associated with energy (see Appendix A for the definition of warm). The relationship between warm and energy are reciprocal (see Appendix A for the definition of energy). The concept of warmth includes both ‘warm’ and ‘energy’ in the context of figurative meaning. Energy associations are related to warm not only by heat as suggested by dictionaries but also by being alive and energetic. Also each concept, which is outcome of physical warmth, such as fire, boiling water, etc., is also related to be energetic because of their active nature. These literal physical features of warmth affect the perception of warmth and relate it to energetic associations. Aforementioned study of Fenko et al. (2010a) which is presented in Figure 18, demonstrated that 35% of participants associate warmth with energy at face-to-face interviews. Energy associations are related to the concept. In this study, warmth was associated with energy associations, which are related to “active”, “energized”, “excited”, “creative”, “proud” and “healthy” (Fenko et al., 2010a: 1330).

4.2. Literal Meaning

Literal meaning of warmth perception is constituted by tactile sense and is related to physical thermal changes of interiors (related to temperature) (see Table 7). These changes could be measured by equipment and could be manipulated. Fenko et al. (2010a) associated scarf with literal warmth that the product creates physical warmth for the user. Similarly, interiors could be warm or cold according to the thermal comfort level. Thermal comfort is defined as indoor thermal conditions, which provide comfort for users (Nicol & Humphreys, 2002). These conditions are defined by regulations and their calculation formulas are based on heat exchange between users and their environment (Nicol, 2004). According to the previous study thermal comfort should have some adaptive features to ensure more suitable indoor conditions for users according to their climates and provide more energy efficient indoor conditions (de Dear & Brager, 2002).

Figurative meaning of warmth perception affects literal meaning of the concept in interiors. Previous studies proved that literal indoor temperature could be perceived 2-4°C higher or lower according to surface properties of indoor walls (Itten, 1970; Clark, 1975; Porter & Mikellides 1976; Mahnke & Mahnke, 1987). Their findings demonstrate that literal meaning of warmth perception could be manipulated by figurative meaning as well. The next chapter will present the experimental study.

CHAPTER - 5

EXPERIMENTAL STUDY

5.1. Aim of Study

Warmth with its physical, semantic and emotional aspects, which are experienced with five senses, has substantial effects on user's perception. In interiors, colours and materials, as visual elements, affect perception more than other elements, which are perceived by smell, touch, etc. The main aim of this study is to investigate how these two important visual elements of interiors associate with warmth perception. Both colours and materials are rarely viewed in isolation, therefore, in this study, they are investigated in pairs. For this scope three colour pairs and three material pairs are chosen as stimuli. In the context of interior architecture, determining meaning aspect of warmth perception and associations of colour pairs and material pairs ensure designers a guide to create more effective interiors and designs for their users. Manipulating the perception of warmth with colours and materials enables designers and users to control physical conditions of interiors, that also provide low cost and easy to build application in order to create efficient, attractive and welcoming interiors. For instance, during the season of winter, perceiving 20°C interior as 22°C will save energy and reduce consumption as well. Not only physical but also semantic effects of warmth in interiors will have fundamental positive effects on users such as: consisting a bond between an user and an interior, arousing positive emotions, increasing energy, etc. Also, warmth perception with its figurative meaning might have implications for well-being and satisfaction of users in interiors. Although, there are some studies on the relationship between warmth perception, and colour and material, there is not any study about how these relationships occur in interiors. In order to investigate the concept, the experiment was conducted under controlled conditions.

5.1.1. Research Questions

The research questions of the study are:

1. How can colours be paired in interiors to induce an effective perception of warmth?
2. How can materials be paired in interiors to induce an effective perception of warmth?

5.1.2. Hypotheses

The hypotheses of the study are:

1. Warmth perception evaluations differ depending on single colours in interiors.
2. Warmth perception evaluations differ depending on paired colours in interiors.
3. Warmth perception evaluations differ depending on single material in interiors.
4. Warmth perception evaluations differ depending on paired materials in interiors.

5.2. Methodology

The experiment was conducted under controlled lighting conditions and in a controlled indoor environment. Natural light was blocked to eliminate any effect of changing daylight. Each participant assessed four models using a seven-point itemized subjective rating scale (semantic differential scale) (e.g. 1: very cold; 7: very warm) after answering the open ended questions. Each colour pair or material pair had four different models and each participant assessed the four different models of one colour pair or one material pair. These four different models consisted of two single colour models (or two single material models) and their pairs, with two combinations (upper and lower combinations), to eliminate any effect of colours' location (e.g. see Figure 19).

Figure-19 The red and green colour pair models in the experiment box (Table 10, Colour pair 2).

Each participant assessed the four models of assigned colour pair or material pair in a different order to control the order effect. There were 24 different order types for four different models. Each set required 32 different participants and in order to have 32 order, eight extra orders were selected randomly. Open-ended questions were asked to investigate participants' free associations for each model. These results were related to the semantic scale questions (direct questions) (Appendix B for the questionnaire) and provided more data for further investigation.

Two sets were created for the experiment: colour set and material set. For the colour set, three single and three paired colours (red and white, red and green, and white and green) with one fixed material (Fabric) were used (see Table 8). Each colour pair was assessed by 32 different participants (16 males and 16 females), for a total of 96 participants (see Table 9). Each colour pair consisted of two single colours and their pairs, and thus every participant saw four different models as stimuli. Same methodology was embraced for material set as well: three single material and three material pairs (fabric and timber, fabric and plasterboard, and timber and plasterboard) with one fixed colour (red) were utilized (see Table 8). Each material pair was assessed by 32 different participants (16 females and 16 males), for a total of 96 participants (see Table 9). Each material pair consisted of two single materials and their pairs, and thus each participant saw four different models as stimuli. Each set was assessed by 96 participants, totalling to 192 participants (see Table 9).

Table 8. Colour set and material set

Colours	**Materials**
1: Red	F: Fabric
2: White	T: Timber
3: Green	P: Plasterboard

Set-1: Colour Differences	(one fixed material)
F1F2: Pair-1	Red fabric and White fabric
F1F3: Pair-2	Red fabric and Green fabric
F2F3: Pair-3	White fabric and Green fabric

Set-2: Material Differences	(one fixed colour)
F1T1: Pair-4	Red fabric and Red timber
F1P1: Pair-5	Red fabric and Red plasterboard
T1P1: Pair-6	Red timber and Red plasterboard

5.2.1. Sample Group

One hundred ninety-two (192) people participated in this study in Belfast, Northern Ireland, UK. Participants were chosen voluntarily. They received no payment or encouragement. Potential participants with color vision impairments were excluded from the experiment. The sample group was between 18 and 70 years of age, and included males and females with full vision (corrective lenses or eyeglasses, if necessary, were required to be worn). The average age of the sample group was 25 (see Appendix C for demographic results).

Table 9. Number of participants

Set-1 (Colour differences)	Pair-1: Red-White Fabric	32 different participants (16 females, 16 males)
	Pair-2: Red-Green Fabric	32 different participants (16 females, 16 males)
	Pair-3: White-Green Fabric	32 different participants (16 females, 16 males)
Set-2 (Material differences)	Pair-4: Red Fabric-Timber	32 different participants (16 females, 16 males)
	Pair-5: Red Fabric-Plasterboard	32 different participants (16 females, 16 males)
	Pair-6: Red Timber-Plasterboard	32 different participants (16 females, 16 males)
Total	192 participants (96 females, 96 males)	

There were two sets in the experiment (see Table 8 and Table 9). Set-1 consisted of three colours in pairs; nevertheless, Set-2 consisted of three materials in pairs. For Set-1, same material (fabric) with different colours (red, green, and white) were paired in two. For Set-2, three different material types (fabric, timber, and plasterboard) were paired in two with the same colour (red).

5.2.2. The Experiment Box and Measurement Equipment

Three different experiment rooms, which had the same controlled conditions, were used for the experimental setting in order to attain 192 participants. All models were viewed under controlled lighting conditions: natural light was blocked with curtains and the only light source was the fixture in the experiment box.

Three different rooms were in three different locations within the same neighbourhood with the same user profile. Room #1 was located at ground floor of the Department of Architecture of Queens University, Belfast. This room was used as an office for the instructors of the department (see Figure 20). It had one window which was covered with curtains and black cardboards by the researcher. The participants were voluntarily chosen and asked while they were walking down the street. Because the researcher had difficulties to find new participants on the same street, the experimental setting had to be moved to other two locations in order to find novel participant and ensure 192 participants. Same neighbourhood was chosen, in addition, other two rooms, which had similar square meters with the first one, were located at the ground floor of their buildings. Room #2 was located at ground floor of the Department of Politics, International Studies and Philosophy of Queens University, Belfast (see Figure 21). Room #2 was actually a room for Ph.D. presentations. It had one window which was covered with curtains. Room #3 was located at ground floor of the Red Barn Gallery, 43b Rosemary Street, Belfast (see Figure 22). Room #3 was a dark room of the Red Barn Gallery, therefore, there were not any windows. At all rooms the same experiment box was used so that models were demonstrated under the same lighting and physical conditions within the same environmental conditions (see Figure 23 and Figure 24).

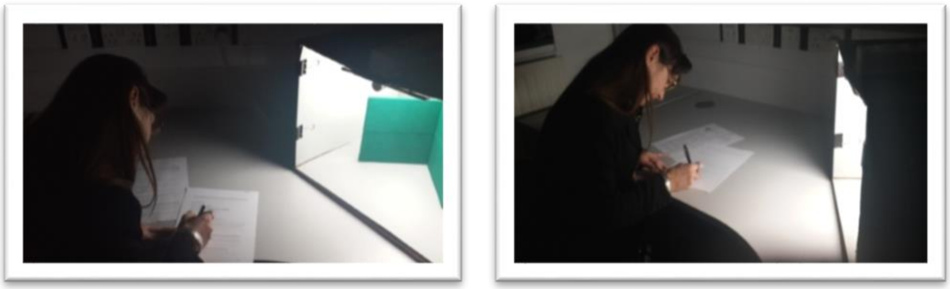


Figure 20. Room-1

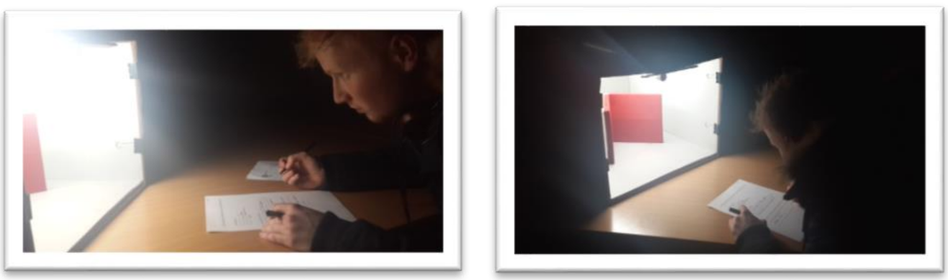


Figure 21. Room-2

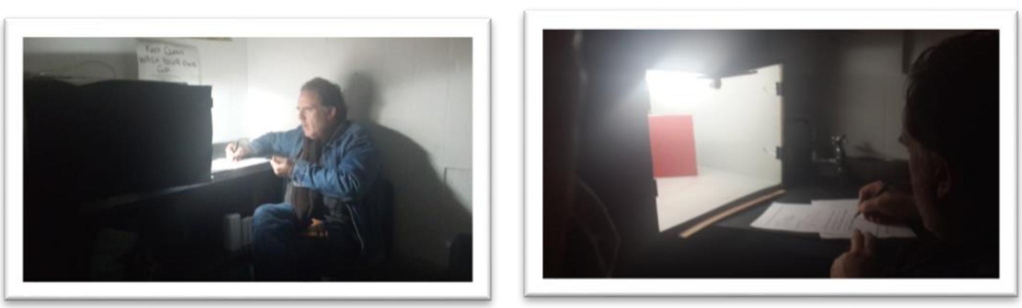


Figure 22. Room-3

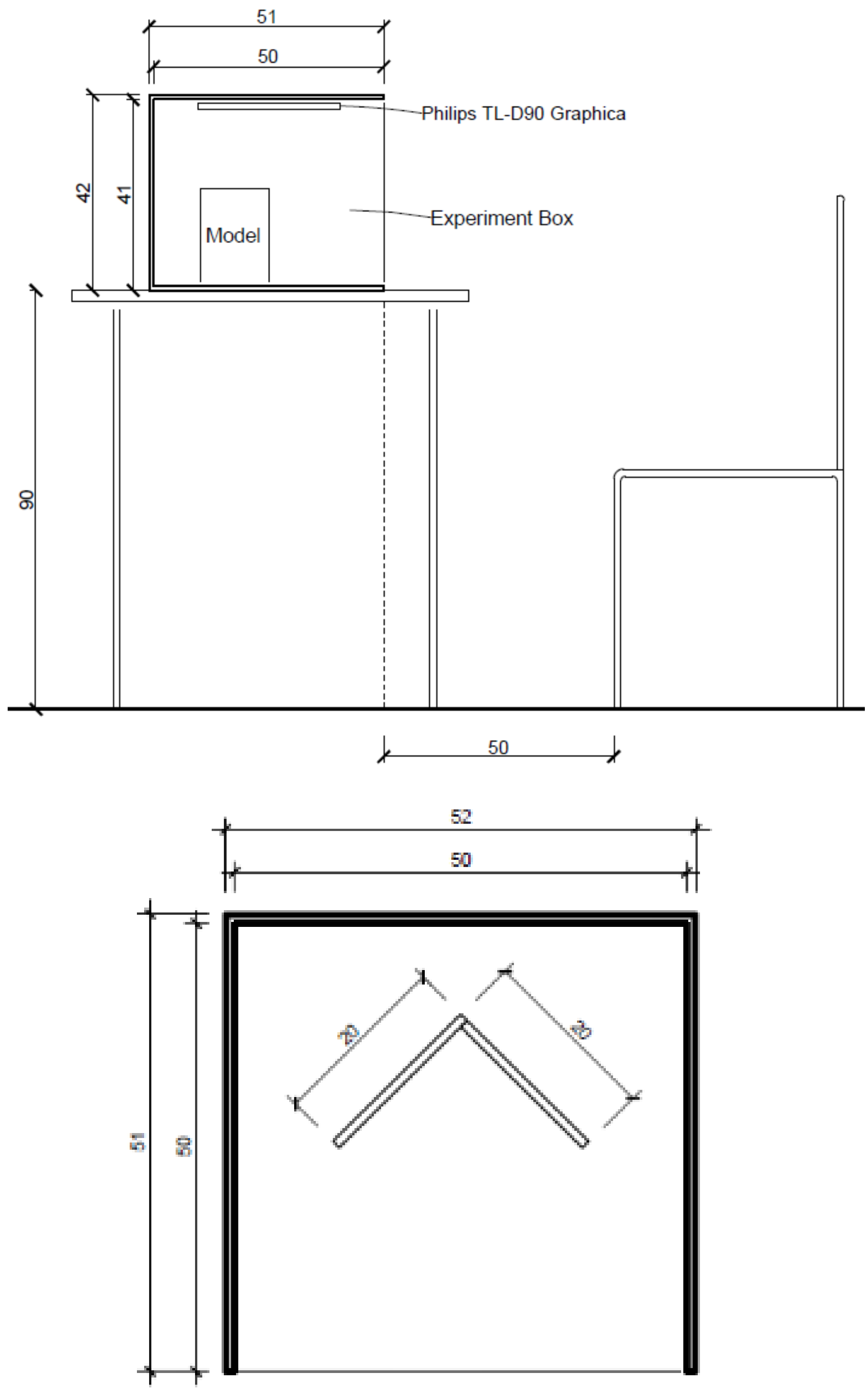


Figure 23. Drawings of the experiment box (side view and top view)

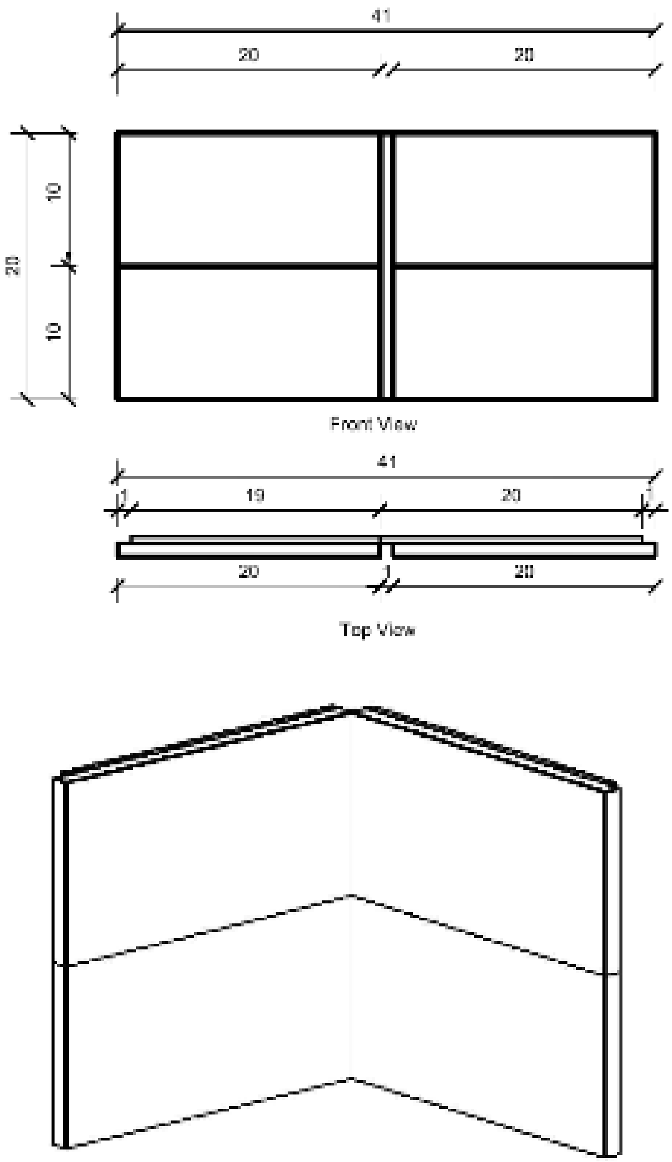


Figure 24. Drawings of the experiment the model (front view, top view, and perspective)

The experiment setting included a box, a lamp, and measurement equipment in a room with controlled conditions (see Figure 23). Measurement equipment were an NCS 96

Atlas, a Konica Minolta Illuminance Meter T-10A, a temperature gauge, and a digital thermometer with Samsung Galaxy S4 sensors.

The experiment box, which the researcher constructed, was used to exhibit the models under controlled conditions. Its inner dimensions were; 40cm height, 50 cm width and 50 cm depth. It was put on a table with 90 cm height. The participants sat down on a chair, which was fixed to the floor, in front of the experiment box. The distance between the chair and the experiment box was 50cm (see Figure 23). Lighting equipment with lamp was assembled on the top of the box. It was located in the middle of the top to ensure homogenous illuminance level inside the box and on the surfaces of the models. The models (see Figure 24) were viewed with grey background in the experiment box (see Figure 23) to provide constant conditions for each model. The outside of the box was covered with black cardboard and the inside was lined with grey cardboard. The NCS colour code of the grey cardboard was ‘S-3000N’, which is the masking colour of the NCS 96 Atlas, was preferred in order to provide a suitable background in the experiment box while participants were assessing the models.

In order to fix indoor environment conditions and satisfy the lighting requirements, lighting and measurement equipment were utilised. Natural light was blocked with curtains and black cardboards, and indoor climate conditions were fixed to ensure there was not any unpredictable effect.

The only light source in the experiment room was the equipment in the experiment box. Philips TL-D 90 Graphica 18W 965 - 59cm (MASTER) was used in the lighting equipment as the lamp. This product of Philips Company provides the best visual conditions for accurate sight of colours with its colour temperature, which is 6500 K with 98 Ra colour rendering index, as a colour temperature of average daylight (see Appendix D). Colour temperature of daylight is recommended by IESNA (Illuminating Engineering Society of North America) (Rea, 2000) to provide suitable lighting conditions for sight. However, real daylight cannot be controlled and is unpredictable; the lamp is constant and can be controlled. In addition, IESNA (Rea, 2000), suggests 500 lux for horizontal and 300 lux for vertical illuminance levels (or approximately 400 lux is accepted) for ordinary space to read and work. Only one light bulb, which was fixed in the lighting equipment: Thorn PP118, satisfied the required lighting conditions for surfaces and inside of the experiment box.

The room temperature was measured both by the temperature gauge and the digital thermometer with Samsung Galaxy S4 sensors. The room temperature was kept constant at 22℃ as recommended by Neufert (1980) in order to provide same indoor conditions for each participant. Temperature, relative humidity and pressure of each room were measured in order to ensure three indoor environments had the same conditions. During the experiment process, to ensure the same indoor temperature, indoor climate conditions were measured by aforementioned equipment and fixed with heating equipment, if necessary, to ensure there were no unpredictable effects on the experiment.

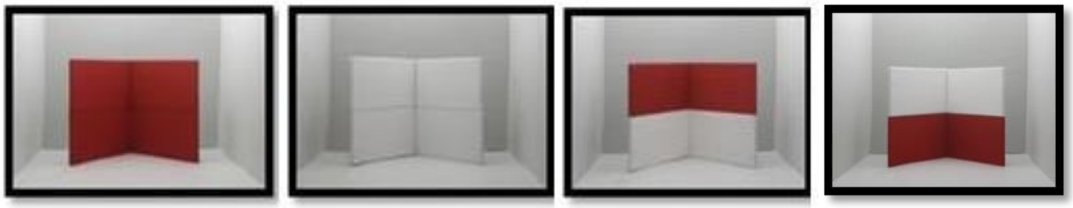


Figure 25. Models (red-white colour pair models) inside of the experiment box. (Table 10, Colour pair 1)

NCS Atlas 96 and NCS Colour Scan 2.0. (see Figure 26) were used to determine colours of the models. Konica Minolta Illuminance Meter T-10A (see Appendix E) was used to measure the illuminance level of box and surfaces of the models (see Figure 26). ISHIHARA Colour Blindness Test was used to detect any colour vision defect of the participants.

Figure 26. NCS Colour meter (left) and Konica Minolta Illuminance Meter T-10A in the experiment box (right) (personal archive of Begüm Ulusoy).

5.2.3. Preparing the Models

Each colour was viewed with another one to create a pair. To eliminate any effect of colour location, the pairs were viewed in upper and lower combinations (see Figure 24, Table 10 and Table 11). For this study, upper colours and upper materials were written first in the text. Table 10 and Table 11 demonstrate how each colour pair or each material pair, which had four different models, were organized. In Table 10, Set-1 as colour differences, the material type was fixed and three different colours were paired. All three colours were viewed as Colour-1, Colour-2, Colours 1+2 and Colours 2+1 in different orders. Red, white, and green fabrics were used and red and white, red and green, and white and green colour pairs were assessed. In Set-1, each model was identical except for its colour (see Table 10 for colour pairs: colour pair-1, colour pair-2 and colour pair-3). In Table 11, Set-2 as material differences, the colour was fixed and three different materials were paired. All three materials were viewed as Material-1, Material-2, Materials 1+2 and Materials 2+1 in different orders. Fabric, timber, and plasterboard, which were coloured with red, were used and fabric and timber, fabric and plasterboard, and timber and plasterboard material pairs were assessed. In the Set-2, each model was identical except for its material type (see Table 11 for material pairs: material pair-1, material pair-2 and material pair-3).

Table 10. Procedure of colour differences (Set-1)

Colours Pairs	Red and White - Red and Green - White and Green			
Colour Difference-1: Red and White	Red Model F F F F	White Model F F F F	Red and White Model F F F F	White and Red Model F F F F
Colour Difference-2: Red and Green	Red Model F F F F	Green Model F F F F	Red and Green Model F F F F	Green and Red Model F F F F
Colour Difference-3: White and Green	White Model F F F F	Green Model F F F F	White and Green Model F F F F	Green and White Model F F F F

Table 11. Procedure of material differences (Set-2)

Material Pairs	Fabric and Timber – Fabric and Plaster – Timber and Plaster			
Material Difference-1: Fabric and Timber	Fabric Model F F F F	Timber Model T T T T	Fabric and Timber Model F F T T	Timber and Fabric Model T T F F
Materials Difference-2: Fabric and Plasterboard	Fabric Model F F F F	Plasterboard Model P P P P	Fabric and Plasterboard Model F F P P	Plasterboard and Fabric Model P P F F
Material Difference-3: Timber and Plasterboard	Timber Model T T T T	Plasterboard Model P P P P	Timber and Plasterboard Model T T P P	Plasterboard and Timber Model P P T T

Each participant saw one colour pair's models or one material pair's models (e.g. only colour pair-1 in Figure 25). Single colours were used for the colour pairs to investigate the relationship between single colours with pairs of them (see Table 10). Identically, single materials were used in order to investigate the relationship between single and paired materials (see Table 11). Therefore, participants assessed four different models (colour models or material models) in different orders. To eliminate any differences between the models, the researcher used four fragments for each model regardless of whether they were single or paired (see Figure 24 for four fragments). They embraced "the Information Integration Theory,"- which is a fundamental theory in the areas of learning, perception, judgment, decision making, personality impressions and attitude change (Anderson, 1971). The theory suggests that individuals react to a stimulus with one integrated response of the result of averaging (mixing, combining) all the information about the stimuli (Anderson, 1971). Thus, four fragments of one model (see Figure 24), were perceived as one stimulus and the participants also responded them as one stimulus.

However, literature review revealed that models are effective representative of real life application (Wastiels et al., 2012a; 2012b; Wastiels, 2013), there might be a gap between the experimental conditions and real life applications which should be considered. Real life applications of same colours, colour pairs, materials, and material pairs might differ slightly. Nonetheless, 40 cm to 40 cm samples were used by Wastiels et al. (2012a) and Wastiels et al. (2013) and 20cm to 20 cm samples were used by Wastiels et al. (2012b) and their results prove that using samples instead of one to one scale rooms is acceptable in the context of interior architecture.

5.2.3.1. Specifying the Colours

Models were painted with three colours, which were a variety of warm and cold colours. According to Hogg (1969) and Wright (1962), hue has a profound effect on the warmth perception, therefore, in this study, three different hues were investigated. Red, a powerful and attention grabbing colour, was preferred with its afterimage complementary colour green. Afterimage complementary colour is “a colour and its afterimage complementary hue. A colour produces an afterimage of the complementary hue when viewed in daylight with the neutral grey area serving as background” (Camgöz, 2000; 243). Also white was preferred as an achromatic colour because it have a wide range of usage in real life.

Colours were chosen so that natural characteristics of every material remained and that the same colour (sameness in all measured dimensions of a colour) could be obtained for each material. Colour of timber was the main concern as it seemed to have the most restricted palette of colours. Main colours of red, green, and white were aimed to be compared for warmth perception responses, therefore these colours were first explored through timber, as fabric and plasterboard were providing wider range of palettes in colour.

With NCS Atlas 96, colours were selected and NCS codes were determined by NCS Colour Scan 2.0 on timber models. The other two materials were modified according to the NCS codes of these three initial colours of timber. After the painting process of all samples, their NCS codes were again measured by NCS Colour Scan 2.0 to ensure their colours are identical (see Table 12).

Colour application and production of white models were much more complicated than the other two chromatic colours. Pure white as an achromatic colour, cannot be found in everyday life. Each colour, which is mentioned as white includes some small amount of another hue according to their natural features; however human eye cannot detect these minor amount of chromatic colours in the materials and perceive them as a white colour (Fridell Anter, 2000). For instance, white plastics or white fabrics may include some chromatic colours according to their production line in their factories. Independent from which chromatic colour (e.g. red, green, yellow, etc.) was included to white colour, human eye is not able to perceive these minor existence of chromatic colour in white colour and, see and perceive it as a pure white. These type of minor differences between white plastics, white fabrics or white papers could only be measured by equipments such as NCS Colour Scan 2.0. Therefore, this nature of white was paid attention in coloured models during the preparation process. To ensure the similar saturation and lightness levels, the original paints were watered down with required proportions (see Table 12).

Table 12. NCS Codes, brands and required proportions of colours

Colours	NCS Codes of the finished surfaces	Brand	Required Proportions
Red	S 3070-Y90R	Sirca CT5503	8.5:5, paint:water
Green	S 5040-B80G	Sirca PWN143	15:5, paint:water
White	S 0510-R50B	Dewilux Eco-colour A-14-1000	1:0, paint:water

5.2.3.2. Specifying the Materials

Materials were selected from typical interior architecture materials, that are commonly used, namely; fabric, timber, and plasterboard. These three materials are widely used for vertical surfaces of interiors: walls, furniture, upholstery, etc. and as a common point they have been used for centuries in interiors. In addition to their wide usage, they could be accurately modified by water-based paints without any loss of identity of their surface properties (see Table 13). In this experiment, all material samples had identically the same colour in order to eliminate the effects of different hues, saturation levels, etc. All material types were chosen to guarantee the same surface qualities since surface qualities of materials have unique characteristics depending on their nature, material selection was made to ensure these characteristics are pertained. Type of timber was preferred according to the paint and sandpaper conditions, type of fabric was preferred according to ability of absorption, and plasterboard that is widely used in the industry, was chosen according to usage at real life and indoor applications. Details of visual texture qualities of these materials and how they were controlled will be explained in the following paragraphs. Wide ranges of fabric and timber types were considered as well.

Table 13. Brands and proportions of red colour for each material type

Materials	Red Colour (with NCS code S 3070-Y90R)	Required Proportions
Fabric	Sirca CT5503	8.5:5, paint:water
Timber	Sirca CT5503	8.5:5, paint:water
Plasterboard	Marshall water-based indoor matt type paint	1:0, paint:water

Due to restricted colour palette of timber, its colour and surface qualities were the main concern specifying colours and materials. Timber dyes not only paint but also cover and change surface properties of materials. To eliminate this change, timber protectors were used, which have impregnated feature. These timber protectors paint the material without any loss of identity, and they are soaked in by the surfaces. Water-based timber protectors penetrate through the surface of the material and doesn't cause any change of identity, except colour to their surface. Texture, grain and structure of timber and other materials are protected as well.

To determine timber and its protector, distributors of Sirca and Dewilux companies were contacted and consulted, and they provided colour charts of their products. Sirca and Dewilux companies' products were preferred because of their wide range of use both in interiors and on furniture in Ankara. Both companies, besides using their own colour systems (Sirca Passion System and Dewimix Colour System) also produce colours with NCS colour system. For timber models, fagus-covered laminated board, as wood veneer laminated board, was used. Fagus was preferred because of its less grained surface quality, therefore, there was not any pattern difference between parts of models. In addition, wood veneer laminated board was preferred instead of solid wood so that surface quality could be controlled. Before the painting process every timber type should be sandpapered to provide same quality of smoothness and texture of their surfaces. After the painting process, solid woods' fibres are moistened and straightened up. Wood veneer laminboard does not have unpredictable textures after these sandpapering and painting processes, nonetheless, its surface is visually identical with solid wood. Timber models were hand-painted by the same person, Atila Akıncı, who is the head manager of the distributor company of the paints (Akıncı Boya ve Dış Ticaret A.Ş.), at constant conditions and with the same brush within an hour (see Table 13). This procedure endured same surface quality and professional application of the paint for timber samples.

100% cotton fabric was used, which are commonly used as interior elements, to prevent any glare. In order to ensure same lighting and viewing conditions in the experiment box, there should be no glare on the surfaces of models. Cotton could absorb all paint which was applied, and because it did not include any plastic ingredient, there were not any white glares inside the fabric and it can be viewed properly with the colour applied. All samples were hand-painted by the researcher on the same day under the same indoor conditions of C-112 (at FC building – Environmental Laboratory) at İhsan Doğramacı Bilkent University with the same brush within two hours (see Table 13). This procedure guaranteed sameness of colour and surface quality for fabric samples. Sirca CT5503, Sirca PWN143, and Dewilux Eco-colour A-14-1000 paints were used for three different colours of fabric models (see Table 12).

Plasterboard was chosen from the products of Bauhaus Company. "Standard Plasterboard" of "Artıpan Alçıpan" was used as base of the model (see Appendix F). Plasterboard was painted with Marshall water-based indoor wall painting. The colour of fabric and timber models were measured by NCS Colour Scan 2.0. and the paint with the colour code (S 3070-Y90R NCS code) was ordered from the company. Matt type paint was particularly used to prevent any glare on the surface of the models, therefore same lighting and viewing conditions were ensured for models in the experiment box. All plasterboard models were hand-painted by the researcher with the same brush on the same day under same indoor conditions of C-112 (at FC building – Environmental Laboratory) at İhsan Doğramacı Bilkent University (see Table 13). This procedure guaranteed the same colour and surface quality for plasterboard samples. All produced samples were measured and sameness of the colour for different materials were assured after the measurement (see Table 14).

Table 14. NCS code of each materials

Measurements of NCS Colour Scan 2.0.	NCS code of finished surfaces
Fabric Models	S 3070-Y90R
Timber Models	S 3070-Y90R
Plasterboard Models	S 3070-Y90R

5.3. Conducting the Experiment

Two different pilot studies were conducted before the main experiment. The first pilot study was conducted to determine how colour or material samples should be demonstrated and how the questionnaire should be designed. The aim of the first pilot study was to answer questions: was the experimental setting feasible in practice, were the questionnaire, questions and adjectives used understandable, and how single and paired models affected the responses. Also it gave reasonable feedbacks about how participants reacted to the questions. Ten participants (five males and five females) were selected among undergraduate students who voluntarily participated in the study. Coloured cardboard models were used for this initial pilot study to save time and effort and to get reasonable results. The pilot study was conducted at Öykücü Kitapevi at M.E.T.U. on 13.06.2013 between 13:00-17:00 with 10 participants. The study also gave reasonable feedback on how participants reacted to the questions. After the study, the questionnaire and models were revised according to the feedback.

The models (see Figure 27) were viewed with grey background. There were not any windows so all participants assessed coloured cardboard models under controlled conditions of light and indoor environment. The questionnaire at Appendix-G was used.

Improvements to the experiment after the first pilot study were as follows:

- Each fragment in each colour and material sample should be equal in order to eliminate any effect of different size of fragments. So every model should consist of four fragments.
- All semantic scale questions should be evaluated on the same sheet but each colour model or material model should be on separate sheets. Participants would fill four sheets of papers to ensure the easier usage. (Appendix G and Appendix H).
- E-mail address should be added to questionnaire as optional part for the participants who would want to get results of the experiment.

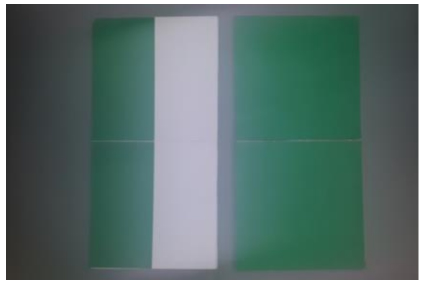


Figure 27. Model of first pilot study.

The second pilot study was conducted to determine if the experimental setting was feasible in practice with real colours and materials, see the responses of participants to real materials, understandability of the questions and questionnaire with its new format and how 4-fragment samples affected the responses. The pilot study was conducted at FC building C-112 at İhsan Doğramacı Bilkent University between 22.07.2013-26.07.2013 with 25 participants (6 participants for green and white fabric model, 7 participants for white and red fabric model, 6 participants for red and green fabric model and 6 participants for red timber and fabric model)

There were not any windows so all participants assessed models under controlled conditions of light and indoor environment. The only light source was the fixture in the experiment box. Two Philips Master TL5 HE 14W 865 1SL lamps were used in the lighting equipment, Philips Pentura Mini. In addition, indoor climate conditions were fixed. The questionnaire at Appendix-I was used. Both the second pilot study and the main experiment had the same physical conditions (such as light, temperature etc.). Based on the results of the pilot study, the researcher also added two additional questions (see Appendix B for the first two open ended questions) to probe more deeply into the concept and to learn participants' free associations.

Improvements to the experiment after the second pilot study:

- Colours, materials and orders of each model should be coded and written directly to the questionnaire sheet to prevent any confusion during the experimental setting.
- One light bulb provided the recommended lighting conditions and illuminance level (IESNA, 2000) in the experiment box.
- Explanations to the participants should be in the same manner, therefore a sheet of semantic scale definitions should be prepared which would be rehearsed by the researcher after two free-association questions.
- Questionnaires should be revised (Appendix H and Appendix I):

1. Year of study should be asked
2. Because the experiment was conducted at the last quarter of the year, date of birth should be asked, not just the age thus the participants' ages could be calculated without any calculation error.
3. 'Not energetic/ Energetic', 'Not intimate/Intimate' and 'Physically very cold/ Physically very warm' should be added to the both ends of the scale. Although, 'warm' and 'cold' are linguistically opposite of each other, there is no opposite scales for 'energetic' and 'intimate'. Therefore, 'not intimate' and 'not energetic' scales were used in order to ensure symmetrical meaning of these scales.

- Questionnaires were printed black ink so black pen should be given to the participants during the experimental setting in order to control any unpredictable effect of blue ink.
- All models should be disassembled, revised and packaged for the journey to the Belfast, UK in order to ensure the exact colours and material surfaces without existing opportunities that the researcher could have in Ankara.
- Lighting equipments and lamps should be revised. Philips lamp (Philips TL-D 90 Graphica 18W 965 - 59cm (MASTER)) which demonstrates colours more accurate than Philips Master TL5 HE 14W 865 1SL lamps (see Appendix D) should be obtained.
- The chair and the experiment box should be fixed in order to provide and ensure same distance and conditions for each participant.

The main experiment had two phases for each set. In the first phase, participants were asked to answer the questionnaire that consists of gender, date of birth, department and year of study. Dr. Geraint Ellies (Queens University Belfast, School of Planning, Architecture and Civil Engineering, QUB) as a native speaker of English, edited the questionnaire (see Appendix B). Ishihara's Tests for Color-Blindness, the information form and consent form were applied to the participants before the experiment (see Appendix J and Appendix K). The participants' eye or vision deficiencies were asked before the experiment and the participants who have any minor eye/vision deficiency were requested to use their correction equipment such as eyeglasses or contact lenses during the experiment. After the researcher administered the Ishihara's Tests for Color-

Blindness, they gave the remaining volunteers an information form about the experiment and asked them to fill out a consent form. Next, all other indoor lighting except the experiment box was turned off. The participants answered the first part of questionnaire (gender, date of birth, department/profession and year of study) under the controlled experiment conditions to ensure adaptation time for their eyes. After the participants answered the first phase, they were shown the first model in their set, as the second phase.

The second phase of the experiment included assessment of models in laboratory conditions. The questionnaire, which included six different questions about the concept, was used (see Appendix B). First two questions were open ended questions to investigate inspiration of the participant about the models. For the first question, they were asked to write down five adjectives which the models inspire them. For the second question they were asked to write down why they prefer these adjectives for the actual model. The other questions were direct questions to measure the effects of models on the participants about the concept. Semantic differential scale was used for the remaining four questions. The last semantic scale question with the adjective of ‘physical warm’ was excluded because the participants were not allowed to touch the models before and during the experiment (see Appendix L for the results). Osgood, Suci and Tannenbaum stated that (1978: 20):

> The semantic differential scale is essentially a combination of controlled associations and scaling procedures. We provide the subject with a concept to be differentiated and a set of bipolar adjectival scales against which to do it, his only task being to indicate, for each item (pairing of a concept with a scale), the direction of his association and its intensity on a seven-step scale.

“The Semantic Differential (SD) measures people's reactions to stimulus words and concepts in terms of ratings on bipolar scales defined with contrasting adjectives at each end” (Heise, 1970; p. 235). ‘Warm’, ‘energetic’ and ‘intimate’ with their contrast adjectives were used. According to Heise (1970), EPA (Evaluation, Potency and Activity) structure has to be used for assessment of any concept with semantic differential scales. These three structures should be included in any semantic differential scale to attain reliable results. For evaluation, “warm” adjective was used. At potency part, “intimate” and for the activity part “energetic” adjectives were utilized. These adjectives were used for semantic scale questions because they are consistently used throughout the literature (Wastiels et al., 2012a; Wastiels et al., 2012b; Fenko et al., 2010a; Karana et al. 2009). Hogg (1969) stated the importance of ‘warmth’ scale in his experimental study. Nonetheless, intimacy and energy are two of the three parameters of warmth (Fenko et al., 2010a). In this study, to concentrate the participants on the concept of warmth, the researcher did not prefer to use any other scales except these three fundamentals.

Each participant assessed each isolated pair with seven point itemized semantic differential scale. They answered on a scale of seven (e.g. 1: very cold, 7: very warm). Each participant assessed four different models; two single colour models or two single material models, with their pairs (in two combinations) (see Table 10 and Table 11). For each pair, each participant assessed the model in a different order to control the effects of order, therefore, any unexpected effect of order on the answers and findings of the experiment could be eliminated. Two different post-tests were conducted in order to clarify the methodology (see Appendix M).

The next chapters will demonstrate data analysis of semantic scale questions and open-ended questions in the experimental study. Data analysis were conducted by Statistical Package for the Social Sciences (SPSS) 20.0 and Nvivo 10.

CHAPTER – 6

DATA ANALYSIS OF THE EXPERIMENTAL STUDY

Findings of the experiment consist of demography of the sample group, data of open-ended questions and data of semantic differential scale questions (see Appendix C for demographics of the sample group).

In this study, each participant was asked to write down five adjectives, as a result of free-association process, that the model they were looking at inspired in them. Data analysis of these open-ended questions was done with grouping method which is based on free associations. The data was analysed by Nvivo's wording frequency function and each data set was grouped in order to elicit the meanings of colours, materials, colour pairs and material pairs in interiors. All synonym adjectives were grouped by Nvivo and the results showed the free-associations of them and word groups were obtained for colours, materials, colour pairs and material pairs. The researcher classified each adjective with one of the descriptor types, which were mentioned in Chapter-4, defined in previous research (Fenko et al., 2010). In order to embrace all the words elicited in the current study, similar word groups were taken into account, in addition to the word itself. For example, in the previous study, 'heavy' might be mentioned as a sensory descriptor; however, in the current study it was assigned as symbolic descriptor (for the fabric and plasterboard material pair) because its similar word group covers dense and deep, and the participants in the current study did not allowed to touch any models.

Semantic differential scale provides ranked data, which is analysed by non-parametric tests (Krathwohl, 1998). In addition, there is not any fixed parameter for the population so that non-parametric tests are adequate for the current study. In this study, semantic differential scale questions were acquired by ‘Wilcoxon Signed Rank Test’ with SPSS. Wilcoxon Signed Rank Test is a non-parametric statistical test that compare medians of two groups. Krathwohl (1998) stated that Wilcoxon signed-rank test is more powerful than using t-test for ranked data. Statistical Package for the Social Sciences (SPSS) 20.0 was used to analyse these quantitative data.

In this study, there were three colours and three colour pairs for the colour set and three materials and three material pairs for the material set: each pair included two colours or materials and their pairs. In the analysis of the data, both with-in sequence and with sequence comparisons were calculated with the same test (Wilcoxon signed-rank test). Contingency tables were demonstrated with Wilcoxon signed-rank test results. All models were compared with the other three models in their colour pairs or material pairs. In addition, colour pairs were compared with the other two colour pairs in their set and material pairs were compared with the other two material pairs in their set. If medians of two items were same, null hypothesis could not be rejected; that shows there was not any statistically significant difference between two items. However, if medians of two items weren't same, null hypothesis could be rejected; that demonstrates difference between these two items was statistically significant. The null hypothesis was that two models were the same with each other and there was not statistically significant difference in warmth perception. Findings from the statistical analysis were given in respect of the stated research hypotheses.

6.1. Data of Open-Ended Questions for Colour Set

For each colour pair, findings began with grouping tables of each model, free-associations and their similar words; continued with the word clouds which demonstrate weighted percentages of the colours. Nvivo analyses were only conducted with the first models of each participant (see Appendix N for number of participants, for each model, who assessed the models as the first one). There were three colour pairs in the colour set: red and white, red and green, and white and green. According to Ludueña, Behzad and Gros (2013: 1) free association is "a task that requires a subject to express the first word to come to their mind when presented with a certain cue". Therefore, in this study, to ensure the results' accuracy with unbiased free associations and to overcome any order effect, the researcher only analysed each participant's answers that related to the first model, and only Nvivo analyses were used for further discussion. ´C´ was used for count of words in the Tables 15, 16, 17, 27, 28, and 29

6.1.1. Red and White Colour Pair

Participants associated the red interior with the meaning of ‘warm’, ‘strong’ and ‘colourful’, white interior with the adjective groups ‘simple’ and ‘bright’, the red + white interior ‘clean’ and ‘spacious’, and white + red interior with ‘colour’, ‘fresh’, and ‘clean’ (see Table 15 and Figure 28).

Table 15. NVivo word frequency table of the red and white set

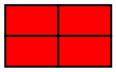
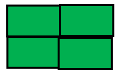
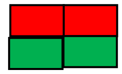
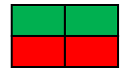
Red			White			Red + White			White + Red		
Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words
Warm	7	lively, strong, warm	Simple	4	plain, simple	Clean	5	clean, white	Colours	6	bright, colours, red, tone, white
Strong	6	hard, intense, powerful, strong	Bright	3	bright	Spacious	3	large, spacious	Fresh	5	clean, fresh, warm
Colourful	6	bright, colourful, dark, vibrant				Cut	3	cold, cut, separate	Clean	5	clean, fresh, white
Bright	5	bright, colourful, happy				Separate	3	cut, separate, separated	Medical	4	block, medical
Reason	- Colour, texture, panels, contrast - Colour of my living room - Materials and colours - Colour and texture - Surfaces - Colour - Texture and colour - Contrast colours and clean lines		Reason	- Colour, shape and position - Look - Colour - Colour - Colour and look - Colour and texture		Reason	- Colour - Colour and shape -Remind workspace -Look - Colour - Colour and split - Colour and contrast		Reason	- Material and contrast of colours - Colours - Colours - Colour and position - Colours and material - Easy to interpretate - Initial thoughts - Colours	

Figure 28. NVivo word clouds of red and white pair

6.1.2. Red and Green Colour Pair

Participants associated red model with ‘colourful’, ‘fabric’ and ‘warm’, green model with ‘bright’ and ‘home’, red + green model with ‘colourful’ and ‘straight’, and green + red model with ‘contrast’ and ‘different’ (see Table 16 and Figure 29).

Table 16. NVivo word frequency table of the red and green set

Red 			Green 			Red + Green 			Green + Red 		
Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words
Colourful	12	bright, colourful, material, paint, red, vibrant	Bright	4	bright, vivid	Colourful	13	bright, colourful colours, dark, flag, green, red, vibrant	Contrast	5	contrast, contrasting, different, lines
Fabric	5	fabric, felt, linen, material	Home	4	comfortable home, plain	Straight	5	square, squarred straight, vertical	Different	5	contrast, contrasting, different, unusual
Warm	4	warm, uncomfor -table				Bright	4	bright, colourful, lurid			
Material	3	linen, material, paint									
Reason	- Colour contrast and surface - Colour and materials - Colour and shade - Colour and design - Colour and surfaces - Colour - Colour		Reason	-Colour - Colour and harmony -Light and surfaces -Material -Experience -Texture and colour -Colour		Reason	- Shape and lines - Border of colours - Material and colour - Look - Colour and size - My perception - Surfaces		Reason	- Colours - Colours - My experiences - Look - Contrast colours - Colour and shape - Combination of colours - Colours and angles	

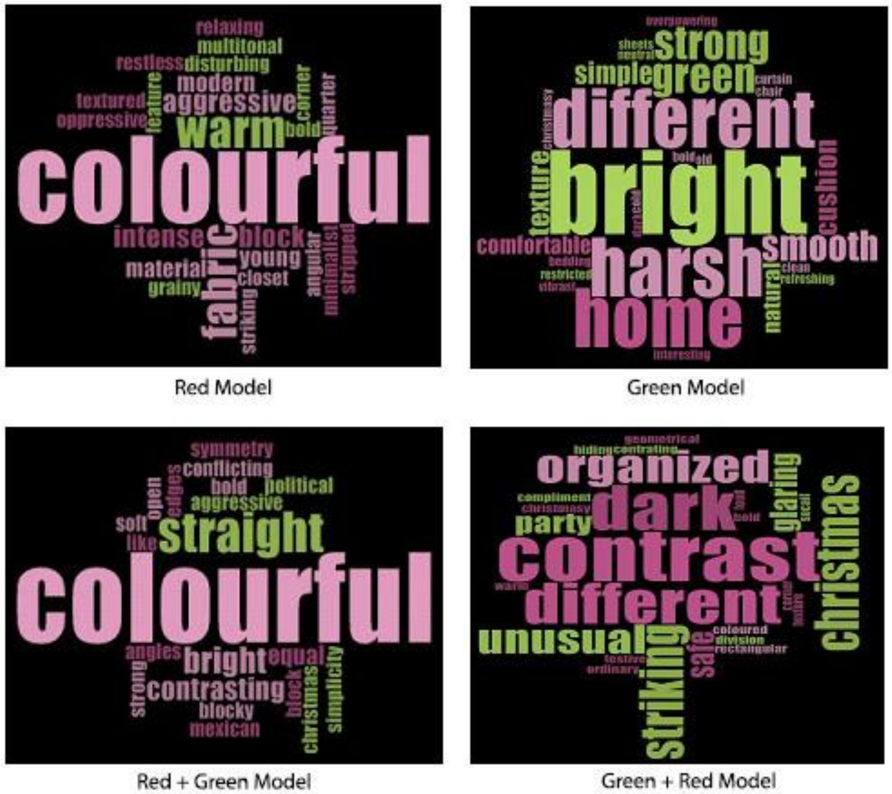


Figure 29. NVivo word clouds of the red and green pair

6.1.3. White and Green Colour Pair

Participants associated white model with ‘clean’, ‘light’, and ‘objective’, green model with ‘calming’ and ‘colour’, white + green model with ‘plain’ and ‘clean’, and green + white model with ‘colour’ and ‘interesting’ (see Table 17 and Figure 30).

Table 17. NVivo word frequency table of white and green set

White			Green			White + Green			Green + White		
Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words
Clean	11	blank, clean, light, neat, white	Calming	6	calming, gentle, smooth	Plain	5	flat, plain, simple	Colour	11	bright, colour, vibrant
Light	7	bright, light, soft, white	Colour	5	bright, colour, green	Clean	4	clean, clear, neat, white	Interesting	8	colour, interest ing
Objective	5	air, clinical, fabric, straight objective	Soft	4	dull, gentle, soft				Clean	8	clean, fresh, light, neat
Soft	5	light, small, soft							Light	7	bright, light, look, soft
Reason	- Details and colour - Coloure - Texture - Light and colour - Impersonal characteristics - Surface - Good condition - Light and colour		Reason	- View - Stand out - Texture and colour - Colour -What I see - Shape, material and style look		Reason	- Lines and colour -Shape and colour - Lines and colour - Colour		Reason	- Texture and colour - Colour matching - The look - Colour - Colour, texture and light - Colour - Colour - Colour - Colour	

Figure 30. NVivo word clouds of the white and green pair

6.1.4. Overall Results

Overall results of associations were investigated by Nvivo grouping. Additionally, these associated notions, which were interpreted by Nvivo software, were related to sensorial, symbolic and affective descriptors. These descriptors are representative of the colours, colour pairs, materials, and material pairs of interiors in the context of meaning, therefore they are related to the perception of warmth in the context of both literal and figurative meanings. To ensure interrater reliability, two more researchers repeated the same procedure, which is to assign three descriptors (sensorial, symbolic and affective) to the overall results, that two researchers did before. The first researcher is recruited by Interior Architecture and Environmental Design department of İhsan Doğramacı Bilkent University, has advanced level English who had lived in U.S.A. The second researcher is a native speaker of English and is recruited by Architecture Department of İhsan Doğramacı Bilkent University. Table 18 shows the results of each model and their descriptors in the light of this interpretation.

Table 18. Overall results of colours and colours pairs

COLOURS		
Red	**White**	**Green**
Colourful - sensory	Clean - symbolic	Calming - affective
Warm - affective	Light - sensory	Colour - sensory
Strong - symbolic	Objective - symbolic	Bright - sensory
Bright - sensory	Soft - sensory	Home - affective
Fabric - sensory	Simple - symbolic	Soft - sensory
Material - sensory	Bright - sensory	
Red and White	**Red and Green**	**White and Green**
Clean - symbolic	Colourful - sensory	Clean - symbolic
Colours - sensory	Straight - symbolic	Colour - sensory
Fresh - symbolic	Contrast - symbolic	Interesting - affective
Medical - symbolic	Different - symbolic	Light - sensory
Spacious - affective	Bright - sensory	Plain - affective
Cut - symbolic		
Separate - symbolic		

6.2. Data of Semantic Differential Scale Questions for Colour Set

Firstly, with-in sequence comparisons were conducted for each colour model by Wilcoxon Signed Rank Test. This test demonstrated findings of single and paired colours about the context (see Table 19 for symbols of colours in the following tables:

20, 22, 24, and 26). Contingency tables were presented for each colour pair with their Wilcoxon Signed Rank Test results. Then between sequences comparisons were conducted with Wilcoxon Signed Rank Test for colour pairs. These comparisons found out the relationship between colour pairs and warmth perception.

Table 19. Symbols of the colours used in the tables 20, 22, 24, and 26

Colours	**Red:** **Green:** **White:**

6.2.1. Red and White Colour Pair

As the first colour pair red and white pair was analysed. For semantic scale 'warm', red was warmer than all other models and the white is the coldest one. For question 'energetic' red was more energetic than white and white was the least energetic one; however there was not any significant difference between red, red + white and white + red models. For question 'intimacy' red was more intimate than all other models; however, white was the least intimate one. There was no difference in perception due to location of the colours in combination (see Table 20, and Table 21).

Table 20. Red and white pair models and their statistical relations

	Red Model	White Model	Red+White Combination Model	White+Red Combination Model
Warm	6.03	2.53	4.19	4.28
Energetic	4.81	3.31	4.38	4.97
Intimate	5.41	1.53	3.44	3.63

	Red vs White	Red vs Red+White	Red vs White+Red	White vs Red+White	White vs White+Red	Red+White vs White+Red
Warm	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	Null (,742)
Energetic	**Rejected (,004)**	Null (,181)	Null (,598)	**Rejected (,007)**	**Rejected (,000)**	Null (,060)
Intimate	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	Null (,526)

Warm	Red > Red + White=White + Red > White
Energetic	Red = Red + White=White + Red > White
Intimate	Red > Red + White=White + Red > White

Table 21. Contingency table of red and white colour pair

	Red			White		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	0.00	21.89	**78.11**	**59.38**	34.37	6.25
Energetic	3.12	**65.63**	31.25	40.62	**46.88**	12.50
Intimate	3.12	37.50	**59.38**	**90.63**	9.37	0.00
	Red + White			White + Red		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	9.37	**68.76**	21.87	9.37	**71.88**	18.75
Energetic	9.37	**68.76**	21.87	3.12	**59.38**	37.50
Intimate	**40.62**	**40.62**	18.76	31.25	**43.75**	25.00

6.2.2. Red and Green Colour Pair

As the second colour pair red and green pair was analysed. For question 'warm' red was warmer than all other models and green was the coldest one. For question 'energetic' red was more energetic than green and green was the least energetic one; however there was not any significant difference between red, red + green and green + red combinations. For question 'intimacy' red was more intimate than green and red was the most intimate one. There was not any significant difference between green, red + green and green + red combinations. There was no difference in perception due to location of the colours in combination (see Table 22 and Table 23).

Table 22. Red and green pair models and their statistical relations

	Red Model	Green Model	Red+Green Combination Model	Green+Red Combination Model
Warm	5.84	3.63	4.59	4.63
Energetic	5.44	3.66	5.03	4.88
Intimate	5.00	3.13	3.25	3.31

	Red vs Green	Red vs Red+Green	Red vs Green+Red	Green vs Red+Green	Green vs Green+Red	Red+Green vs Green+Red
Warm	**Rejected (,000)**	**Rejected (,001)**	**Rejected (,000)**	**Rejected (,013)**	**Rejected (,013)**	Null (,924)
Energetic	**Rejected (,000)**	Null (,242)	Null (,067)	**Rejected (,000)**	**Rejected (,003)**	Null (,472)
Intimate	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	Null (,729)	Null (,660)	Null (,743)

Warm	Red > Red + Green = Green + Red > Green
Energetic	Red = Red + Green = Green + Red > Green
Intimate	Red > Red + Green = Green + Red = Green

Table 23. Contingency table of red and green colour pair

	Red			Green		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	0.000	31.250	**68.750**	37.500	**43.750**	18.750
Energetic	6.250	37.500	**56.250**	21.870	**56.250**	21.880
Intimate	12.500	**50.000**	37.500	34.380	**62.500**	3.120
	Red + Green			Green + Red		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	6.250	**68.750**	25.000	9.370	**59.380**	31.250
Energetic	3.120	**62.500**	34.380	3.120	**56.250**	40.630
Intimate	34.370	**53.130**	12.500	34.380	**56.250**	9.370

6.2.3. White and Green Colour Pair

As the last colour pair white and green pair was analysed. For question 'warm' green model was warmer than white model and white model was the coldest one. Green model was warmer than green + white combination; however, green and white + green combination were the same. For question 'energetic' there was not any significant difference between models except green and to combinations; it was less energetic than both white + green and green + white combinations. For question 'intimacy' green was more intimate than white, and green + white combination was more intimate than white. There was no difference in perception due to the location of the colours in combination (see Table 24 and Table 25).

Table 24. White and green pair models and their statistical relations

	White Model	Green Model	White+Green Combination Model	Green+White Combination Model
Warm	2.41	4.06	3.59	3.47
Energetic	3.59	3.16	4.34	3.97
Intimate	2.28	3.56	3.03	3.16

	White vs Green	White vs White+ Green	White vs Green+ White	Green vs White+Green	Green vs Green+White	White+Green vs Green+White
Warm	**Rejected (,000)**	**Rejected (,001)**	**Rejected (,005)**	Null (,105)	**Rejected (,021)**	Null (,776)
Energetic	Null (,427)	Null (,097)	Null (,377)	**Rejected (,001)**	**Rejected (,016)**	Null (,189)
Intimate	**Rejected (,012)**	Null (,082)	**Rejected (,034)**	Null (,131)	Null (,201)	Null (,693)

Warm	Green > White, White+Green > White, Green+White > White, Green = White+Green, Green > Green+White, White+Green = Green+White
Energetic	Green = White, White+Green = White, Green+White = White, White+Green > Green, Green+White > Green, White+Green = Green+White
Intimate	Green > White, White+Green = White, Green+White > White, White+Green = Green, Green+White = Green, Green+White = White+Green

Table 25. Contingency table of white and green colour pair

	White			Green		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	**65.630**	28.120	6.250	21.870	**50.000**	28.130
Energetic	37.500	**43.750**	18.750	40.630	**46.870**	12.500
Intimate	**71.880**	18.750	9.370	40.630	**43.750**	15.620
	White + Green			Green + White		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	34.380	**50.000**	15.620	34.380	**50.000**	15.620
Energetic	15.620	**62.500**	21.880	21.870	**53.130**	25.000
Intimate	40.620	**43.750**	15.630	**50.000**	37.500	12.500

6.2.4. Comparison of Colour Pairs

Comparisons of colour pairs were made between sequences (see Table 26). Red and white, red and green, and white and green pairs were compared with each other to find out how colour pairs affect the warmth perception. For each three questions, colours were compared in pairs in terms of warmth perception. In terms of warm, red and white pair, and red and green pair were perceived the same and warmer than white and green pair. In terms of energetic, red and white pair and red and green pair were assessed more energetic than white and green pair. For intimacy, there was not any difference between colour pairs (see Table 26).

Table 26. Colour pairs and their statistical relations

	Red and White Model	Red and Green Model	White and Green Model
Warm	4.23	4.60	3.53
Energetic	4.67	4.95	4.15
Intimate	3.53	3.28	3.09
	Red+White vs Red+Green	Red+White vs White+Green	White+Green vs Red+Green
Warm	Null (,127)	Rejected (,016)	Rejected (,001)
Energetic	Null (,228)	Rejected (,039)	Rejected (,009)
Intimate	Null (,428)	Null (,155)	Null (,582)

Warm	Red and White Pair = **Red and Green Pair > White and Green Pair**
Energetic	Red and White Pair = **Red and Green Pair > White and Green Pair**
Intimate	Red and White Pair = Red and Green Pair = White and Green Pair

6.3. Data of Open-Ended Questions for Material Set

Each material set began with grouping tables of each model, free-associations and their similar words; continued with the word clouds which demonstrate weighted percentages of the material. Similar to colour pairs, Nvivo analyses were only conducted with first models of each participant (see Appendix N for number of participants, for each model, who assessed the models as the first one). There were three material pairs in the material set: fabric and timber, fabric and plasterboard, and timber and plasterboard. The same procedure that was utilized for the colour set was used.

6.3.1. Fabric and Timber Material Pair

Participants associated fabric model with ‘deep’, ‘intense’, ‘smooth’, and ‘soft’, timber model with ‘strong’, ‘comfortable’, and ‘homely’, fabric + timber model with ‘bright’, ‘wood’, and ‘texture’, and timber + fabric model with ‘colour’ and ‘colour’ (see Table 27 and Figure 31).

Table 27. NVivo word frequency table of the fabric and timber pair

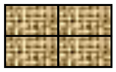
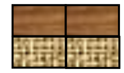
Fabric			Timber			Fabric + Timber			Timber + Fabric		
											
Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words
Deep	6	broad, deep, intense, thick	Strong	7	hard, solid, strong, warm	Bright	5	bright, happy, silky	Colour	9	bright, colour, red, vibrant, crimson
Intense	6	deep, intense, sharp, thick	Comfortable	5	calm, comfortable, cozy, homelyrich	Wood	3	wood, splinters	Red	6	bloody, red, violent, crimson
Smooth	4	bland, textures mooth	Homely	4	comfortable, homely, house, plain	Texture	3	rough, texture			
Soft	3	dull, soft	Solid	4	corner, hard, solid, square	Lines	3	lines, rough			
Reason	- Both simple and bold - Shape, colour and space - Simplicity and colour - Colour - Colour and angle - Lighting - Colour - Colour - Colour and light		Reason	- Material and colour - My associations - Colour and material - Reminds me – associations - Solidity and colour - Connected, space - Angle		Reason	- Material experience - Look - Colour - Colour - Texture and colour - Contrast (texture) - Contrast		Reason	- Surfaces - Colour and angle - The way space is used, closing in, - Colour - See and feel - Light - Colour experience - Angle and space - Materials and colour		

Figure 31. NVivo word clouds for the fabric and timber pair

6.3.2. Fabric and Plasterboard Material Pair

Participants associated fabric model with ‘soft’, ‘red’, and ‘lined’, plasterboard model with ‘strong’, fabric + plasterboard model with ‘colours’, and plasterboard + fabric model with ‘closed’, ‘coloured’, and ‘heavy’ (see Table 28 and Figure 32).

Table 28. NVivo word frequency table of fabric and plasterboard pair

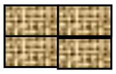
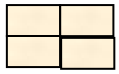
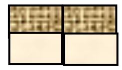
Fabric 			Plasterboard 			Fabric + Plasterboard 			Plasterboard + Fabric 		
Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words
Soft	6	small, soft	Strong	5	hard, strong, warm, powerful	Colours	5	bright, red, colours	Closed	5	warm, closed
Red	4	red							Coloured	5	bright, deep, red, coloured
Lined	4	cotton, cross, lined, rough							Heavy	4	deep, dense, heavy
Rough	4	lined, rough, texture, textured									
Reason	- Look - Material and colour - Form and material - Surfaces - Look - Material, size, colour - Colour and shape - My feelings - Material		Reason	- Angle, colour and position - Look - Colour and material - Colour - Angle and colour - Cultural associations - Colours		Reason	-Look - Colour - Colour - Colours and contrast of textures - Best description - Texture and look		Reason	- Use of material and corner - Colour and pastel shades - Perception - Position - Shape, colour, construction and orientation - Colour, texture, tone and shade - Cognitive process - Colour and materials	

Figure 32. NVivo word clouds of fabric and plasterboard pair

6.3.3. Timber and Plasterboard Material Pair

Participants associated timber model with ‘colourful’, ‘wooden’, and ‘closed’, plasterboard model with ‘red’, ‘flat’, and ‘square’, timber + plasterboard model with ‘colour’, and plasterboard + timber model with ‘rough’, ‘contrast’, and ‘natural’ (see Table 29 and Figure 33).

Table 29. NVivo word frequency table of the timber and plasterboard pair

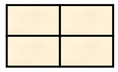
Timber 			Plasterboard 			Timber + Plasterboard 			Plasterboard + Timber 		
Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words	Word	C	Similar Words
Colourful	11	bright, colourful dark, deep, painted, red	Red	5	red	Colour	7	bright, colour, red, complem en -tary	Rough	5	hard, rough
Wooden	5	wooden	Flat	5	flat, plain, straight				Contrast	3	contrast, contrasts, different
Closed	5	closed, enclosed, warm	Square	4	square, straight				Natural	3	blood, natural
Pointed	4	deep, high, pointed	Pointe d	3	corner, pointed, sharp						
Reason	- Colour - Colour - Colour - Colour and position - Barriers - Colour - Go forward - Look - Colour		Reason	- Observing them - Texture and colour - Right angle shape - Angular properties - Colour and shape - Texture - Colour		Reason	- Surfaces - Comparison - Colour - Colour - Colour differences		Reason	- Look - Texture, colour partition - Light direction - Look - Colour surface texture - Surfaces - Differences - Colour and surface	

Figure 33. NVivo word clouds of the timber and plasterboard pair

6.3.4. Overall Results

These results demonstrated that warm was a substantial notion for all four different interiors with single or paired fabric and timber materials. Additionally, there was a tendency that plasterboard decreases the frequency of warm in pairs more than any other material in the set and location of plasterboard also manipulates the meaning. The same process, which was utilized in the Set-1 (colour differences) was used for Set 2 (material differences) as well. These processes showed how the users associated materials and material pairs in interiors with sensory, symbolic, and affective descriptors and revealed associations and meanings (see Table 30).

Table 30. Overall results of materials and materials pairs

MATERIALS		
Fabric	**Timber**	**Plasterboard**
Soft - sensory	Colourful - sensory	Strong - symbolic
Deep - affective	Strong - symbolic	Red - sensory
Intense - affective	Comfortable - symbolic	Flat - sensory
Smooth - sensory	Wooden - sensory	Square - sensory
Red - sensory	Closed - affective	Pointed - symbolic
Lined - sensory	Homely - affective	
Rough - sensory	Solid - sensory	
	Pointed - symbolic	
Fabric and Timber	**Fabric and Plasterboard**	**Timber and Plasterboard**
Colour - sensory	Colours - sensory	Colour - sensory
Red - sensory	Closed - affective	Rough - sensory
Bright - sensory	Coloured - sensory	Contrast - symbolic
Wood - sensory	Heavy - symbolic	Natural - symbolic
Texture - sensory		
Lines - sensory		

6.4. Data of Semantic Differential Scale Questions for Material Set

Firstly, with-in sequence comparisons were conducted for each material model by Wilcoxon Signed Rank Test. This test demonstrated findings of single and pair materials about the context. Contingency tables were presented for each material pair. Then between sequences comparisons were conducted with Wilcoxon Signed Rank Test for material pairs (see Table 31 for symbols of materials in the following tables: 32, 34, 36, and 38). These comparisons found out the relationship between material pairs and warmth perception.

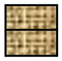
Table 31. Symbols of the materials used in the tables 32, 34, 36, and 38.

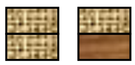
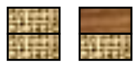
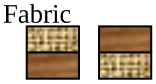
Materials	Fabric: 	Timber: 	Plasterboard: 

6.4.1. Fabric and Timber Material Pair

As the first material pair fabric and timber pair was analysed. For questions ‘warm’ and ‘energetic’ there were not any significant difference between fabric, timber, and their two combinations. For question ‘intimacy’ there was not any significant difference between models, except timber + fabric combination model (timber on top of the surface) was more intimate than fabric + timber combination model (see Table 32 and Table 33).

Table 32. Fabric and timber pair models and their statistical relations

	Fabric Model 	Timber Model 	Fabric+Timber Model 	Timber+Fabric Model 
Warm	5.31	5.06	5.13	5.44
Energetic	4.53	4.34	4.28	4.56
Intimate	4.81	4.75	4.38	4.94

	Fabric vs Timber 	Fabric vs Fabric + Timber 	Fabric vs Timber + Fabric 	Timber vs Fabric + Timber 	Timber vs Timber + Fabric 	Fabric + Timber vs Timber + Fabric 
Warm	Null (,386)	Null (,398)	Null (,489)	Null (,719)	Null (,203)	Null (,185)
Energetic	Null (,480)	Null (,246)	Null (1,000)	Null (,921)	Null (,391)	Null (,302)
Intimate	Null (,792)	Null (,142)	Null (,569)	Null (,265)	Null (,734)	**Rejected (,044)**

Warm	Fabric=Timber, Fabric=Fabric + Timber, Fabric=Timber + Fabric, Timber=Fabric + Timber, Timber=Timber + Fabric, Fabric + Timber=Timber + Fabric
Energetic	Fabric=Timber, Fabric=Fabric + Timber, Fabric=Timber + Fabric, Timber=Fabric + Timber, Timber=Timber + Fabric, Fabric + Timber=Timber + Fabric
Intimate	Fabric=Timber, Fabric=Fabric + Timber, Fabric=Timber + Fabric, Timber=Fabric + Timber, Timber=Timber + Fabric, **Fabric + Timber<Timber + Fabric**

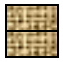
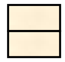
Table 33. Contingency table of fabric and timber material pair

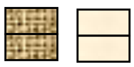
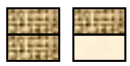
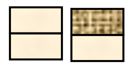
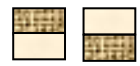
	Fabric			Timber		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	3.220	45.160	**51.620**	12.900	**45.160**	41.940
Energetic	16.130	**51.620**	32.250	16.140	**48.380**	35.480
Intimate	12.900	41.940	**45.160**	19.000	**42.000**	39.000
	Fabric + Timber			Timber + Fabric		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	3.220	**48.390**	**48.390**	0.000	45.160	**54.840**
Energetic	9.690	**64.510**	25.800	19.350	**45.170**	35.480
Intimate	16.140	**51.610**	32.250	6.450	**51.610**	41.940

6.4.2. Fabric and Plasterboard Material Pair

As the second pair of material set, fabric and plasterboard pair was analysed. For question ‘warm’, fabric was warmer than plasterboard and plasterboard was colder than any of their combinations. There was not any significant difference between fabric and paired combinations. For question ‘energetic’, there was not any significant difference between models except plasterboard + fabric combination was more energetic than plasterboard. For question ‘intimacy’ plasterboard + fabric and fabric + plasterboard combinations were more intimate than plasterboard. There was no difference in perception due to location of the materials in combination (see Table 34 and Table 35).

Table 34. Fabric and plasterboard pair models and their statistical relation

	Fabric Model	Plasterboard Model	Fabric+Plasterboard Model	Plasterboard+Fabric Model
				
Warm	5.31	4.16	5.03	5.06
Energetic	3.88	3.69	4.16	4.34
Intimate	4.13	3.19	4.22	4.44

	Fabric vs Plasterboard	Fabric vs Fabric+ Plasterboard	Fabric vs Plasterboard+ Fabric	Plasterboard vs Fabric+ Plasterboard	Plasterboard vs Plasterboard+ Fabric	Fabric+ Plasterboard vs Plasterboard+ Fabric
						
Warm	**Rejected (,003)**	Null (,392)	Null (,529)	**Rejected (,003)**	**Rejected (,009)**	Null (,814)
Energetic	Null (,644)	Null (,386)	Null (,093)	Null (,109)	**Rejected (,036)**	Null (,406)
Intimate	Null (,052)	Null (,988)	Null (,357)	**Rejected (,003)**	**Rejected (,001)**	Null (,508)

Warm	**Plasterboard < Fabric**, Fabric=Fabric + Plasterboard, Fabric=Plasterboard + Fabric, **Plasterboard<Fabric + Plasterboard**, **Plasterboard<Plasterboard + Fabric**, Fabric + Plasterboard=Plasterboard + Fabric
Energetic	Fabric=Plasterboard, Fabric=Fabric + Plasterboard, Fabric=Plasterboard + Fabric, Plasterboard=Fabric + Plasterboard, **Plasterboard<Plasterboard + Fabric**, Fabric + Plasterboard=Plasterboard + Fabric
Intimate	Fabric=Plasterboard, Fabric=Fabric + Plasterboard, Fabric=Plasterboard + Fabric, **Plasterboard<Fabric + Plasterboard, Plasterboard<Plasterboard + Fabric**, Fabric + Plasterboard=Plasterboard + Fabric

Table 35. Contingency table of fabric and plasterboard material pair

	Fabric			Plasterboard		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	3.120	46.880	**50.000**	15.620	**59.380**	25.000
Energetic	21.870	**53.130**	25.000	28.130	**50.000**	21.870
Intimate	21.870	**50.000**	28.130	37.500	**56.250**	6.250
	Fabric + Plasterboard			Plasterboard + Fabric		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	3.120	**53.130**	43.750	3.120	**53.130**	43.750
Energetic	18.750	**59.380**	21.870	9.370	**65.630**	25.000
Intimate	18.750	**53.130**	28.120	12.500	**56.250**	31.250

6.4.3. Timber and Plasterboard Material Pair

As the last pair of the material set, timber and plasterboard pair was analysed. For question 'warm', timber was warmer than plasterboard and timber + plasterboard combination, plasterboard + timber combination was warmer than plasterboard. For question 'energetic' there was not any significant difference between models except plasterboard + timber combination being more energetic than plasterboard. For question 'intimacy' timber was more intimate than plasterboard and timber + plasterboard combination. Plasterboard was less intimate than plasterboard + timber combination. There was no difference in perception due to location of the materials in combination (see Table 36 and Table 37).

Table 36. Timber and plasterboard pair models and their statistical relations

	Timber Model	Plasterboard Model	Timber + Plasterboard Model	Plasterboard + Timber Model
Warm	5.81	4.47	4.97	5.34
Energetic	4.59	3.81	4.13	4.56
Intimate	5.28	3.88	4.56	4.88

	Timber vs Plasterboard	Timber vs Timber + Plasterboard	Timber vs Plasterboard + Timber	Plasterboard vs Timber + Plasterboard	Plasterboard vs Plasterboard + Timber	Timber + Plasterboard vs Plasterboard + Timber
Warm	**Rejected (,000)**	**Rejected (,001)**	Null (,098)	Null (,099)	**Rejected (,014)**	Null (,321)
Energetic	Null (,085)	Null (,108)	Null (,815)	Null (,419)	**Rejected (,023)**	Null (,187)
Intimate	**Rejected (,003)**	**Rejected (,041)**	Null (,311)	Null (,086)	**Rejected (,025)**	Null (,310)

Warm	**Timber>Plasterboard, Timber>Timber + Plasterboard**, Timber=Plasterboard + Timber, Plasterboard=Timber + Plasterboard, **Plasterboard + Timber > Plasterboard**, Timber + Plasterboard=Plasterboard + Timber
Energetic	Timber=Plasterboard, Timber=Timber + Plasterboard, Timber=Plasterboard + Timber, Plasterboard=Timber + Plasterboard, **Plasterboard<Plasterboard + Timber**, Timber + Plasterboard=Plasterboard + Timber
Intimate	**Timber>Plasterboard, Timber>Timber + Plasterboard**, Timber=Plasterboard + Timber, Plasterboard=Timber + Plasterboard, **Plasterboard<Plasterboard + Timber**, Timber + Plasterboard=Plasterboard + Timber

Table 37. Contingency table of timber and plasterboard material pair

	Timber			Plasterboard		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	0.000	31.250	**68.750**	6.250	**68.750**	25.000
Energetic	18.750	**40.620**	**40.630**	28.130	**56.250**	15.620
Intimate	3.120	37.500	**59.380**	28.120	**43.760**	28.120
	Timber + Plasterboard			Plasterboard + Timber		
	Low (1-2) %	Medium (3-4-5) %	High (6-7) %	Low (1-2) %	Medium (3-4-5) %	High (6-7) %
Warm	6.250	**56.250**	37.500	0.000	**62.500**	37.500
Energetic	18.750	**56.250**	25.000	9.370	**62.500**	28.130
Intimate	9.370	**59.380**	31.250	6.250	**59.380**	34.370

6.4.4. Comparison of Material Pairs

Comparison of material pairs were made between sequences. Fabric and timber, fabric and plasterboard, and timber and plasterboard pairs were compared with each other to find out how material pairs affect the warmth perception. For each three question, materials were compared in pairs, but there was not any significant difference between material pairs in terms of warmth perception. For all comparison pairs null hypothesis could not be rejected (see Table 38). The results concluded that there is not any difference for warmth perception between material pairs.

Table 38. Material pairs and their statistical relations

	Fabric and Timber Model	Fabric and Plasterboard Model	Timber and Plasterboard Model
Warm	5,28	5,04	5,15
Energetic	4,42	4,25	4,34
Intimate	4,65	4,32	4,71

	Fabric and Timber vs Fabric and Plasterboard	Fabric and Timber vs Timber and Plasterboard	Timber and Plasterboard vs Fabric and Plasterboard
Warm	Null (,266)	Null (,432)	Null (,557)
Energy	Null (,353)	Null (,673)	Null (,656)
Intimacy	Null (,328)	Null (,926)	Null (,152)

Warm	Fabric and Timber Pair = Fabric and Plasterboard Pair= Timber and Plasterboard Pair
Energetic	Fabric and Timber Pair = Fabric and Plasterboard Pair= Timber and Plasterboard Pair
Intimate	Fabric and Timber Pair = Fabric and Plasterboard Pair= Timber and Plasterboard Pair

The next chapter will discuss these analyses that revealed how colours, colour pairs, materials, and material pairs affect the concept. The discussion part includes charts and tables that demonstrate how these visual interior elements affect the concept.

CHAPTER – 7

DISCUSSION

The main purpose of this study was to investigate the relationship between the warmth perception and colours with colour pairs, or materials with material pairs in interiors. Nonetheless, free associations of these interior architecture elements were also under investigation. Three colours (red, green, and white), three colour pairs (red and white, red and green, and white and green), three materials (fabric, timber, and plasterboard), and three material pairs (fabric and timber, fabric and plasterboard, timber and plasterboard) were used to elicit how warmth perception in interiors could be manipulated. Colours and materials were investigated in two different sets: colour set and material set, therefore, the findings of the study were presented accordingly. Additionally, findings were discussed in connection with the hypotheses (see Chapter 5).

7.1. Colour Pairs

Hypothesis 1: Warmth perception evaluations differ depending on single colours in interiors.

Hypothesis 2: Warmth perception evaluations differ depending on paired colours in interiors.

Various studies mentioned the positive relationship between red and the perception of warmth (Clark, 1975; Mahnke & Mahnke, 1987). Tn addition, previous studies investigated the difference between warm colours (red-yellow-orange) and cold colours (blue-green-purple) and have discussed reddish or yellowish colours being perceived warmer than bluish or greenish colours (Itten, 1970; Ou et al., 2004; Fenko et al. 2010a; Wastiels et al. 2012a; Wastiels et al. 2012b; Seimiere & Kamarauskaite, 2014;). Some studies determined a negative relationship between green and warmth perception (Mahnke, 1996; Michael & Rolhion, 2008; Michael et al., 2010); however, except Mahnke (1996), none of them were in the context of interior architecture. On the other hand, Wastiels et al. (2012a) indicated that white as an indoor colour, was perceived to be the coolest one. According to findings of this thesis, there is a significant difference between red, green and white colours and their colour pairs on the perception of warmth in interiors.

7.1.1. Warm

The results showed that red is perceived warmer than green and green is perceived warmer than white (see Table 39). Previous research (Wastiels et al., 2012a; Wastiels et al., 2012b; Newhall, 1941) suggests that reddish and warmer colours are perceived warmer than greenish and colder colours. In single colours, red was assessed as the warmest colour and white was assessed as the coldest colour. When they were paired; however, their warmth levels were adjusted to a medium level (see Table 39). White as a single colour is perceived as the coldest colour; this assessment was also suggested by one previous study (Wastiels et al., 2012a). When white is paired with green, the white upper and green lower combination has the same magnitude with green in terms of warmth; however, reverse combination (green upper and white lower combination) is less warm.

Table 39. The relationship between three colours and three colour pairs with 'warm'

Red and White Colour Pair	Red > Red + White=White + Red > White
Red and Green Colour Pair	Red > Red + Green = Green + Red > Green
White and Green Colour Pair	Green > White, White+Green > White, Green+White > White, White+Green = Green, Green > Green+White, White+Green = Green+White
Three Colour Pairs	Red and White = Red and Green > White and Green

The pair comparisons conclude that there is no difference between red and white and red and green pairs; both were perceived as warmer than the white and green pair. Colour pairs that include red were assessed as warmer than colour pairs without red (see Table 39). The results demonstrate that red is associated with warmth, and that including red in any colour pair makes the pair warmer than others. In contrast with previous studies (Mahnke, 1996; Michael & Rolhion, 2008; Michael et al., 2010), green does not have a negative relationship with the concept. Green decreases the warmth perception of any pair with a warm colour.

7.1.2. Energy

The results show that as a single colour, white and green are less energetic than red. However, when white is paired with red, the pairs are perceived as energetic as red and more energetic than white. In the same way, when green is paired with red, warmth perception increases. When white and green pair is analysed, the results demonstrate that white and green are perceived the same in interiors in terms of energy. There is also no difference among white and white + green combinations in terms of energy. But when green and white + green combinations are compared, green is less energetic than the combinations. Pairing green with white tend to increase that pair’s level of energy when compared to green (see Table 40).

Table 40. The relationship between three colours and three colour pairs with 'energetic'

Red and White Colour Pair	Red = Red + White=White + Red > White
Red and Green Colour Pair	Red = Red + Green = Green + Red > Green
White and Green Colour Pair	Green = White, White+Green = White, Green+White = White, White+Green > Green, Green+White > Green, White+Green = Green+White
Three Colour Pairs	Red and White = Red and Green > White and Green

As colour pairs, red and white pair and red and green pair have the same level of energy and are more energetic than a white and green colour pair. The results show that pairs including red are perceived as more energetic than the other pairs studied (see Table 40). Moreover, red increases its pairs' level of warmth to its own.

7.1.3. Intimacy

The results demonstrate that red is the most intimate colour and white is the least intimate, but when they are paired, intimacy is adjusted to a medium level. Red is perceived as more intimate than green and both of their combinations. As a single colour, white is less intimate than green. As a paired colour, there is no difference among the other combinations except when green is on top and white is on the bottom (green + white combination), which results in the pair being perceived as more intimate than white (see Table 41).

Table 41 The relationship between three colours and three colour pairs with 'intimate'

Red and White Colour Pair	Red > Red + White=White + Red > White
Red and Green Colour Pair	Red > Red + Green = Green + Red = Green
White and Green Colour Pair	Green > White, White+Green = White, Green+White > White, White+Green = Green, Green+White = Green, Green+White = White+Green
Three Colour Pairs	Red and White = Red and Green = White and Green

There was is difference between or among colour pairs in terms of intimacy, which demonstrates that none of the colour pairs in this study has a stronger or lesser effect on intimacy in interiors (see Table 41). Although, red is perceive warmer than green and green is perceived warmer than white however, they lost the difference magnitude of influence when they paired with each other.

7.1.4. Discussion of Free-Associations

According to Ou et al. (2004), red was related to warm in interiors. The findings demonstrate that people associated red in interiors with strong, colourful and warm, and these are all types of descriptors. In addition, the findings show that, in contrast with Helvacıoğlu's (2011) study, red was not related to sadness, fear, anger, disgust or surprise in interiors. However, high-quality (Seimiene & Kamarauskaite, 2014) and powerfulness (Helvacıoğlu, 2011) might be related to strong, and warm might be an aspect of love (Seimiene & Kamarauskaite, 2014), happiness, enjoyment and passionate

(Helvacıoğlu, 2011) (see Table 42). Because of different methodologies, these differences might occur between previous studies and this study. Helvacıoğlu (2011), preferred same colour names with different colour properties, used only direct questions and utilised virtual representation and Seimiene and Kamarauskaite (2014) explored brand colours.

The green model is related to home, colour, calming, etc. and these are sensory and affective descriptors. Similar to previous studies (Seimiene & Kamarauskaite, 2014; Helvacıoğlu, 2011) these adjectives show that green had positive associations for the participants of current study (see Table 42). However, these adjectives are not directly associated with the words or adjectives of these previous studies. In contrast with Ou et al. (2004) and Mahnke (1996), green was not related to cool, in the current study. For both UK and Ireland green has the special folkloric situation (Hutchings, 2004). In fact, the participants who participated the study were actually living in Belfast (as a UK city that has close relation with Ireland). In this study, green was not related to unluckiness and had positive associations in interiors (see Table 43).

Table 42. Comparison of overall results with previous studies

Colour	Emotions - adapted from Helvacıoğlu, (2011: 83)		Brand colour associations - adapted from Seimiere and Kamarauskaite (2014)	Results of current study (adjectives)
	Positive Emotions	Negative Emotions		
RED	Happiness, Surprise, Energetic, Powerfulness, Enjoyment, Passionate	Sadness, Anger, Fear	High quality, Love	Colourful Warm Strong Bright Fabric Material
GREEN	Happiness, Calmness, Peacefulness, Hopefulness, Relaxation, Comfort, Modernism	Aversion, Boredom, Fearfulness, Anxiety, Sadness, Annoyance, Mystery, Neutral, Non-emotional	Sincerity, Warmth, Honesty	Calming, Colour, Bright, Home, Soft
WHITE	Surprise	Sadness, Anger, Boredom, Fear	Low-classes, Low price	Clean, Light Objective, Soft, Simple, Bright

The results show that white is related to light, clean etc. and they are sensory and symbolic descriptors. It is interesting to note that in interiors, white does not have any affective associations. White is not associated with low classes, low-price surprise, fear, boredom, anger or sadness, in contrast with previous studies (Seimiene & Kamarauskaite, 2014; Helvacıoğlu, 2011) (see Table 42). Na and Suk (2014) stated that, in the context of industrial design, white is mentioned as elegant. Findings show that white was not directly associated with elegance, but is related to positive terms such as soft and clean. Differences of context and scales might cause these difference between the previous study and the current study. In addition, white was associated with light, clean and bright because white was related to purity as mentioned by the previous study (Holtzschue, 2006). White as a widely used colour, evokes humble meanings, such as simple, soft and objective.

Except red and green colour pair, other two colour pairs are related to all types of descriptors. The results demonstrated that red and green, as single colours, lost their affective descriptors when they are paired with each other. Overstimulation in interiors was mentioned as an unacceptable situation for users by Mahnke (1996). Red and green colour pair, in this study, may cause this overstimulation effect and that could be explanation why they lost their affective descriptors which they had as a single colour. Red and white colour pair, and white and green colour pair had affective descriptors, however, as a single colour, white did not have. That difference reveals that white should be paired in interiors with other colours to add some affective arousals. Moreover, both single colour white and its two pairs with other two colours (red or green) are related to 'clean' that reveal that adding white to any pair also added the association of 'clean' to that pair.

7.1.5. Overall Discussion

The results show that for warm and energetic notions, red and white pair, and red and green pair are warmer and more energetic than white and green pair. There is no difference between colour pairs in terms of intimacy. The effect of single colours in interiors are subtle in warmth perception: red is perceive warmer than green and green is perceived warmer than white. Red as a warm colour is warmer than green as a cold colour. However, white as an achromatic colour has the lowest level of warmth perception (see Figure 34). Their pairs have consistently mid-range values compared to their single values for all scales, but are not an exact average value. In other words, the warmth level of single colours is a good indicator for their pairs. Paired colours affect the warmth perception of interiors more than paired materials. This result could be related to the Wastiels et al. (2012b) study, which stated that the influence of colour is more important than roughness in interiors (see Table 43 and Table 44).

Table 43. Overall results of single colours

Changes of Surface Properties (Colours)		Quantitative Data: Warmth Perception of Interior	Qualitative Data: Free-associations of Interior
Red	➡	5,43	Colourful - sensory Warm - affective Strong - symbolic Bright - sensory Fabric - sensory Material - sensory
Green	➡	3,53	Calming - affective Colour - sensory Bright - sensory Home - affective Soft - sensory
White	➡	2,61	Clean - symbolic Light - sensory Objective - symbolic Soft - sensory Simple - symbolic Bright - sensory

Table 44 Overall results of paired colours

Changes of Surface Properties (Colours)		Quantitative Data: Warmth Perception of Interior	Qualitative Data: Free-associations of Interior
Red-White	⇨	4,14	Clean - symbolic Colours - sensory Fresh - symbolic Medical - symbolic Spacious - affective Cut - symbolic Separate – symbolic
Red-Green	⇨	4,28	Colourful - sensory Straight - symbolic Contrast - symbolic Different - symbolic Bright – sensory
White-Green	⇨	3,59	Clean - symbolic Colour - sensory Interesting - affective Light - sensory Plain - affective

The interpretation of semantic scale results and free association results revealed that, the perception of warmth in interiors are affected by both single colours and paired colours. Red as a single colour has a positive and strong effects on warmth perception, additionally it is associated with 'warm' and adding red to any colour pair also add the meaning of 'warm' and increases the warmth perception in interiors. Free association results reveal that green is associated with 'calming', which could not be related to warmth. However, green does not have a negative relationship with warmth perception, its neutral effect on the concept causes to decrease its pair's warmth perception with red.

This semantic scale result is also supported by free association result of the same colour pair: red and green, single colours, lost all affective descriptors after they are paired. Both semantic scale results and free association results support that green is not related to cold in interiors as suggested by previous studies. It is worth to note that green colours which were used by previous studies and the current study might not have same colour properties such as saturation, lightness, etc., therefore their comparison might result in different associations. However, it has calming effect that could not be an aspect of the perception of warmth as well. This indicates that green, with moderate level of warmth and 'calming', 'home', and 'soft' associations, has a neutral effect on the concept and positive associations in interiors. When green and white are paired, their pair is perceived warmer than their single appearance, which shows that pairing cold colour with an achromatic colour might have positive effects on the perception of warmth in interiors. In the same way, free-associations of white and green pair includes affective associations such as 'interesting', which white, as a single colour, does not have. These results reveal that pairing white with green not only increases their pairs' warmth perception but also brings on affective arousals in interiors. White, as a single colour, have negative and strong correlation with the perception of warmth in interiors. In order to eliminate that negative effect, it should be paired with a corresponding hue, either a warm or a cold colour. When it is paired with a warm colour, their pair will be perceived warmer than any other white and cold colour pair. Moreover, white is associated with humble meanings in interiors and adding it to a colour pair also adds the meaning of 'clean'. Free-association results support that pairing white with other colours increase its affective arousal, as it increases its perception of warmth as well.

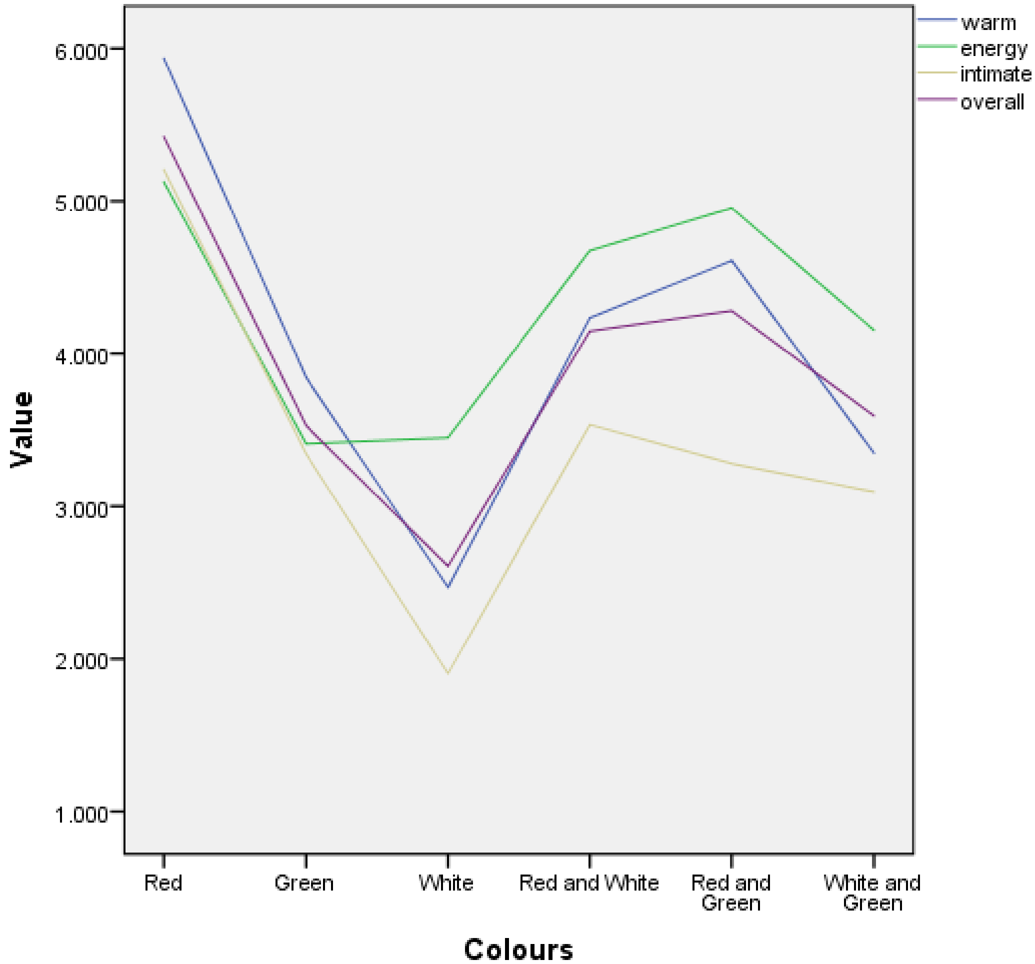


Figure 34. Overall relationship chart for single colours and paired colours

The difference between this study and the previous studies, which are in the context of industrial design, textile design, etc., prove that the relationship between the perception of warmth and colours or materials are context dependent, therefore, the concept should be investigated and tested further by empirical studies with more colours, colour pairs, materials and material pairs. Another important finding from the study is that there is no effect of colour location in paired colours. The same colour, regardless of whether it was on the top or bottom, had the same effect as the total effect of the colour pair on warmth perception. As long as they cover the equal amount of surface with in the space.

7.2. Material Pairs

Hypothesis 3: Warmth perception evaluations differ depending on single materials in interiors.

Hypothesis 4: Warmth perception evaluations differ depending on paired materials in interiors.

Previous product design studies mentioned the relationship between material properties (both surface properties and manufacturing properties) and the perception of warmth (Karana et al., 2009; Karana & Hekkert, 2010; Fenko et al., 2010a; Hekkert & Karana, 2014). Hekkert and Karana (2014) stated, for product design, natural materials are perceived warmer because of their previous lives. Chen et al. (2009) proved a positive correlation between perception of warmth and natural perception, which means not only natural materials but also materials that are perceived as natural are associated with warmth for packing design. The result of the thesis support that there are strong and positive correlation between natural material and the perception of warmth in interiors as well. Previous product design and textile studies (Schneider & Holcombe, 1991; Gürcüm, 2010; Bacci et al., 2012) stated fabric to be perceived warm and its thickness and layer thickness was a fundamental determinant (Schneider & Holcombe, 1991;

Bacci et al., 2012). Various product design studies (Chen et al., 2009; Karana et al., 2009; Karana & Hekkert, 2010; Hekkert & Karana, 2014) related timber to the perception of warmth. Similarly, interior design studies proved timber is associated with warmth as well (Farrelly, 2009; Gagg, 2012). These findings supported that there is an effect of materials on warmth perception in interiors. According to findings of this study, there is a significant difference between single materials in interiors on the perception of warmth, but this does not apply to their pairs.

7.2.1. Warm

The study results show that both in single materials and in paired materials, fabric and timber have the same level of warmth; there is no difference between these materials or among their combinations. As a single material, fabric is assessed as being warmer than plasterboard, but when paired, fabric dominated the pair; together, the combinations are found to be warmer than plasterboard and as warm as fabric on its own. In single materials, timber is perceived to be warmer than plasterboard. Timber is assessed as warmer than timber+ plasterboard combination but equal for warmth in plasterboard + timber combination. Plasterboard is assessed as cooler than the plasterboard + timber combination, but equal to the timber + plasterboard combination (see Table 45). The results demonstrate that, although both timber and fabric have the same magnitude of warmth in interiors, timber does not dominate its combinations (in its material pairs) as much as fabric does.

Table 45. The relationship between three materials and three material pairs with 'warm'

Fabric and Timber Material Pair	Fabric = Fabric + Timber = Timber + Fabric = Timber
Fabric and Plasterboard Material Pair	Fabric>Plasterboard, Fabric=Fabric + Plasterboard, Fabric=Plasterboard + Fabric, Plasterboard<Fabric + Plasterboard, Plasterboard<Plasterboard + Fabric, Fabric + Plasterboard=Plasterboard + Fabric
Timber and Plasterboard Material Pair	Timber>Plasterboard, Timber>Timber + Plasterboard, Timber=Plasterboard + Timber, Plasterboard=Timber + Plasterboard, Plasterboard + Timber > Plasterboard, Timber + Plasterboard=Plasterboard + Timber
Three Material Pairs	Fabric and Timber = Fabric and Plasterboard = Timber and Plasterboard

7.2.2. Energy

As noted, the results show that both in single materials and in paired materials fabric and timber have the same level of energy. As a single material, plasterboard is assessed as less energetic than plasterboard + fabric combination; however, there is no difference between the other models in terms of energy (see Table 46). Similarly, plasterboard as a single material is perceived as less energetic than plasterboard + timber combination, and there is no difference between the other timber and plasterboard pair models (see Table 45). In interiors fabric and timber have the same effect in terms of energy; they both increase the level of energy under plasterboard. There is a tendency with plasterboard upper combinations for both fabric and timber are more energetic than plasterboard itself. However, all three materials have the same level of energy in solitude but, their pairs' comparison support that there is a tendency for plasterboard to be perceived less energetic.

Table 46. The relationship between three materials and three material pairs with 'energetic'

Fabric and Timber Material Pair	Fabric=Timber, Fabric=Fabric + Timber, Fabric=Timber + Fabric, Timber=Fabric + Timber, Timber=Timber + Fabric, Fabric + Timber=Timber + Fabric
Fabric and Plasterboard Material Pair	Fabric=Plasterboard, Fabric=Fabric + Plasterboard, Fabric=Plasterboard + Fabric, Plasterboard=Fabric + Plasterboard, Plasterboard<Plasterboard + Fabric, Fabric + Plasterboard=Plasterboard + Fabric
Timber and Plasterboard Material Pair	Timber=Plasterboard, Timber=Timber + Plasterboard, Timber=Plasterboard + Timber, Plasterboard=Timber + Plasterboard, Plasterboard<Plasterboard + Timber, Timber + Plasterboard=Plasterboard + Timber
Three Material Pairs	Fabric and Timber = Fabric and Plasterboard = Timber and Plasterboard

7.2.3. Intimacy

The results reveal that as a single material there is no difference between fabric and timber in terms of intimacy association. But when they are paired as timber and fabric combination, that is, with timber on top, it is perceived as more intimate than the reverse combination. As single materials, fabric and plasterboard have the same intimacy level, but when they are paired, plasterboard appears to be less intimate than its pairs (see Table 47). In single materials, participants assessed timber as more intimate than plasterboard. But when they are paired, plasterboard + timber combination is perceived as intimate as timber alone, and is assessed as more intimate than plasterboard alone. However, timber + plasterboard combination is less intimate than timber and has the same intimacy level with plasterboard. These results demonstrate that there is a tendency with plasterboard as is the least intimate material and could be manipulated by other materials to increase its intimacy level in interiors.

Table 47. The relationship between three materials and three material pairs with 'intimate"

Fabric and Timber Material Pair	Fabric=Timber, Fabric=Fabric + Timber, Fabric=Timber + Fabric, Timber=Fabric + Timber, Timber=Timber + Fabric, Fabric + Timber<Timber + Fabric
Fabric and Plasterboard Material Pair	Fabric=Plasterboard, Fabric=Fabric + Plasterboard, Fabric=Plasterboard + Fabric, Plasterboard<Fabric + Plasterboard, Plasterboard<Plasterboard + Fabric, Fabric + Plasterboard=Plasterboard + Fabric
Timber and Plasterboard Material Pair	Timber>Plasterboard, Timber>Timber + Plasterboard, Timber=Plasterboard + Timber, Plasterboard=Timber + Plasterboard, Plasterboard<Plasterboard + Timber, Timber + Plasterboard=Plasterboard + Timber
Three Material Pairs	Fabric and Timber = Fabric and Plasterboard = Timber and Plasterboard

7.2.4. Discussion of Free-Associations

The findings of qualitative questions support that people tend to associate fabric and timber with the concept of warmth more than they associated plasterboard. However, for paired materials, both fabric and plasterboard combinations are associated with warmth. Only one of timber + plasterboard combinations (plasterboard up and timber down) is related to warm (see Table 28 and Table 29). These findings reveal that fabric has more profound effect on the perception of warmth in paired materials.

In the current study, the results demonstrate that fabric is related to sensory and affective descriptors such as: intense, deep and soft. In the context of industrial design, Karana et al. (2009) suggested that textiles are regarded as sexy; this study reveal that fabric is not directly associated with sexy in interiors but emotional terms such as intense and deep. The scale differences between the two disciplines and surface property differences between and among textiles might be reasons for this difference.

The results show that, timber is related to adjectives such as: strong, colourful, comfortable etc. and these are sensory, symbolic and affective descriptors (see Table 32). In this study, it is interesting to note that, in contrast with previous study (Farrelly, 2009) timber is not directly related to warmth. However; timber is associated with home and comfortable, which could be mentioned as not literally but figuratively warm concepts. The participants related timber to home, comfort and closed adjectives; this assessment was also suggested by Brown & Farrelly's (2012) study. As other previous research suggested (Gagg, 2012), timber was one of the first materials which was used in human shelters, therefore it has been historically related to home (Brown & Farrelly, 2012).

In this study, the results show that plasterboard is related to sensory and symbolic descriptors such as: red, strong and flat. The firm and smooth surface of plasterboard are related to the adjectives of flat and strong by the participants. The reasons that were mentioned by participants for their free associations show that people concentrate on colour with texture, shape and angle when it was on plasterboard (see Table 28 and Table 29). The results show that plasterboard, as an artificial material, is related to more materialistic words than the other materials and that plasterboard alone is not associated with any affective adjective or warmth association. Plasterboard that is as a widely used material for interiors, has not been explored as much as other two materials: fabric and timber. It is fruitful to investigate its associations and possible effective and diversified usage in interior architecture.

Fabric and timber pair is related to only sensory descriptors. Fabric and plasterboard pair is associated with sensory, symbolic and affective descriptors. Timber and plasterboard pair is related to sensory and symbolic descriptors. The study demonstrates that single materials, in interiors, are related to different descriptors by themselves. However, their pairs are related to fewer affective descriptors. The study reveals that both pairs of timber with other two materials do not have affective associations which shows that when timber is paired it loses its affective associations. Pairing timber with other two materials causes a loss of affective associations. The plasterboard and fabric pair has affective associations that plasterboard alone does not have. These results demonstrate that plasterboard not only does not affect the pairs, but also does not arouse affective associations.

7.2.5. Overall Discussion

The study reveals that single materials as well as single and paired colours have different effects on the perception of warmth in interiors. As a single material, fabric and timber are assessed as warmer than plasterboard. But when these three materials are paired (fabric and timber, fabric and plasterboard, and timber and plasterboard pairs), their level of warmth became the same. The study reveals that single materials affect the perception of warmth in interiors by themselves, but when paired they lose their differences for warmth perception. It is interesting to note that, the results also show, there is no difference in warmth perception among material pairs, and this phenomenon is consistent for all these semantic scales of all pairs. Fenko et al. (2010a) suggests that colour and material have the same magnitude of influence for warmth perception in the context of product design. This thesis reveals that when colours are paired, colour pairs have different effects on the perception of warmth; however material pairs have the same effect. Both semantic differential scale results and free association results are compatible; all materials have the same potency for warmth perception when paired, and material pairs have less affective descriptors than single natural materials. Pairing materials in interiors have profound effect on the perception of warmth, their meanings and their associations. Another exciting finding is, except for the fabric and timber pair for ‘intimacy’ semantic scale, the results also show that there is no effect of material location for all scales in terms of perceived warmth (i.e. whether a material is on the top or the bottom of an interior wall) (see Table 48 and Table 49).

Table 48. Overall results of single materials

Changes of Surface Properties (Materials)		Quantitative Data: Warmth Perception of Interior	Qualitative Data: Free-associations of Interior
Fabric	→	4,66	Soft - sensory Deep - affective Intense - affective Smooth - sensory Red - sensory Lined - sensory Rough - sensory
Timber	→	4,98	Colourful - sensory Strong - symbolic Comfortable - symbolic Wooden - sensory Closed - affective Homely - affective Solid - sensory Pointed - symbolic
Plasterboard	→	3,87	Strong - symbolic Red - sensory Flat - sensory Square - sensory Pointed - symbolic

Table 49. Overall results of paired materials

Changes of Surface Properties (Materials)		Quantitative Data: Warmth Perception of Interior	Qualitative Data: Free-associations of Interior
Fabric-Timber	→	4,79	Colour - sensory Red - sensory Bright - sensory Wood - sensory Texture - sensory Lines - sensory
Fabric-Plasterboard	→	4,54	Colours - sensory Closed - affective Coloured - sensory Heavy - symbolic
Timber-Plasterboard	→	4,74	Colour - sensory Rough - sensory Contrast - symbolic Natural - symbolic

According to Schifferstein and Wastiels (2014), materials that have previously been part of a living creature are associated with warmth. The results demonstrate that natural materials (fabric and timber for this study) are perceived as warmer than artificial materials (plasterboard) as recommended by Schifferstein and Wastiels (2014). Further, natural materials are associated with more positive terms. Free associations show that while fabric and timber are associated with adjectives such as ‘warm’ and ‘soft’, plasterboard is associated with ‘hard’ and ‘cold’. Apparently, when natural materials are paired with artificial ones, the paired materials are perceived as warmer than the artificial ones on their own. In addition, two natural materials (timber and fabric) lost their other associations when they are paired. Similarly, the semantic scale results demonstrate that pairing fabric and timber does not increase the perception of warmth in interiors more than their single materials, however as single materials both of them have strong positive relationship with the perception of warmth (see Table 32 and Table 33). These findings show that single natural materials could be used for interior walls to arouse a variety of associations and affective appearance. Pairing timber and fabric might create ruction and fuzziness which cause overstimulation in interiors, which is mentioned as the reason of negative perception and experience in interior architecture (Mahnke, 1996).

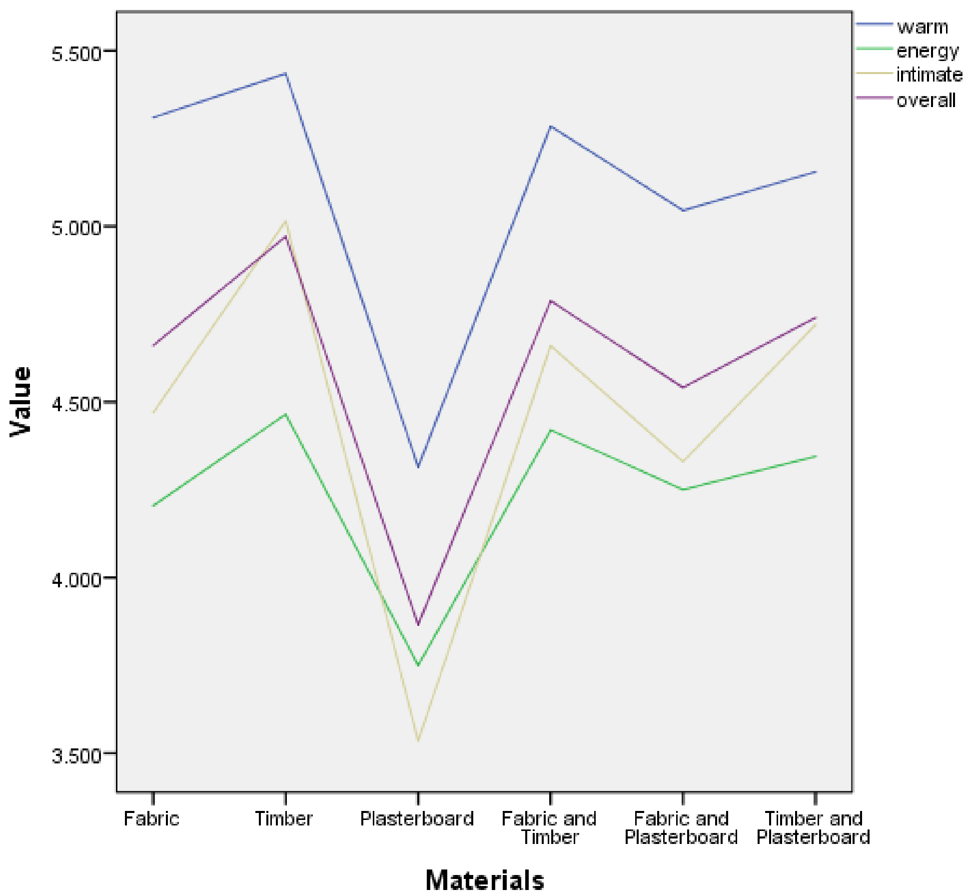


Figure 35. Overall relationship chart for single materials and paired materials

The interpretation of both semantic scale results and free associations results demonstrate that timber and fabric are associated with figuratively warm concepts. They inspired more participants to write down ‘warm’, and their semantic assessment are significantly warmer than plasterboard. However, timber is as warm as fabric and fabric could dominate its pairs more than timber in the context of warmth perception. There is a strong and significant negative relationship between plasterboard and warmth (see Figure 35). Plasterboard has the lowest level of warmth perception, and it decreases the frequency of the associations of ‘warm’ in its pairs (see Table 28 and Table 29), and has more materialistic associations than other materials and material pairs. Moreover, according to the results, the location of plasterboard might manipulate the meaning in interiors. Additionally, the findings reveal that artificial materials such as plasterboard, which has firm surfaces and does not have any texture, should be paired with natural materials to increase the perception of warmth and arouse positive associations in interiors. This thesis discusses that in order to eliminate negative associations of artificial materials in the context of warmth perception, artificial materials should be paired with natural materials or materials that have the perception of natural surfaces.

CHAPTER - 8

CONCLUSION

Design needs to provide pleasure and meaning (Hassenzahl, Eckoldt, Diefenbach, Laschke, Lenz, & Kim, 2013), pursuit well-being of an user (Desmet & Pohlmeyer, 2013), and arouse positive emotions (Desmet, 2012). Colours and materials have associations in interiors that might be utilized to promote features of design. Therefore, appropriate colour and material can enhance people's interior experiences. Warmth perception, with its meaning aspect, has a profound effect on the experience of interiors. Previous studies concentrated on the difference between the effects of single colours or single materials on warmth perception; however, these studies do not reveal the relationship between single colours or single materials with their paired colours or paired materials in interiors. In addition, the effects of paired colours or paired materials in interior architecture have not been elicited before. The main aim of this study is to investigate the effects of colours, colour pairs, materials, and material pairs on warmth perception in interiors. It is also aimed to find the relationship between single colours with paired colours, and single materials with paired materials. Furthermore, the secondary aim of the study is to explore free associations of these interior architecture elements in order to clarify their meanings in interiors. In this study, an experimental setting was used to investigate the relationship between warmth perception and colour pairs or material pairs with their single colours or single materials, that frequently appear in interiors.

In contrast with previous research (Fenko et al., 2010a), which stated that colour of a product affects warmth perception the same as material of a product does, the results show that, paired colours have effects on the perception of warmth different than paired materials in interiors. While, both single colours and single materials have an effect on warmth perception, colour pairs have a variety of effects on the concept in interiors that material pairs do not have. As single colours, red, green, and white were assessed as more or less warm alone than their pairs. Red and its pairs with other colours increase the warmth perception in interiors; however green has a neutral effect on the concept. It is interesting to note that white as a widely used interior wall colour has a negative effect on the perception of warmth and is mostly associated with clean. White should be paired either with chromatic colours in order to be perceived warmer and be associated with positive meanings in interiors. Colours as pairs have more moderate warmth than their single colours. Red appears to increase and white appears to decrease the warmth perception of their pairs for interiors (see Figure 36). The results also indicate that as single materials, timber and fabric are warmer than plasterboard; however, when paired there is no difference in warmth among the material pairs (see Figure 37). The meaning aspect of warmth seems to be more apparent with single materials than paired materials.

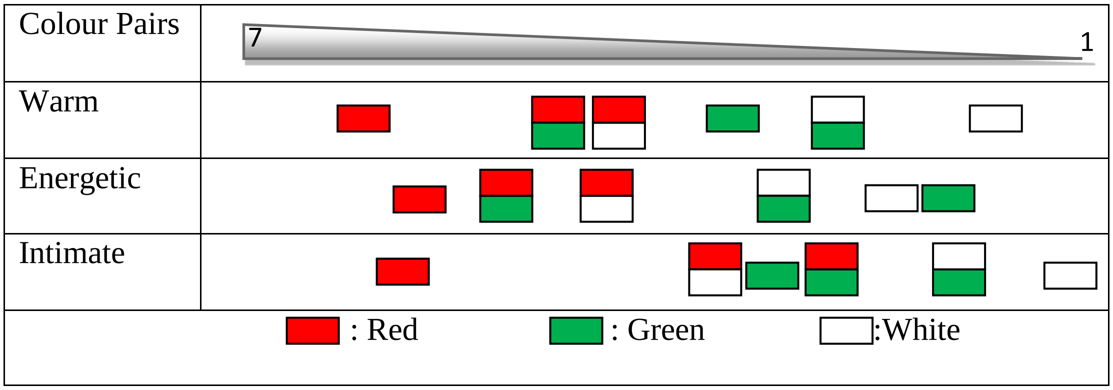


Figure-36 Colour associations with related adjectives

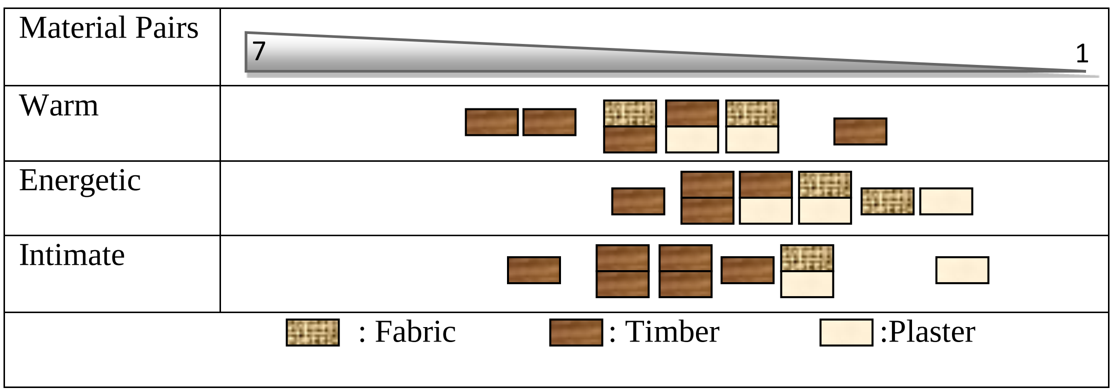


Figure-37 Material associations with related adjectives

The interpretation of semantic differential scale results reveal that warm colours are warmer than cold colours, and cold colours are warmer than achromatic colours and all colour pairs have moderate level of warmth as pairs. Adding red to colour pairs, increase the perception of warmth and add the meaning of 'warm', adding green decrease the warmth perception of its pairs with warm colours and increase the warmth of its pairs with achromatic colours, and tend to add some positive meanings such as calming and home, whereas adding white to any pair decrease the warmth perception and add the meaning ‘clean’ to their pairs. The study suggested that white should be paired with other colours in order to increase the perception of warmth in interiors and have more positive associations. All results demonstrate that natural materials have positive relationship with the perception of warmth in interiors and are associated with positive meanings such as soft, intense, comfortable, and homely. Both fabric and timber have the same positive effect on the perception of warmth but fabric dominate pairs more than timber. However, plasterboard, as an artificial material, has strong negative relationship with warmth in interiors and is associated with more materialistic concepts such as strong and flat. Pairing materials provide medium level of warmth in interiors, which could be utilized to arouse positive meanings in interiors. Fabric, timber and three pairs are associated with warmth in interiors; however, plasterboard, as a single material, should be paired with other natural materials in order to have positive effects on the perception of warmth. Although, both fabric and timber have profound effects on the concept, their pair have mid-range values and cannot increase the effect more than its single materials. Pairing fabric and timber may cause overstimulation and not only could decrease the warmth perception but also the affective associations.

There is not any effect of the location of colours and materials in pairs. The same colour or material on top or bottom of the surface has the same effect to the total effect of colour and material pairs on warmth perception. There is a slight difference between fabric upper and timber lower combination for intimacy as an exception.

Additionally, the experimental setting was used to investigate free associations of colours, colour pairs, materials, and material pairs. Clarifying these associations and meanings could be important and helpful for designers, these results might be used during colour and material selection stage. Based on the results, colours and materials could be chosen to arouse and create specific associations and meanings, such as 'fresh' and 'medical' are associated with red and white colour pair, 'contrast' and 'different' are related to red and green colour pair, and 'clean' and 'interesting' are associated with white and green colour pair, 'closed' and 'heavy' are related to fabric and plasterboard material pair, 'natural' and 'contrast' are related to timber and plasterboard material pair (see Table 18 and Table 30). Free association, as a method, reveals diverse results. As a paired colour, red and white colour pair and white and green colour pair, and as a single colour, red single colour and green single colour, evoke affective descriptors; however, as a single colour white and as a paired colour red and green do not. The study shows that when white is paired, that pairing improves its existence in interiors and enriches its pairs' associations in interiors. Natural materials, as a single material, have affective associations; however artificial material ones do not have. Timber has the most diverse associations (with all three types of descriptors) as a single material. However, plasterboard has the least diverse association. In addition, when materials are paired they have fewer affective descriptors than their single materials. Pairing timber causes a loss of affective associations in interiors. It is interesting to note that plasterboard does not affect its pairs in the same way.

This study contributes to the literature as an empirical study on colour and material pairs' effects on warmth perception in interiors since these interior architecture elements have not been investigated much before. Even though they are widely used, it is interesting to note that, both white as a single colour and plasterboard as a single material were not related to any affective descriptors. In addition, both timber as a single material and green as a single colour evoked similar meanings such as home; this relationship might be probed further in the future studies. The participants were asked to write down which property of the model inspired the adjectives they chose. Colour was mentioned as the reason more than other properties, for all models. Some other properties were material, shape, texture, experience, etc. The study reveals that both colours and materials can be used to effectively manipulate a user's perception, an important finding for both designers and scholars. These results provide designers, architects, interior architects, builders and industrial designers more knowledge about how colour pairs and material pairs alter the perception of warmth, and thus will enable them to adjust their designs accordingly. By this way, designers are able to use outcomes of the experimental study for real life applications.

Despite meaningful results, participants' citizenship could be a limitation of the study, which could lead to future studies. In this study, all participants were UK citizens living in Belfast. For example, green has positive associations that might be a result of the country's lush nature and folkloric meanings. Therefore, in order to compare, the same experiment might be conducted with participants who have different cultural backgrounds. Future studies could concentrate on more colour and material pairs. Future studies might include other materials (e.g. concrete, metals or plastics) and colours (e.g., yellow-violet or blue-orange) as well as their pairs, and with other achromatic colours (grey and black). In future studies, combinations of three or more colours and materials could also be investigated.

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APPENDIX-A

DICTIONARY MEANINGS OF WARM, INTIMACY AND ENERGY

A.1. WARM:

1 - a: having or giving out heat to a moderate or adequate degree; warm weather, a warm fire.

b: serving to maintain or preserve heat especially to a satisfactory degree; a warm sweater

c: feeling or causing sensations of heat brought about by strenuous exertion

2 - comfortably established: secure

3- a: marked by strong feeling: ardent

b: marked by excitement, disagreement, or anger <the argument grew warm>

4: marked by or readily showing affection, gratitude, cordiality, or sympathy; a warm welcome, warm regards.

5: emphasizing or exploiting sexual imagery or incidents

6: accompanied or marked by extreme danger or duress

7: newly made: fresh; a warm scent

8: having the color or tone of something that imparts heat; specifically: of a hue in the range yellow through orange to red

9: near to a goal, object, or solution sought; not there yet but getting warm.

(http://www.merriam-webster.com/dictionary/warm, 01.03.2012; 11:47, www.merriam-webster.com).

A.2 INTIMACY:

1: the state of being intimate: familiarity

2: something of a personal and private nature

3: a state marked by emotional closeness <the intimacy of old friends>

4: a quality suggesting closeness or warmth <the café’s intimacy>

5: something that is very personal or private < They shared little intimacies in their letters>

(http://www.merriam-webster.com/dictionary/intimate , 27.02.2016; 14:15, www.merriam-webster.com).

A.3. ENERGY:

1: ability to be active: the physical or mental strength that allows you to do things

2: natural enthusiasm and effort

3: usable power that comes from heat, electricity, etc.

(http://www.merriam-webster.com/dictionary/energy , 27.02.2016; 14:40, www.merriam-webster.com).

APPENDIX-B:

QUESTIONNAIRE SHEET (IN ENGLISH)

TITLE: PERCEPTION OF INTERIORS IN ASSOCIATION WITH COLOUR PAIRS

General Information:

1. Gender: Female____ Male____
2. Date of Birth: __________________
3. Department/Profession: _______________
4. Year of Study:________________

Eye and Colour Vision Deficiency

1. Do you have any eye or vision deficiency? If yes, please describe;

____

2. Do you have any correction equipment (such as contact lenses etc.) for any eye or vision deficiency you have? If yes, please explain and indicate whether you intend use this during this experiment.

____

PLEASE LOOKING AT THE MODEL AND ANSWER THE FOLLOWING QUESTIONS:

1. Please record at least 5 adjectives which you think describes these two surfaces when you imagine them as an ordinary interior space?

____

2. Why do you think these two surfaces inspire you to use these adjectives?

____

3. Please imagine these surfaces as an ordinary interior space and please rate them according to how **warm** they make you feel, using the following 7-point scale.

(Very cold) 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ (Very warm)

4. Please imagine these surfaces as an ordinary interior space and please rate them according to how **energetic** you think they are, using the following 7-point scale.

(Not energetic) 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ (Energetic)

5. Please imagine these surfaces as an ordinary interior space and please rate them according to how **intimate** you think they are, using the following 7-point scale.

(Not intimate) 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ (Intimate)

6. Please imagine these surfaces as an ordinary interior space and please rate them according to how **physically warm** they make you feel, using the following 7-point scale.

(Physically very cold) 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ (Physically very warm)

APPENDIX C

DEMOGRAPHIC RESULTS

Table C1. Red and white colour pair

Red and White Pair				
	Gender	Date of birth	Department/Profession	Year of Study
P-1	F	28.11.1991	Medicine	4
P-2	M	02.02.1995	Mechanical Engineer	1
P-3	F	14.01.1993	Hairdressing	NA
P-4	F	25.12.1984	Accounts	NA
P-5	M	29.12.1992	Medicine	3
P-6	M	24.02.1986	Management	Master
P-7	F	30.08.1984	Call Center (Debt Advice)	NA
P-8	F	19.09.1954	Teacher	NA
P-9	F	05.10.1982	Planning, Research Assitant	NA
P-10	M	31.08.1988	Civil Servant	NA
P-11	M	05.07.1982	Lighting Designer	NA
P-12	M	07.11.1994	Spanish&Irish Languages	1
P-13	M	26.04.1995	Psychology	1
P-14	M	05.01.1978	Planning	NA
P-15	M	11.09.1992	Antropology	1
P-16	M	15.02.1990	Management	Ph.D. 1st year
P-17	M	21.09.1991	Mechanical Engineer	4
P-18	F	18.12.1991	Pharmacy	4
P-19	F	29.07.1994	Architecture	1
P-20	F	21.11.1993	Medicine	2
P-21	F	26.02.1992	Politics+Philosophy	3
P-22	M	26.07.1983	Software Engineer	NA
P-23	F	30.12.1993	Architecture	2
P-24	F	10.06.1993	Pharmacy	3
P-25	F	28.09.1992	Stranmillis	3
P-26	F	11.01.1994	Chemistry	1
P-27	M	02.11.1991	Publishing	Master
P-28	M	09.07.1994	Accounting	1
P-29	M	05.12.1991	Pharmacy	4
P-30	F	29.02.1993	Management	1
P-31	F	12.01.1994	Architecture	2
P-32	M	25.06.1993	Maths & Physics	2

Table C2. Red and green colour pair

Red and Green Pair				
	Gender	Date of birth	Department/Profession	Year of Study
P-1	F	14.07.1993	Law	2
P-2	F	25.07.1991	Architect	1
P-3	F	31.07.1966	MI Resourse and Planning	NA
P-4	F	02.02.1983	Research Manager	NA
P-5	F	15.07.1994	Architecture	1
P-6	F	15.11.1993	Architecture	1
P-7	M	01.03.1991	English	Master 1st year
P-8	F	27.12.1971	Conservation Worker	NA
P-9	F	03.04.1991	Medical	4
P-10	F	17.12.1994	Modern Languages	1
P-11	F	29.03.1995	Geography	1
P-12	M	16.12.1994	Chemistry	1
P-13	F	21.12.1994	Mechanical Engineer	1
P-14	F	01.12.1981	Technical Uriter	NA
P-15	F	06.01.1988	Architecture	Master 1st year
P-16	M	27.08.1994	Mechanical Engineer	1
P-17	M	04.11.1944	Retired	NA
P-18	M	17.08.1994	Civil Engineer	1
P-19	M	18.02.1991	Stocktaker/Classroom Assitant	NA
P-20	M	28.12.1992	Mechanical Engineer	3
P-21	M	18.05.1993	B. Ed. Teaching	2
P-22	M	02.04.1989	Mechanical Engineer	3
P-23	M	21.08.1988	Irish Celtic Studies	Graduate
P-24	M	06.01.1994	Physics	1
P-25	M	02.05.1993	Arts-Languages	2
P-26	M	09.08.1993	Film Studies	1
P-27	M	18.04.1984	Architect	NA
P-28	M	07.10.1994	Mechanical Engineer	1
P-29	F	12.11.1993	Architecture	2
P-30	F	15.11.1989	Architecture	Master 1st year
P-31	M	22.08.1973	Unemployed	NA
P-32	F	30.04.1980	A.I. Consultant	NA

Table C3. Green and white colour pair

Green and White Pair				
	Gender	Date of birth	Department/Profession	Year of Study
P-1	F	26.08.1987	Political Analyst	NA
P-2	F	15.04.1994	Philosophy	2
P-3	M	05.10.1976	Architect	NA
P-4	M	01.10.1994	Architecture	1
P-5	F	09.03.1994	Mechanical Engineer	1
P-6	M	03.01.1989	School of biology	Master degree
P-7	M	10.02.1994	Mechanical Engineer	1
P-8	M	20.03.1995	Mechanical Engineer	1
P-9	M	04.04.1994	Teacher	NA
P-10	F	08.02.1995	Geograph	1
P-11	M	14.04.1990	Electrical Engineer	4
P-12	F	09.02.1995	Film Studies	1
P-13	F	06.03.1991	Catering Supervisor	NA
P-14	M	21.12.1991	Architecture	4
P-15	M	04.11.1993	Music	1
P-16	M	20.12.1994	Mechanical Engineer	1
P-17	M	16.10.1980	Accountant	NA
P-18	M	15.01.1994	History	1
P-19	F	19.04.1993	Teaching (Primary)	3
P-20	F	24.07.1994	Nursing	1
P-21	F	24.09.1984	Team Leader	NA
P-22	M	17.01.1995	Medicine	1
P-23	F	23.05.1958	Classroom Assisstant	NA
P-24	M	29.11.1991	Mechanical Engineer	3
P-25	F	29.11.1993	International Business with Spanish	2
P-26	F	01.03.1994	Psychology	2
P-27	F	19.12.1991	Mechanical Engineer	3
P-28	F	20.12.1942	Teacher (Retired)	NA
P-29	F	18.05.1964	Civil Servant	NA
P-30	M	23.05.1993	Pharmacy	3
P-31	M	23.03.1994	Architecture	2
P-32	F	18.02.1995	English	1

Table C4. Fabric and timber material pair

Fabric and Timber Pair				
	Gender	Date of birth	Department/Profession	Year of Study
P-1	M	01.07.1994	History&Philisophy	2
P-2	M	07.03.1982	Software Engineering	1
P-3	F	25.08.1964	Medicine (CME)	NA
P-4	F	04.03.1959	Computer Office	NA
P-5	M	31.12.1978	Projectionist	NA
P-6	F	06.02.1993	English and Theology	3
P-7	F	29.07.1986	Modern Languages	Ph.D 3rd year
P-8	F	11.05.1993	Film Studies	3
P-9	F	08.03.1960	Officer	NA
P-10	M	21.09.1970	Sacristan	NA
P-11	M	31.10.1983	Civil Servant	NA
P-12	M	06.04.1993	Music	2
P-13	M	22.06.1991	Civil Engineer	3
P-14	M	12.11.1991	Physiotheraphy	3
P-15	M	12.20.1987	PISP	Master
P-16	M	20.08.1993	Politics	2
P-17	M	01.08.1973	Sales	NA
P-18	M	05.06.1992	Science	3
P-19	M	15.07.1983	Sales	NA
P-20	M	02.05.1992	Architecture	2
P-21	F	21.08.1977	Socail Care Worker	NA
P-22	F	29.03.1961	Genealogect	NA
P-23	F	03.04.1954	Retired (Socail Worker)	NA
P-24	F	01.07.1968	NA	NA
P-25	F	20.01.1947	Manager	NA
P-26	F	14.07.1992	Law	3
P-27	F	25.09.1993	Law	1
P-28	F	10.01.1982	PISP	3
P-29	F	06.11.1991	English	3
P-30	M	15.10.1951	Teacher	NA
P-31	M	31.05.1993	Architecture	1
P-32	F	25.01.1954	Retired (Nurse)	NA

Table C5. Fabric and plasterboard material pair

Fabric and Plasterboard Pair				
	Gender	Date of birth	Department/Profession	Year of Study
P-1	M	21.05.1987	Designer	NA
P-2	M	14.09.1947	Retired	NA
P-3	F	12.08.1989	Accountancy Trainer	NA
P-4	F	30.06.1979	Musician	NA
P-5	F	23.08.1949	Artist	NA
P-6	F	16.06.1992	BFA Photography	NA
P-7	F	11.11.1966	Clerical	NA
P-8	F	29.10.1967	Author	NA
P-9	F	16.12.1959	Artist	NA
P-10	M	09.10.1958	Manager	NA
P-11	M	10.09.1978	Photographer	NA
P-12	M	29.10.1993	Art student	Foundation
P-13	M	26.10.1973	Library	NA
P-14	M	14.09.1972	Architecture	1
P-15	M	10.07.1983	Civil Engineer	NA
P-16	M	12.10.1976	Caretaker	NA
P-17	M	02.11.1993	Psychology	2
P-18	M	22.10.1991	Architecture	2
P-19	M	28.09.1994	PISP	1
P-20	M	14.11.1992	Socail Antrophology	3
P-21	M	07.11.1990	Chemist	2
P-22	F	02.10.1993	Mathematics	2
P-23	F	24.07.1990	History	Ph.D 1st year
P-24	F	10.01.1995	Poitics	1
P-25	F	28.08.1993	Nursing	1
P-26	F	31.03.1983	Yoga teacher	NA
P-27	F	02.02.1992	History&Politics	3
P-28	F	06.06.1994	Psychology	2
P-29	F	16.08.1992	Psychology	4
P-30	M	23.04.1947	Lecturer	NA
P-31	M	06.08.1993	Architecture	2
P-32	F	25.09.1992	Architecture	1

Table C6. Timber and plasterboard material pair

Timber and Plasterboard Pair				
	Gender	Date of birth	Department/Profession	Year of Study
P-1	F	10.10.1991	Foundation Art	1
P-2	M	04.07.1968	Assistant Bar Manager	/
P-3	M	30.08.1976	Microbiologist	/
P-4	M	22.09.1987	Mechanical Engineer	/
P-5	M	21.02.1988	Law	Postgraduate
P-6	F	23.06.1993	Film Student	3
P-7	F	05.22.1993	Film Studies	3
P-8	M	20.03.1995	Biological Sciences	1
P-9	F	11.01.1993	English	3
P-10	F	15.04.1993	History	3
P-11	M	19.04.1995	Histrory+Politics Student	1
P-12	M	20.03.1992	English	2
P-13	M	08.01.1995	Actor	1
P-14	M	09.03.1994	Politics	2
P-15	M	02.01.1992	PISP	4
P-16	M	03.06.1991	Politics	2
P-17	M	26.06.1959	Architect	/
P-18	M	09.05.1966	Photographer	/
P-19	M	03.10.1945	Artist	/
P-20	M	02.09.1990	Photographer	/
P-21	F	00.11.1978	Creative Arts, Ph.D.	1
P-22	F	23.08.1994	Politics	2
P-23	F	01.11.1982	Marketing	4
P-24	F	05.08.1995	Modern Languages	1
P-25	F	22.04.1994	English	2
P-26	F	23.08.1971	Social Work	/
P-27	F	11.09.1970	Carer	/
P-28	F	31.05.1995	High School	last year
P-29	F	18.11.1958	Translator	/
P-30	F	19.04.1965	Civil Servant	/
P-31	F	13.05.1994	Architecture	2
P-32	M	25.05.1985	Architecture	1

APPENDIX D

PHILIPS MASTER TL-D 90 GRAPHICA

MASTER TL-D 90 Graphica

MASTER TL-D 90 Graphica 18W/965 1SL

This TL-D lamp has excellent color rendering which makes it very suitable for the graphical and printing industry to check the quality of printed material.

Product data

• General Characteristics

Cap-Base	G13 [Medium Bi-Pin Fluorescent]
Bulb	T8 [26 mm]
Life to 10% failures EM	12000 hr
Life to 10% fail Preheat EL,3h	17000 hr
Life to 10% fail Nonpreh EL,3h	10000 hr
Life to 50% failures EM	15000 hr
Life to 50% fail Preheat EL,3h	20000 hr
Life to 50% fail Nonpreh EL,3h	12000 hr
LSF EM 2000h Rated, 3h cycle	99 %
LSF EM 4000h Rated, 3h cycle	99 %
LSF EM 6000h Rated, 3h cycle	99 %
LSF EM 8000h Rated, 3h cycle	99 %
LSF EM 12000h Rated,3h cycle	89 %
LSF EM 16000h Rated,3h cycle	33 %
LSF EM 20000h Rated,3h cycle	2 %

• Light Technical Characteristics

Color Code	965 [CCT of 6500K]
Color Rendering Index	98 Ra8
Color Designation (text)	Cool Daylight
Color Temperature	6500 K
Luminous Flux EM 25°C, Rated	930 Lm
Luminous Flux EM 25°C, Nominal	930 Lm
Lum Efficacy Rated EM 25°C	51.7 Lm/W
Luminance Average EM	0.80 cd/cm2
LLMF EM 2000h Rated	93 %
LLMF EM 4000h Rated	90 %
LLMF EM 6000h Rated	88 %
LLMF EM 8000h Rated	85 %
LLMF EM 12000h Rated	82 %
LLMF EM 16000h Rated	80 %
LLMF EM 20000h Rated	78 %
Design Temperature	25 C
Chromaticity Coordinate X	309 -
Chromaticity Coordinate Y	323 -

• Electrical Characteristics

Lamp Wattage	18 W
Lamp Wattage EM 25°C, Nominal	18 W
Lamp Wattage EM 25°C, Rated	18.0 W

asimpleswitch.com

PHILIPS

MASTER TL-D 90 Graphica

Lamp Voltage EM 25°C	59 V
Lamp Current EM 25°C	0.360 A
Dimmable	Yes

• Environmental Characteristics

Energy Efficiency Label (EEL)	B
Mercury (Hg) Content	3.0 mg
Energy consumption kWh/1000h	22 kWh

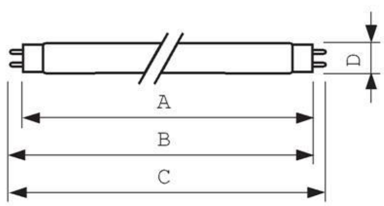
• Product Dimensions

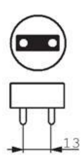
Base Face to Base Face A	589.8 (max) mm
Insertion Length B	594.5 (min), 596.9 (max) mm
Overall Length C	604 (max) mm
Diameter D	28 (max) mm

• Product Data

Order code	928043796581
Full product code	928043796581
Full product name	MASTER TL-D 90 Graphica 18W/965 1SL
Order product name	MASTER TL-D 90 Graphica 18W/965 1SL/10
Pieces per pack	1
Packing configuration	10
Packs per outerbox	10
Bar code on pack - EAN1	8711500888525
Bar code on outerbox - EAN3	8711500888532
Logistic code(s) - 12NC	928043796581
ILCOS code	FD-18/65/1A-E-G13
Net weight per piece	49.700 gr

Dimensional drawing





G13

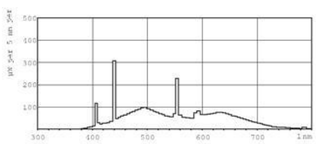
MASTER TL-D 90 Graphica 18W/965 1SL

Product	A (Max)	B (Min)	B (Max)	C (Max)	D (Max)
TL-D Graphica 18W/965	589.8	594.5	596.9	604	28

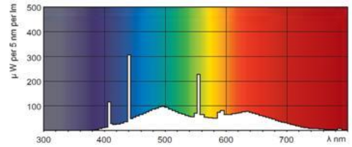
2014, March 4
data subject to change

MASTER TL-D 90 Graphica

Photometric data



Lightcolor TL-D Graphica /965



Lightcolor TL-D Graphica /965

www.philips.com/lighting

2014, March 4
data subject to change

(http://download.p4c.philips.com/lfb/c/comf-2540/comf-2540_pss_en_aa_001.pdf, 25.05.2016; 15:45, http://download.p4c.philips.com)

APPENDIX-E

KONICA MINOLTA ILLUMINANCE METER T-10A

Model	IlluminanceMeter T-10A (Standard receptor head)	IlluminanceMeter T-10MA (Mini receptor head)	IlluminanceMeter T-10W$_s$A (Waterproof mini receptor head)	IlluminanceMeter T-10W$_L$A (Waterproof mini receptor head)
Type	Multi-function digital illuminance meter with detachable receptor head (Multi-point measurements of 2 to 30 points is possible)			
Illuminance meter class	Conforms to requirements for Class AA of JIS C 1609-1: 2006 “Illuminance meters Part 1: General measuring instruments” Conforms to DIN 5032 Part 7 Class B		Conforms to requirements for specialIlluminance meters of JIS C 1609-1: 2006[*1]	
Receptor	Silicon photocell			
Relative spectral response	Within 6% (f_1') of the CIE spectral luminous efficiency V (λ)			
Cosine response (f_2)	Within 3%		Within 10%	
Measuring range	Auto range (5 manual ranges at the time of analog output)			
Measuring function	Illuminance (lx). Illuminance difference (lx). Illuminance ratio (%). Integratedilluminance (lx·h). integration time (h). average illuminance (lx).			
Measuring range	Illuminance	0.01 to 299,900 lx; 0.001 to 29,990 fcd	1.00 to 299,900 lx; 0.1 to 29.990 fcd [*2]	

	Integrated illuminance	0.01 to 999,900 x 10^3 lx·h 0.001 to 99,990 x 10^{*3} fcd·h / 0.001 to 9999 h
User calibration function	CCF (Color Correction Factor) setting function: Measurement value x 0.500 to 2.000	
Linearity	±2% ±1 digit of displayed value	
Temperature/ humidity drift	Within ±3%	
Digital output	USB	
Analog output	1 mV/digit, 3 V at maximum reading; Output impedance: 10 K Ω; 90% response time: 28 ms	
Display	3 or 4 Significant-digit LCD with backlight illumination (Automatic illumination)	
Power source	2 AA-size batteries / AC adapter AC-A308 (optional; for 1 to 10 receptors) or AC adapter AC-A311 (optional; for 1 to 30 receptors)	
Battery life	72 hours or longer (when alkaline batteries are used) in continuous measurement	
Operating temperature/ humidity range	-10 to 40°C, relative humidity 85% or less (at 35°C) with no condensation	5 to 40°C, relative humidity of 85% or less (at 35°C) with no condensation
Storage temperature/ humidity range	-20 to 55°C, relative humidity 85% or less (at 35°C) with no condensation	0 to 55°C, relative humidity of 85% or less (at 35°C) with no condensation
Dimensions	69 x 174 x 35 mm	Main body : 69 x 161.5 x 30 mm Receptor: Ø16.5 x 13.8 mm

Cord length	-	1 m	5 m	10 m
Weight (without battery)	200 g (7.0 oz.)	205 g	260 g (Receptor head only: 120 g)	340 g (Receptor head only 200 g)

*1 Conforms to requirements for Class AA of JIS C 1609-1:2006 for all items except cosine response (f_2).

*2 Although measurements below 1.00 lx are possible, they may not be stable due to the effects of electrical noise.

<Notes regarding mini receptors and waterproof mini receptors>

(http://sensing.konicaminolta.asia/products/t-10a-illuminance-meter/, 20.05.2016; 10:00, http://sensing.konicaminolta.asia/)

APPENDIX F

ARTIPAN STANDARD PLASTERBOARD

ARTIPAN® Standard Plasterboard is composed of high purity reinforced of noncombustible gypsum core by the additives with the special surface cardboards at our high technology production line.

ADVANTAGES

*Through its special surface cardboards, it allows having a smooth surface and provide excellent base for ceramic and tile coating or prior to a variety of decorative applications by use of ATIŞKAN® Cement Based adhesive mortar.

*It minimizes problems arising from handling, application and use due to its high resistance,

*As a ‘breathable’ material, it balances the ambient humidity and helps formation of healthy environments.

*Besides being easy to prepare, apply and disassemble, it helps saving time and labor, permitting to pass the installation and insulation materials through the application cavities.

*Compared to the conventional wall applications, it considerably decreases the building wall loads and reduces the beam, column and slub sizes, thus minimizing the construction costs.

APPLICATION AREA

Partition walls, cladding walls and suspended ceilings.

APPLICATION CONDITIONS

*It should not be applied under conditions at 4^{o}C and below.

*The application should be made by auxiliary materials which should be in accordance with the standart.

SURFACE PREPARATION

The application surface should be made free of any dust, dirt, grease, paint and weak decoration products. If required, the application surface is fixed with Esfix Joint Filling Mortar.

WARNINGS AND PRECAUTIONS

*For partition wall applications, maximum framing spacing should be 60 cm. in dry condition. In case of wet area, high wall and load bearing application, the framing spacing should be reduced down to 30cm. Depending on the conditions, DC profile width should be increased.

*For ceiling applications, the profiles are connected to the board direction as a parallel, the framing spacing should be 40 cm., If the connection is vertical, It should be 50 cm.

APPLICATION RESTRICTIONS

*When high level sound and thermal insulation is required, it should be used together with proper insulation material. For ceiling application, you should use extra fastening components.

*Any damaged board and auxiliary materials should be renewed and application should not be made by any defective materials.

STORAGE CONDITIONS

In order that the plasterboards are not damaged, store them on a flat and clean floor also It will not contact directly with the ground and should be stored in areas that offer protection against adverse conditions (condensation, humidity, etc.)

TECHNICAL SPECIFICATIONS

Lenght	2000 - 3600 mm			
Width	1200 mm			
Thickness	9.5 mm	12.5 mm	15 mm	18 mm
Average Weight	≤ 7.5 kg/m²	≤ 9 kg/m²	≤ 11 kg/m²	≤ 13 kg/m²
Flexural Strenght	≥ 400 N	≥ 550 N	≥ 650 N	≥ 650 N
Flexural Strenght	≥ 160 N	≥ 210 N	≥ 250 N	≥ 250 N

Edge Type	İK (Tapered Edge) - KK (Square Edge)
Thermal Conductivity (λ)	0.23 W/mK
Fire Class	A2 - s1, d0 (according to TS EN 520)
Steam Passage Resistance Factor	10
Standard	TS EN 520

PACKAGING

Thickness	9.5 mm	12.5 mm	15 mm	18 mm
Number of boards in one palette	60 pc/palette	50 pc/palette	40 pc/palette	30 pc/palette

(http://www.atiskanalci.com/m/en/products/plaster-board_2/standard-plaster-board_10/bilgi, 04.05.2016; 19:30, http://www.atiskanalci.com)

APPENDIX G.

ASSESSMENT SHEET OF FIRST PILOT STUDY (IN TURKISH)

1. Cinsiyet: K☐ E☐

2. Yaş:

3. Bölüm:

4. Herhangibi bir görme bozukluğunuz var mı? Varsa açıklayınız lütfen

____

5. Göz bozukluğunuzu gidermek için herhangibi bir ekipman (gözlük, lens vb.) kullanıyor musunuz? Cevabınız 'evet' se şuanda kullanıyor musunuz?

____

6. Renk Görme Kusuru (Ishara Renk Körlüğü Testi)

7.Görmekte olduğunuz malzeme ne kadar sıcak?

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak) [KIRMIZI]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak) [YEŞİL]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak) [KIRMIZI/YEŞİL]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak) [YEŞİL/KIRMIZI]

8. Görmekte olduğunuz malzeme ne kadar enerjik?

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5 6☐ 7☐ (çok sıcak) [KIRMIZI]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7 (çok sıcak) [YEŞİL]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6 7☐ (çok sıcak) [KIRMIZI/YEŞİL]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6 7☐ (çok sıcak) [YEŞİL/KIRMIZI]

9. Görmekte olduğunuz malzeme ne kadar içten/samimi?

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak) [KIRMIZI]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak) [YEŞİL]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak) [KIRMIZI/YEŞİL]

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak) [YEŞİL/KIRMIZI]

APPENDIX H.

ASSESSMENT SHEET OF SECOND PILOT STUDY (IN TURKISH)

Genel Bilgiler:

1. Cinsiyet: K☐ E ☐

2. Yaş:

3. Bölüm:

4. E-mail:

5. Herhangibi bir görme bozukluğunuz var mı? Varsa açıklayınız lütfen

____

6. Göz bozukluğunuzu gidermek için herhangibi bir ekipman (gözlük, lens vb.) kullanıyor musunuz? Cevabınız 'evet' se şuanda kullanıyor musunuz?

____

7. Renk Görme Kusuru (Ishara Renk Körlüğü Testi)

Var ___ Yok ___

8.Görmekte olduğunuz malzeme ne kadar sıcak?

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak)

9. Görmekte olduğunuz malzeme ne kadar enerjik?

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak)

10. Görmekte olduğunuz malzeme ne kadar içten/samimi?

(çok soğuk) 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ (çok sıcak)

APPENDIX I.

ASSESSMENT SHEET OF SECOND PILOT STUDY (IN ENGLISH)

General 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 deficiency? If your answer is yes, please define it;

---

2. Do you have any correction equipment (contact lenses etc.) for any eye or vision deficiency you have? If your answer is yes, please explain and indicate if you are using it during the experiment.

---

3. Ishihara's Test for Colour Blindness
Has ____ Has **Not** ___

Subjective Assessment:

1. How warm do you find this material/colour?
(very cold)1__ / 2__ /3 __ /4 __ / 5__ / 6__ / 7__ / 8 __ / 9 __ / 10___ (very warm)

2. How physically warm do you find this material/colour?
(very cold)1__ / 2__ /3 __ /4 __ / 5__ / 6__ / 7__ / 8 __ / 9 __ / 10___ (very warm)

3. How energetic do you find this material/colour?

(very cold)1__ / 2__ /3 __ /4 __ / 5__ / 6__ / 7__ / 8 __ / 9 __ / 10___ (very warm)

4. How intimate do you find this material/colour?
(very cold)1__ / 2__ /3 __ /4 __ / 5__ / 6__ / 7__ / 8 __ / 9 __ / 10___ (very warm)

APPENDIX J

INFORMATION SHEET (IN ENGLISH)

Queen's University Belfast

Begüm Ulusoy
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.../11/13

Title: Perception of Interiors in Association with Colour Pairs

What is the purpose of the study?

The study is part of a PhD study that is exploring the ways in which colour pairs affect the perception of interior spaces.

Why have I been chosen to take part?

The study is seeking to explore the views of a wide range of participants and we are targeting undergraduate and post-graduate students in SPACE.

Do I have to give consent to take part?

Yes, your consent is needed for taking part of the study and it is important for you to understand what the study entails.

What will I be asked to do?

You will be asked to give some very basic personal information and to then complete a questionnaire that records your perception about different pairs of colours represented in studio models.

What are the possible disadvantages to my taking part?

It is not anticipated that there are any disadvantages in taking part in the study.

What are the possible benefits?

It is anticipated that the research will contribute to a better understanding of how to colour pairs can affect the perception of user in interior spaces. The results of the survey in QUB will be compared with the results of the same study at Bilkent University, Turkey. It is anticipated that this comparison will reveal the relationship of cultural differences and perception of interiors.

If you would like to receive the results of the survey, please indicate on the consent form and leave your e-mail address.

Will my participation be kept confidential?

Yes, all responses to the interviews will be kept anonymous. Any responses used in the publication of research will not be made directly attributable to you.

What will happen to the results of the study?

The results will constitute a cross-cultural study with the same setting with Turkish participants. It will be published as a doctorate thesis in Bilkent University and potentially in peer-reviewed articles.

Who is organising and funding the study?

This research is being undertaken as part of an IAED, Bilkent University PhD studentship and has been organised through the School of Planning, Architecture, and Civil Engineering (SPACE) of Queen's University Belfast.

Who has reviewed the study?

Associate Professor Doctor Nilgün Olguntürk (Acting Chair), Department of Interior Architecture and Environmental Design (IAED), Bilkent University

What if there is a problem?

In the first instance please contact the researcher's host supervisor Prof.. Geraint Ellis who may be contacted at: g.ellis@qub.ac.uk or 028 9097 4370.

Thank you for taking time to read this information leaflet.

APPENDIX K

CONSENT FORM SHEET (IN ENGLISH)

Queen's University Belfast

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.../11/13

CONSENT FORM

Title of Project: Perception of Interiors in Association with Colour Pairs

Name of Researcher(s): Begum Ulusoy

Supervisor Details:
Prof. Geraint Ellis – SPACE, QUB.
g.ellis@qub.ac.uk *(Main Supervisor)*

Please Tick Box

1. I confirm that I have read and understand the information sheet dated ...., November, 2013; for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. ☐

3. I agree to take part in the above study. ☐

*If you would like to have a report of the results, please write your e-mail here:

____

Name of Participant	Date	Signature
Name of Person Taking consent	Date	Signature

APPENDIX L:

RESULTS OF 'PHYSICAL WARM' SEMANTIC SCALE QUESTION

Table L1. Red and white pair and their statistical relations

Median	Red Model	White Model	Red-White Model	White-Red Model
Physical Warmth	5.75	2.06	3.72	3.84

	Red vs White	Red vs Red+White	Red vs White+Red	White vs Red+White	White vs White+Red	Red+White vs White+Red
Physical Warmth	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	**Rejected (,000)**	Null (,516)

Table L2. Red and green pair and their statistical relations

Median	Red Model	Green Model	Red+Green Model	Green+Red Model
Physical Warmth	5.50	3.38	4.31	4.59

	Red vs Green	Red vs Red+Green	Red vs Green+Red	Green vs Red+Green	Green vs Green+Red	Red+Green vs Green+Red
Physical Warmth	**Rejected (,000)**	**Rejected (,001)**	**Rejected (,001)**	**Rejected (,019)**	**Rejected (,001)**	Null (,478)

Table L3. White and green pair and their statistical relations

Median	White Model	Green Model	White+Green Model	Green+White Model
Physical Warmth	2.41	3.97	3.28	3.38

	White vs Green	White vs White+Green	White vs Green+White	Green vs White+Green	Green vs Green+White	White+Green vs Green+White
Physical Warmth	**Rejected (,001)**	**Rejected (,006)**	**Rejected (,030)**	**Rejected (,009)**	**Rejected (,024)**	Null (,750)

Table L4. Colour pairs and their statistical relations

	Red White Pair	Red Green Pair	White Green Pair
Physical Warmth	3.78	4.45	3.32

	Red White vs Red Green	Red White vs White Green	White Green vs Red Green
Physical Warmth	**Rejected (,006)**	Null (,088)	**Rejected (,000)**

Table L5. Fabric and timber pair and their statistical relations

Median	Fabric Model	Timber Model	Fabric+Timber Model	Timber+Fabric Model
Physical Warmth	4.75	4.72	4.63	5.09

	Fabric vs Timber	Fabric vs Fabric+ Timber	Fabric vs Timber+ Fabric	Timber vs Fabric+Timber	Timber vs Timber+Fabric	Fabric+Timber vs Timber+Fabric
Physical Warmth	Null (,830)	Null (,481)	Null (,110)	Null (,680)	Null (,115)	Null (,053)

Table L6. Fabric and plasterboard pair and their statistical relations

Median	Fabric Model	Plasterboard Model	Fabric-Plasterboard Model	Plasterboard-Fabric Model
Physical Warmth	5.06	4.22	4.91	4.81

	Fabric vs Plasterboard	Fabric vs Fabric+ Plasterboard	Fabric vs Plasterboard+ Fabric	Plasterboard vs Fabric+ Plasterboard	Plasterboard vs Plasterboard+ Fabric	Fabric+ Plasterboard vs Plasterboard+ Fabric
Physical Warmth	**Rejected (,025)**	Null (,704)	Null (,349)	**Rejected (,026)**	**Rejected (,023)**	Null (,632)

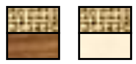
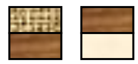
Table L7. Timber and plasterboard pair and their statistical relations

Median	Timber Model	Plasterboard Model	Timber+Plasterboard Model	Plasterboard+Timber Model
Physical Warmth	5.63	4.00	4.66	4.94

	Timber vs Plasterboard	Timber vs Timber+ Plasterboard	Timber vs Plasterboard+ Timber	Plasterboard vs Timber+ Plasterboard	Plasterboard vs Plasterboard+ Timber	Timber+Plasterboard vs Plasterboard+Timber
Physical Warmth	**Rejected (,000)**	**Rejected (,005)**	**Rejected (,012)**	**Rejected (,044)**	**Rejected (,020)**	Null (,464)

Table L8. Material pairs and their statistical relations

	Fabric-Timber Pair 	Fabric-Plasterboard Pair 	Timber Plasterboard Pair 
Physical Warmth	4,85	4,85	4,79

	Fabric Timber vs Fabric Plasterboard 	Fabric Timber vs Timber Plasterboard 	Timber Plasterboard vs Fabric Plasterboard 
Physical Warmth	Null (,992)	Null (,671)	Null (,858)

Physical Warmth	**Red > Red + White=White + Red > White**
	Red > Red + Green = Green + Red > Green
	White < White + Green = Green + White < Green
	Red-White < Red-Green, Red-White = White-Green, **Red-Green > White-Green**
	Fabric = Timber, Fabric = Fabric + Timber, Fabric = Timber + Fabric, Timber = Fabric + Timber, Timber = Timber + Fabric, Fabric + Timber = Timber + Fabric
	Fabric > Plasterboard, Fabric = Fabric + Plasterboard, Fabric = Plasterboard + Fabric, **Plasterboard < Fabric + Plasterboard, Plasterboard < Plasterboard + Fabric**, Fabric + Plasterboard = Plasterboard + Fabric
	Timber >Plasterboard, Timber > Timber + Plasterboard, Timber >Plasterboard + Timber, Plasterboard < Timber + Plasterboard, Plasterboard < Plasterboard + Timber, Timber + Plasterboard = Plasterboard + Timber

APPENDIX M

POST TESTS

In order to clarify the accuracy of the methodology and investigate different perspectives two different post tests were conducted. Firstly 30 students participated the experiment in the same way with 192 participants in the main experiment. Answers of these new 30 participants were used to compare with two different post-tests in order to check the accuracy of the main experiment. Then another 10 students attended the same experiment with a human figure for first post-test. Finally, another 30 students got the experiment under virtual conditions for the second post-test. 70 students attended for 3 sets of experiment for post-tests (10 students for first post-test, 30 students for second post-test and 30 students in order to compare the post-tests). Only red fabric model was used for these post-tests, and experimental conditions were kept the same with the main experiment. Both post tests were conducted with 10 participants for initial analysis. Initial analysis of the post-test 1 (human figure) was significant, however, second post-test (virtual representation) required further investigation in order to clarify its initial results, therefore, 20 more participants attended.

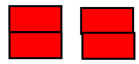
Post-test-1: Human Figure

The main aim of first post-test was to clarify whether a human figure in the model could change the results. Human-figure, its dimensions and its posture were chosen from Neufert's human model (Neufert, 1998: 28). To eliminate any location effect, the human figure was placed both right and left sides of the model. It was placed at the right side of the model for five participants and left side of the model for the other five participants, totalling to 10 participants (see Figure M1). Except the human figure, all conditions were the same for both experimental settings.

Figure M1. Human figure at left and right sides of red fabric model.

Wilcoxon Single Rank Test was used to analyse the results (see Table M1). Results indicate that there is not any difference between the results of the main experiments and the post-test (with human-figure) and demonstrated that the human figure does not affect the perception of the participants. The result of the post-test might be beneficial for future studies, whether to recruit human figures in controlled modelled conditions.

Table M1. Results in terms of warmth, energetic and intimacy (Wilcoxon Test Results)

	With human-figure versus without human-figure 
Warm	Null (,726)
Energetic	Null (,573)
Intimate	Null (,180)

Post-test-2: Virtual

Second post-test was conducted to investigate the opportunities of virtual representation. For that investigation the same red fabric model was used. Due to low quality of computer aided virtual representations, a new method was used at the post-test. Red fabric model was scanned by HP Officejet 7500-A Wide Format and this jpeg file was reflected to the white wall with Sony Data Projector (Model No: VPL-EX 100) to provide accurate colours. Its dimensions and distance was calibrated in order to ensure the same proportions with the main experiment (see Figure M2). 30 participants assessed the virtual representation of the red fabric model with the same questionnaire.

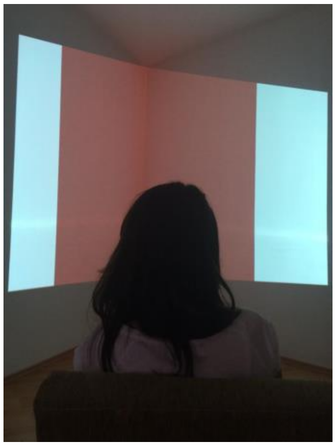


Figure M2. Virtual test conditions.

Wilcoxon Single Rank Test was used to analyse the results (see Table M2.). Results of ‘warm’ and ‘intimate’ indicated that there was not any difference between the two experimental conditions. However, for the semantic scale results of ‘energetic’, virtual representation could not affect the participants as a real colour and material did. These results demonstrate that this virtual representation method may be replaced with real materials and colours, however, it cannot be recommended for all semantic scales.

Table M2. Results in terms of warmth, energetic and intimacy (Wilcoxon Test Results)

	Virtual Representation versus Real Colour and Material
Warm	Null (,054)
Energetic	**Rejected** (,012)
Intimate	Null (,544)

APPENDIX N

NUMBER OF PARTICIPANT

Table N1. Number of participants, for each model, who assessed the models as the first one.

Material Models	Participants	Colour Models	Participants
Fabric	18	Red	18
Timber	17	Green	16
Plasterboard	16	White	16
Fabric+Timber	15	Red+White	15
Fabric+Plasterboard	15	Red+Green	15
Timber+Plasterboard	15	Green+White	16