VISUAL ATTRIBUTES OF PRODUCTS AS THE FACTORS INFLUENCING USERS' EMOTIONAL REACTIONS: A STUDY ON DENTAL INSTRUMENTS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

KIVILCIM ÇINAR OKUŞLUĞ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
INDUSTRIAL DESIGN

FEBRUARY 2014

Approval of the thesis:

VISUAL ATTRIBUTES OF PRODUCTS AS THE FACTORS INFLUENCING USERS' EMOTIONAL REACTIONS: A STUDY ON DENTAL INSTRUMENTS

submitted by **KIVILCIM ÇINAR OKUŞLUĞ** in partial fulfillment of the requirements for the degree of **Master of Science in Industrial Design Department, Middle East Technical University** by**,**

Prof. Dr. Canan Özgen _____
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Gülay Hasdoğan _____
Head of Department, **Industrial Design**

Dr. Canan E. Ünlü _____
Supervisor, **Industrial Design Dept., METU**

Examining Committee members:

Assoc. Prof. Dr. Bahar Şener-Pedgley _____
Industrial Design Dept., METU

Dr. Canan E. Ünlü _____
Industrial Design Dept., METU

Dr. Dalsu Özgen Koçyıldırım _____
Industrial Design Dept., METU

Assist. Prof. Dr. Aydın Öztoprak _____
Industrial Design Dept., TOBB

M.S. Evren Akar, _____
User Experience Specialist, UTRLAB

Date: 06.02.2014

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: Kıvılcım ÇINAR OKUŞLUĞ

Signature :

ABSTRACT

VISUAL ATTRIBUTES OF PRODUCTS AS THE FACTORS INFLUENCING USERS' EMOTIONAL REACTIONS: A STUDY ON DENTAL INSTRUMENTS

ÇINAR OKUŞLUĞ, Kıvılcım

M. Sc., Department of Industrial Design

Supervisor: Dr. Canan E. ÜNLÜ

February 2014, 195 pages

Despite the technological advances in the field of dentistry, it is asserted that the instruments that are used in treatments may be one of the reasons of negative emotions that are still effective on dental patients. However, studies that investigate how dental instruments trigger emotions of patients are so scarce. In this study that aims to overcome this deficiency, it is tried to show relationship between product appearance and individual's emotional response on dental instruments. This thesis dwells on patients' emotions towards appearance of dental instruments and which product visual attributes trigger these emotions. As the relationship between individual's emotional responses and product appearance is defined for different product categories with various studies, in this study, similar relationships are investigated by conducting questionnaires and interviews. According to the results of the data analysis, the appearance of dental instruments create negative emotions such as fear, worry and anxiety, and these negative emotions can be decreased with certain changes on the design of dental instruments.

Keywords: dental instruments, medical device design, emotion in medical design, negative emotions

ÖZ

KULLANICILARIN DUYGUSAL TEPKİLERİNİ ETKİLEYEN FAKTÖRLER OLARAK ÜRÜNLERİN GÖRSEL NİTELİKLERİ: DİŞÇİLİK ALETLERİ ÜZERİNE BİR ÇALIŞMA

ÇINAR OKUŞLUĞ, Kıvılcım

Yüksek Lisans, Endüstri Ürünleri Tasarımı Bölümü

Tez Yöneticisi: Dr. Canan E. ÜNLÜ

Şubat 2014, 195 sayfa

Diş hekimliği alanındaki teknolojik gelişmelere rağmen hastalar üzerinde hala etkili olan olumsuz duyguların nedenlerinden birinin tedavilerde kullanılan aletler olabileceği ileri sürülmektedir. Ancak bu aletlerin hastalardaki olumsuz duyguları nasıl tetiklediğini araştıran çalışma sayısı çok azdır. Sözü edilen eksikliğin giderilmesine katkı sağlamak amacıyla yapılan bu çalışmada, diş hekimliği aletlerinin görünüşleri ile kişilerin duygusal tepkileri arasındaki ilişki ortaya çıkarılmaya çalışılmıştır. Hastaların diş hekimliği aletlerinin görünüşlerine yönelik duyguları ve hangi ürün biçim özelliklerinin bu duyguları tetiklediği bu çalışmanın temelini oluşturmaktadır. Ürün görünüşü ve kişilerin duygusal tepkileri arasındaki ilişki farklı ürün kategorileri üzerine çeşitli çalışmalarla belirlendiğinden, bu çalışmada da benzer ilişkiler anketler ve görüşmelerle araştırılmıştır. Yapılan analizler, diş hekimliği aletlerinin görünüşlerinin kişilerde korku, sıkıntı ve endişe gibi olumsuz duygular oluşturduğunu ve bu aletlerin tasarımında yapılacak belirli değişiklikler ile olumsuz duyguların azaltılabileceğini göstermiştir.

Anahtar kelimeler: diş hekimliği aletleri, medikal cihaz tasarımı, medikal tasarımda duygu, olumsuz duygular

To my endless love…

ACKNOWLEDGEMENTS

First and foremost, I would like to express my deepest gratitude to my supervisor Dr. Canan E. Ünlü for her guidance, advice and encouragement throughout this thesis.

I would like to thank to Assoc. Prof. Dr. Çiğdem Erbuğ and Aykut Coşkun for their patience in providing feedback on early studies of this work by commenting, criticizing, and contributing ideas.

I would like to express my special thanks to my dentists relatives Yavuz & Duygu Çınar, Nilay Şeniz & Sencer Seçer and Yılmaz Çınar; my dentist friends Duygu Karasan and Miray Taştankaya. I would not have been able to accomplish this task without their invaluable contributions. I also gratefully thank all of my 240 participants for their participation and contribution.

This thesis would not have been possible without the great support of my company so I gratefully acknowledge ASELSAN Inc. I am greatly indebted to my design leader İsmail Güler and manager Mustafa Murat Karasan for their high patience and support for the entire thesis study.

I am thankful to my sweetest friends Ceren Batmaz Sarı, İrem Çakır, Şerife Yıldırımer, Duygu Ürün Çınar and Merve Aydın for their friendship and motivation all the time. I also thank to the rest of my friends, Cüneyt Yılmazer, Süha Doruk Kadıoğlu, Okan Çınar, Selçuk Öksüz, Koray Taştankaya, Korgün Karakuzu for the good times they provided me throughout this thesis.

I want to thank to my parents and to my family for their endless encouragement and motivation. It is never enough how much I thank my dearest mom, Fatma Ünlü Çınar; my dad, Ömer Çınar; my brother, Arif Çınar. Their love and support throughout the study will stay with me forever. Also I would like to thank to all my extended family for their support throughout the thesis.

I would like to express my warmest thanks and love to my husband, Ali Okuşluğ for his endless support and encouragement. I wish to live with him forever.

Finally, I would like to give my deepest gratitude to Mustafa Kemal ATATÜRK for inspiring my studies and me with his immortal idea.

TABLE OF CONTENTS

ABSTRACT v
ÖZ vi
ACKNOWLEDGEMENTS viii
TABLE OF CONTENTS ix
LIST OF TABLES xiii
LIST OF FIGURES xv
LIST OF ABBREVIATIONS xviii
CHAPTERS
1. INTRODUCTION 1
1.1 Background 1
1.2 Scope of the Study 3
1.3 Structure of the Thesis 4
2. LITERATURE REVIEW 5
2.1 Negative Emotions in Dentistry 6
2.1.1 Emotions in Dentistry 6
2.1.2 What are Dental Fear, Phobia and Anxiety? 7
2.1.3 Studies Related to Dental Fear 7
2.1.4 Instruments to Measure Fear of Dental Treatment 9
2.1.5 Reasons of Dental Fear 11
2.1.6 Dental Fear Management Techniques 12
2.1.6.1 Pharmacological Interventions 13
2.1.6.2 Dentists' Techniques to Make Patients Calm 13
2.1.6.3 Patients' Techniques to Calm 14
2.1.6.4 Arrangements of Environmental Factors 15
2.2 Dental Treatments and Instruments 16
2.2.1 Basic Examination and Anesthetic Instruments 17
2.2.2 Restorative Instruments 19
2.2.3 Surgical Instruments 20

2.2.4 Periodontics Instruments 21
2.2.5 Endodontic Instruments 22
2.2.6 Prosthodontic Instruments 22
2.3 Medical Area 23
2.3.1 What is Medical Device? 24
2.3.2 General Requirements for Medical Hand Tool Designs 25
2.3.3 Factors Influencing Medical Device Design 28
2.3.3.1 Functionality 29
2.3.3.2 Ergonomics 29
2.3.3.3 Technological Development 31
2.3.3.4 Aesthetic Appeal 32
2.3.3.5 Universal Design 35
2.3.3.6 Design for Emotion 36
2.3.4 Design for Emotion in Medical Area 37
2.4 Product Appearance 44
2.4.1 User Response to Product Appearance 45
2.4.1.1 Cognitive Response 48
2.4.1.2 Affective Response 49
2.4.1.3 Behavioral Response 49
2.4.2 Research Studies on Product Visual Attributes and User Responses 49
2.5 Emotion in Product Design 58
2.5.1 Approaches to Product Emotion 59
2.5.1.1 Pleasure Based Approach to Product Emotion 59
2.5.1.2 Process-Level Approach to Product Emotion 61
2.5.1.3 Appraisal Approach to Product Emotion 61
2.5.2 Measuring Emotions 64
2.5.2.1 Objective Measures of Emotion 65
2.5.2.2 Subjective Measures of Emotion 66
3. METHODOLOGY 75
3.1 Objective of the Study 75
3.2 Preliminary Study I 77

3.2.1 Material Selection Study for the Preliminary Study I 77
3.2.1.1 Sample 78
3.2.1.2 Method 79
3.2.1.3 Results 79
3.2.2 Data Collection Tool 80
3.2.3 Sample 81
3.2.4 Analysis and Results 82
3.2.4.1 Quantitative Data 83
3.2.4.2 Qualitative Data 84
3.2.4.2.1 Product Properties and Related Qualities 85
3.2.4.2.2 The Relation between Related Quality of Product Properties and Emotion 95
3.2.5 Conclusions and Discussion 97
3.2.6 Evaluation of the Preliminary Study I 98
3.3 Preliminary Study II 99
3.3.1 Material Selection Study for the Preliminary Study II 100
3.3.1.1 Sample 100
3.3.1.2 Method 101
3.3.1.3 Results 101
3.3.2 Data Collection Tool 104
3.3.3 Sample 105
3.3.4 Analysis and Results 105
3.3.5 Conclusions and Discussion 110
3.3.6 Evaluation of the Preliminary Study II 112
4. MAIN STUDY 113
4.1 Method 113
4.1.1 Selection of the Study Material for the Main Study 113
4.1.2 Data Collection Tool 115
4.2 Sample 117
4.3 Results and Analysis 118
4.3.1 Injector 118

4.3.2 Forceps 124
4.3.3 Drill 131
4.4 Conclusion and Discussion 137
5. CONCLUSION 139
5.1 State of the Literature 139
5.2 Research Questions Revisited 140
5.3 Recommendations for Designers 145
5.4 Limitations of the Study 148
5.5 Recommendations for Further Studies 149
REFERENCES 151
APPENDICES
A. Material Selection Study of the Preliminary Study I-Interview Schedule 163
B. Questionnaire of the Preliminary Study I 165
C. Example of a Data Analysis Document of the Preliminary Study I 171
D. Comparison Results for the Instruments in Preliminary Study I 173
E. Material Selection Study of the Preliminary Study II-Interview Schedule 175
F. Questionnaire of the Preliminary Study II 177
G. SPSS Analysis Results 187
H. Interview Schedule of the Main Study 191
I. A Sample Data Analysis Sheet of the Main Study 195

LIST OF TABLES

TABLES

Table 3-1 Profiles of the Participants_ Material Selection Study for the Preliminary Study I 78
Table 3-2 Selected Dental Instruments and Related Dental Treatments 80
Table 3-3 Data Analysis Procedure Example 82
Table 3-4 The Percentages of Positive and Negative Emotions for Instruments' Product Properties 86
Table 3-5 Significance of Product Visual Attributes for Injector Designs 88
Table 3-6 Significance of Product Visual Attributes for Drill Designs 89
Table 3-7 Significance of Product Visual Attributes for Forceps Designs 90
Table 3-8 Significance of Product Visual Attributes for Elevator Designs 90
Table 3-9 Participants' Descriptions of Product Related Qualities of Product Properties 91
Table 3-10 Profiles of the Participants _Material Selection Study for the Preliminary Study II 100
Table 3-11 Dental Instruments and Related Treatments 102
Table 3-12 Participants' Emotions Towards Dental Treatments _the Preliminary Study II 106
Table 3-13 Percentages of the Participants According to Seeing the Instruments .. 107
Table 3-14 Participants' Positive, Negative and Neutral Emotions Towards Dental Instruments 108
Table 3-15 Results of Spearman Correlation Analysis between Instruments' Possibility to be Seen and Participants' Emotions 110
Table 4-1 General Characteristics of the Participants 117
Table 4-2 Number of Participants' Statements Towards Injector's Product Visual Attributes 120
Table 4-3 Number of Participants' Statements Towards Forceps' Product Visual Attributes 126

Table 4-4 Number of Participants' Statements Towards Drill's Product Visual Attributes 132
Table D-1 Significance of Product Visual Attributes for the Instruments Given in the Preliminary Study I..... 173
Table G-1 Results of Spearman Correlation Analysis between Instruments' Possibility to be Seen and Participants' Emotions 187
Table G-2 Results of Spearman Correlation Analysis between Number of Dental Treatments and Participants' Emotions 188
Table G-3 Results of Spearman Correlation Analysis between Gender of Participants and Participants' Emotions 189

LIST OF FIGURES

FIGURES

Figure 2-1 Parts of Dental Instruments 17
Figure 2-2 Basic Examination and Anesthetic Instruments 18
Figure 2-3 Restorative Instruments 19
Figure 2-4 Surgical Instruments 20
Figure 2-5 Periodontics Instruments 21
Figure 2-6 Endodontic Instruments 22
Figure 2-7 Prosthodontic Instruments 23
Figure 2-8 Contextual Factors Affect the Medical Hand Tool Design 26
Figure 2-9 The Ratings Towards Factors Related to Dental Instrument Design 31
Figure 2-10 Birmingham Hip Resurfacing 32
Figure 2-11 The Somatom Sensation 33
Figure 2-12 Scanadu Scout- A Medical Tricorder 34
Figure 2-13 Aira- auto Injector 35
Figure 2-14 Hierarchy of Consumer Needs 38
Figure 2-15 Butterfly Needle 39
Figure 2-16 Life Science Category – Sonny 39
Figure 2-17 Dolphin Project - Kolding School of Design 2007 40
Figure 2-18 Dino Chair 41
Figure 2-19 Accupal 42
Figure 2-20 The DentalVibe 42
Figure 2-21 Zen Cordless Prophy, Dental Drill 43
Figure 2-22 Basic Model of Communication 45
Figure 2-23 Basic Framework for Design as a Process of Communication 46
Figure 2-24 A Model of Consumer Responses to Product Form 47
Figure 2-25 Framework for Design - Process of Communication 48
Figure 2-26 Averaged Values for Design Factors and Design Factor Levels 51

Figure 2-27 A List of Shape Features, Levels and Characteristics of Hsiao & Chen's Study 52
Figure 2-28 Coding of the Data from Questionnaire of Chungs & Wu's Study 54
Figure 2-29 The Kansei Hierarchy of Visual Comfort Appreciation of Digital Camera Design 55
Figure 2-30 The Matrix Map Method 57
Figure 2-31 Basic Model of Emotional Response 62
Figure 2-32 Geneva Emotion Wheel 68
Figure 2-33 An Example of Product Personality Profiling Form 69
Figure 2-34 Visual Product Evaluation Fill-out Form 71
Figure 2-35 Approach to the Measurement of Emotion – Self-Confrontation Method 72
Figure 3-1 Diagram-Presentation of Methodology 76
Figure 3-2 Desmet's PrEMO Product Emotion Measurement Tool Characters 81
Figure 3-3 The Percentages of Participants' Emotions towards Dental Instruments Presented in the Preliminary Study I 83
Figure 3-4 The Distribution of Positive and Negative Emotions Selected by the Participants 84
Figure 3-5 Number of Statements Related to Product Properties. 85
Figure 3-6 Number of Statements Made by Participants to Related Qualities of Product Properties 92
Figure 3-7 The Relation Between Product Visual Attributes and Related Qualities . 93
Figure 3-8 Number of Statements Related to Participants' Feelings towards Dental Instruments Presented in the Preliminary Study I 95
Figure 3-9 The Relation Between Prominent Feelings and Related Qualities of Dental Instruments' Product Properties 96
Figure 3-10 Number of Participants Who Feel Negative Towards Dental Treatments 106
Figure 4-1 The Instruments that Create more Negative Emotions for Each Item in the Preliminary Study I 114
Figure 4-2 The Selected Instruments for the Main Study 115

Figure 4-3 Participants' Feelings Towards Injector 119
Figure 4-4 Participants' Feelings Towards Forceps 124
Figure 4-5 Participants' Feelings towards Drill 131
Figure 5-1 Diagram-Presentation of Research Studies 144
Figure C-1 Excel Sheet of Data Analysis of the Preliminary Study I 171
Figure I-1 Coding Example Sheet for the Main Study 195

LIST OF ABBREVIATIONS

DAS	Dental Anxiety Scale
MDAS	Modified Dental Anxiety Scale
DFS	Dental Fear Survey
DAI	Dental Anxiety Inventory
DBS	Dental Belief Survey
G'sDFS	Gatchel's Dental Fear Scale
FDA	Food and Drug Administration

CHAPTER 1

INTRODUCTION

1.1 Background

> *Lately, I have been to dentist for my wisdom teeth. I have known that my wisdom teeth would be extracted. I had also been to a dentist for tooth extraction before. I have never guessed that the appearance of tooth extraction instrument would look like hand instruments that are used for repairs at home. Before the tooth extraction, dentist injected liquid medicine to anesthetize. I have known that I would not feel pain. However, the appearance of the instrument made me feel uncomfortable. I feared that this pliers shaped instrument which had long handle could destroy my teeth instead of extract it. I knew that I would not feel much pain but I could not find words to describe my feeling when I saw the extraction instrument (Participant 8 of the Main Study)*

Dental fear is one of the most common fears and undoubtedly is experienced by many people. Dental fear prevents patients going to dentist, which result in deterioration of oral health. There have been many studies to understand reasons of dental fear and prevent it (Toet et al., 2010; Cientifica et al., 2011; Foreman, 1988). However, there is still not a clear solution for this fear. The studies that are focusing on fear factor and dental anxiety and the reasons of this emotion are mostly defined with bad experience, distrust to dentist and dental procedure. Along similar lines, Serra-Negra et al. (2011) argue that the reason of dental fear or negative emotions may also be related with the appearance of dental instruments, even though it is not scientifically investigated (Serra-Negra et al., 2011).

Although user's demand for emotional products has increased and designers concentrate on emotion in product design apart from functionality and ergonomics of

products, in the medical devices design field, the situation is slightly different. Generally, medical devices are used in critical situations, and their efficiency, the flexibility and safety handling are significant for the nurses, physicians and other users to carry out their works (Doerr et al., 2008). On the other hand, there are products like blood pressure monitor and insulin injector that are used by patients as well as the physicians and nurses. Since the patients are not regarded as direct users in many clinics, many medical devices and instruments are designed without taking patients' emotions into consideration. In the dentistry field, patients are not direct users of dental instruments. Thus, the dental instruments are designed by considering especially the dentists' needs and the factors such as long instrument life and ease of use whereas the emotion of patients are not considered (Lowe, 2010). As technology advances, dental instruments have improved, and latest anesthesia techniques and equipment lessen pain in patients during dental treatments. Although dentists give patients opportunity to have painless treatment, dental fear has not decreased. Moreover, the dental fear is still taking effect nowadays and it is observed that technological advances in dental instruments do not seem to have noticeable effect in reducing dental fear (Smith & Heaton, 2003 in Klages et al., 2008).

Visual sense plays an important role at the interaction between product and users. It is impossible to deny the effects of the product's appearance on user's emotions since the emotion can be evoked by product's appearance. In the same way, the appearance of dental instruments may have influence on patient's emotions.

Positive and negative emotions are elicited by appearances of products. Users evaluate visual attributes of product at first sight, and the visual unity of a product consists of color, texture, material, form, and proportion (Bloch, 1995). The visual appearance of the product gives clues on how the product can be used. Moreover, the appearance of products incorporates different values; aesthetic, symbolic, functional and ergonomic. Actually product appearance provides an overall impression to users. Product visual attributes are communicative and meaningful; thus products create different moods and emotions on users (Gotzsch, 2006). As product appearance

results in emotional responses of users, in this thesis, the focus of interest is on product visual attributes influencing the emotional reactions of the patients to the dental instruments.

1.2 Scope of the Study

This study investigates the emotional reactions of the patients to the dental instruments and explores which product visual attributes and related qualities trigger these emotions. The aim of this study is to define product visual attributes influencing positive and negative emotions of patients and to support industrial designers with suggestions on patients' emotions towards dental instruments' qualities. As the literature lacks comprehensive studies on the relation between patients' emotions and product visual attributes of dental instruments, it is thought that a research study would contribute to the related literature.

So, the main research question of this thesis study is as follows:

- What are the influences of product visual attributes on the emotional reactions of the patients to the dental instruments?

To be able to answer the main research question, some additional questions should be addressed. It is vital for the study to analyze dental fear, dental instrument design, and design for emotion in dentistry field and product appearance. Therefore, this study also aims to find answers for the following sub-questions:

- What is dental fear and what are the reasons of dental fear?
- Which methods are applied to decrease dental fear?
- What are general design requirements of medical hand tools?
- Which factors are taken into consideration in the process of medical device design?
- To what extent emotions are taken into consideration in the process of medical device design?

- Is there a relationship between seeing the dental instruments in the previous dental treatments and patients' negative feelings?
- How might the dental instrument's product visual attributes be to decrease the negative emotions of patients?

1.3 Structure of the Thesis

The thesis contains five chapters. It starts with an introduction chapter presenting the background and the aim of the study and research questions. In the second chapter, the findings of the literature review study are presented. As the thesis investigates the emotional reactions of the patients to the dental instruments and explores which product visual attributes and related qualities trigger these emotions, the second chapter includes sections devoted for the topics of effective negative emotions in dentistry, factors influencing the medical device design and lastly product appearance and product emotions.

In the third chapter, two preliminary studies are presented. The first preliminary study focuses on the emotional reactions of the patients to the dental instruments and explores which product visual attributes and related qualities trigger these emotions. The second preliminary study tries to find out if there is a relationship between seeing the instruments in the previous dental treatments and feeling negative.

In the fourth chapter, the Main Study, which is shaped by the findings of the two preliminary studies, is revealed.

Finally, the fifth chapter presents a brief summary of the thesis and the findings of the two preliminary studies and the Main Study. The thesis is concluded with recommendations for dental instrument designers, and suggestions for further research.

CHAPTER 2

LITERATURE REVIEW

This literature review study benefits from different sources such as; literature related with the dental instruments for the analysis of patients' emotions towards these instruments; literature on the medical device design and user's emotion in medical area; and the literature about the product emotions and product appearance. A variety of keywords including; emotions in dentistry, dental fear, reasons of dental fear, measurement methods of dental fear, dental fear management techniques, dental treatments and dental instruments, medical device design, design factors in medical device, design for emotion in medical area, product emotions, approaches to product emotions, emotion measurement methods, product appearance, user response to product form, are scanned for the time period 1980-2013 through METU Library and various electronic databases such as Science Direct, Taylor & Francis Online Journals, EbscoHost and varying dental magazines from direct access or Google Academic search engine.

The chapter is organized into four sections. In the first section, emotions in dentistry environment will be analyzed. Dominant negative emotions, dental fear, and the reasons of dental fear will be defined. The second section focuses on the medical device design. The factors influencing the medical device design will be explained. The situation of emotion as an influencing factor for medical device design will be described. As there are scarce sources about dental instruments design and patient's emotion towards dental instruments, medical device design and its related design factors are analyzed from a general perspective since it is thought that it would be valuable for this thesis. Dental instruments are also regarded as medical hand tools so general design requirements of medical hand tools are listed in the second section. In the third section product appearance will be discussed to provide a basis for evoking emotions on users. Then, product emotions, how these emotions evoke and leading

approaches to product emotions will be analyzed. And then, objective and subjective measurement methods of emotions will be explained with benefits and limitations of the methods to provide a basis for the research study.

2.1 Negative Emotions in Dentistry

In this section, negative emotions of patients related with dental treatments, underlying reasons of these emotions and dental fear management techniques are covered.

2.1.1 Emotions in Dentistry

In dentistry clinics, intense negative emotions have been dominant on patients more than in other medical clinics. Dominant emotions refer to dental fear and dental anxiety in the related literature. Besides fear and anxiety, feeling of anger and nervousness can be observed especially in pediatric dental clinics (Salmela et al., 2011). Moreover, embarrassment is another feeling that patient experience during the dental treatment (Poritt et al., 2012).

The effect of negative emotions on dental treatment is huge and needs to be considered. Due to these negative emotions, patients easily give up their appointments that have to be done regularly. Thus, patients prefer dental treatments only in emergency cases such as having decay (Liu, 2011). This situation causes decrease in dental health of people, having dental pain and an effect on people's social lives (Toet et al., 2010). All these dental health problems result in feeling insecure and loss of self-esteem for patients ("Dental Phobia," n.d.). Moreover, feelings of inferiority, shame and fear also occur in patients (Olszewska & Zarow, 2003). The study of Schuller et al. is a good example for this situation. They advance an argument that people with high dental fear make a dental appointment rarely. They conclude that people with high dental fear generally postpone their appointment and end up having more dental health problem (Schuller et al., 2003).

2.1.2 What are Dental Fear, Phobia and Anxiety?

Dental fear, dental anxiety and dental phobia are three terms, which are used interchangeably; however, all of them have different kind of dental anxiety.

Dental fear: It is considered that dental fear is an emotional reaction of patients aroused by specific stimulus such as needles, drilling (Jaakkola et al., 2009; Poritt et al., 2012).

Dental Anxiety: Dental anxiety is believed to occur with the fear towards the unknown (Rubin et al., 1988). It can be regarded as a reaction of patient to upcoming situations during the operation.

Dental phobia: Dental phobia is the strongest feeling among these three. Patients avoid going to dentists and suffer great anxiety during dental treatments (Poritt et al., 2012; Rubin et al., 1988).

The thesis focuses on dental fear, which refers to fear of dentistry. Dental fear is one of the most common fears in the adult population with 5% to 20% prevalence (Oosterink et al., 2009). The literature review study investigates dental fear, the reasons of dental fear and instruments for measuring dental fear.

2.1.3 Studies Related to Dental Fear

The large body of literature about patients' negative emotions towards dentistry is mainly focusing on the reasons of dental fear. In the study of Milgrom et al (1985 in Klages et al., 2008), they explain dental fear as fear of dental procedures, fear of somatic reactions (fainting, panic) and distrust of dental staff behavior (Milgrom et al., 1985 in Klages et al., 2008). The fear from dental procedure may include the appearance of dental instruments. Especially for children, the appearance of dental stimuli may have negative effect on them. According to Porritt et al. (2012), the sight

and sensation of dental drill and fear of pain from dental instruments have been regarded to be the most fear evoking stimuli for children (Porritt et al, 2012).

Chapman & Kirby (1999) deal with the dental fear of children and they categorize fears into five groups;

- fear of pain,
- fear of trust,
- fear of loss of control,
- fear of the unknown,
- fear of intrusion.

Previous dental experiences or conversation about dentistry among family members can affect children to think that they can feel pain during the treatment. Children may not feel comfortable during dental treatments, as they are not aware of what is going on in their mouths (Chapman & Kirby, 1999).

Besides the reasons of dental fear, some investigation has been made to understand characteristics of patients. A mail survey by Locker et al. (1999 in Liu, 2011) shows that 50.9% of participants become fearful when they are child (under 12 years old). Moreover 22.0% of participants start to fear from dental treatments during their adolescence. Consequently, 27.1% of them answer that they become anxious and fearful during their adulthood. (Locker et al., 1999 in Liu, 2011)

Some researchers claim that dental fear can be experienced due to certain stimuli involved in dental treatment (Pohjola et al., 2009; Armfield et al., 2010; Yoshida et al., 2009). The reason of dental fear or negative emotions can be related with the appearance of dental instruments; however, it has not been fully explored. This thesis aims to shed light on this aspect of dental fear reasons.

2.1.4 Instruments to Measure Fear of Dental Treatment

Measuring dental fear is not easy as it is subjective and multidimensional (Pohjola, 2009). However, many measurement scales for dental fear have been developed (Toet et al., 2010). In this section brief information about prominent scales are given in chronological manner.

Dental Anxiety Scale (DAS), which was developed by Corah in 1969, is one of the most used scales to measure dental fear (Jaakkola et al., 2009). DAS consists of four questions and the first two questions are about general anxiety whereas the other two refer to the fear caused by instruments (Armfield, 2010). These four questions are evaluated according to 5-point Likert Scale and 12-13 points out of 20 means to having dental fear.

Another scale is Kleinknecht's Dental Fear Survey (DFS, 1973). This scale has 20 questions about physiological response of patients during the treatment and dental stimuli and anxiety. Four of the questions are related to dental instruments. These four questions examine how patients feel when they see anesthetic needle and drill, when they feel the vibration of drill, and when they hear the drill (Pohjola, 2009). When the outcomes of this scale are analyzed, three different types of responses are gathered.

Physiological responses: Increase in breathing and heart rate, feeling queasy (Locker et al., 1999), and muscle tension (Raciene, 2004) are most important patient's physiological responses.

Behavioral responses: Postponing appointments or cancelling them due to dental anxiety are patient's behavioral responses, which result in avoidance of dental treatment (Locker et al., 1999).

Fear associated with specific dental stimuli: Seeing needle, hearing noise

of drill or feeling vibration (Raciene, 2004) result in dental fear.

Gatchel's Dental Fear Scale (G'sDFS), which was developed by Gatchel in 1989, has only one question. This scale asks patients to rate their feelings on 10-point scale. One point out of 10 means no dental fear whereas 10 point means intense fear. As this scale has only one general question, it seems difficult to gather information about dental instruments (Pohjola, 2009).

According to Stouthard et al.(1995), DAS and DFS provide limited information about reasons of dental fear. Another scale, The Dental Anxiety Inventory (DAI), which was described by Stouthard in 1993, is improved to provide detailed information for dental anxiety. This scale has 36 questions focusing on general dental anxiety, fear of dentist's comments and fear of some procedures such as fear of drilling, extraction and anesthesia (Stouthard et al., 1995). The questions, which are related to dental instruments, are only focusing on dental drill and anesthetic needle.

Modified Dental Anxiety Scale (MDAS) which was developed in 1995, has been an alternative for DAS. MDAS has one more question than DAS has, and it is about local anesthesia (Pohjola, 2009).

The Getz Dental Belief Survey (DBS) was developed in 1995 to identify generally anxious patients. DBS tries to measure dental fear with 28 questions on 5-point Likert Scale. Apart from previous scales, this scale generally focuses on patient's perception of dentist in terms of "professionalism, communication, and lack of control" (Pohjola, 2009).

All these above mentioned scales are developed to find possible reasons of dental fear. DAS, MDAS, DFS, DAI and DBS are examples of multi-item questionnaires whereas G'sDFS has only one question. In the next section, the reasons of dental fear that are gathered from previous studies are explained.

2.1.5 Reasons of Dental Fear

There have been many studies about dental fear and anxiety of patients. In every study, the reasons of evoking these negative emotions and solutions to decrease them are analyzed. When the related literature is scrutinized, the following can be grouped and listed as the reasons of dental fear and anxiety. Reasons of dental fear mentioned below are not in an order since there is no information in the related literature about their level of significance.

Fear of pain: Although pain-free treatments are possible with pharmacological tools in dentistry, patients are still afraid of feeling pain during treatments.

Embarrassment: Many patients become uncomfortable during the treatment because of such a closer position of dentist. This physical closeness is a situation that can increase negative emotions ("ABCs of Dental Anxiety, Fear and Phobia," n.d.).

Secondary learning: Patients can also be affected from previous experiences of other members of family. Keating (2011) claims that people can learn fear as an emotional response by observing their family and society (Keating, 2011).

Bad experiences: Investigations about dental fear has presented that bad experience is one of the most effective reasons of dental fear (Serra-Negra et al., 2011; Liu, 2011). Liu's (2011) findings lend support to the claim that unpleasant experience has really impressive effect on dental fear. It is possible for patients to feel fearful at the following appointment if they have already lived a bad experience (Liu, 2011). Moreover, reasons of bad experience can be composed of injury, behavior of dentists and emotional responses (Liddell & Gosse, 1998 in Klages et al., 2008).

Dental procedure - instrument: Appearance of needle, noise of drill and other dental instruments can evoke negative emotions. Yoshida et al. (2009) search for the most fear-evoking instrument in dentistry, and noise of drill and appearance of

needle are voted the most uncomfortable and fearful items (Yoshida et al., 2009). Drill is painless in comparison with needle, however noise and sharp end of drill make it fearful and frightening. Noise of drill while it is working resembles a tool that is used by cutting metal surfaces and this situation reminds patients of danger and that's why it causes fear (Liu, 2011).

Several studies have indicated that the reason of dental fear or negative emotions can also be related with the appearance of dental instruments. However, as mentioned before, studies on the fear of dental instruments are so scarce.

Fear of the unknown: Patients generally does not know what goes on in their mouths and what to expect during treatment. They are not aware of the steps of dental treatments and cannot interfere in treatment and see what is happening. Thus, this situation can trigger negative feelings (Hmud & Walsh, 2009).

All reasons of dental fear mentioned above are gathered from the studies obtained from related literature. According to these reasons, solution alternatives to decrease negative emotions have been developed. In the next part, dental fear management techniques are explained.

2.1.6 Dental Fear Management Techniques

As many people experience dental fear, some techniques are improved to make patients overcome dental fear. These techniques can be grouped as:

- pharmacological interventions,
- dentists' techniques,
- patients' techniques, and
- arrangements of environmental factors (Toet et al., 2010).

2.1.6.1 Pharmacological Interventions

General anesthesia, sedation and drugs used in dentistry are risky and require fund of knowledge and well-conditioned instruments (Toet et al., 2010). Pharmacological interventions substantially are used to manage anxiety of patients and the dosage of these drugs is related to the situation of patients, skill of dentists and anxiety level of patients (Foreman, 1988).

2.1.6.2 Dentists' Techniques to Make Patients Calm

The distraction and behavioral techniques require much time and superiority for professional practice. Giving importance to these management techniques provide dentist a wide perspective for their professional careers (Toet et al., 2010). Below, some techniques for dentist to make patients calm are explained briefly.

Tell-show-do: This approach is generally preferred by pediatric clinics. After dentist explains what he will be doing, shows the child what is to be done by showing visual or auditory resources (Murphy et al., 1984).

Voice control: It is preferred for dentist to influence patient's behavior by controlling change of volume and tone of his voice.

Nonverbal communication: It refers to support and guidance from dentist through behaviors with appropriate posture and body language.

Reinforcement: It is possible to divide reinforcement into two subheadings: social and non-social reinforcements. Facial expression, physical indication of affiliation and positive voice can be regarded social reinforcements whereas gift and toy can be given as an example of non-social reinforcement for children.

Distraction: Distraction is one of the most common used techniques both for

patients and dentists. From dentist's side the aim is to draw patient attention to another point when the procedure can be perceived as a bad situation.

2.1.6.3 Patients' Techniques to Calm

Apart from dentist's techniques, patients can also apply some techniques to calm. Patients' techniques for dental fear can be any of followings.

Pain control: The main reason for patient to get further away from dental treatment is the assumption of feeling pain. Patients should trust that they are not going to experience pain. Moreover, during dental treatment, patient can relax by breathing slowly and deeply ("ABCs of Dental Anxiety, Fear and Phobia," n.d.).

Communicate with dentist: It is crucial to share feelings and opinions with dentists. Asking questions to dentists about things which patients are curious about make them feel comfortable.

Sedation: It is reliable and safe to manage dental anxiety with sedation. Central nervous system can be relaxed with sedatives that result in feeling calm for patients (Hmud & Walsh, 2009).

Therapy: Therapy can be regarded as a helpful method for patients who complain about not attending dental control and treatment due to dental fear.

Distraction: Distraction refers to alienation from stressful environment mentally and thinking right, beautiful and positive things during the treatment (Hmud & Walsh, 2009).

Relaxation techniques: Relaxation breathing can be used during dental treatments. Patients can take a deep breath, hold it for a few moments and then release it slowly. It is recommended to repeat relaxation breathing before and during dental treatments.

Guided imagery is another relaxation technique that means imaging a pleasant mental fantasy or pleasant memories during dental treatments (Milgrom et al., 1995 in Elde, 2012).

2.1.6.4 Arrangements of Environmental Factors

Arrangements of environmental factors are also considered to decrease negative emotions of patients. Some researchers try to show in which way environmental factors in dentistry affect the patients' psychology. Cientifica et al. (2011) put forward the view that music and video images make patient to relax during treatments. Especially animation demonstration and video games have started to be used to distract children's attention from treatments. Music and telling a tale can be shown as a relaxing element for pediatric clinics (Cientifica et al., 2011).

Olszewska & Zarow (2003) chose music as an environmental factor for dentistry to study on. Based on the findings of their study it can be argued that patients who listen to music during dental treatment become more comfortable to every treatment and patients who have dental fear and anxiety also affected by the music positively. Music is regarded as a crucial factor to make the environment more pleasant for patients (Olszewska & Zarow, 2003). Besides music, odor of environment can also have positive effect on emotions of patients. It is a conclusion of Toet et al.'s (2010) study that orange odor has the ability to decrease anxiety level of people so this odor can be used for dental environment (Toet et al., 2010). Effects of odor may be taken as a consideration for dental instrument design in future even if it seems a utopic idea.

Among dental fear management techniques, *pharmalogical intervention* is still one of the most efficient and preferable methods for the patients who feel fear during the treatment. On the other hand, a wide range of behavioral and distraction techniques have been carried out although they are complex and require hard work (Berggren & Carlsson, 1986).

All these mentioned techniques aim to decrease negative emotions of patients. However, in the related literature, changing product features of instruments is not mentioned to the full extent and not considered as one of the solutions to decrease dental fear. Krochak and Friedman (1998) seem that they are first-of-their-kind who try to decrease patient anxiety by changing design of dental injectors. Krochak and Friedman (1998) describe a new injection system that can decrease patient's fear of injection. In their study, they develop dental injection sensitivity survey both for conventional injector and their new injection system. They conclude the survey with that the new injection system is successful in decreasing dental anxiety caused by injection.

2.2 Dental Treatments and Instruments

As it is stated before, this thesis examines emotional reaction of patients to the appearance of dental instruments. Therefore, in this section, what kinds of dental instruments are used during dental treatments is briefly explained. Afterwards, the matter of "to what extent patients' emotions are taken into consideration in the process of dental instrument design" will be analyzed.

Dental instruments are grouped according to dental treatments and their functions in dentistry. Each dental instrument group has many instruments with similar functions. For instance, each type of tooth requires specific extraction and cleaning instruments.

Dental instruments can be categorized into six:

- Basic examination and anesthetic instruments,
- Restorative instruments,
- Surgical instruments,
- Periodontic instruments,
- Endodontic instruments, and
- Prosthodontic instruments.

Dental hand instruments generally have three main parts; working end, shank and handle (Figure 2-1).

Figure 2-1 Parts of Dental Instruments (Retrieved from http://mentorissalespower.com/archives/0111/features/24.htm)

Working end: It is the functional part of an instrument. Its form can vary according to its function such as cutting, placing and carving. As presented in Figure 2-1, instruments can be single-ended or double-ended.

Shank: The shank part is between handle and working end. Instrument's function determines shank to be angled or straight.

Handle: Dentists use this part to grasp instruments.

Brief information about dental instruments is given in the following section.

2.2.1 Basic Examination and Anesthetic Instruments

Basic examination is preliminary procedure for every dental treatment. Dentists use basic examination instruments in order to check the condition of teeth before performing oral surgery, root canal, filling or any other dental treatments. These

instruments are mirror, probes, tweezers and vitalometer (Figure 2-2). First one, *mirror*, is particularly used to see gums that are bleeding or red, and areas where the decayed teeth or tartar is. Second instrument, *probe*, is used for poking patient's teeth to understand the depth of gum pockets and looking for holes to determine tooth decay (Cohen, n.d.). Another basic examination instrument, *dental tweezers*, is used to place cotton rolls into the mouth especially between gum and cheek. Lastly, *vitalometer*, is used to measure the vitality of tooth.

Figure 2-2 Basic Examination and Anesthetic Instruments a) Dental Probe, b) Dental Mirror, c) Dental Tweezers (Retrieved from http://www.asadental.com) , d) Vitalometer (Retrieved from http-//articulo.mercadolibre.com), e) Dental Injector/syringe (Retrieved from http://www.holtdentalsupply.com)

Following basic examination, anesthetic can be applied with anesthetic syringe (cartridge) when required. Anesthesia, which provides loss of sensation, can be applied to patients locally or generally.

2.2.2 Restorative Instruments

In restorative section, decayed teeth are repaired or rebuilt by using artificial materials such as resins. Before the restoration of a tooth, a cavity should be created on tooth. Motor driven rotary instruments, instruments for cavity preparation, matrix retainers, intruments for filling prepared cavity, and finishing instruments are used during restorative treatment (Figure 2-3).

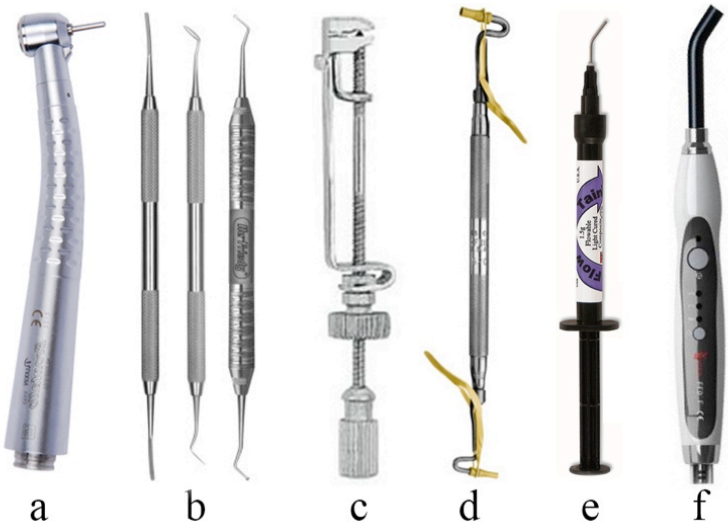


Figure 2-3 Restorative Instruments a) Dental Drill (Retrieved from http-//maryelizabethmiller.com), b) Restorative Hand Tools (Retrieved from http-//www.hu-friedy.com/), c) Matrix Retainer (Retrieved from http-//www.asadental.com), d) Amalgam Carrier (Retrieved from http-//www.hu-friedy.com/), e) Composite Injector (Retrieved from http-//www.whiteoakorthodontics.com), f) Led Curing Light (Retrieved from http-//dentalsatis.com)

For restorative operation, first of all, the situation of tooth is analyzed with basic examination instruments. Then, cavity is created with motor driven rotary instruments. Various types of instruments for cavity preparation are used. Matrix retainers are used to shape missing teeth walls. They provide proper surface during

restoration treatment. Amalgam carriers and composite syringes are used for filling cavity. And, at the end of treatment, finishing instruments are used to polish teeth.

2.2.3 Surgical Instruments

Oral surgery is concerned with surgical and diagnosis treatment of injuries and diseases. Surgical treatment should be applied in an isolated place rather than the place where other patients receiving basic dental treatment ("*Dental Instruments Setup,"* n.d.). Extraction of tooth is the most frequently applied treatment in oral surgery. Therefore, a large number of surgical instruments are used for the extraction of tooth.

Figure 2-4 Surgical Instruments a) Dental Elevator (Retrieved from http-//www.holtdentalsupply.com/instruments/surgical/elevators), b) Dental Extraction Forceps (Retrieved from http-//www.hu-friedy.com)

Basically forceps and elevators are used as surgical instruments (Figure 2-4). Dental forceps are used to extract the tooth. There are a lot of dental forceps due to having specific form appropriate to each tooth that will be removed. Elevators are another

instruments used for removing the tooth. They help to loosen the tooth for easier extraction by separating ligament from the tooth.

2.2.4 Periodontics Instruments

Periodontics is concerned with prevention, treatment and diagnosis of diseases which occur in tissue structure around the teeth. Loose teeth and bleeding tissues while brushing the teeth are the main symptoms of periodontic diseases. Periodontic treatment includes cleaning plaques. To cleaning plaques, probes and ultrasonic scalers are used. Probes has already mentioned in basic examination instrument category. Ultrasonic scaler is an electrically driven device which removes plaque from the teeth (Figure 2-5).

Figure 2-5 Periodontics Instruments a) Periodontal Hand Tools, b) Ultrasonic Scaler (Retrieved from http-//www.hu-friedy.com)

2.2.5 Endodontic Instruments

Endodontics is concerned with dental pulp diseases. The instruments; barbed broach, files, spreader, plugger are used inside the root canal (Figure 2-6). They are used for cleaning root canal, shaping and smoothing canal walls, and filling root canals (Endodontic Instruments and Their Uses, n.d.)

Figure 2-6 Endodontic Instruments a) Barbed Broach (Retrieved from http-//www.net32.com), b) Endodontic File (Retrieved from http-//www.diytrade.com), c) Spreader (Retrieved from http-//www.medical-supplies-equipment-company.com), d) Plugger (Retrieved from http-//www.am-eagle.com)

2.2.6 Prosthodontic Instruments

Prosthodontics is concerned with replacement of structures and missing teeth artificially. The aim is to maintain oral function by this operation. Prosthesis is also done in this section. Impression tray, spatulas, knife, crown remover, roach carver are prosthodontic instruments (Figure 2-7). Most of these instruments are used

during making prosthesis. Impression tray serves as a mold of the teeth and hold materials during the production of impressions.

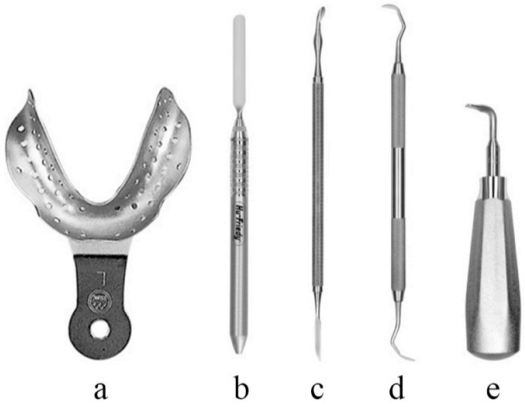


Figure 2-7 Prosthodontic Instruments a) Impression Tray (Retrieved from http-//www.britesources.com), b) Spatula, c) Knife, d) Crown Remover, e) Roach Carver (Retrieved from http-//www.hu-friedy.com/)

Dental instruments are briefly explained in this section. In the following section, the criteria, which are taken into consideration in the process of dental instrument design, will be investigated in order to analyze to what extent patients' emotions are considered.

2.3 Medical Area

As the author assumes that there might be product visual attributes influencing the emotional reaction of the patients to the dental instruments, it can be useful to analyze factors related to dental instruments' design and how effective design for emotion is in dentistry. Due to scarce studies dealing with dental instrument design process, this study benefits from the literatures of medical device design. As a result, the reader can also recognize the situation of dental instruments in medical device area.

In this part of literature review study, factors that influence medical device design, and how designers consider patient's emotional response towards medical devices are investigated. Firstly, the definition of medical device is given, and then design requirements of medical hand tools that include dental instruments are analyzed. Lastly, the factors that influence medical device design are investigated and emotional issues on medical device design are deeply analyzed.

2.3.1 What is Medical Device?

European Council's "Medical Device Directive" is a 'New Approach' Directive and includes the laws relating to medical devices. It became mandatory on March 21, 2010 and all medical devices have to meet the requirements to be used in Europe. The Directive defines a medical device as "*any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for its proper application intended by the manufacturer to be used for human beings for the purpose of:*

- *diagnosis, prevention, monitoring, treatment or alleviation of disease,*
- *diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap,*
- *investigation, replacement or modification of the anatomy or of a physiological process,*
- *control of conception,*

and which does not achieve its principle intended action in or on the human body by pharmacological, immunological or metabolic means, but may be assisted in its function by such means."

(European Council Directive 2007/47/EC, p. 23-24)

To provide patient' and physicians' safety, medical devices are determined by complex regulations. Medical device regulations vary across countries. Medical Device Directives, and Food and Drug Administration (FDA) regulations are the two

most important regulations that are obligatory to market and sell medical devices in Europe and USA, respectively.

2.3.2 General Requirements for Medical Hand Tool Designs

Medical devices consist of many different product categories *'Medical hand tools'* is one of those product categories, which covers the tools used to perform clinical tasks and operated by hands. Dental instruments are regarded as medical hand tools. Although there are numerous ergonomic design guidelines for hand tools, they are generally valid for non-medical hand tools (Botney et al., 2008). Botney et al. (2008) compose comprehensive review of general guidelines and design recommendations about medical hand tool design.

A handle and a working end are the parts of a hand tool sometimes there can be a body between them (Botney et al., 2008). Design of medical hand tools is crucial as the usage of these tools requires hand skills and they should enable user (the term of "user" is used instead of physician, nurses or other people who uses medical devices) to make repetitive movements. That's why users should test these hand tools more during the development process (Sawyer, 1997).

Every medical hand tool has discrete properties and all the medical hand tools are supposed to meet all safety and clinical requirements. Firstly, a well-designed hand tool is expected to provide patient and user safety, then comfort, ease of use and effectiveness (Botney et al., 2008). Medical hand tools can be used in many locations such as operating room, hospital wards, emergency room, intensive care and dental offices.

By considering the related literature, it can be said that there is a lack of studies providing guidelines for hand tool design. Botney et al., (2008) gather contextual factors affecting the medical hand tool design, and group them into five: equipment related, user related, task related, patient related and others. Sub-categories for user

and patient related factors are worth to mention in this point of the thesis and can be seen in Figure 2-8. In the list, mood, attitude and psychology factors are regarded to have influence on users where as these factors for patients are not even in the list. Namely, patients' emotional responses do not appear to be contextual factors in medical hand tool design. Individual anatomy, age, gender and medical conditions of patients are the factors that should be considered in medical hand tool design process.

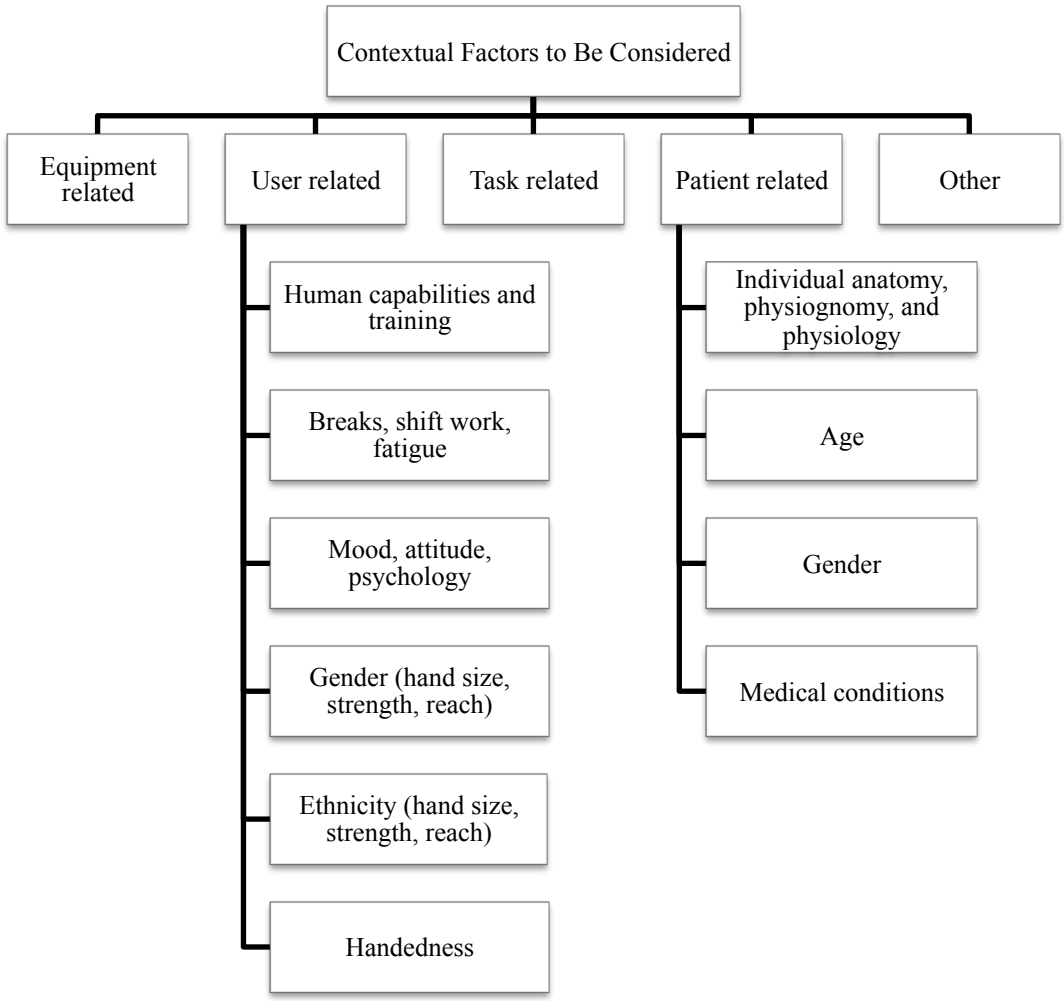


Figure 2-8 Contextual Factors Affect the Medical Hand Tool Design (Adapted from Botney et al. (2008).

The criteria such as tool size, applied forces, variety of handle shapes, weightiness, surface, material and texture affect design of the tools. Most of them have an impact on usability and safety of tools (Botney et al., 2008). There have been some studies on hand tool design criteria and several design guidelines are developed. Botney et al. (2008)'s design guide covers context of use, handle and end part as a whole tool. According to their study, design requirements of medical hand tools are listed below.

- Handle length should be defined according to hand dimension of user population (%95 percentile). Too short and too long handles should be avoided.
- Handle diameter should be appropriate for user hand dimension. Power and precision grips are directly affected by handle diameter. Different sizes in diameter provide user to select appropriate tool.
- Handling force and user comfort are affected by handle cross-sectional shape. Generally circular, elliptic and cylindrical shaped tools are used.
- Handle material:
    - Handle materials should be appropriate to sterilize by gas, chemical and heat. Wood is an example of non-appropriate material, as it cannot be sterilized.
    - Non-porous material should be preferred in order to protect from bacteria and viruses.
    - Materials should not cause slipping and make difficult to grasp. Generally slippery metal surfaces are not preferred as they have low coefficient of friction. Besides this, plastics and leather can be used provided that they can be sterilized.
    - The material should not transfer heat such as too cold and too hot.
    - Non-conducting materials should be preferred.
    - Light-weight material should be preferred so large handle surfaces can be designed (Botney et al., 2008).
- Surface finishing procedure and texture can be applied to all medical hand tools. It can provide to increase friction of surface that prevents slipping. On

the other hand, surface finishing can be used to define hand-grasping area on handle. Generally round surfaces are preferred instead of sharp edges. What is more, smooth and glossy surfaces are not preferred as they reflect the light, which disturb user's eyes (Botney et al., 2008).

All these criteria mentioned above have influences on the design of medical hand tools. These criteria include information about the medical hand tools' purposes and how these instruments are used. In the next section, factors that influence medical device design are analyzed.

2.3.3 Factors Influencing Medical Device Design

Medical devices that show variety from simple to complex structure are under the control of FDA and Medical Device Directive regulations as they are directly connected with human's health (Teixeira & Bradley, 2003). Besides these regulations, user's needs are effective in designs of medical devices. To design a medical device, firstly the device should be identified and understood and then be decided who will be the users and in which environment it will be used (Chhibber, 2009).

In the 19th century engineers were the only person who had decided device's design. Functionality of device was the only consideration. The time period of the Second World War was the turning point for ergonomics and it started to be regarded as another consideration. Immediately after the occurrence of ergonomics in medical design, technological development appeared to be driving force behind medical device design (Lishan et al., 2007). Companies were in search of opportunities to make a difference from other competitors as all the needs of users are clear and finally they chose to put emphasis on industrial design and aesthetic appeal (Çetin, 2004).

The factors that have influence on medical device design can be described into six groups; functionality, ergonomics, technological development, aesthetic appeal, universal design and design for emotion. *Functionality* stands for finding a solution to the problem. Then *ergonomics* comes with the need for safety. *Technological development* gives opportunity to replace mechanical aspects of devices and then, *aesthetic appeal* is formed with the integration of new materials and forms into design. *Universal design* tries to decrease failure of medical device design. *User experience and design for emotion* refers to precise factor that shapes the future of medical devices with interaction and emotion (Lishan et al., 2007). All these factors will be described to understand the relationship between these factors and how design for emotion is created in medical devices.

2.3.3.1 Functionality

In 1900s, functionality was the only concern for medical device design and only basic need of users were considered. Purpose of product was purely functional and related about neither aesthetics nor emotional reaction of patients. If a product functioned well, it meant it was sufficient. Product functionality is generally about what the product is used for. Function of product also leads the way about product's design, construction and material selection (Lishan et al., 2007). However, only regarding function of product results in dissatisfaction for users.

2.3.3.2 Ergonomics

Besides function, the term of ergonomics emerged in 1940s. In 1950s ergonomics started to have effect on medical device design. Ergonomics refers to physical ergonomics in terms of efficient, effective and safe operation in medical area (Lishan et al., 2007). Physical ergonomics that refers to responses of human's body towards physical loads constitute the main approach of ergonomics. Medical devices must be efficient and safe for physicians, nurses and the user to perform their job effectively (Doerr et al., 2008).

Ergonomics has a significant role in medical device design as it provides user-centered design principles to manufacturers. Although medical devices have a lot of value about their innovativeness in functionality, little user research has been conducted in early stages of medical device evolution (Martin et al., 2008).

In order to understand the impact of physical ergonomics in medical device design, the interaction between user and medical device have been examined through many years (Sharples et al., 2012). In the last decade, the researchers have started to focus on the relationship between medical device design, usability and patient safety (Martin et al., 2008).

However, being safe and efficient are not sufficient for a medical device. A medical device has to meet all the requirements of users. In medical area, as it is hard to define end users, the designers have to balance the different needs of physicians, nurses, patients and also people who are responsible for the maintenance of the medical devices (National Patient Safety Agency, 2010). Majority of the studies related with the design of medical devices perceive direct users as physicians. Patients can be regarded as end-users even if they do not use these devices; therefore, they should be taken into consideration while evaluating the devices (Chhibber, 2009). Especially for home use medical devices, some tactics are developed by companies such as increasing the positive interaction between patients and medical devices, which can provide companies to be acceptable in market (Jordan, 2008). User centered, in other words patient centered design has become a popular issue and companies start giving importance to medical device design according to patient's needs and values. However, patient centered design approach has not been adopted for dental instruments in dentistry, as patients are not regarded as users.

Expectations of users and patients from a medical device may differ, and this may have an effect on the decisions taken during the design process. For example, Feine et al. (1998) illustrates opinions of patients and prosthodontists towards the factors influencing dental prostheses. Seven factors; cleaning, esthetics, speech, chewing

function, stability, comfort and occlusion are gathered from their study as the factors influencing both patients and prosthodontists. Feine et al (1998) conclude that patients give more importance to each factor compared to prosthodontists. As can be seen from Figure 2-9, only patients rate comfort whereas occlusion, which means simply contact between teeth, is rated only by prosthodontists. As it is evidenced by Feine et al.'s study (1998) too, the needs of patients and users can be different.

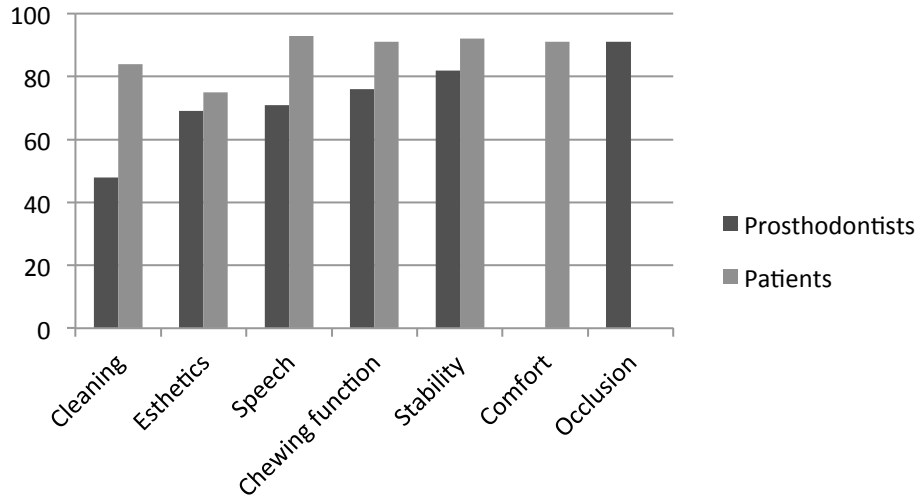


Figure 2-9 The Ratings Towards Factors Related to Dental Instrument Design (Adapted from Feine et al., 1998)

With the advancements in design, safety and comfort criteria can be provided by ergonomic approach in medical device design. Nowadays, ergonomics has started to be familiar in medical device design area due to the considerations of usability in home use medical devices (Lishan et al., 2007).

2.3.3.3 Technological Development

The contribution of technological advancements to medical device design is huge. Developments in manufacturing technologies, material advancements, new inventions and improvement in existing technologies have been influential on the

advancements in medical area (O'Brien et al., 2001 in Lishan et al., 2007). With the advancements in material technology, very strong and lightweight materials such as titanium and certain plastics have started to be used in medical area. Innovative materials have been used in applications such as joint replacements, spine and trauma systems and dental implants (Lishan et al., 2007). Birmingham Hip Resurfacing that is an alternative procedure for patients who need a hip replacement can be an example for material innovation in medical area (Figure 2-10). Birmingham Hip Resurfacing is manufactured from "as-cast cobalt chrome" which provides more wear resistance than metal-on- polyethylene-joint of traditional hip replacements (Birmingham Hip Resurfacing System, 2007).

Figure 2-10 Birmingham Hip Resurfacing (Retrieved from Birmingham Hip Resurfacing System, 2007)

A wide range of medical devices has started to be used by patients out of clinics owing to increase in specialization of medical devices (Bitterman, 2011). Moreover, new manufacturing machines and their supporting technologies open the doors to new surface finishing of medical devices with smooth and curvilinear surfaces. This advancement results in different design opportunities on the medical devices.

2.3.3.4 Aesthetic Appeal

Functionality and ergonomics are the primary concerns in medical design. Aesthetic

appeal appears to be a new strategy for manufacturers to come into prominence. Aesthetic appeal refers to visual form of products and it relates to visual attributes such as color, texture, usability, simplicity, modernity and symmetry (Lishan et al., 2007). Visual attributes of the devices become important as they convey about how the devices will be used.

Industrial designers have entered into medical device design area which resulted in heading for different and organic forms (Lishan et al., 2007). Although aesthetic appeal enhances user's experience with the product, the medical manufacturers find it difficult to develop aesthetically appealing products. Medical device industry has stayed behind other industries in designing aesthetically appealing products. According to Kossack et al. (2007) significant developments have occurred in medical device design over the past 10 years (Kossack et al., 2007).

A good example of aesthetically innovative medical design is a computerized tomography machine, Somatom Sensation from Siemens Company (Figure 2-11). It is designed with the latest technology and apart from requirements of medical devices, they constitute a new requirement which has become a slogan form them. "Appearance to be friendly and non-threatening to the patient" (Lishan et al., 2007).

Figure 2-11 The Somatom Sensation (Siemens AG 2006 in Lishan et al., 2007).

Another aesthetically appealing medical device example is Scanadu's scout device (Figure 2-12). This device gives users opportunity to measure heart rate, body temperature, respiratory rate, blood pressure, ECG, emotional stress at anytime and anywhere. Moreover, the device captures vital signs and can synchronize the data with a smart phone to show body's information to users (Lam, 2013). Besides the aesthetic appeal, the adaption of technological development is taken as a consideration for this device.

Figure 2-12 Scanadu Scout- A Medical Tricorder (Retrieved from http://alexisavvy.com/category/big-data/)

Another medical device is Aira, which is developed as an auto-injector for rheumatoid arthritis patients who often do injections themselves (Figure 2-13). As the medicine is cold since it is stored in refrigerator, patients feel more pain during the injection and it takes much time. Aira auto-injector warms medicine to body temperature and provide a quick injection. The handle of Aira enable users a soft grip. According to Alexander (2013), the appearance of Aira is more user-friendly than other devices on the market (Alexander, 2013).

Figure 2-13 Aira- auto Injector (Alexander, 2013)

2.3.3.5 Universal Design

The priority of medical device is to eliminate the risk of use errors and provides patient safety, which can be provided by improved usability and universal appeal of devices (Kossack et al., 2007). Universal design is an approach, which refers to "design for all". According to this approach, products, services or environments can be usable by many people regardless of age, culture and ability (Lishan et al., 2007).

Universal design principles such as *"equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for approach and use*" affect the appearance of medical devices (Bitterman, 2011). As medical devices can have more complicated components or user interfaces, physicians, nurses, homecare patient or different users from other parties should universally understand and use devices (Kossack et al., 2007).

2.3.3.6 Design for Emotion

Emotional experience of user is subject to physical and cognitive issues. Aesthetic experience and experience of meaning build up emotional experience during user-product interaction. Emotional experience of user can be achieved by user-product interaction in three different ways:

- usability of product,
- usefulness of product,
- user's affinity for product.

Usability is about using the devices in an effective way whereas usefulness is described as the reason user seeks a product. The last one is the affinity that refers to the emotional connection between devices and users. It is completely about user desires. If these three ways of user-product interaction are considered in the medical device development process, more successful devices can be presented (Jordan, 2008).

Designing medical device by regarding user's emotional needs generally depends on financial and regulatory situation of markets. Since the patients are not regarded as direct users in many clinics but physicians, many medical devices and tools are designed without taking patients' emotions into consideration.

Money et al. (2011), in their study, make interviews with 11 medical device manufacturers. Their aim is to learn "to whom manufacturers consult during medical device design process" and "how the manufacturers define the needs of users". The findings reveal that manufacturers get design input data from individuals who purchase devices instead of the users of devices. Manufacturers who attend the interviews generally consult healthcare professionals during the design period even if the user is nurse or patient. Manufacturers claim that less senior health professionals' or patients' opinions towards medical device design only have little effect on market sales (Money et al., 2011). According to Sharples et al. (2012) the situation is a bit

worse. They claim that while design for emotion is expected to be considered in medical device design, even user-centered design approach is not considered. Actually some medical devices are designed without considering users (Sharples et al., 2012).

Due to sales considerations of medical device manufacturers in market share, they begin to produce medical devices that make patients to feel more comfortable. However, medical device manufacturers give importance to only home use medical devices. Manufacturers aim to develop patient's psychological well-being in order to make them to buy their medical devices.

2.3.4 Design for Emotion in Medical Area

Regarding emotional reactions of users and considering possible relation between medical device and user are the latest approaches in medical device design (Lishan et al., 2007). There are rare researches about design for emotion in the dentistry field. Therefore, design for emotion is going to be analyzed for medical device design area from a general perspective, as there is sufficient research on design for emotion in medical devices.

One of the reasons of emerging design for emotion factor is the marketing concern. Manufacturers believe that one of the most important factors in choosing home use medical devices is emotional experience; therefore design for emotion as a factor has become significant for these devices. According to Jordan's (1997 in Chhibber, 2009) hierarchy steps of user needs, after functionality and usability steps, the need of pleasure comes (Figure 2-14). When this hierarchy steps are considered for medical area, due to getting over both functionality and usability steps, user pleasure comes to the point. Thus, patients can prefer devices, which make them feel safe and peaceful (Çetin, 2004).

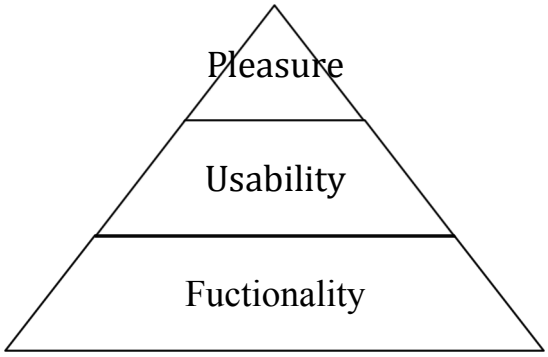


Figure 2-14 Hierarchy of Consumer Needs (Adapted from Jordan, 1997 in Chhibber, 2009)

It is difficult to predict probable emotional responses of user during medical device design process. It requires multi-dimensional researches. Desmet & Dijkhuis (2003) have designed a new wheelchair for children that can evoke positive emotions more than conventional ones. In their study, first of all, the existing wheelchair models are examined to decide which positive and negative emotions are evoked. Then they try to understand why these positive and negative emotions are evoked. After gathering data about existing wheelchairs, they design a new wheelchair and emotional reactions of participants are evaluated by comparing the previous wheelchairs. This approach from Desmet & Dijkhuis's (2003) study can provide designers with a method to understand the emotional responses and the needs of users. If this approach is applied in other medical areas and devices, medical devices may be carried to a more successful level (Desmet & Dijkhuis, 2003).

Apart from these personal home use medical devices, clinical use medical devices, even if just a bit, consider ergonomics and positive emotions. The first concern for these devices can be the well-being of patients, but designers can also work towards a solution according to patients' emotions. There are some examples of devices from clinical use. Butterfly needle in Figure 2-15 can be a good example for decreasing the negative emotions of patients towards medical treatment. It is used to draw blood from patients. Its appearance is far away from the visual form of a classic injector.

Figure 2-15 Butterfly Needle (Retrieved from http://www.rgs-group.co.uk)

Another product, designed with emotional value, is called Sonny. This needle aims to decrease the injection fear of young patients during blood drawing period. Sonny comprises of small thumb toy and syringe. Small thumb toy is designed as a gift for patients and is presented after the operation. This toy aims to make patient to think happy thoughts (Figure 2-16).

Figure 2-16 Life Science Category – Sonny (Retrieved from Red Dot Award Design Concept 2006)

Another newly developed project is a blood-drawing unit for hospitals. The situation of blood drawing generally evokes negative emotions. The aim of the device, called

Dolphin, is to make patients to feel safe and secure (Folkmann, 2010). As shown in Figure 2-17 the syringe is hidden inside the Dolphin. Thus, it prevents the fear and anxiety of seeing the syringe for patients. Moreover, the aesthetic appeal of Dolphin creates pleasurable experience for patients (Folkmann, 2010).

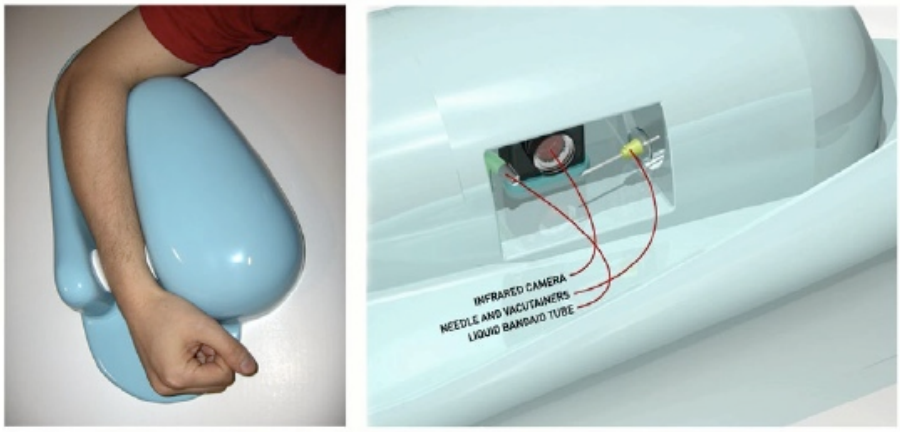


Figure 2-17 Dolphin Project - Kolding School of Design 2007 (Torstein Helgason, Nils Koster, Johan Kristiansen & Michael Larsen)

These medical device examples shown above are designed by considering patients' emotions. However, little attention has been paid to design for emotion in the production of dentistry instruments.

The Dino Chair is one of the few examples of design for emotion in dentistry field (Figure 2-18). It is a dental chair for children. As it is difficult to make children stay put during dental treatments, this chair aims to make the environment friendly for children by reducing their fear ("Dino Chair Kid's Dental Chair", 2013).

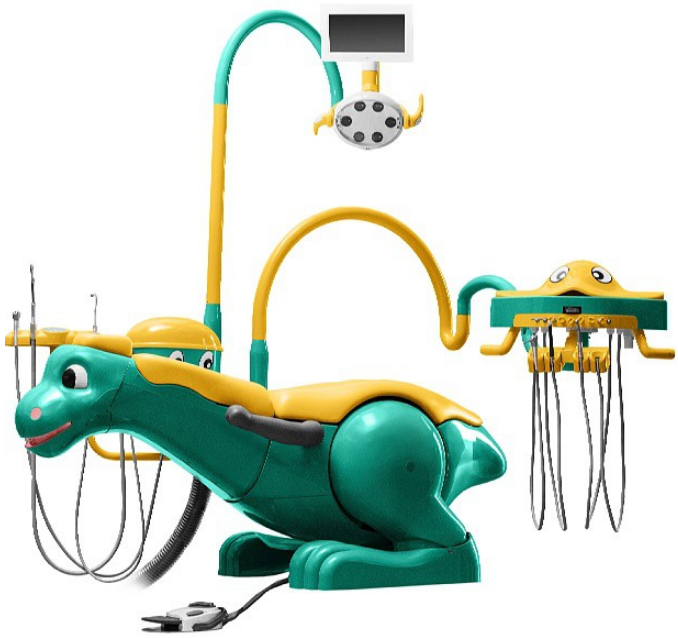


Figure 2-18 Dino Chair (Retrieved from http://www.pingram.me/tag/dinochair)

Moreover, if the developments of dental instruments are examined, it is possible to see some noteworthy approaches to dental needle in the last few years. According to Saxena et al. (2013) dental needle, frequently used during dental treatments as mentioned in the previous sections, triggers feelings of fear. As patient may feel pain during injection, there are some instruments which have been recently developed to decrease this pain (Saxena et al.,2013).

Dentists are still using traditional syringe, which was designed 150 years ago. The Accupal is a cordless instrument that uses vibration to practice pain-free injection (Figure 2-19). This instrument is placed at the injection site before the injection is applied. According to Dr. Zweifler who is the inventor of Accupal, this instrument has a positive effect on patients as it reduces needle's pain ("ACCUPAL is new alternative anesthesia delivery system", 2008)

Figure 2-19 Accupal (Retrieved from http://www.mwdental.com/supplies/anesthetics/accupal-injection-kit.html)

Another similar instrument is DentalVibe that also uses vibration to block sense of pain during injection (Figure 2-20). Dr. Steven Goldberg, inventor of DentalVibe, claims that patients do not want to see one more threatening instrument during dental treatment; therefore, DentalVibe is designed with patient-friendly appeal and it looks like a power toothbrush ("From an everyday dentist to entrepreneur", 2010).

Figure 2-20 The DentalVibe (Retrieved from http://www.dental-tribune.com/articles/business/usa/3284_from_an_everyday_dentist_to_entrepreneur.html)

Like fear of dental needle, fear of dental drill has also been scarcely investigated in the design process. Karten Design firm develops a dental drill that is used to create cavity on teeth. They believe that “an elegant design helps to re-frame the frightening dental visit”. According to Karten Design firm, at least 5% of U.S population has dental fear because of the dental instruments’ appearances. As shown in Figure 2-21, Zen Cordless Prophy, the appearance of dental drill with its “beautiful, clean and iconic design” is far away from traditional dental drills (“Zen Cordless Prophy”, n.d.).

Figure 2-21 Zen Cordless Prophy, Dental Drill (Retrieved from http://www.kartendesign.com/paradigm-shifting/standing-up-for-patients/zen-cordless-prophy/)

By considering the dental instruments’ designs mentioned above, it may be said that some manufacturers accepted the idea that the visual appeal of dental instruments may diminish negative emotions of patients. However, these emotional approaches towards medical device design are limited.

2.4 Product Appearance

This section benefits from the literature about consumer response to products. As Crilly et al. (2004) state, the term "consumer" is used not only for those involved in purchase decision but also for anyone involved in the visual consumption of the product, every users may also be regarded as a consumer. In this section instead of the term "consumer", the term "user" will be used as the thesis focuses on patients' namely end users' response to dental instruments.

All the senses of human get involved in any activity when there is an interaction between human and product (Ginnow-Merkert, 2006). Especially visual sense plays a crucial role in this interaction and provides further information about the product (Schifferstein, 2010). This information is mostly about visual attributes of the product. First evaluation starts with the visual attributes of products and leave the place to color combinations, material applications and other physical attributes (Blijlevens et al., 2009). Throughout the thesis the term of "product visual attributes" is used to define product visual properties such as form, color, proportion, texture and etc.

People make inference about the product by evaluating product visual attributes. Product's color, material, form, proportion and texture define visual unity (Bloch, 1995). The product visual attributes give clues on how the product can be used and how it can be interpreted. At this stage, it is substantial to examine how people receive this information from which attributes of product and how they filter these attributes while evaluating the product (Crilly et al. 2009; Creusen & Schoormans, 2005).

Various product visual attributes affect user's preference regarding product design. Therefore, it is significant that designers identify these product visual attributes in developing products (Shieh & Yang, 2008). There have been many studies on this issue from different product perspectives (Chang, 2008; Hsiao & Chen, 2006; Yang,

2011) However, this issue needs more detailed work and the studies that have been already done are generally focusing on very limited product categories and certain dimensions. According to Yang (2011), there is a cause-and-effect relationship between product visual attributes and users' responses (Yang, 2011).

Studies focusing on product visual attributes and users' affective responses, and their results will be examined in the next section.

2.4.1 User Response to Product Appearance

Visual attributes of products evoke responses in users. In order to analyze user response to products' forms, it is important to understand the communication between user and the product first. During the interaction between user and product, there is no chance to ask the designer what meaning is coded to product. It is necessary to analyze the communication between user and product. Shannon (1948) describes this communication with five elements; source, transmitter, channel, receiver and destination (Figure 2-22). In his approach, the meaning is encoded in a signal and a channel transmits it. Next, the meaning is decoded by the receiver and then transferred to the destination (Shannon, 1948 in Crilly et al., 2004).

Figure 2-22 Basic Model of Communication (Shannon 1948 in Crilly et al., 2004)

Monö (1997) transfers Shannon's communication model to product design study. In the design process, the message is decoded in a product by design team. In an environment the signal is received by the senses of user and then responses are occurred towards the products (Monö, 1997, in Crilly et al., 2004) (Figure 2-23).

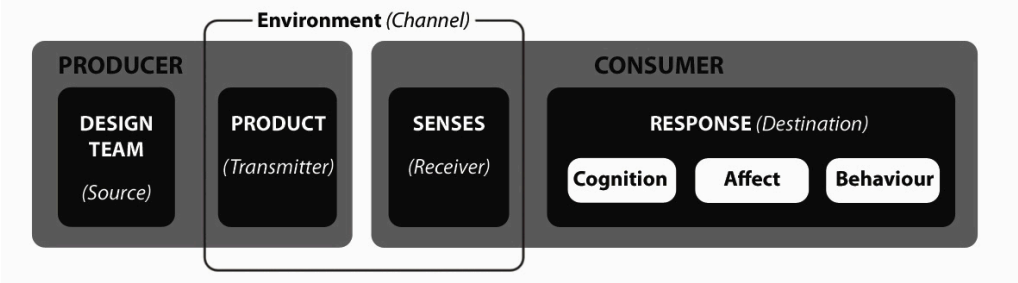
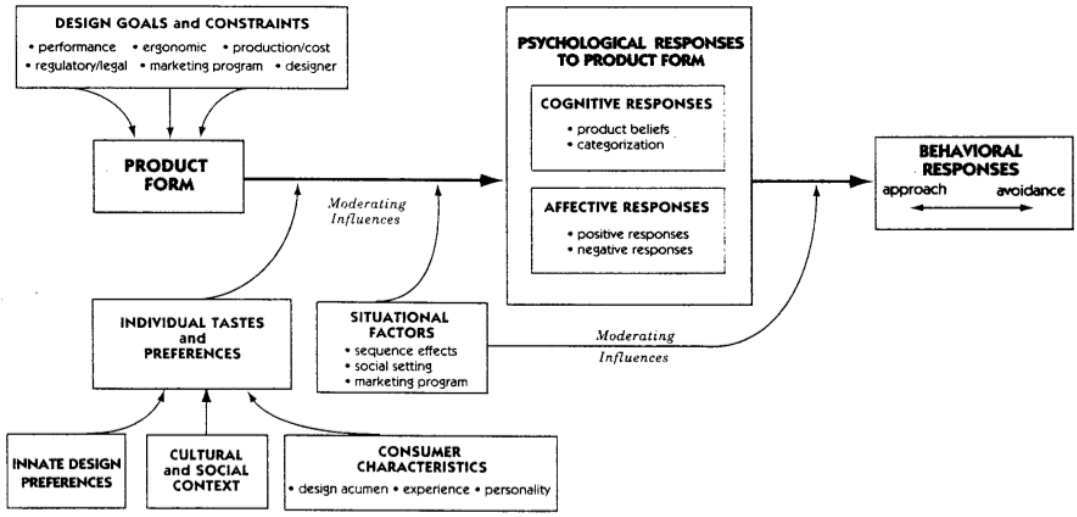


Figure 2-23 Basic Framework for Design as a Process of Communication (Crilly et al., 2004)

Bloch (1995) mentions which aspects of product appearance have strong influence on users. One of them is *visual uniqueness* of product. It is believed that if a product has unusual and unique form, it will be more attractive than others. Another aspect is the product's *visual meaning*. A good example of this is conveying different meaning to users such as ease of use. The products that experience pleasure are believed to be more preferred and this experience is one of the aspects of the product appearance (Bloch, 1995). According to his model, the process starts with the design goals and constraints that are effective in shaping product form. The product, which is developed, is also influenced by individual tastes, preferences and situational factors. These factors reflect how the users evaluate the product. Moreover, Bloch (1995) defines individual tastes and preferences with the innate design preferences, cultural and social context and consumer characteristics. The last chain as seen in Figure 2-24 is comprised of psychological and then behavioral response that occur as a result of psychological response.



”

Figure 2-24 A Model of Consumer Responses to Product Form (Bloch, 1995)

Crilly et al. (2004) gather many sources from literature that are related with user response to product forms. Bloch (1995) categorizes user response into two, behavioral and psychological whereas Crilly et al. (2004) divide them into three categories consisting of cognition, affect and behavior. Design team, product, senses and environment are four important factors influencing the response of users as it is seen in Figure 2-25.

Figure 2-25 shows the communication process between product and user. The design team decides what meaning will be conveyed with the appearance of the designed product (Crilly et al., 2004). The physical product is characterized by its shape, material, color, texture, geometry, dimension, ornamentation, graphics and proportion (Crilly et al., 2004; Bloch, 1995).

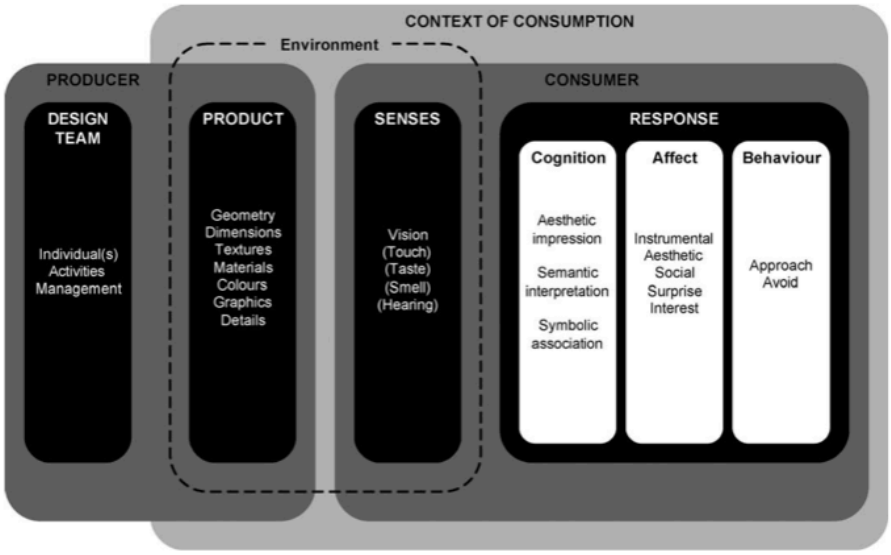


Figure 2-25 Framework for Design - Process of Communication (Crilly et al., 2004)

In this thesis, three responses to product appearance are distinguished: cognitive response, affective response and behavioral response.

2.4.1.1 Cognitive Response

Cognitive response can be defined as an evaluation of the product appearance according to perceived qualities (Crilly et al., 2004). Besides "beliefs, thoughts, memorial situations, perceived qualities" (Bettman and Park, 1980 in Park et al., 2008), cognitive response includes also "imaginary elements and associations". (Holbrook and Hirschman, 1982 in Park et al., 2008).

Crilly et al. (2004) analyze cognitive response approach of previous studies and define three sub-categories for cognitive responses: Aesthetic Impression, Semantic Interpretation and Symbolic Association. The first one, aesthetic impression, is about attractiveness or unattractiveness of products and it attracts users' one or a few senses in a positive way. The second one, semantic interpretation, can be defined

what a product says about its function, mode of use and qualities (Crilly et al., 2004; Seva et al., 2011). The last sub-category is symbolic association that refers to what a product says about its user (Gotzsch, 2000 in Crilly et al., 2004).

2.4.1.2 Affective Response

Another psychological response is affective response. It refers to users' feelings that are aroused by appearance of product or refers to emotions that occur during the interaction. When user sees a product, the evaluation process starts: the appearance of product causes different feelings. "Previous experiences about similar product or the recollection of related information" comprise these positive or negative feelings (Seva et al., 2011).

Affective responses of users towards products will be analyzed deeply in "approaches to product emotions" section.

2.4.1.3 Behavioral Response

Affective and cognitive responses affect the behavioral response of users to the product (Crilly et al., 2004). According to Bloch (1995), behavioral response can be either one of approach or avoidance. Approach can be defined by the desire to interact with the product whereas the avoidance has a reverse definition (Bloch, 1995). Approach can be supplied with totally positive feelings. At the end of this situation, user can have an experience with the product, buy it or use it. However, avoidance occurs as a result of negative psychological responses. Consequently, user refuses the product, gives up buying it or does not have any experience with it (Crilly et al., 2004; Bloch, 1995).

2.4.2 Research Studies on Product Visual Attributes and User Responses

There are hundreds of studies on how product appearance affects the psychological and behavioral responses of people (Yang et al., 1999; Hsu et al., 2000; Hsiao &

Chen, 2006, Lin et al., 2013). In this section, studies about product visual attributes and user responses are investigated. Unfortunately, studies on the product visual attributes of medical device or dental instruments are still lacking. Therefore, different product categories are chosen to show the relationship between product visual attributes and user responses.

Kansei engineering and semantic differential are most common methods used in these studies that show the relationship between product visual attributes and user responses. Kansei Engineering is developed by Nagamachi (1995) and refers to user's feelings for a product (Nagamachi, 1995). It is defined as "translating technology of a consumer's feeling and image for a product into design elements" (Nagamachi, 1995). Users' feelings towards products seem as significant input in product development process. In this method, user's feelings are translated into design elements so this method provides user satisfaction (Seva et al, 2005). Although Kansei Engineering is a rather old method, it is still starting point for many researches. In most studies, Kansei engineering focuses on measuring responses to one product. If the product has small components, every component needs separated Kansei engineering study and then the results are combined.

In Kansei engineering, semantic differential method is mostly used to gather data. Semantic differential method that was introduced by Osgood (1957 in Khalid & Helander, 2006) is a psychological measurement tool. This method is developed as a rating scale to measure people's affective responses to words, phrases, drawings and concepts in terms of ratings of scales defined with adjectives. A semantic differential scale consists of a pair of adjectives of opposite meaning such as dirty-clean, ugly-beautiful and strong-weak. For this method, the most important thing is to select word pairs that are relevant for the product (Khalid & Helander, 2006).

Hsu et al. (2000) study on how users and designers perceive product visual attributes. In their study, 24 telephone samples are presented to 20 users and 20 designers. Then participants are asked to evaluate these telephones by using 14 image-word pairs. It

is revealed that the most preferred telephone differs from users to designers. Hsu et al. (2000) uses conjoint analysis to determine how users value different visual attributes of products. The design factors for telephone are defined as body, receiver, digital button, display and keys. The aim is to specify the affective design factors and provide designers a guideline for later telephone designs. Levels for each design factor are defined. The result of the study reveals that the perceptions of product visual attributes are different for users and designers. In Figure 2-26, averaged values for users and designers towards design factors of telephone and design factor levels can be seen. According to Figure 2-26, for example, in the results of telephone keys, users find rectangular keys negative whereas designers do not much consider. Elliptical functional keys are positive for both groups. The running track circle style is positive for users whereas it is negative for designers (Hsu et al., 2000).

Designers		Design factor levels	Users	
Importance	Utility (part-worths)		Utility (part-worths)	Importance
Body	− 0.686	a1: Rectangular	− 0.1681	Body
22.66%	− 0.189	a2: Solid	− 0.8073	24.46%
	1.2106	a3: Curvilinear	0.786	
	− 0.3356	a4: Geometric	0.1894	
Receiver	0.0577	b1: Curvilinear	− 0.0222	Receiver
23.47%	− 1.1055	b2: Old K-type	− 0.1944	17.56%
	1.0068	b3: Sharp geometric	0.2151	
	0.041	b4: Rounded rectangular	0.0015	
Digital buttons	− 0.0598	C1: Rectangular	− 0.3061	Digital buttons
12.09%	0.4411	C2: Elliptical	0.1386	14.28%
	− 0.3813	C3: Organic	0.1674	
Display	0.5613	d1: Separated	− 1.0738	Display
30.91%	− 1.4231	d2: Integrated	− 0.1482	24.53%
	1.0629	d3: Organic	1.0579	
	− 0.2011	d4: None	0.1641	
Function keys	0.096	e1: Rectangular	− 0.6896	Function keys
10.86%	0.0822	e2: Elliptical	0.4442	19.17%
	− 0.1783	e3: Running track circle	0.2455	

Figure 2-26 Averaged Values for Design Factors and Design Factor Levels (Hsu et al., 2000)

Similar to Hsu et al.(2000), Hsiao & Chen (2006) conduct a study about users' affective responses to product shape. They choose automobile, sofa and kettle, and 19 automobiles, 20 sofas and 21 different kettles are selected to study on for the

study. They try to define affective responses of users by using semantic differential method and analyzing trend, emotion, complexity and potency factors. To get more specific data, they analyze these four factors on a level with significant shape features and feature levels. They collect 13 shape features that can affect affective responses of user. They separate 13 shape features into two categories: shape elements and shape manipulations. First one stands for external elements of product features and the second one presents cognitive features. Shape elements are identified as corner type, line type, surface type, volume type, element amount, unity level, overall form and stability level. Then they divide each shape elements into three sub-categories. For example, volume type is divided into three levels of heavy, medium and light whereas surface type is divided into three levels of flat, curve and flat+curve. They also define shape manipulations into prototypical level, symbolic level, functional level, comfortable level and pleasurable level. For these five shape manipulations, they use levels of high, medium and low. All these shape elements and shape manipulations and their levels can be seen in Figure 2-27.

	Shape feature	Feature level	Characteristic of shape feature
Shape elements	A. Corner type	A1. Sharp, A2. Small arc, A3. Large arc	Distinguishing corner types on the edges of product shape
	B. Line type	B1. Straight, B2. Curve, B3. Straight +curve	Distinguishing line types on the surfaces of product shape
	C. Surface type	C1. Flat, C2. Curve, C3. Flat +curve	Distinguishing surface types on the appearance of product shape
	D. Volume type	D1. Heavy, D2. Medium, D3. Light	Distinguishing the level of volume on product image
	E. Element amount	E1. Less, E2. Suitable, E3. More	Distinguishing the element quantity of product shape
	F. Unity level	F1.One-piece, F2.Simple combination, F3.Compound	Distinguishing the integral level of product shape
	G. Overall form	G1.Geometric, G2. Organic, G3. Geometric+organic	Distinguishing the form categories of whole product image
	H. Stability level	H1. Stable, H2. Suitable, H3. Unstable	Distinguishing the levels of stable condition on product image
Shape manipulation	I. Prototypical level	I1. High, I2. Medium, I3. Low	Distinguishing the levels of prototype among product shapes
	J. Symbolic level	J1. High, J2. Medium, J3. Low	Distinguishing the levels of symbolic meaning among product shapes
	K. Functional level	K1. High, K2. Medium, K3. Low	Distinguishing the levels of practicability among product images
	L. Comfortable level	L1. High, L2. Medium, L3. Low	Distinguishing the levels of comfortable feeling among product images
	M. Pleasurable level	M1. High, M2. Medium, M3. Low	Distinguishing the levels of pleasurable feeling among product images

Figure 2-27 A List of Shape Features, Levels and Characteristics of Hsiao & Chen's Study (Hsiao & Chan, 2006)

Participants are asked to select one type of shape features and its level for each product. From their study, they find some correlations between shape elements and manipulations and four perception factors. According to the results, for trend factor, “prototypical level”, “symbolic level”, “functional level” and “pleasurable level” are found to be effective. Emotion factor is influenced by “line type”, “corner type”, overall form”, surface type”, comfortable level” and “pleasurable level”. “Element amount” strongly influences complexity factor whereas “volume type” is the main item that influences potency factor. This study reveals the relationship between emotional expression and product shape elements and manipulations (Hsiao & Chen, 2006).

Lin et al. (2013) also study form of a product and user’s responses. They choose classic chair to study on and try to understand how users like and perceive the forms of chairs. The aim is to transform users’ preferences into design specifications. Semantic differential method and quantitative analysis are used to investigate more and less preferred classic chairs. They define design elements of classic chair as seat, back, leg, stretcher, texture and color. Every design elements are divided into several patterns. They focus on the weightiness of each pattern. After the analysis of each pattern, they come up with user’ preference about classic chair. Modern, simple, unique and practical classic chairs are more preferable chairs.

Chang & Wu (2007) explores types and characteristics of household products which elicit pleasurable feelings. Designers are asked to choose most pleasurable products between 262 images. 19 most pleasurable products are chosen and in-depth interviews are hold with 30 participants. After interviews, they group the sentences from data analysis and identify “five types of pleasurable form and 14 associated characteristics”. In Figure 2-28, the coding of data can be seen. They define key word factors from the sentences of participants and then the related key word factors are grouped into 14 associated characteristics. Lastly, they come up with five types of pleasure forms. For their study, they aim to find the types and characteristics of products that elicit pleasurable responses. This method can be used to define

characteristics of dental instruments that have positive or negative effects on patients. However, this method does not include emotional measurement.

Types of pleasurable form	Characteristics	Key word factors
Aesthetic Form	Beautiful material	Transparent material, pretty material
	Attractive color	Natural color, bright & sharp color, various colors
	Delightful shape	Curved surface, soft surface, proportion, dynamic, combination, a/symmetry, simplicity, detail
Bios Form	Concrete form	Concrete animal, human, object, natural form
	Abstract form	Abstract animal, human, object, natural form
	Interesting movement	Functional movement, gesture
Cultural Form	Intangible effect	Fashion/taste, pride, literary meaning, nostalgia
	Playful interaction	Playful, sharing
	Tangible effect	Display
Novelty Form	Unique appearance	Smart material, unique shape, special color
	Structural innovation	New mechanism
	Creative concept	New concept
Ideo Form	Personal preference	Favorite aesthetic
	Personal value	Value

Figure 2-28 Coding of the Data from Questionnaire of Chungs & Wu's Study (2007)

In another study, Chang (2008) works on how product visual attributes affect the visual comfort of users. He chooses to study digital camera because he finds out that participants can clearly express visual comfort for digital camera. Then he defines product mechanism with "total form, color, texture, interface, function and lines". With a questionnaire, subcategories are added under these mechanisms. Moreover, six parts for digital camera are defined with the data from the literature. These parts are body, holding part, lens location, lens type, body proportion and color. At the end of study, Chang (2008) evaluates the weightiness of the visual attributes on the perception of user's comfort and also reveals the interaction between product components and these values (Chang, 2008). He creates "Kansei hierarchy of visual comfort appreciation of digital camera design" from participants' descriptions about visual comfort of digital camera and different aspects from the related literature. In

Figure 2-29, the hierarchy can be seen. This hierarchy chart can be used as a guideline for digital camera design.

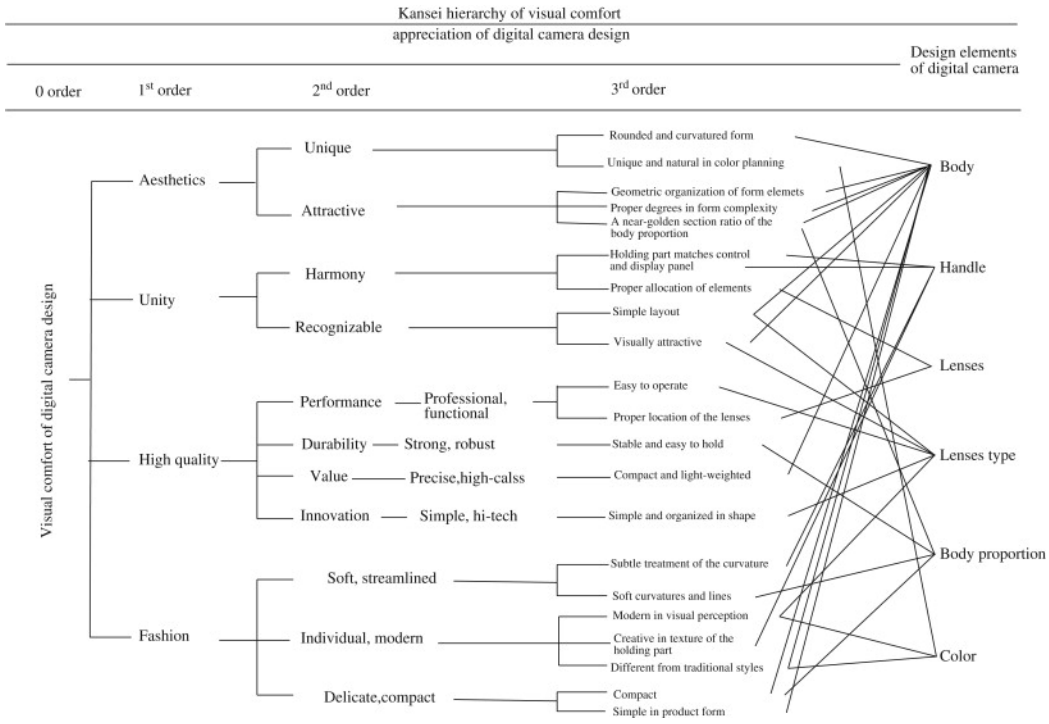
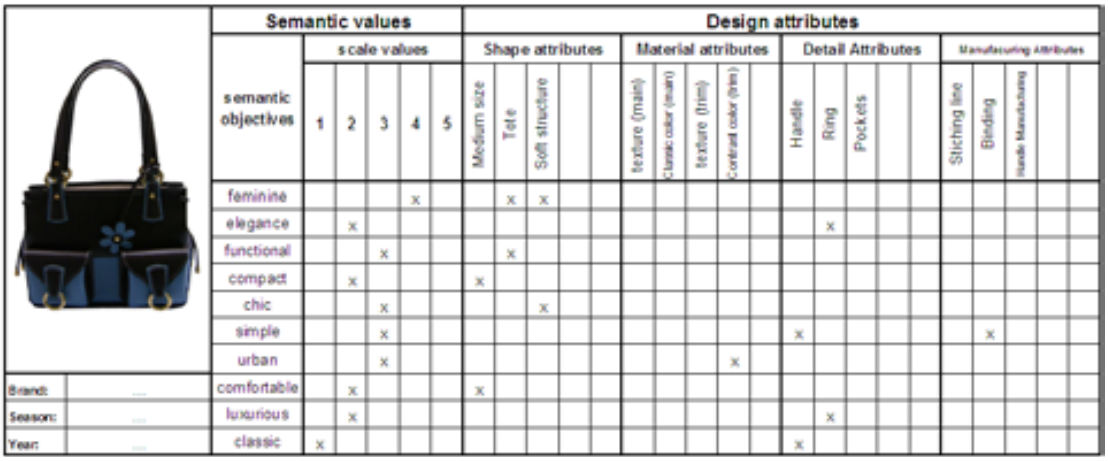


Figure 2-29 The Kansei Hierarchy of Visual Comfort Appreciation of Digital Camera Design (Chang, 2008)

According to Figure 2-29, visual comfort of digital camera design should include aesthetics, unity of form, high quality and fashion for the first order. In the second order, image words gathered from questionnaires are listed under the first order. For example, uniqueness and attractiveness are listed for the aesthetics of digital camera. Moreover, significant descriptions about visual comfort are listed in the third order hierarchy. Then the relationship between significant descriptions and design elements of digital camera are shown. This hierarchy chart can be useful for this thesis study. Kansei hierarchical framework for dental instruments can be constructed through verbal descriptions about product form of dental instruments.

The studies mentioned above try to explain the relationship between product visual attributes and users' affective responses by choosing electronics or sophisticated products to study on. Apart from these products, some researchers select simpler products to study on (Kongprasert et al., 2009; Wu et al., 2011).

Kongprasert et al. (2009) try to help designers to understand users' perception by using a new method. Their study is structured by a matrix map, which evaluates the relationship between product visual attributes and semantic adjectives. They choose leather bag to study on. First of all, semantic adjectives are gathered from magazines and websites. Then designers and engineers classify design attributes into four groups: shape attributes, material attributes, accessory and detail attributes, and manufacturing attributes. These four design attributes are also divided into sub-groups. Type of shape, size, structure and complexity are sub-groups of shape attributes. Type of material, surface finishing, color and flexibility are material attribute's sub-groups. Their questionnaire includes two parts; semantic values and design attributes. The questionnaire can be seen in Figure 2-30. In the first part, participants are expected to rate 10 semantic values with 5 degree Likert-scale. Then in the second part of the questionnaire, participants select the related design attributes according to the picture of the product. After participant fills this questionnaire, interview is conducted. Interview is based on this questionnaire. From this interview and questionnaire, Kongprasert et al. (2009) find the relation between bag's design attributes and semantic adjectives for each handbag. Design attributes that have maximum values can be considered in the process of new handbag design whereas the minimum values design attributes can be removed from the bag or can be replaced.



	Semantic values						Design attributes																							
		scale values					Shape attributes					Material attributes					Detail Attributes					Manufacturing Attributes								
	semantic objectives	1	2	3	4	5	Medium size	Tote	Soft structure			texture (main)	Classic color (main)	texture (trim)	Contrast color (trim)		Handle	Ring	Pockets			Stitching line	Binding	Handle Manufacturing						
	feminine				x			x	x																					
	elegance		x															x											
	functional			x				x																						
	compact		x				x																							
	chic			x					x																					
	simple			x													x						x						
	urban			x											x														
Brand:	comfortable		x				x																							
Season:	luxurious		x															x											
Year:	classic	x															x												

Figure 2-30 The Matrix Map Method (Kongprasert et al., 2009)

With this matrix map method, the relationship between the semantic objectives and design attributes of products can be found. If one or two of the semantic objectives of a product are supposed to have maximum value, designers can give more importance to the related design attributes in the product design process. This matrix map method can also be applied for dental instruments. Although this method does not have any part to measure emotions of users, some detailed information from the users can be gathered from in-depth interview.

User responses to product forms are investigated in the studies mentioned above. However, none of these studies take emotional responses to product form into account. Wu et al., (2011) in their study, try to understand the relationship between emotional response and design elements. Shoulder bag is chosen to study on. They consider positive (happiness, love, pride and contentment) and negative (anger, fear, sadness and shame) emotions of users. The results show that “pride” and “love” should be built in bag design whereas “sad” and “fear” emotions should be eliminated from the bag design. Due to the importance of the emotion on preference of users, it is needed to define the relationship between user’s emotional response and product design. In this thesis, this method can be applied to dentistry instruments. It can be considered which emotions evoke from these instruments.

In this section, it is investigated how people response to product appearances. As the thesis focuses on affective responses of patients to dental instruments' product visual attributes, it is also significant to analyze how a product elicit emotions, approaches to product emotion and how emotions can be measured. They will be explained in the next section.

2.5 Emotion in Product Design

Users expect every product -that they interact with, look at, feel, hear and smell- to meet their wants and needs. As all these expectations can change according to users' characteristics, designers should take the variety of users' expectations into the consideration in the product development process. Functionality, ergonomics, usability, affordability, aesthetic appeals are the product attributes, which are expected to exist for products (Demirbilek & Şener, 2003). Moreover, Desmet et al., (2004) claim that functionality, usability, efficiency and aesthetic appeal are not sufficient to exist for a product. As people are emotional beings, products can contribute to people's perception, values and their general well-being by eliciting emotions (Desmet et al., 2004). In this thesis, the term "product emotion" is used to refer all emotions that are elicited by using, seeing, owning or thinking about products.

In this thesis, the product is regarded as the starting point and the thesis focuses on the emotions of patients to dental instruments. Emotion is indispensable part of life. It has influence on how people feel, behave and think. The influence cannot result from rational and logical thinking; on the contrary, it comes from the feelings, perceptions and values (Khalid & Helander, 2006). Hence, it is difficult to predict how people react to products and which aspects of product attributes evoke emotions (Desmet et al., 2001). Since every person can have different emotions towards same product, people's concerns are the important factors to evoke emotions and emotions can only be understood with the person who experiences those (Desmet et al., 2004).

With the increase in expectations of users from products, the emotion-driven strategy of product design has become a current issue. Due to this strategy, designers are supposed to understand how emotions are evoked, how they affect the user and how this knowledge can be transferred to new product development process. Although people can have different emotions towards the same product, Desmet et al. (2004) claim that universal patterns can be defined to show how these emotions are evoked (Desmet et al., 2004).

2.5.1 Approaches to Product Emotion

Design for emotions can be achieved by understanding the emotional process in which products are designed to elicit certain emotions. Several models and approaches have been proposed to analyze emotional process (Jordan, 1999 in Desmet, 2007; Desmet, 2003; Norman, 2004 in Desmet, 2007). Three groups of product emotion approaches are developed to help designers to understand users' emotions and design products that can elicit intended emotions. The first one is pleasure approach, which is introduced by Jordan (2000); the second one is process-level approach in which Norman (2004 in Desmet, 2007) explains product emotion with information processing levels and a "neurobiological emotion-framework". The third one, appraisal approach, is introduced by Desmet (2002 in Desmet, 2007)

2.5.1.1 Pleasure Based Approach to Product Emotion

Patrick Jordan (2000) proposes a pleasure-based approach towards human factors. This approach exactly focuses on pleasure in product use that is also described as emotional and practical benefits related with products (Jordan, 2000). He combines Tiger's (1992) theory in which four types of pleasure are distinguished. Jordan (2000) investigates different sources about pleasure in products and divides the elements of pleasure into four: physiological, psychological, sociological, and ideological. These four elements of pleasure are important and every designed product can enhance each pleasure (Jordan, 2000).

The physio-pleasure: Bodily sensations are involved and sensory organs directly derive pleasure. It causes direct physio-pleasure or displeasure. For example physio-pleasure can be enhanced by a new ipad due to its smooth surface, soft touch and aesthetic appeal (Demir et al., 2009).

The socio-pleasure: Social interaction is the starting point of this pleasure. The products that facilitate social gatherings provide socio-pleasure. A vending machine can be illustrated as a good example because it can be regarded as a focal point for coming together (Desmet, 2007).

The psycho-pleasure: It is related with emotional reactions and gained from a completing a job with a product. For example a higher level of psycho-pleasure is derived from a product that is easy to operate than a product that is illogical and provide user to complete the task in a short time (Demir, 2008).

The ideo-pleasure: It is experienced with the product which is related to people's values. For example, a product which is made from reusable materials can be seen a value for environmental responsibility. People who concern about environmental issues can evoke ideo-pleasure for this product (Demir, 2008).

These four pleasures can be used as a source for understanding user's pleasure because these pleasures depend on the needs of users. Khalid & Helander (2006), in their study extend four pleasures to five. These are physical, social, psychological, reflective and normative pleasure. Although Jordan (2000) categorizes pleasure into four, the ideo-pleasure of Jordan can be stand for both reflective and normative pleasure of Khalid & Helander. Reflective pleasure is related to user's knowledge and experiences whereas normative pleasure focuses on social values (Khalid & Helander, 2006).

2.5.1.2 Process-Level Approach to Product Emotion

Donald Norman (2004) explains product emotion with information processing levels. He believes that emotional design has impacts on users' decision on products and users' affective responses. Then he focuses on the information processing which causes affective responses and describes this processing in three levels.

The first level, visceral level, is related to first impact with product appearance and is unconscious (Chu et al., 2011). The second one, behavioral level, is a routine response and is learnt through time (Demir et al., 2009). The third level, reflective level, involves consciousness and high level of cognitive skills such as making plans and solving problems. Furthermore, reflective level gives clues about user self-image and personal satisfaction. However, reflective level is sophisticated because every person has different cultural background and this results in a variety of responses (Chu et al., 2011).

These three levels of information processing help designers understand how a product elicits emotion and why. With these three levels, design approaches are developed. Visceral design is concerned with automatic responses to product appearance. Behavioral design is expectation-based and related to pleasure and effectiveness. And the last one, reflective design, is related to "self-image, personal satisfaction, and memories" and focuses on cultural meanings of products (Desmet, 2007; Demir, 2008). Visceral design can be related to the subject of the thesis as patients' first impact to dental instruments' appearances are investigated.

2.5.1.3 Appraisal Approach to Product Emotion

Desmet (2002 in Desmet, 2007) proposes appraisal theory to show how product appearance affects users and evokes emotions. This theory can be used to understand how products elicit emotions. According to this theory, emotion is elicited because of the personal significance of product. For example, as it is stated before, people can

feel different emotions to the same products as they appraise in different ways (Desmet, 2002 in Desmet, 2007). Desmet (2002 in Demir et al., 2009) proposes four main types of appraisals:

- the relation of a product to one's goals,
- the sensorial appeal of the product,
- the legitimacy of an action represented by the product,
- the novelty of the product (Desmet, 2002 in Demir et al., 2009).

These four types of appraisal can have three possible outcomes. According to the outcomes, product can be beneficial, harmful or irrelevant to user. These outcomes result in "a pleasant emotion, an unpleasant emotion or the absence of an emotion", respectively (Desmet, 2007).

Based on the Desmet's basic model of emotion, emotions arise when the products are appraised as beneficial or harmful according to individual's concern. To analyze this model, three key variables from appraisal theory are described to understand how emotions evoke (Figure 2-31).

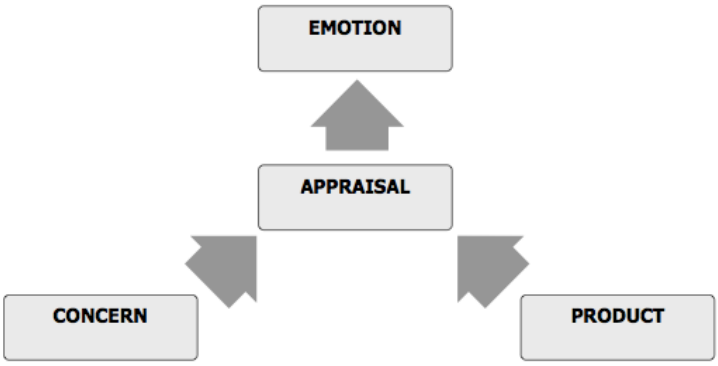


Figure 2-31 Basic Model of Emotional Response (Adapted from Desmet et al., 2001)

The first key variable is appraisal. Appraisal is the automatic evaluation of the importance of the product for individual's well-being. If a situation has relevant effect on individuals, the appraisal produces an appropriate response (Schifferstein, 2010).

The second key variable is concern. In order to understand user's appraisal to products, user's concern in the context of product usage must be understood (Schifferstein, 2010). A concern is described as "a more or less stable preference for certain states of the world" (Frijda, 1986 in Schifferstein, 2010). There are a variety of human concerns and some of them are universal whereas the others depend on individual's well-being and are personal. In the related literature, goals, values, needs, instincts and motives are regarded as types of concerns.

The last variable is the stimulus. Perceiving the product, using it or a consequence of using the product can be regarded as stimuli in the case of product emotion. Events that are dreamed, remembered and imagined can also elicit emotion just the way events that actually happen elicit emotions (Schifferstein, 2010).

These three key variables are effective in evoking emotions. The stimuli are appraised as beneficial or harmful according to matching or mismatching user's concerns. Individuals bring concerns into the emotion process, and stimuli are only relevant in the context of individual's concerns. Individuals have different concerns, which result in a variety of emotional responses in these individuals. Desmet et al. (2001) claim that the goals, standards and attitudes of user are important in product design process to predict which emotions can be elicited (Desmet et al., 2001). Goals, standards and attitudes are related to user's concerns. Goals refer to things that individuals want to see happen. For example, using scissors to have a haircut can be a utilitarian goal. Individuals can appraise the products if the products facilitate their goals (Desmet et al., 2001). Goals are related to what individuals want to obtain whereas standards refer to situations which individuals believe ought to be. Desmet (2007) defines standards as social norms, beliefs or conventions of how individuals

think things should be (Desmet, 2007). The last concern type is attitudes. It is about individuals' dispositional liking or disliking namely their preferences. For example, some people like American cars whereas others like Italian cars (Desmet, 2007).

Pleasure based approach, process-level approach and appraisal approach are explained to understand emotional process of user. In order to help designers to understand emotional reaction of users, some methods of measuring emotions have been developed. In the next part subjective and objective measures of emotion are explained.

2.5.2 Measuring Emotions

Emotions are multifaceted phenomenon and consist of components such as "behavioral reactions, expressive reactions, physiological reactions and subjective feelings". Various methods are developed to measure user emotions. However, each developed instrument generally measures one of these components (Desmet, 2003).

Khalid & Helander (2006) describe five significant criteria for measuring emotions. These are "dynamics, context, reliability, validity, and measurement error" (Khalid & Helander, 2006). Emotions are difficult to capture and are generated by different system. These properties of emotion are related to dynamic criterion. The second one is context. As it is mentioned before, emotions occur in a context. Emotions can differ from person to person and related to user experience and mood. The mood and the environment have influence on user's emotions. So it is important to capture context while measuring the emotions. The third criterion is reliability. Emotional responses can change from time to time. However, for the measurement methods, emotions should be measured reliably. User's mood changes needs to be considered. The fourth criterion is validity. The emotion which is intended to measure can be complex so one single measure may not be sufficient to measure. The last one is measurement error. To prevent measurement error, many measures can be applied instead of one measure. These five criteria have important impact measuring

emotions and should be taken into consideration (Khalid & Helander, 2006).

Methods for measuring emotions range from simple rating scales to high-tech methods including brain waves and eye movement measurement (Desmet, 2003). The methods that are related to user ratings of product and the methods that are related to design for emotion are grouped in two categories: subjective and objective measurement methods (Khalid & Helander, 2006).

2.5.2.1 Objective Measures of Emotion

Objective methods are relevant to design for emotion. Recording facial and vocal expressions are two main methods that are used to record and analyze emotions (Khalid & Helander, 2006). They are non-verbal and language-independent. These methods do not disturb participants during the measurements since they are not required to answer the questions. To measure facial expressions, the expressions of participants are recorded and then the relation between participants' emotions and facial expressions are analyzed. Facial Action Coding System has been developed to understand facial expression automatically and classify them (Khalid & Helander, 2006).

Like facial expression, vocal expressions are recognized from the patterns of vocal clues of emotion such as "average pitch, pitch changes, intensity color, speaking rate, voice quality, and articulation" (Desmet, 2003).

Actually, facial expressions of patients during dental operation can be recorded and analyzed to understand the facial expressions of patients towards dental instruments. However, for this method, it is hard to match the facial expression with emotions. Moreover, Kubovy (1999) claims that recording facial expression method is not appropriate for product design. He believes pleasures cannot make any facial expression changes (1999 in Khalid & Helander, 2006).

Another objective measure is related to physiological reaction. It is about the change in the autonomic nervous system (ANS), which affects the emotions. Measuring blood pressure, heart rate, brain waves and skin responses can be examples of physiological reactions (Desmet, 2003).

These non-verbal and objective measures are generally have limited basic emotions such as fear, surprise and anger. However, these methods cannot assess mixed emotions; therefore, it is not appropriate to measure emotions related to product (Desmet, 2003).

2.5.2.2 Subjective Measures of Emotion

Subjective measures are related to user evaluation of product characteristics. Kansei Engineering and Semantic Differential methods are commonly used subjective measurement methods. There are a number of emotional scales and techniques to measure emotions. Some of them are verbal whereas the others are non-verbal. In the following section some prominent scales that can be used at emotional level are described.

As one of the oldest method, The Self-Assessment Manikin (SAM), is developed as a non-verbal pictorial method by Lang (1985 in Desmet, 2003). In this method, schematic manikins are used to present different emotions and this makes it to be useful for other cultures as it is non-verbal. One-to-one or straight translation is not available for emotion words. SAM is developed to overcome this problem. This method is generally used for consumer experience marketing (Chu et al., 2011; Laurans et al., 2009).

Another method for consumer experience is developed by Richins (1997 in Schifferstein, 2010). The Consumption Emotion Set includes 47 emotion descriptors. It is like an emotion descriptors pool and the items can be drawn when measuring "pre-purchase, shopping and consumption emotions". According to Richins, the

emotions that are elicited by products can differ according to person and the situation. Richins (2008 in Schifferstein, 2010) claims that there is a distinction of emotion between mundane, extraordinary and conditional products. Mundane products such as pencil, glass, and toothbrush are unlikely to elicit emotions. If there is an unusual situation about the mundane products, then they have probability to elicit emotions. On the other hand, Richins (2008 in Schifferstein, 2010) explains that extraordinary products are likely to elicit emotions especially right after purchasing them. Added symbolic value is effective for the product to be regarded as extraordinary. The situation for conditional products is a bit different. For example, a suit can be a mundane product; however, it can be important to person if he is wearing it on a first day of work (Richins, 2008 in Schifferstein, 2010).

The methods mentioned above are mainly related to marketing experience. Some methods directly related to product development are analyzed below. For example, Jordan (2000) develops a questionnaire for Philips Corporate Design. The questionnaire is used to measure pleasure in products and consists 14 questions about user's feelings about products. A 5-point Likert scale is used. In addition, open-ended questions could be used as an option, if the approach of participant towards product is not understood by the investigator (Jordan, 2000).

Like Jordan, Desmet (2003) develops the Product Emotion Measurement Instrument (PrEmo) to measure individual's emotional responses to products. However, PrEmo is a non-verbal and self- report instrument. It has 14 measured emotions and gives opportunity to participant to express their feelings by selecting appropriate cartoon characters. There are seven positive and seven negative emotions. Each character animation includes facial and body expression and also vocal expression. According to Desmet, PrEmo can be used cross-culturally since participants do not verbalize their feelings. It is also possible to measure mixed emotion with PrEmo. (Desmet, 2003).

Premo, at first glance, seems to be appropriate method to define people's emotions. For this thesis, this method can be used to provide information about emotional reaction of patients towards dental instruments. However, it seeks an answer in detail. Patients are supposed to explain why they feel in that way. Therefore, this method can only be useful for a preliminary study to guide patients to express their feelings towards the instruments.

Scherer (2005) develops a verbal self-report instrument that is called The Geneva Emotion Wheel. It is available in other languages and includes 20 emotion families. It is used to measure user's affective responses to events, objects, and situations (Figure 2-32).

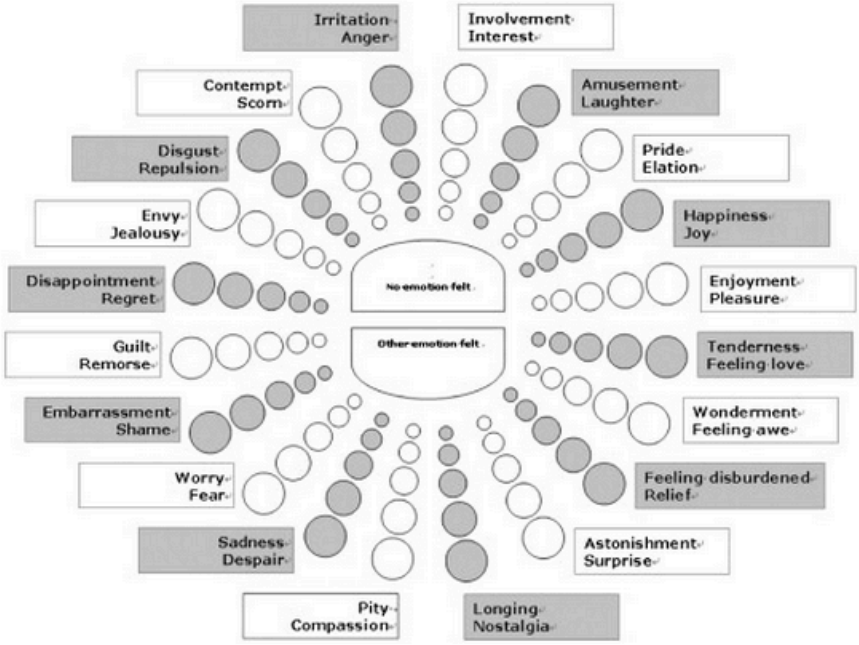
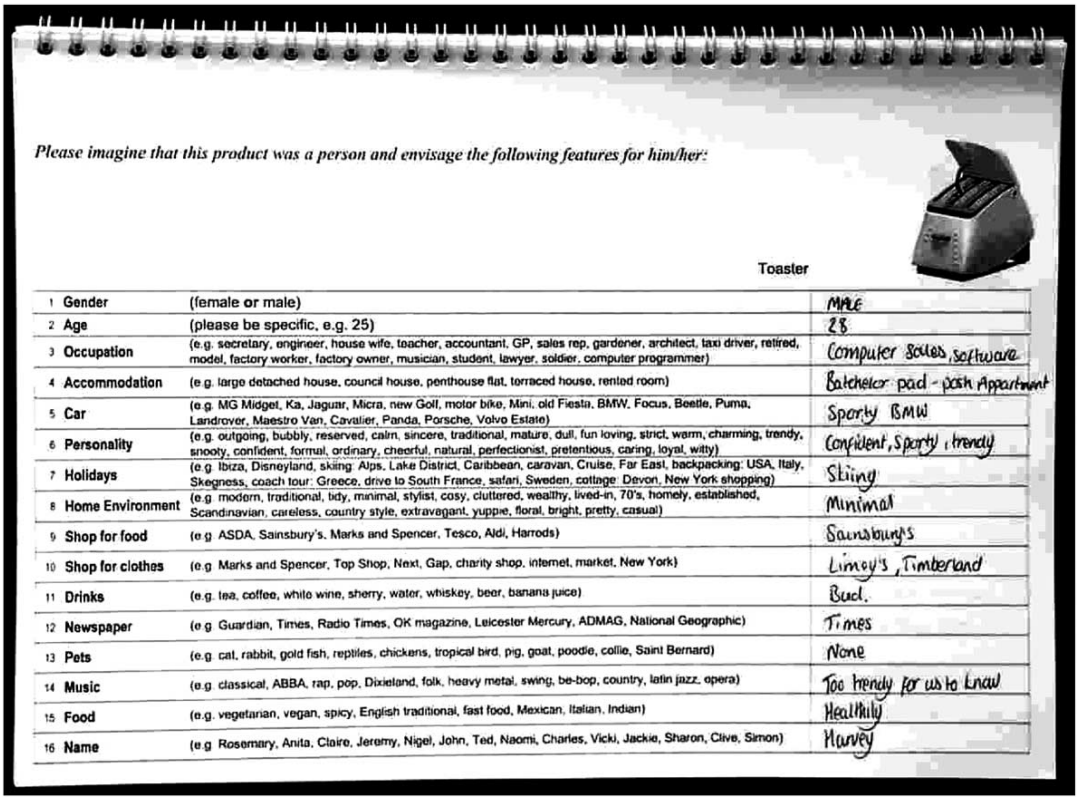


Figure 2-32 Geneva Emotion Wheel (Scherer, 2005)

These methods mentioned above can be used to measure users' feelings towards a product in the product development process (Laurans et al., 2009).

The method of McDonagh et al. (2002), Product Personality Profiling (PPP), is adapted from market research area. It is used to elicit user's emotional perceptions; participants are required to imagine a product as a person and then they are asked to fill out a questionnaire immediately in a short time by considering product's personality, character and its lifestyle. McDonagh et al. (2002) believe that this method helps participants to express their affective responses to products. In Figure 2-33, an example of user responses to toaster can be seen. In a focus group the responses of every participants are discussed to understand the reason why the participant choose in that way. McDonagh et al. (2002) claims that this method reveals hidden expressions and perceptions of users and make them to understand the aspects that many users are unaware of (McDonagh et al. 2002).



Please imagine that this product was a person and envisage the following features for him/her:

Toaster

1 Gender	(female or male)	MALE
2 Age	(please be specific, e.g. 25)	28
3 Occupation	(e.g. secretary, engineer, house wife, teacher, accountant, GP, sales rep, gardener, architect, taxi driver, retired, model, factory worker, factory owner, musician, student, lawyer, soldier, computer programmer)	Computer Sales, software
4 Accommodation	(e.g. large detached house, council house, penthouse flat, terraced house, rented room)	Batchelor pad - posh Apartment
5 Car	(e.g. MG Midget, Ka, Jaguar, Micra, new Golf, motor bike, Mini, old Fiesta, BMW, Focus, Beetle, Puma, Landrover, Maestro Van, Cavalier, Panda, Porsche, Volvo Estate)	Sporty BMW
6 Personality	(e.g. outgoing, bubbly, reserved, calm, sincere, traditional, mature, dull, fun loving, strict, warm, charming, trendy, snooty, confident, formal, ordinary, cheerful, natural, perfectionist, pretentious, caring, loyal, witty)	Confident, Sporty, trendy
7 Holidays	(e.g. Ibiza, Disneyland, skiing: Alps, Lake District, Caribbean, caravan, Cruise, Far East, backpacking: USA, Italy, Skegness, coach tour: Greece, drive to South France, safari, Sweden, cottage: Devon, New York shopping)	Skiing
8 Home Environment	(e.g. modern, traditional, tidy, minimal, stylist, cosy, cluttered, wealthy, lived-in, 70's, homely, established, Scandinavian, careless, country style, extravagant, yuppie, floral, bright, pretty, casual)	Minimal
9 Shop for food	(e.g. ASDA, Sainsbury's, Marks and Spencer, Tesco, Aldi, Harrods)	Sainsburys
10 Shop for clothes	(e.g. Marks and Spencer, Top Shop, Next, Gap, charity shop, internet, market, New York)	Limey's, Timberland
11 Drinks	(e.g. tea, coffee, white wine, sherry, water, whiskey, beer, banana juice)	Bud.
12 Newspaper	(e.g. Guardian, Times, Radio Times, OK magazine, Leicester Mercury, ADMAG, National Geographic)	Times
13 Pets	(e.g. cat, rabbit, gold fish, reptiles, chickens, tropical bird, pig, goat, poodle, collie, Saint Bernard)	None
14 Music	(e.g. classical, ABBA, rap, pop, Dixieland, folk, heavy metal, swing, be-bop, country, latin jazz, opera)	Too trendy for us to know
15 Food	(e.g. vegetarian, vegan, spicy, English traditional, fast food, Mexican, Italian, Indian)	Healthily
16 Name	(e.g. Rosemary, Anita, Claire, Jeremy, Nigel, John, Ted, Naomi, Charles, Vicki, Jackie, Sharon, Clive, Simon)	Harvey

Figure 2-33 An Example of Product Personality Profiling Form (McDonagh et al., 2002).

Moodboard is another method that provides designers to understand user's emotions. Users can express their feelings and experiences through abstract images (McDonagh et al., 2002). Applying the moodboard method requires much time as participants cut out images and arrange them. Sometimes a simple version can be applied. Participants can choose images among the images that investigator has selected. Hence, investigator defines the certain aspect (McDonagh et al., 2002). This method provides participative design activities but does not provide design solutions. It only gives clues about participant's feelings and responses towards visual stimuli. This method can be preferred as it is inexpensive to generate and language-independent. It can also be applied in diverse activities such as focus group and create a discussion environment between designers and users. On the other hand, participants can be unfamiliar with this method and also investigators can misinterpret moodboards. Preparing moodboards and application period needs much time in comparison with product personality profiling form (McDonagh et al., 2002).

On the contrary to moodboard, visual evaluation of products method takes extremely short time. The visual data of products such as product's form, material, shape, texture, color are examined in this method. The aim is to understand which product attributes are effective on user's selection. The data is gathered both users' and designers' perspectives (McDonagh et al., 2002). In this method, the participant is required to fill a form to evaluate the product based two-dimensional image. Moreover, the participant is required to complete the evaluation on his own. It takes 5 minutes for each product form. Moreover, this method may also be applied by providing the products to the participant. Therefore, a real simulation of usage scenario may be provided (McDonagh et al., 2002).

Two different visual evaluation fill-out forms have been developed (McDonagh et al., 2002). The first one is based on evaluating a product's visual data and the fill-out form includes only selected products (Figure 2-34). The aim of this fill-out form is to measure first reaction of user to product's visual data (McDonagh et al., 2002). The second fill-out form has been developed by Bruseberg & McDonagh (2001 in

McDonagh et al., 2002). This fill-out form includes 20 variations of the same product categories and is based on the evaluation of product shape. It concentrates on the main reasons of user preferences through the products (Bruseberg & McDonagh, 2001 in McDonagh et al, 2002). However, the visual product evaluation method and its fill-out forms have also some limitations. The picture quality, form and questionnaires can affect user responses. Participants can be unfamiliar with this method and misunderstood how they can fill these forms.

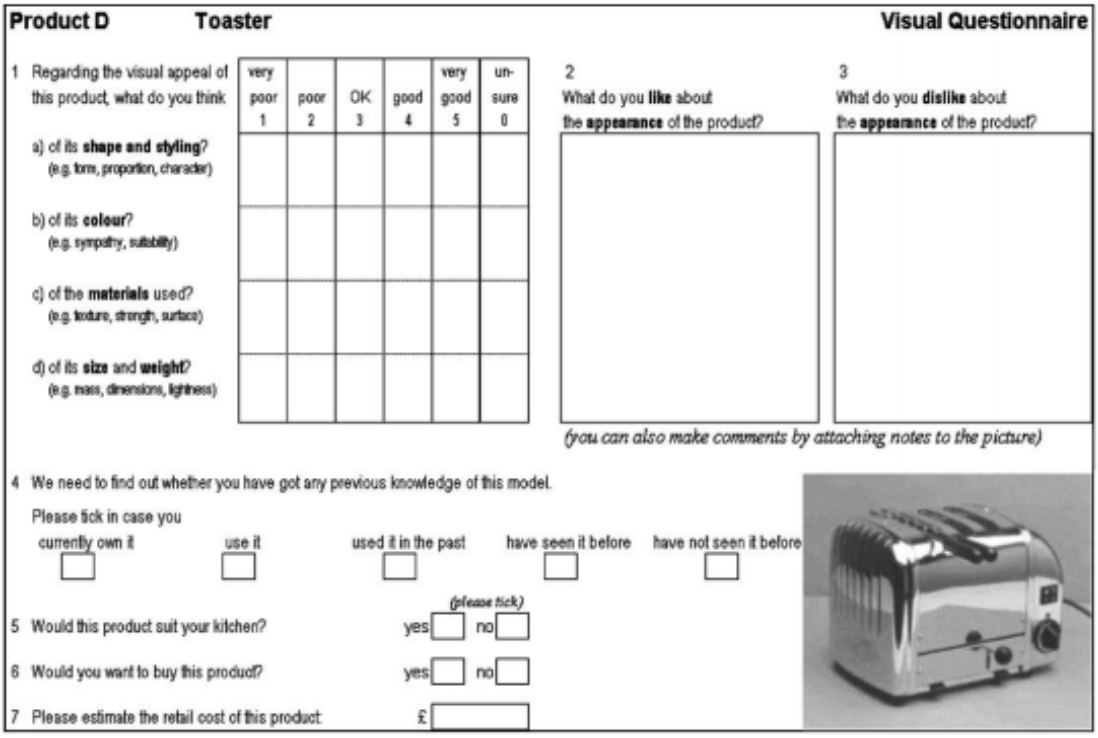


Figure 2-34 Visual Product Evaluation Fill-out Form (McDonagh et al., 2002).

All these objective and subjective measurement methods for emotions are used to understand users' affective responses to products. Both methods have benefits and limitations. Recording facial and vocal expressions are extremely difficult to match with emotions. On the other hand, self-assessment methods can interfere with the

experience. Thus, Laurans et al. (2009) has developed a method that can be a combination of several available methods. This method is called Self-Confrontation (Laurans et al., 2009). The principle of this method is that users are filmed while interacting with the product and then they are required to report about their experience while watching the video. They believe that the video provides users to remember their facial and physiological expression, their experiences and their feelings towards products (Laurans et al., 2009) (Figure 2-35). This method can be beneficial as it combines objective and subjective measurement methods. However, for this thesis' main study, it can be difficult to monitor patients during the dental treatments as they are under stress condition and monitoring them may increase their stress.

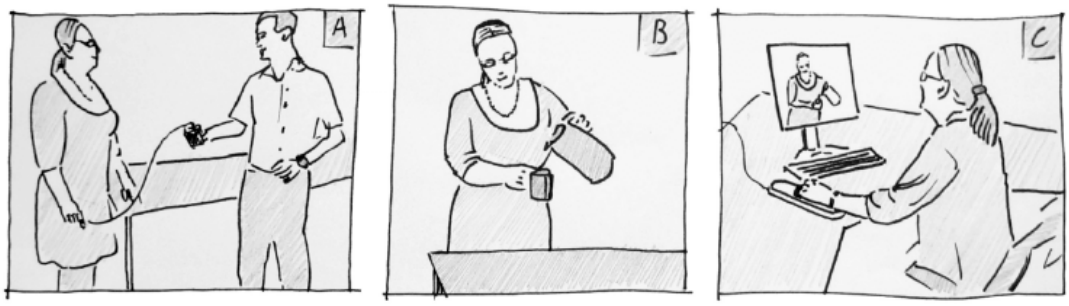


Figure 2-35 Approach to the Measurement of Emotion – Self-Confrontation Method (Laurans et al., 2009).

Moreover, Laurans et al. (2009) have developed a device, the emotion slider, to provide users to express their emotions while interacting with the products. Self-report of emotions is possible with this device. After the interaction, the device reports the feelings (Laurans et al., 2009).

All these measurement methods mainly focus on the visual interaction with the product. A product can elicit emotion due to many reasons. This thesis only focuses

on visual features of products and how these features help eliciting emotions.

In this chapter, findings of the literature review study are presented. Firstly, emotions in dentistry environment are explained. And then, dental instruments and treatments are presented. Then, general design requirements of medical hand tools and the factors influencing the medical device design are analyzed. Product appearance and the values related with product appearance are discussed. And lastly, product emotions and inducement of these emotions are explained. In the next chapter, research studies that focus on patients' emotional reactions towards dental instruments will be presented.

CHAPTER 3

METHODOLOGY

A research study composed of two preliminary studies and one main study is conducted to explore patients' emotional responses to the dental instruments and the influences of the product visual attributes on these emotions. The chapter gives details about these studies including their data collection tools, samples, data-analysis procedures, and the results. Discussion on the findings is also presented at the end of the chapter.

3.1 Objective of the Study

As presented in the previous chapter, there are many studies on user's psychological responses to product forms and prominent negative emotions of patients in dentistry. Results of the literature review study show that, product visual attributes can have influence on user's affective responses. This is also relevant for medical area. When the design history of medical devices is analyzed, it is seen that user emotions has recently started to be taken into consideration as an important factor in design process. This newly emerged approach has not spread out in medical device design area.

Moreover, as stated in the literature on dental fear, intense negative emotions are influential in dentistry environment and the reasons of these negative emotions can be instrument-related. Thus, considering the literature on the user's psychological responses to product visual attributes and prominent negative emotions of patients in dentistry, it is pre-assumed that the emotions of patients are affected from the dental instrument related factors.

The most important output of the literature review study is that there have been no studies about the relationship between the emotions of patients and visual attributes of dental instruments.

In order to examine the research questions of the thesis, a research study is composed of three parts. The first two studies are planned to conduct as preliminary studies to gather quantitative and qualitative data to shape the Main Study. As shown in Figure 3-1, the diagram-presentation of the methodology of this thesis is presented. The first preliminary study aims to gather instruments' product visual attributes and related qualities, which are effective on patients' emotions. To understand the effects of previous dental experiences on patients' emotions towards dental instruments, second preliminary study is planned to conduct. From the results of second preliminary study, the "study materials" will be decided for the Main Study. Lastly, in depth interview will be conducted to get more detailed data about the visual attributes of dental instruments.

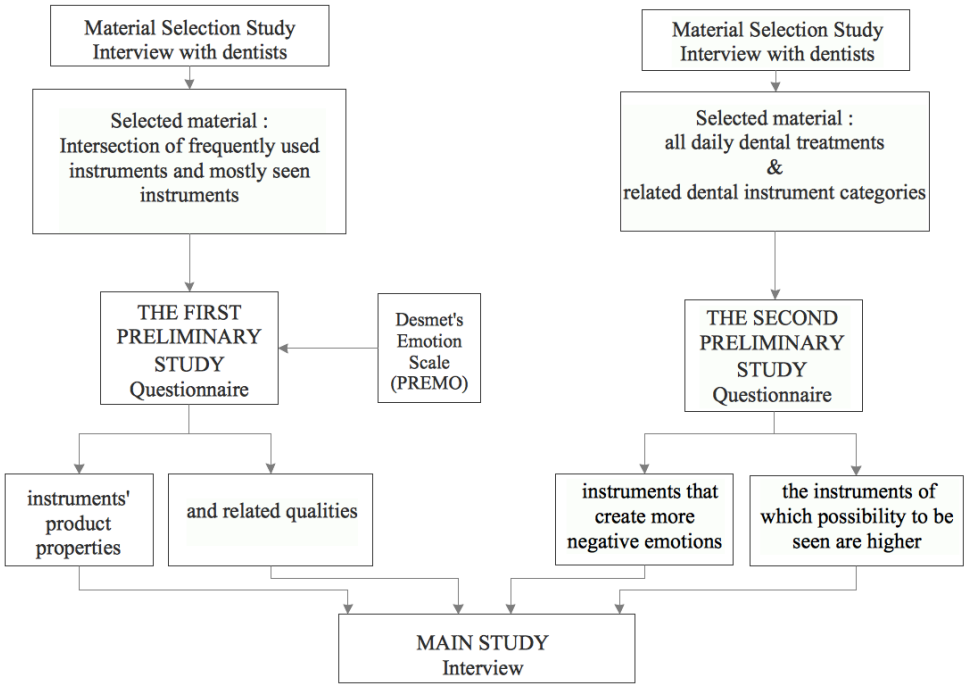


Figure 3-1 Diagram-Presentation of Methodology

Preliminary studies focused on the following research questions.

- What are the influences of product visual attributes on the emotional reactions of the patients to the dental instruments?
- Is there a relationship between seeing the dental instruments in the previous dental treatments and patients' negative feelings?
- How might the dental instrument's product visual attributes be to decrease the negative emotions of patients?

All the questionnaires and the interviews were conducted in Turkish, as all of the participants' native language is Turkish. Details of two preliminary studies and the Main Study can be seen in the Appendices B, F and I. Moreover, English version of each study is also provided in the related Appendix.

3.2 Preliminary Study I

First preliminary study aimed to show the emotional reactions of the patients to the dental instruments and explain which product visual attributes and related qualities trigger these emotions. In doing so, first preliminary study focused on the following question:

- What are the influences of product visual attributes on the emotional reactions of the patients to the dental instruments?

In the related literature, there are scarce sources about the dental treatments and which instruments are used frequently. Therefore, to select dental instruments for the first preliminary study, it was decided to consult dentists. Therefore, a material selection study was conducted with dentists.

3.2.1 Material Selection Study for the Preliminary Study I

The material selection study focuses on the following question:

- Which dental treatments are the daily routine treatments performed by a general practitioner dentist?
- Which dental instruments are used frequently during those daily routine treatments?
- Which instruments can patients see during those dental treatments?

3.2.1.1 Sample

In order to create a meaningful sample for the study, all the related data bases or documents searched out but even a list of all dentists who work in Ankara, the capital of Turkey and also the city that the author of this thesis lives, could not be reached; the author got in touch with 20 dentists by using her own contacts as resources. Five of 20 dentists accepted the invitation to the interview. Therefore the material selection study was conducted with five dentists. One dentist from METU Medical Center, three dentists from Hacettepe University Hospital and one dentist from a private dental clinic in Ankara participated in the interview. In Table 3-1, profiles of the participants are presented. They were consulted to decide which instruments could be used as study material for the first preliminary study.

Table 3-1 Profiles of the Participants_ Material Selection Study for the Preliminary Study I

Participants	Office of participants	Age	Speciality
Dentist 1	Dental Office / METU	30-35	No speciality
Dentist 2	Dental Office / Hacettepe	25-30	Prosthodontics
Dentist 3	Dental Office / Hacettepe	35-40	Pediatrics
Dentist 4	Dental Office / Hacettepe	30-35	Periodontics
Dentist 5	Dental Office / Ankara	45-50	No speciality

3.2.1.2 Method

Four open-ended questions were asked to the dentists during the interviews (Appendix A). They were required to define their daily dental treatments and its related instruments. According to the dentists, there were many treatments and the treatments could change according to their specialties. Therefore, they suggested selecting general dental treatments used by general practitioner dentists for the first preliminary study.

3.2.1.3 Results

From this study, five daily routine dental treatments were designated.
These are:

- General Diagnosis
- Restoration of tooth
- Extraction of tooth
- Periodontal treatment
- Root canal treatment

According to these treatments, nine instruments were selected owing to the information gathered from five dentists. Dentists selected the dental instruments by considering their possibility to be seen during the treatments by patients. In Table 3-2, selected dental instruments and related dental treatments are presented. *Probe*, *mirror* and *tweezers* are used for general diagnosis. *Forceps* and *elevator* are main instruments for extraction of tooth. Apart from general diagnosis, almost all treatments need *injector*. *Drill* is used for restoration of tooth. *Ultrasonic scaler* and *probe* are used for periodontal treatments. *Endodontic file* is used for root canal treatment.

Table 3-2 Selected Dental Instruments and Related Dental Treatments

	General Diagnosis	Restoration of tooth	Extraction of tooth	Periodontal treatment	Root canal treatment
Probe	✓			✓	
Mirror	✓				
Tweezer	✓				
Forcep			✓		
Elevator			✓		
Injector		✓	✓		✓
Ultrasonic scaler				✓	✓
Drill		✓			
Endodontic file					✓

From the material selection study, nine dental instruments were selected. For each instrument, Google images were searched with instrument names as keywords in May 2012 and almost all images were collected. All the images were grouped according to their types and then their visual attributes. Then the instruments were selected randomly through these image groups (Appendix B). At the end, three variations of each dental instrument, which are different in design, material and color applications if it is possible, were decided as study materials.

3.2.2 Data Collection Tool

An Internet based questionnaire was designed as data collection tool. The questionnaire had three pages with images of dental instruments (Appendix B). Each page had three instruments and their three variations. At the bottom of each page, the emotions of Pieter Desmet's (2003) Premo product emotion measurement tool, which was mentioned in the previous chapter, were provided. Brief descriptions of each instrument were given such as tooth extraction instruments, endodontic files, general diagnosis-mirror etc. Participants were expected to choose one of the Premo characters representing his/her emotions. After selecting a character for each dental instrument, they were required to write the reason of selected emotions by referring instrument's product visual attributes.

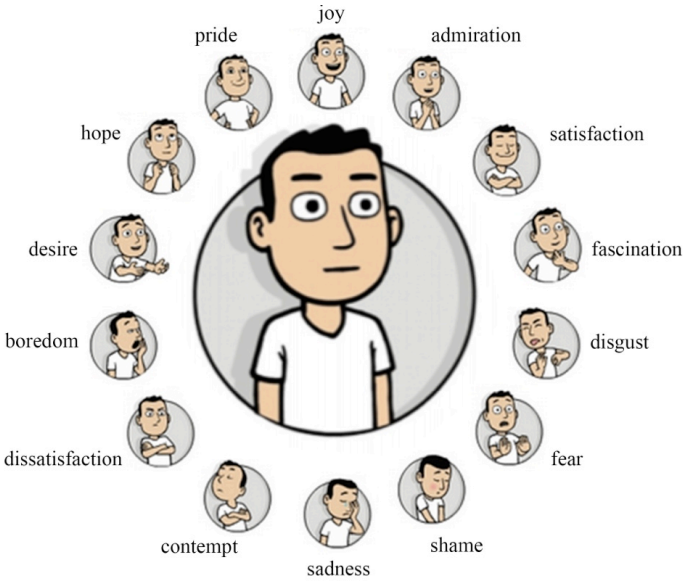


Figure 3-2 Desmet's PrEMO Product Emotion Measurement Tool Characters (2003)

Pieter Desmet's product emotion measurement tool (PrEmo) is a non-verbal self-report instrument to measure emotional responses of product users. It is based on seven positive (desire, hope, pride, joy, admiration, satisfaction and fascination) and seven negative emotions (disgust, fear, shame, sadness, contempt, dissatisfaction and boredom) of a cartoon character. This tool is computerized and has an interface to choose the emotions according to expression on the characters' faces. However, for this thesis, only 2D drawings of cartoon characters were provided (Figure 3-2). The aim of using this tool was to help participants to define their feelings towards the dental instruments. The data gathered from the selection of emotions was only used to reach quantitative data. The explanations of the reasons were analyzed with content analysis method.

3.2.3 Sample

The sample consists of 50 female and 50 male participants. The ages of the participants were between 25 and 53. An Internet based questionnaire was distributed to 150 people from the author's workplace since it is a huge company in which

around 4000 employees work. Approximately 70% of employees are engineers. So the participants are middle aged and educated persons. 104 participants sent the questionnaire back after completing. Four of them completed the questionnaire partially that's why the results were generated from the data coming from 100 participants.

3.2.4 Analysis and Results

Quantitative data was gathered through emotion selection. Microsoft Excel program was used to visualize quantitative data with graphics. The statements that were written by all the participants were content analyzed. Each statement was coded in three steps. Firstly, product property such as form, proportion, and color was determined with respect to participant's statement. And then, related quality of product property was decided. Lastly, feelings of participants were coded. An example of this data analysis procedure is presented in Table 3-3 (also see Appendix C).

Table 3-3 Data Analysis Procedure Example

Statements by Participants	Related Product Property	Related Quality	Related Feeling
I feel safe because of its form. I think it does not make me feel pain.	Form	Safe appearance	Feeling safe
I am disgusted by the elevator because of its green color.	Color	Unpleasing appearance	Feeling disgust

3.2.4.1 Quantitative Data

Participants were required to select one emotion (emotional -facial- expression of the cartoon character) for each instrument from Premo (Desmet, 2003). In Figure 3-3, the results for positive and negative emotions towards all dental instruments are presented. 70% of the participants have negative feelings towards dental instruments presented in the questionnaire. Fear has come into prominence with a prevalence of 30% (Figure 3-3). Besides fear, boredom and disgust are the most significant negative emotions towards dental instruments considering participants' selections.

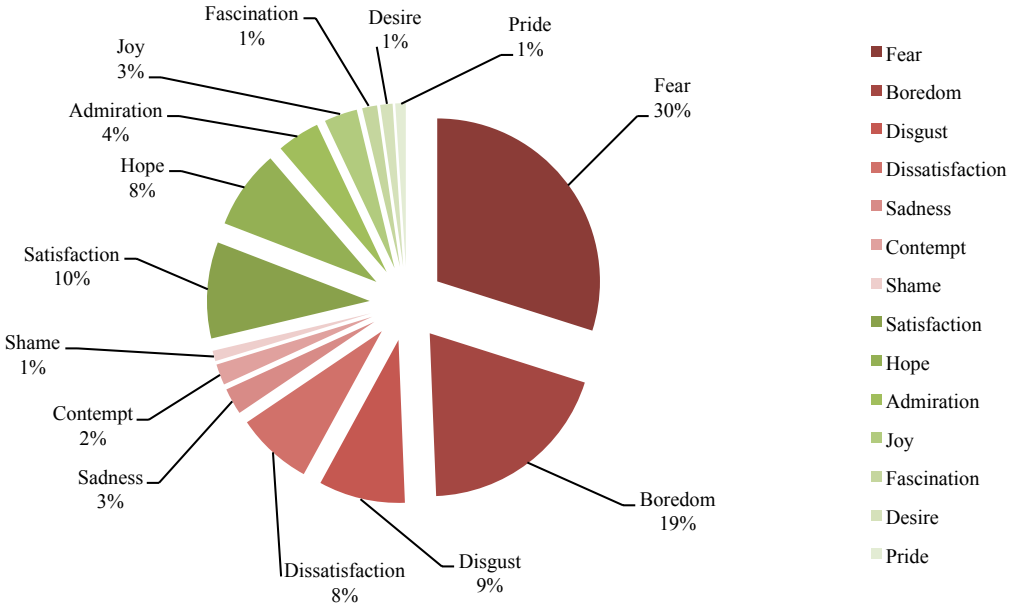


Figure 3-3 The Percentages of Participants' Emotions towards Dental Instruments Presented in the Preliminary Study I

The quantitative data about each emotion were grouped into two categories: positive and negative emotions. When positive and negative emotions toward dental instruments were analyzed, it was found that there is no significant difference between dental instruments (Figure 3-4). The difference has reached its minimal

value for dental mirror and ultrasonic scaler. The reason of this minimal difference is due to the high frequency in positive emotions. Furthermore, mirror is the only instrument in which positive emotions come into prominence. Forceps and elevator used for extracting tooth, probes and tweezers used for basic examination are having negative influence on the participants' emotions.

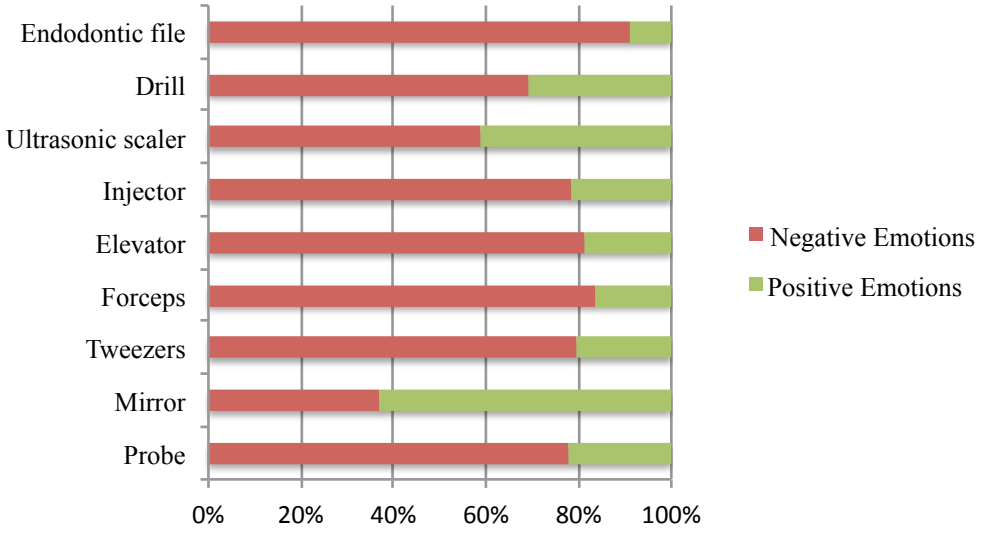


Figure 3-4 The Distribution of Positive and Negative Emotions Selected by the Participants

3.2.4.2 Qualitative Data

As mentioned previously, with the questionnaire, besides selecting emotions for each dental instrument, participants were asked to explain why they feel that emotion towards dental instrument. They were asked to explain at least three instruments for each paper in order to gather which product properties and related qualities of product properties had effects on participants' emotions.

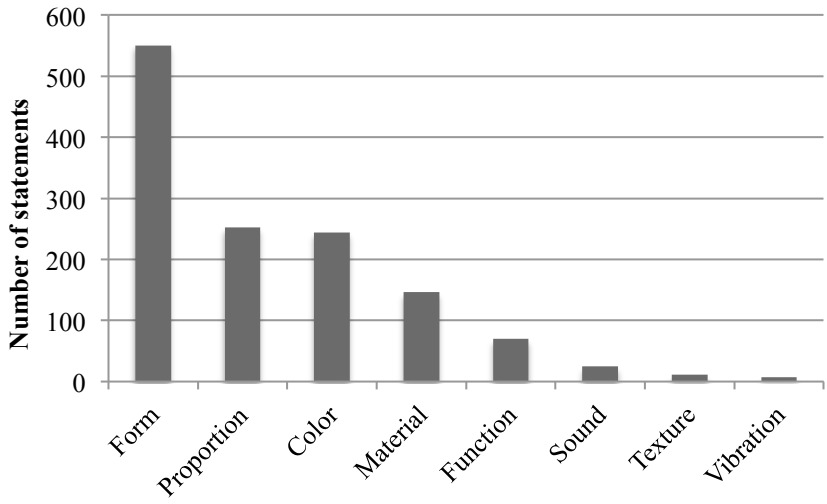


Figure 3-5 Number of Statements Related to Product Properties.

1305 statements in total by the participants were coded and grouped in eight main categories and thirteen sub-categories. Main categories are related with product properties: form, proportion, color, material, function, sound, texture and vibration (Figure 3-5).

3.2.4.2.1 Product Properties and Related Qualities

Form

Form refers to visual shape of the instrument. In the first preliminary study, most of the statements were made on visual forms of the instruments. As seen in Table 3-4, the visual form of an instrument triggers positive and negative emotions and their significance are so close. As it can be seen in the related literature, negative emotions towards dental treatments are dominant. However, it was found out from statements of the first preliminary study that positive emotions towards dental instruments have also significant percentage. Since different designs of dental instruments were selected, the significance of positive emotions might be related to these different designs of the instruments.

Table 3-4 The Percentages of Positive and Negative Emotions for Instruments' Product Properties

	Positive Emotions (%)	Negative Emotions (%)
Form	52.4	47.6
Proportion	9.1	91.9
Color	72.5	27.5
Material	35.6	64.4
Texture	63.6	36.4
Function	47.1	52.9
Sound	0.0	100.0
Vibration	0.0	100.0

Statements related to instruments' forms are mainly about dental instruments' resemblance to other products such as toothbrush, spoon, candy, corkscrew, hand tools and machine tools. Participants also state that sharp ends and edges, and curly end parts affect their emotions negatively. There are also statements about handle part of instruments. For example, length and thickness of handle results in negative emotions on participants.

Proportion

Proportion refers to the relative size and scale of the instruments, namely the relationship between parts of the instruments. As seen in Figure 3-5, after the form, proportion has strong effect on participants' emotions. Participants explain that for some dental instruments, some parts of some dental instruments are slimmer, or sharper, or bulkier than the other parts of the instruments that make participants feel negative or positive. According to Table 3-4, negative effects of proportion are extremely higher than its positive effects.

Color

By considering all the images gathered from the Internet for this study, it can be said that it is rare to see colored dental instruments in dentistry. It is observed that,

generally metallic silver color is preferred for the instruments. For the study, colored dental instruments are also selected to see the effect on participants' emotions. However, it is difficult to find colored instruments for all the dental instruments so for some instruments only partially colored dental instruments are selected. It is possible to see positive affect of color from Table 3-4. The prevalence of positive emotions (72.5%) is more than the negative one (27.5%) while analyzing only the color.

Material

Plastics and metals are dominant materials for dental instruments. Therefore, for each dental instrument groups, plastics and metal instruments are searched for. However, for the elevator, none of the image of elevator that is made of plastic is found.

When the effect of material is analyzed, the prevalence of negative emotions (64.4%) is much more than the positive one (35.6%). From the statements, participants mention material with its hygienic or unhygienic appearance. Safe or unsafe appearance is also mentioned because of material of instruments.

Function

Function is related with what the instrument is used for. Although in the questionnaire participants are asked to write the reason why they select emotions by referring instrument appearance, there are also statements about instruments' functions. The reason of statements related to function may be participants' previous dental experience or short description of instruments' function given in the questionnaire. As the function is not a product visual attribute, it will be omitted in the next studies.

Texture

Texture refers the perceived surface quality of dental instruments. As the participants only see the image of dental instruments, it is hard to analyze texture of these instruments from the images. Therefore, for this study unlike form, proportion, color

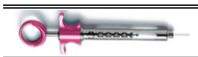
and material, it is found that, according to the participants, texture has little effect on participants' emotions. As seen in Table 3-4, participants who wrote statements about texture, mentioned texture as triggering positive emotions.

Sound & Vibration

Sound and vibration are relevant for only two of the selected instruments for this study; dental drill and ultrasonic scaler. Similar to function, sound and vibration are not product visual attributes. Although participants have not experience sound and vibration in the study, the reason why participants mention sound and vibration of these instruments may be because of participants' previous dental experiences.

Positive and negative effects of product visual attributes – form, proportion, color, material and texture- are counted quantitatively for each instrument. All values are expressed as percentages of the statements that related to specific product visual attributes for each instrument. For example, for injector design 2, participants have made 10 statements on its proportion: four positive and six negative statements. The percentages of injector design 2's proportion are calculated by considering 10 statements. Therefore, in Table 3-5, it can be seen that the significance of positive effect is defined 25% whereas negative effects of second injector design's proportion is defined 75%.

Table 3-5 Significance of Product Visual Attributes for Injector Designs

		Form (+)	Form (-)	Proportion (+)	Proportion (-)	Color (+)	Color (-)	Material (+)	Material (-)	Texture (+)	Texture (-)
	Injector Design 1	76.2	23.8	25.0	75.0	85.7	14.3	0.0	100.0	0.0	0.0
	Injector Design 2	57.9	42.1	40.0	60.0	0.0	0.0	0.0	100.0	0.0	0.0
	Injector Design 3	15.0	85.0	0.0	100.0	0.0	0.0	50.0	50.0	0.0	0.0

Injector, drill, forceps and elevator designs are selected to analyze, as there are differences in product visual attributes for the instruments in the same group. The significance of product visual attributes for all dental instruments can be seen in Appendix D.

In Table 3-5, the significance of product visual attributes for injector designs can be seen. The form of classical injector design (injector design-3) has extremely negative effect on participants' emotions. Partially colored injector design 1 affects participants positively with 85.7%. The first two designs are made of metals whereas plastic is used for third design. From Table 3-5, it can be told that, plastic usage in injector design may have more positive effect on participants' emotions.

When drill designs are considered, unlike injector designs, plastic usage has more negative effects on participants' emotions that metal usage (Table 3-6). The form of first drill design has more positive effect when considering the other two drills. Similar to injector designs, colored drill designs affect participants' emotions positively. Participants also define positive effects of texture for second and third drill design.

Table 3-6 Significance of Product Visual Attributes for Drill Designs

	Form (+)	Form (-)	Color (+)	Color (-)	Material (+)	Material (-)	Proportion (+)	Proportion (-)	Texture (+)	Texture (-)
 Drill design 1	100.0	0.0	20.0	80.0	0.0	100.0	9.1	90.9	0.0	0.0
 Drill design 2	57.9	42.1	69.2	30.8	18.2	81.8	0.0	100.0	100.0	0.0
 Drill design 3	38.5	61.5	0.0	100.0	47.8	52.2	0.0	100.0	100.0	0.0

Metal instruments were selected for forceps and elevator as plastic forceps and elevators cannot be found through Google image search carried out in May 2012. Color is used partially in first design of both two instruments (Table 3-7 and Table 3-

8). And positive effects of color are mentioned in the statements. As seen in Table 3-7, although all forceps are in metal, the significance of material changes for the forceps. For example, for the first forceps the significance of material on participants' emotions are equal -50% positive and 50% negative effects- whereas for the third forceps the significance of material on participants' emotions is totally negative. The reason of this difference may result from metallic appearance.

Table 3-7 Significance of Product Visual Attributes for Forceps Designs

	Form (+)	Form (-)	Proportion (+)	Proportion (-)	Color (+)	Color (-)	Material (+)	Material (-)	Texture (+)	Texture (-)
 Forcep Design 1	44.4	55.6	0.0	100.0	75.0	25.0	50.0	50.0	0.0	0.0
 Forcep Design 2	50.0	50.0	10.0	90.0	0.0	0.0	33.3	66.7	100.0	0.0
 Forcep Design 3	7.7	92.3	33.3	66.7	0.0	0.0	0.0	100.0	0.0	0.0

Similar to forceps design, negative effects of proportion and material for elevator designs are mentioned in participants' statements (Table 3-8).

Table 3-8 Significance of Product Visual Attributes for Elevator Designs

	Form (+)	Form (-)	Proportion (+)	Proportion (-)	Color (+)	Color (-)	Material (+)	Material (-)	Texture (+)	Texture (-)
 Elevator Design 1	43.8	56.3	28.6	71.4	84.6	15.4	33.3	66.7	0.0	0.0
 Elevator Design 2	25.0	75.0	0.0	100.0	33.3	66.7	33.3	66.7	0.0	0.0
 Elevator Design 3	15.0	85.0	0.0	100.0	0.0	0.0	12.5	87.5	0.0	100.0

As mentioned before, besides product properties, 13 related qualities with these properties are coded. Table 3-9 presents which statements of participants are coded as which product related qualities.

Table 3-9 Participants' Descriptions of Product Related Qualities of Product Properties

Related qualities	
Distinctive appearance	Visual quality which makes the product different from similar tools.
Disturbing sound	It refers to sound of vibration for dental drills.
Ease of use	To what extent people regard the instrument as easy to use for dentist.
Hygienic appearance	It refers to visual appearance of product which seems to be healthy and clean.
Low quality appearance	It refers to product which has low quality appearance because of its form, color and material application.
Non-medical appearance	To what extent medical products resemble any other products from different sector.
Ordinary appearance	To what extent products have common appearance compared to similar tools.
Pleasing appearance	It relates to overall attractiveness of product visual form.
Professional appearance	It can be used for products which seem to be perfect, effective in accomplishing its work.
Safe appearance	Visual quality which makes the product to appear safe.
Unhygienic appearance	It refers to visual appearance of product which seems to be unhealthy and unclean.
Unpleasing appearance	It relates to overall unattractiveness of product visual form.
Unsafe appearance	Visual quality which makes the product appear as if it can involve or cause risk.

In Figure 3-6, the frequency of each related qualities of product properties can be seen. According to all statements, five related qualities have highest frequency among the others. These are unsafe appearance, pleasing appearance, non-medical appearance, safe appearance and unpleasing appearance. In the following section these related qualities will be explained in detail by giving examples from the statements made by the participants.

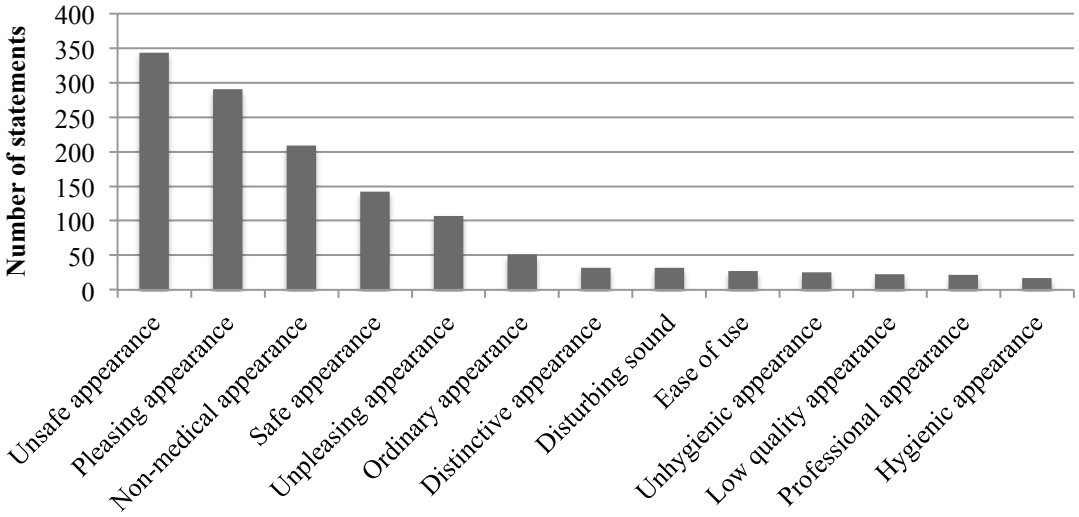


Figure 3-6 Number of Statements Made by Participants to Related Qualities of Product Properties

Unsafe appearance: It refers to being unsafe generally due to the proportion and the form of the instrument. An instrument that has sharp ends and which seems as it may hurt the patients is regarded as unsafe instrument. One of the participant states that;

"The instrument has two sharp ends and it makes me concerned about being pricked during the operation."

Another participant also emphasizes the unsafety of the instrument by stating;

"The instrument has slimmer structure that other instrument, which makes me worried. I think that dentists do not feel comfortable while using this thinner product. If he makes it move in a wrong way, I may feel sore."

Participants have also matched the unsafe appearance with the material usage. They worry that if metal material is used for dentistry, the instrument will hurt them. Although there have been many negative statements on metal usage, there are also some on plastics by reason of not being so rigid. A participant states that;

"I think this instrument can be broken while extracting the tooth because of plastic usage. I cannot rely on this."

Pleasing appearance: It refers to aesthetic appearance of products. Pleasing appearance of instrument results in safe and pleasant feelings for participants. There has been high frequency of pleasing appearance in this study. This result may grow out of the comparison of dental instruments.

According to the participants, pleasing appearance can occur firstly due to the color and then form (Figure 3-7). They match slim structure, sympathetic form and high tech appearance with pleasant appearance.

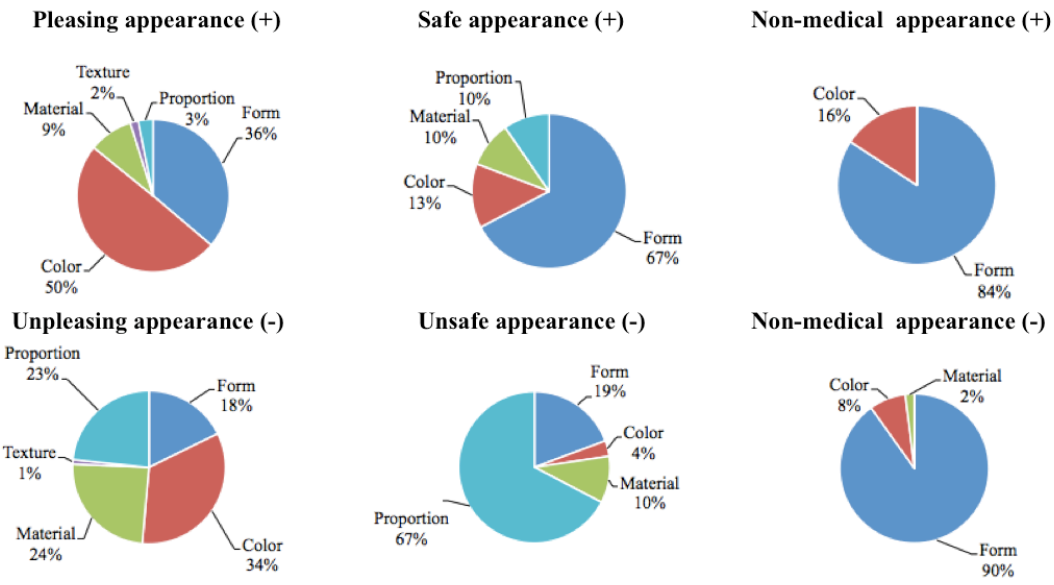


Figure 3-7 The Relation Between Product Visual Attributes and Related Qualities

Non-medical appearance: It refers to what extent medical products resemble any other products from other area. Non-medical appearance, which is generally associated with form, has both negative and positive effect on patients' emotions.

Some of the dentistry instruments seem like hand tools such as pliers and screwdriver, which make them trigger negative emotions.

However, non-medical appearance also makes participants feel positive. It is derived from this study that the instrument that resembles toy, pen or candy decrease the negative emotions of participants. On the other hand, making the instrument look like a toy makes the patient feel unsafe due to instruments' simple and fragile structure. One participant states that;

"This instrument looks like a toy due to its color and plastic material. Using this instrument while extracting my tooth, makes me feel anxiety."

In Figure 3-7, to show positive and negative effects of non-medical appearance, two pie charts are presented for non-medical appearance.

Safe appearance: It refers to the instruments that are seen to be safe. Form has the strongest effect on safe appearance. Apart from this, participants also match the instruments with their function in their mind and if they have already known the instruments' functions, it may affect their emotions. For example, mirrors are used only for examination and this function may make people to assume mirrors as safe. Additionally, instruments that do not have sharp ends or have hidden ends makes participants feel comfortable.

Usage of plastic and metal material has also effect on the safe appearance. Some participants think that metal should not be preferred due to its coldness; on the other hand some of them think that it should be used due to its rigidity. In addition to this, plastic materials can be used partly to decrease the dominant character of metal material usage.

Unpleasing appearance: It refers to unaesthetic appearance of product. From Figure 3-7, it can be derived that color, material and proportion have equal effect. Dark

color choice and metallic color usage makes the participants feel unpleasant. A participant states that;

"Metallic color makes me feel anxiety. I do not want to feel the coldness of metal."

3.2.4.2.2 The Relation between Related Quality of Product Properties and Emotion

The statements of participants were coded into three levels. First level is the product properties and the second level is the related qualities of product properties. These two levels and their relationships were already described. The third level includes participants' feeling. The statements were coded into seven feelings: pleasant, fear, anxiety, safe, unpleasant, disgust and unsafe (Figure 3-8).

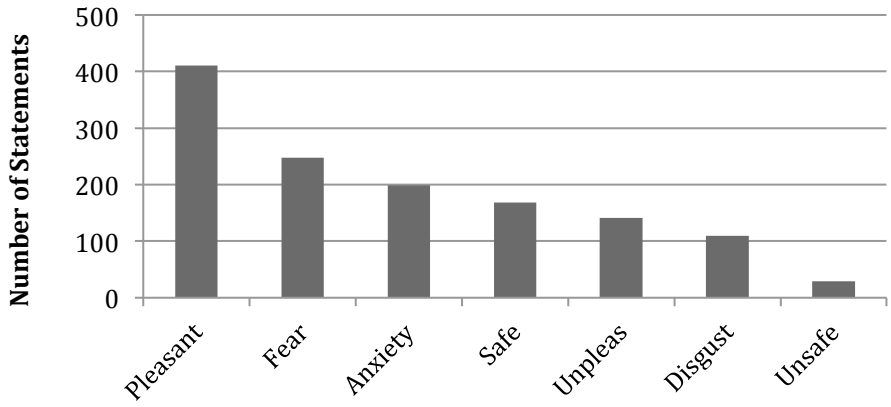


Figure 3-8 Number of Statements Related to Participants' Feelings towards Dental Instruments Presented in the Preliminary Study I

Feeling pleasant has the highest frequency in participants' feelings towards dental instruments presented in the Preliminary Study I. Other most prominent feelings are fear and anxiety. They are related with unsafe and non-medical appearance of instruments. As seen in Figure 3-9, unsafe appearance of instruments has the highest frequency among related qualities that results in negative emotions such as fear,

anxiety and disgust. Only non-medical appearance has both negative and positive effect on participants, that's why designers should consider this quality if they choose to make the instrument resemble other products.

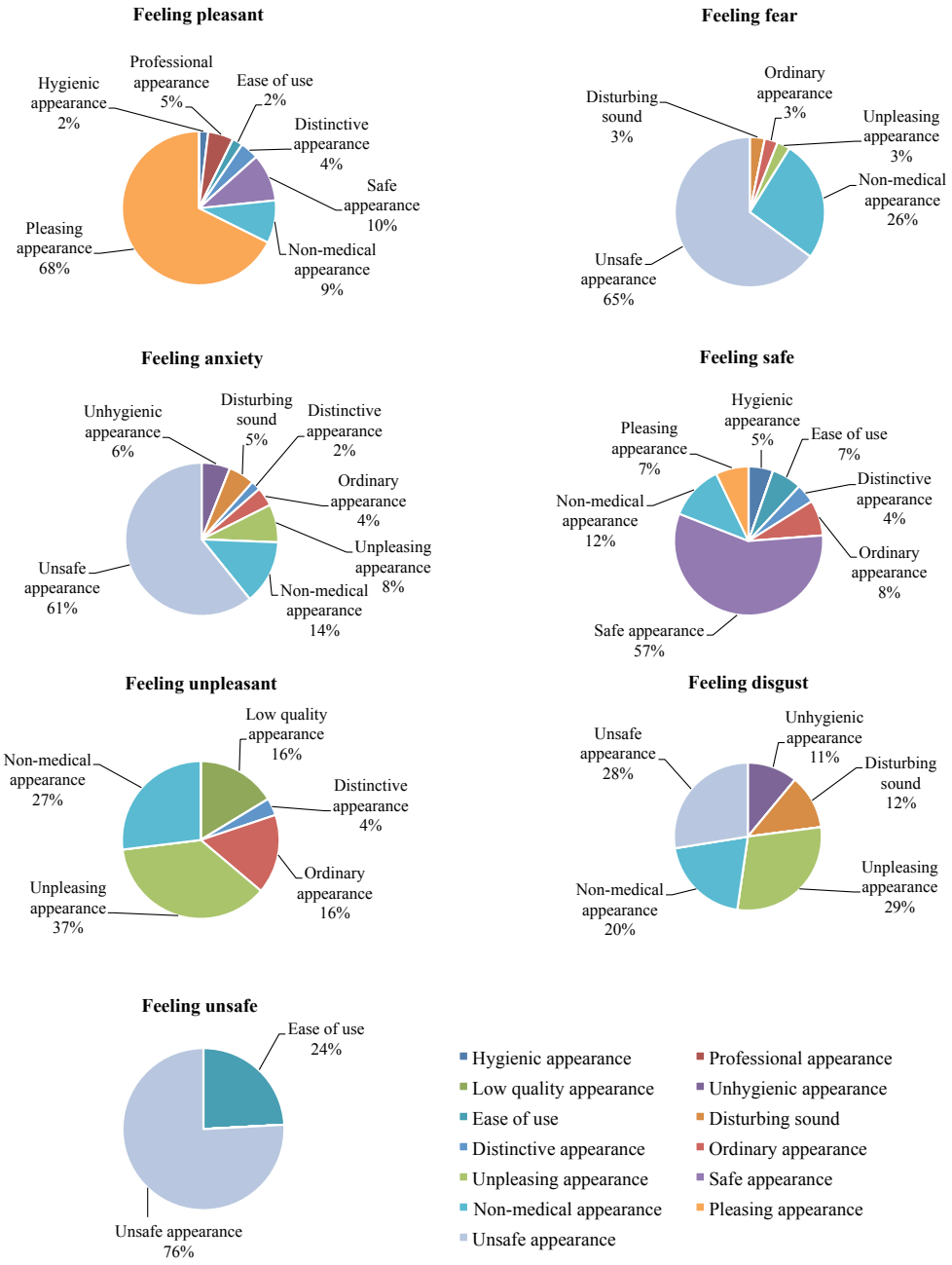


Figure 3-9 The Relation Between Prominent Feelings and Related Qualities of Dental Instruments' Product Properties

3.2.5 Conclusions and Discussion

The first preliminary study aimed to understand which product visual attributes and its related qualities have influence on the emotional reactions of patients. A questionnaire that consisted of nine dental instruments (three variations for each instrument) was conducted. Quantitative and qualitative analyses were carried out. From the qualitative data, the statements of the participants about the reason of their feelings towards dental instruments were analyzed with content analysis method. For the study, Desmet's (2003) emotion scale, Premo was used since the negative emotions in the scale overlap the emotions about dental treatment mentioned in literature such as fear, disgust, and shame. Moreover, this scale serves cartoon characters for each emotion that may help participants to express their feelings with the cartoon characters. However, the scale was only used to enable participants to define their emotions. In the analyses, the selection of emotions was only used for defining negative and positive emotions.

Analysis of the Preliminary Study I shows that:

- Negative emotions towards dental instruments are dominant.
- Positive emotions are only dominant for mirrors.
- The results show that form, proportion, color, material, texture, function, sound and vibration are the main product properties that affect the emotions of participants.
- 13 related qualities that affect the product properties are coded from content analysis. Furthermore, unpleasing appearance, ordinary appearance, unsafe appearance, non-medical appearance, safe appearance and pleasing appearance are the most prominent qualities related with product properties.
- Color and form have positive effects on pleasing appearance whereas color, material, proportion and form have effects on unpleasing appearance.
- There is a huge effect of form on safe appearance whereas proportion has prominent effect on unsafe appearance.
- Participants associate non-medical appearance with form of the instruments.

- All these product properties and its related qualities result in different feelings for participants: feeling pleasant, fear, anxiety, safe, unpleasant, disgust and feeling unsafe.
- Feeling pleasant is associated with pleasant appearance. Therefore, color is the second attribute on feeling pleasant after form of the instrument.
- Feeling fear and feeling anxiety are related with unsafe appearance and non-medical appearance, thus proportion and form of the instruments are effective on fear.
- Feeling safe is related with safe appearance on which form of the instrument has effect. In addition, material, proportion and color have less effect (than form) on safe appearance of the instruments.
- In addition to unpleasing appearance, non-medical appearance, ordinary appearance and low quality appearance have effect on feeling unpleasant. Low quality appearance is often associated with material choice. Material and mainly form of the instruments affect ordinary appearance.
- Unpleasing appearance and unsafe appearance result in feeling disgust. Unpleasing appearance is affected by color, material and proportion respectively. Unsafe appearance is affected by proportion of instruments.
- Unsafe appearance and ease of use have influence on feeling unsafe.

3.2.6 Evaluation of the Preliminary Study I

Desmet's (2003) emotion scale, Premo was used for the Preliminary Study I. The emotion scale was chosen as it had developed for measuring emotions of users from design perspective. The scale has negative emotions such as fear and disgust which can be similar to negative emotions mentioned in the related literature. However, participants had difficulties in selecting appropriate emotions. From content analyses of the statements, in the third level, seven feelings were found; feeling fear, anxiety, pleasant, safe, unpleasant, unsafe and disgust.

The questionnaire was conducted through the Internet. Due to limitations of online survey, participants could not feel free to ask questions while answering it. From this study, instruments' product properties and their related qualities were found. However, to get more information, it would be better to add open-ended questions.

27 instruments were presented in the questionnaire. This number of instruments was quite much; as a result, participants might have been bored while filling the questionnaire. Nonetheless, with the advantage of this questionnaire, valuable data for many dental instruments were gathered.

3.3 Preliminary Study II

From the Preliminary Study I, it was found that the used instruments as study materials have strong effects on participants' emotions. It was observed during the first preliminary study that, selecting emotions from Premo scale might not reflect all the emotions of participants towards dental instruments since some of the participants state emotions which were not categorized under the Premo, it was seen that it would be valuable to conduct complementary study without leading participants with given emotions.

Previous dental experiences might be effective for patients' evaluations about appearance of dental instruments. To investigate this possibility, it was aimed to seek an answer to the following question in the Preliminary Study II.

- Is there a relationship between seeing the dental instruments in the previous treatments and patients' negative feelings?

In addition, the instruments that can be seen mostly during dental treatments and the instruments that can have more negative effects on patients' emotions will be searched. Three instruments will be selected for the Main Study according to the results of the Preliminary Study II.

Similar to the Preliminary Study I, to select study material for the second preliminary study it was decided to consult dentists. In doing so, again a material selection study was conducted with different dentists.

3.3.1 Material Selection Study for the Preliminary Study II

The material selection study focuses on the following question:

- Which dental treatments are daily routine treatments of dentist?
- Which dental instruments are used in these dental treatments?
- How these instruments can be categorized?

3.3.1.1 Sample

Similar to material selection study of the Preliminary Study I, as a list of all dentists who work in Ankara could not be reached, the author got in touch with five dentists to conduct interviews. Two dentists from dental clinics in Ankara, one dentist from Gulhane Military Medical Academy, one dentist from Başkent University Hospital and one dentist from Gazi University Hospital participated the interview. In Table 3-10, profile of the participants can be seen. They were consulted to decide which instruments can be used as study material for the second preliminary study.

Table 3-10 Profiles of the Participants _Material Selection Study for the Preliminary Study II

Participants	Office of participants	Age	Speciality
Dentist 1	Dental Office / Ankara	40-45	No speciality
Dentist 2	Dental Office / Gata	35-40	Prosthodontics
Dentist 3	Dental Office / Ankara	35-40	Pediatrics
Dentist 4	Dental Office / Gazi	25-30	Periodontics
Dentist 5	Dental Office / Başkent	45-50	Prosthodontics

3.3.1.2 Method

The interviews were conducted separately with five dentists. Three open-ended questions were asked during the interviews (Appendix E). In each interview, firstly, dentists were asked to define all dental treatments and instruments. As there are countless instruments used in dentistry, each dentist was required to categorize all instruments.

3.3.1.3 Results

The first question of interview was about the routine dental treatments. All the dentists attended the interview stated six dental treatments.
These are:

- General Diagnosis
- Restoration of tooth
- Extraction of tooth
- Periodontal treatment
- Prosthodontic treatment
- Root canal treatment

In the second question, dentists were asked to define related dental instruments for each dental treatment. The results of second question can be seen in Table 3-11. In the interviews, 21 dental instruments are mentioned. Moreover, in the third question, dentists were asked to categorize the instruments, which they mentioned in previous question, as it was possible.

Table 3-11 Dental Instruments and Related Treatments

		General diagnosis	Restoration of tooth	Extraction of tooth	Periodontal treatment	Prosthesis treatment	Root canal treatment
	Probe	✓					
	Presel	✓					
	Mirror	✓					
	Injector		✓	✓		✓	✓
	Excavator		✓				
	Spatula		✓				
	Fulvar		✓				
	Cleoids discoid		✓				
	Amalgam carrier		✓				
	Composite injector		✓				
	Matrix		✓				
	Led curing light		✓				
	Forcep			✓			
	Elevator			✓			
	Cretuar				✓		

Table 3-11 (continued) Dental Instruments and Related Treatments

		General diagnosis	Restoration of tooth	Extraction of tooth	Periodontal treatment	Prosthesis treatment	Root canal treatment
	Ultrasonic scaler				✓		
	Curette				✓		
	Periodontal probe				✓		
	Drill		✓			✓	✓
	Endodontic file						✓
	Vitalometer	✓					✓

From the results of these five interviews, *excavator*, *spatula*, *fulvar and cleoids discoid* were grouped as restorative hand tools, and *cretuar*, *curette and periodontal probe* were grouped as periodontal hand tools. Therefore 17 instruments were selected. These instruments are:

- Probe
- Tweezers
- Vitalometer
- Mirror
- Injector
- Drill
- Matrix
- Amalgam carrier
- Composite injector

- Restorative hand tools
- Led curing light
- Elevator
- Forceps
- Periodontal hand tools
- Ultrasonic scaler
- Endodontic file
- Impression tray

Thus, by the material selection study, 17 dental instruments were selected. For each instrument, Google images were scanned and instruments were grouped according to different material and color applications. Instruments were selected randomly through many images. For each instrument three different designs were selected which were different in design, in material and color applications if it was possible.

3.3.2 Data Collection Tool

An Internet based questionnaire was designed as data collection tool (Appendix F). The questionnaire is composed of two parts. After gathering demographical information about participants, in the first part, they were asked to select which treatments they feel negative. Moreover, they were required to write how many times they had each dental treatment. The aim of this part was to define dental treatments which participants felt negative and how previous dental experiences of participants affected their feelings. In the second part, firstly they were required to define whether they had seen the instruments before or not. And then they were asked to write what did they feel toward all dental instruments even if they had not seen before. The aim of this second part was to define which instruments could be seen during the treatments and how seeing the instruments in their previous dental experiences affected participants' feelings. The instruments were presented in six separate pages as one page for each dental treatment.

3.3.3 Sample

The questionnaire was distributed to 100 employees in the company of the author and it was also requested from these employees to send this questionnaire to maximum four people. At the end, 130 participants sent the questionnaire back after completing. 10 of them completed the questionnaire partially that's why the results were generated from the data coming from 120 participants. 98 participants were from the company where the author works and the rest are from outside of the company. Ages of the participants were between 18 and 58.

3.3.4 Analysis and Results

With the data collection procedure both qualitative and quantitative data were gathered. Participants defined their emotions to dental instruments by writing as many words as they wanted. All the words were evaluated and coded as negative, positive or neutral feelings for an effective analysis. Most of the words were daily spoken words however the dictionary of The Turkish Language Association was consulted to be sure about for some words.

Firstly, participants were asked to select whether they felt negative or positive towards the dental treatments. According to the results shown in Figure 3-10, most of the participants feel negative about root canal treatments and then by order about extraction of tooth and restoration of tooth. Only a few participants feel negative about general diagnosis.

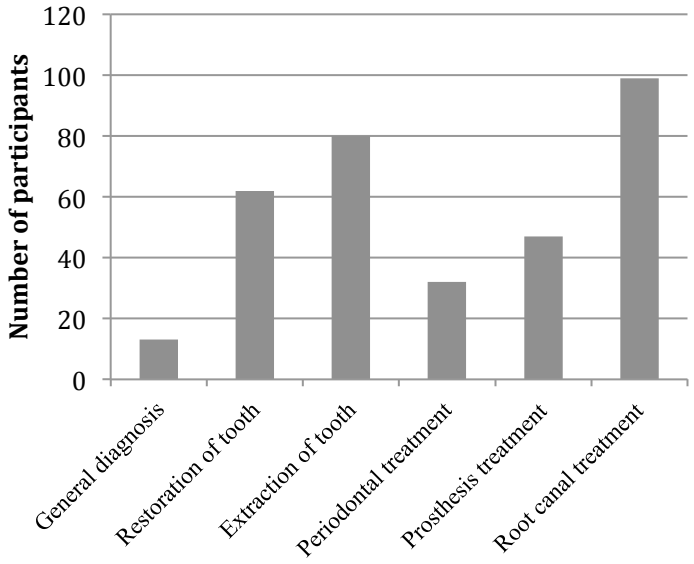


Figure 3-10 Number of Participants Who Feel Negative Towards Dental Treatments

Secondly, participants were asked to define how many times they had dental treatments. The aim of this question was to analyze how previous dental experiences of participants affected their feelings. The results are presented in the Table 3-12 below.

Table 3-12 Participants' Emotions Towards Dental Treatments _the Preliminary Study II

	Had dental treatments	Had dental treatments and feel negative	Haven't had dental treatments but feel negative
General diagnosis	120	9	4
Restoration of tooth	91	51	11
Extraction of tooth	82	56	24
Periodontal treatment	74	22	10
Prosthesis treatment	9	5	42
Root canal treatment	45	38	61

In Table 3-13, percentages of participants who have seen or not the instruments in their previous dental experiences are presented. Percentages are calculated for each dental instrument. For example, only nine participants have experienced dental prosthesis treatment. Impression tray is an instrument used during this treatment. All of the nine participants have seen the impression tray during the treatments; therefore, in Table 3-13, the percentage of participants who have seen the impression tray is 100. Impression tray, mirror, drill, forceps, endodontic file, injector, probe, periodontal hand tools, restoration hand tools and ultrasonic scaler are seen much more than other dental instruments.

Table 3-13 Percentages of the Participants According to Seeing the Instruments

	Have seen the instruments during the treatments	Have not seen the instruments during the treatments
Impression tray	100.0	0.0
Mirror	98.3	1.7
Drill	95.6	4.4
Forcep	87.8	12.2
Enododontic file	84.4	15.6
Injector	84.6	15.4
Probe	81.7	18.3
Periodontal hand tools	81.6	18.4
Restoration hand tools	78.0	22.0
Ultrasonic scaler	72.4	27.6
Led curing light	49.5	50.5
Amalgam carrier	48.4	51.6
Tweezers	45.0	55.0
Elevator	35.4	64.6
Vitalometer	23.3	76.7
Composite injector	19.8	80.2
Matrix	13.2	86.8

The words, which were stated by participants for each dental instrument group, as mentioned before, were coded as negative, positive and neutral emotions. In Table 3-14, participants' positive, negative and neutral emotions towards each dental instrument are presented. According to results, mirror and led curing light have slightly more positive effect than their negative effects. As it is seen from the table, injector, drill, forceps and probe have extremely negative effects on participants' emotions (Table 3-14).

Table 3-14 Participants' Positive, Negative and Neutral Emotions Towards Dental Instruments

	Positive Emotions (%)	Negative Emotions (%)	Neutral Emotions (%)
Probe	4.2	82.5	13.3
Tweezers	8.3	46.7	45
Vitalometer	22.5	23.3	54.2
Mirror	30	15	55
Injector	1.7	86.6	11.7
Drill	0.8	87.5	11.7
Matrix	1.7	70.8	27.5
Amalgam carrier	14.2	30.8	55
Composite injector	5.8	45	49.2
Restorative hand tools	3.4	68.3	28.3
Led curing light	18.33	17.5	64.2
Elevator	4.2	59.2	36.6
Forcep	0.8	83.4	15.8
Periodontal hand tools	3.33	63.3	33.3
Ultrasonic scaler	5	58.3	36.7
Impression tray	8.3	47.5	44.2
Endodontic file	4.2	65	30.8

As mentioned before, one of the aims of the Study II is to find out if there is a relationship between seeing the dental instruments in the previous treatments and

patients' negative feelings about them. To analyze the relationship, Spearman's correlation test was used. In the analyses, statistical significance is considered to be $p < 0.05$. All statistical evaluations were conducted using SPSS software (Version 22.0).

According to the results of the analyses, it is seen that for some dental instruments there is a relationship between seeing the instruments in the previous treatments and their negative feelings about them. It is accepted that there is a significant relationship if asymptotic significance is less than 0.05. In Table 3-15, only the instruments that have significant relationship are listed (full list of the instruments and their significances are presented in Appendix G). The second column of Table 3-15 shows the direction of the relationship. If the value is negative, it means that there is a negative relationship between seeing the instrument in the previous treatments or not and feeling negative or positive. Namely, the probability of feeling negative towards dental instrument is higher for participants who have seen the instruments during their dental treatments than for participants who have not seen the instruments. On the other hand, if the value is positive, it means there is a positive relationship between seeing the instrument in the previous treatments or not and feeling negative and positive. Namely, the probability of feeling positive towards dental instrument is higher for participants who have seen the instruments during their dental treatments than for participants who have not seen the instruments. According to the results, participants may feel negative towards vitalometer, drill, elevator, and periodontal hand tools because of their previous experiences. As participants who have not seen these instruments before, can feel more positive than the participants who have seen them before. The correlation is stronger for elevator as the value of "the direction of relationship" is closer to the value -1.

Table 3-15 Results of Spearman Correlation Analysis between Instruments' Possibility to be Seen and Participants' Emotions

	Asymptotic significance (2-sided)	**The direction of relationship (Spearman Correlation)**	**Approx. Sig.**
Vitalometer	0.003	**-0.288**	.001[c]
Drill	0.036	**-0.222**	.010[c]
Elevator	0.001	**-0.351**	.000[c]
Periodontal hand tools	0.012	**-0.191**	.037[c]

Besides this analysis, two more correlations were analyzed. The questions related to analyses are:

- Is there a relationship between feeling negative and positive towards dental instruments and number of treatments?
- Is there a relationship between feeling negative and positive towards dental instruments and gender of participants?

However, for these two questions, there is no significant relationship found with Spearman Correlation analysis (Appendix G).

3.3.5 Conclusions and Discussion

The Preliminary Study II aimed to investigate whether previous dental experiences have effects on patients' emotions towards dental instruments or not. Furthermore, treatments that create more negative emotions and instruments' possibility to be seen were investigated.

Analysis of the Preliminary Study II shows that:

- Root canal treatment and extraction of tooth are the treatments that create the most negative emotions.
- Most of the participants, who have had the treatments of restoration of tooth, extraction of tooth and root canal, feel more negative than the participants, who have not had.
- Root canal treatment and prosthesis treatment are the treatments towards which participants feel more negative although they have not had these treatments. This shows that participants may have prejudice for these two treatments.
- Percentages of the participants according to seeing the dental instruments during treatments are variable. The percentages of instruments' -impression tray, mirror, drill, forceps, endodontic file, injector, probe, periodontal hand tools, restoration hand tools and ultrasonic scaler- possibility to be seen during treatments are higher than other dental instruments' possibility to be seen. On the other hand, matrix, composite injector, vitalometer and elevator are the least noticed instruments by participants during the treatments.
- Positive, negative or neutral emotions of the participants vary according to dental instrument types.
- Mirror, vitalometer, led curing light are the dental instruments which have positive effect on participants' emotions.
- The results show that injector, drill, forceps and probe are creating most negative emotions, respectively.
- According to Spearman correlation analyses,
    - Participants may feel negative towards vitalometer, drill, elevator and periodontal hand tools because of their previous experiences.
    - Apart from the instruments mentioned above, having already seen the instruments -of probe, mirror, tweezers, injector, matrix, amalgam carrier, composite injector, restorative hand tools, led curing light, forceps, ultrasonic scaler, impression tray and endodontic file- during the treatments experienced in the past do not effect participants'

emotions. If there is negative emotion, this may be associated with appearance of the instruments.

3.3.6 Evaluation of the Preliminary Study II

In the Preliminary Study II, it was preferred to let participants free to write their feelings in order to gather data as detailed as possible.

The questionnaire was conducted through the Internet. Because of the limitations of online survey, participants could not feel free to ask questions while answering it. The instruments' possibility to be seen and the instruments that have most negative effect on patients' emotions were gathered. Another finding of the second preliminary study was the effects of seeing the instruments in their previous dental experience on the participants' emotions. Furthermore, quantitative analyses of positive, negative and neutral emotions of participants towards each instrument were performed.

To sum up, in the first preliminary study, product properties and their related qualities of dental instruments were gathered. The second preliminary study showed that the appearances of dental instruments had negative effects on participants' emotions regardless of participants' previous dental experience. The main study is conducted to get more detailed information about "which product visual attributes have negative effects on patients' emotions" and "how the appearance of dental instruments can be changed to make patients feel more positive".

CHAPTER 4

MAIN STUDY

The findings of preliminary studies constituted inputs to shape the Main Study. The aim of the study is to demonstrate the instrument's product visual attributes influencing the emotional reactions of patients to the dental instruments.

The chapter starts with the explanation of method and sampling and then the second section reveals the outcomes of the study. After providing findings for each dental instrument, the chapter concludes with a conclusion and discussion section.

Aiming at exploring the effects of the appearance of dental instruments on patients' emotion, the specific research questions of this study are as follows.

- What are the influences of product visual attributes on the emotional reactions of the patients to the dental instruments?
- How might the dental instrument's product visual attributes be to decrease the negative emotions of patients?

4.1 Method

The results of preliminary studies provided general perspective on the thesis' field of interest. According to these results, the Main Study was shaped to gather more specific data. In the following section the details of the Main Study will be explained.

4.1.1 Selection of the Study Material for the Main Study

As the results of the Preliminary Study II shows, injector, forceps and drill are the

dental instruments that create more negative emotions than other dental instruments. Moreover, these three instruments are the most seen ones by the participants during dental treatments. Therefore, it was decided to continue with these three instruments.

As it is mentioned before, in the Preliminary Study I, each item created for a dental instrument has three variations of that instrument and they are analyzed separately (see in Table 3-5, Table 3-6 and Table 3-7). According to findings of the Preliminary Study I, one injector, one forceps and one drill that create the most negative emotions in each item were selected for the Main Study (Figure 4-1).

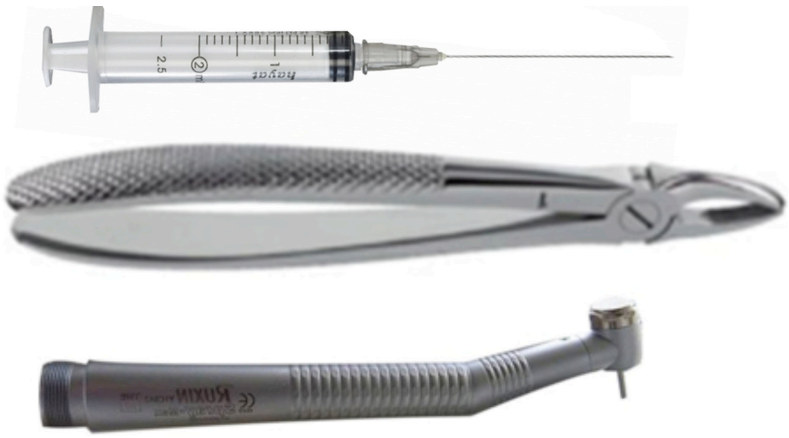


Figure 4-1 The Instruments that Create more Negative Emotions for Each Item in the Preliminary Study I

For the Main Study, three real-physical instruments were used instead of showing instruments' pictures. Three instruments were borrowed from SYÇ dental office in Ankara. Borrowed instruments were selected by considering their similar characteristics with the instruments that have been found as the most negatively effective on the participants among their group from the Preliminary Study I (Figure 4-2).

Figure 4-2 The Selected Instruments for the Main Study

4.1.2 Data Collection Tool

As the research question requires extended responses from participants, semi structured interviews were conducted for the Main Study. Depth of meaning can be gathered with open-ended questions in interview method. Participants can express their opinions about related subject. In this study, the interviews enabled participants to explain their emotions towards dental instruments in detail and the reasons why they feel in that way. Each interview with each participant was carried out separately.

In the beginning of the interviews, participants were introduced to the study with the explanation of the aim of the study. And then, they were asked for permission to record the interview.

Interviews took place at the homes or offices of the participants. A typical interview session took 20-30 minutes.

The interview schedule was composed of two parts. In the first part, participants were asked for their demographic information such as age, sex, and occupation. They were also asked to define how many times they had dental treatments. In the second

part, three dental instruments were given the participants, respectively and four questions were asked related to each instrument (Appendix H)

The interview questions were open-ended. It was aimed to get direct opinions of the participants about the appearance of the instruments. For each instrument, firstly participants were asked about their feelings towards the instrument and they were required to explain the reason of their feelings. Secondly, participants were required to define instruments' product visual attributes that make them feel negative and positive. And lastly, they were asked for design suggestions that make them feel more positive than before. Moreover, during the interview, if it seemed necessary, participants were asked to express their idea about instrument's product visual attributes (form, color, proportion, material, texture) and their related qualities (such as non-medical appearance, low and high quality appearance, safe and unsafe appearance, pleasing and unpleasing appearance) that are the findings of the Preliminary Study I. The interview can be called semi-structured as some unwritten or probe questions were directed by the author according to the flow of the interview. These further questions are not pointing on specific issue, on the contrary aim to grasp the underlying reasons why participants feel negative or positive towards each instruments.

All statements gathered from all participants were collected in a pool regardless of the participants of the statements, and total numbers of statements for each instrument were considered for the analyses. Therefore, if a participant stated different opinions about a dental instrument, each opinion was counted as one statement for that instrument. Then, the statements were divided into categories according to their relations with the dental instruments. If a statement were related with more than one product visual attributes, then that statement would be considered separately for each product visual attribute.

4.2 Sample

Interviews were carried out with 20 participants (10 Female, 10 Male). The participants were volunteers selected from author's neighborhood and work environment that is in Ankara, Turkey. The general characteristics of the participants can be seen in Table 4-1.

Table 4-1 General Characteristics of the Participants

	Gender	Age	Work Description	Duration of Participation
Participant 1 (P1)	M	26	mechanical engineer	26 minutes
Participant 2 (P2)	F	27	nutritionist	25 minutes
Participant 3 (P3)	F	27	mechanical engineer	20 minutes
Participant 4 (P4)	M	24	mechanical engineer	20 minutes
Participant 5 (P5)	F	48	statistician	25 minutes
Participant 6 (P6)	F	26	mechanical engineer	22 minutes
Participant 7 (P7)	M	23	electronical engineer	21 minutes
Participant 8 (P8)	F	29	chemical engineer	21 minutes
Participant 9 (P9)	F	29	mathematician	20 minutes
Participant 10 (P10)	M	25	mechanical engineer	37 minutes
Participant 11 (P11)	M	28	physicist	29 minutes
Participant 12 (P12)	M	25	mechanical engineer	25 minutes
Participant 13 (P13)	M	31	mechanical engineer	23 minutes
Participant 14 (P14)	M	28	mechanical engineer	23 minutes
Participant 15 (P15)	F	25	trade specialist	22 minutes
Participant 16 (P16)	F	31	assistant specialist	22 minutes
Participant 17 (P17)	F	28	manager	26 minutes
Participant 18 (P18)	M	27	mechanical engineer	26 minutes
Participant 19 (P19)	M	24	mechanical engineer	22 minutes
Participant 20 (P20)	F	28	teacher	20 minutes

As seen from the table above, sample of the Main Study was composed mainly of mechanical engineers (12), and the others are from different backgrounds. The ages of the participants are between 23 and 48.

4.3 Results and Analysis

All the interviews conducted were recorded and fully transcribed, labeled with the participant name and the instruments. All interview texts were coded thematically. The following section is dedicated to the analysis of the transcribed data according to the participants' descriptions of their emotions towards dental instruments. Reading through the transcribed data, similar patterns, themes and thoughts were analyzed (Appendix I).

In the first part of the interview, participants were asked which dental treatments they had before. All participants have already had diagnosis and periodontal treatment. 16 out of 20 participants had restorative treatment and 9 out of 20 participants had extraction of tooth. All the participants who have already had restorative treatment and extraction of tooth mention that they have seen the instruments during the treatments.

In the second part of the interview, three instruments were given to the participants to be examined, respectively. Results of the analysis will be given for each instrument separately in the following sections.

4.3.1 Injector

In the first question, participants were asked to define their feelings towards the given injector. According to their answers, all the feelings towards injector are negative and fear has the most prominent feeling among the participants (Figure 4-3).

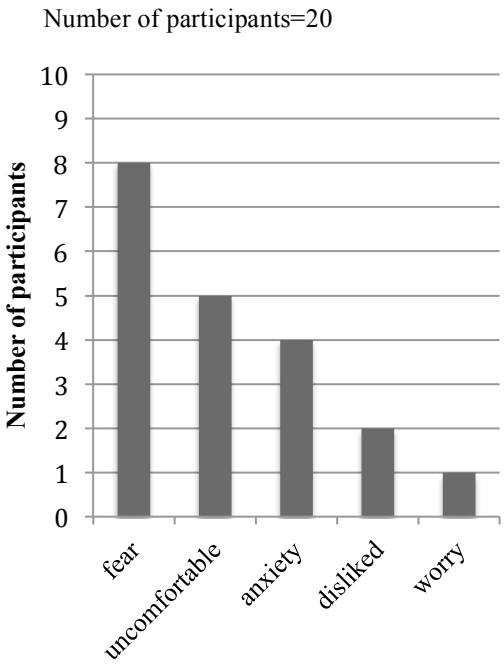


Figure 4-3 Participants' Feelings Towards Injector

In the second question, participants mentioned the exact reasons why they feel these feelings. According to results, 19 out of 20 participants feel negative towards injector because of the needle. The sharpness (11/19) and the length (10/19) of the needle have negative influence on participants. Only one participant mentioned the brightness and metal surface of the needle as reasons for negative feelings.

In the third question, participants were asked to analyze the instrument's product visual attributes in terms of form, proportion, color, material, texture, etc.

Form:

There are 10 statements in total about the form of the injector. Three of them are positive whereas seven statements are negative (Table 4-2). Only two participants (P6, P9) find the dimension of the injector is smaller than the conventional one, which make them feel positive. On the other hand, 4 out of 20 participants mention

that the barrel of the injector is large and therefore, they are worried about the increase in the injection time that results in more pain for them. However, only one participant thinks the barrel of the injector is reasonable. Two participants mention that the injector has an ordinary appearance and also another participant feel negative because of the sharp edge of the injector.

Table 4-2 Number of Participants' Statements Towards Injector's Product Visual Attributes

Injector's Visual Attribute	Number of Positive Statements	Number of Negative Statements
Form	3	7
Proportion	-	11
Material	16	18
Graphical elements	2	-

Proportion:

By considering all the statements made by the participants, there are only 11 statements about the proportion of the injector and all are negative (Table 4-2). These statements are about the proportion of the needle. The participants think that the needle is on the front and too long for this injector. In addition, due to the length of the needle, 4 out of 11 participants think that the needle penetrates skin deeply and one participant states that:

"The needle can be broken during the injection as it is too long, which make me feel negative."

Material:

34 statements about the material of the injector are received. 18 out of 34 statements are negative, whereas the rest 16 statements are positive (Table 4-2). According to 5

participants, transparent barrel for the injector make them feel positive as 3 of them want to see the amount of the liquid medicine and one of them want to see the color of the liquid medicine. On the other hand, 9 out of 20 participants feel negative towards the material of the injector, as the barrel is transparent. 5 out of 9 participants do not want to see the amount and 2 participants do not want to see the color of the liquid medicine.

11 participants like the plastic barrel as they find plastic material less threatening due to its softness (4/11), and more hygienic due to its single-use (3/11). The other 4 feel positive because they think that plastic material is lighter and can be more practical for dentists. However, 6 out of 20 participants find current plastic barrel cheap that make them feel negative about its material.

Graphical elements:

Only 2 participants have made statements about the graphical elements on the injector (Table 4-2). These two statements are about the professional appearance of the lines on the plastic barrel that are used to measure the amount of liquid medicine. For example one participant states that:

"The lines and writings on the barrel of the injector make me feel positive towards the injector as the graphics gives the impression of scientific instrument."

In the next question, participants were asked for design suggestions that might make them feel more positive than before. Participants explained the characteristics of their imagined injector. All the statements were categorized according to injector's product visual attributes and are listed below.

Form related statements:

- 6 participants suggest an injector which resembles a pencil shape. Moreover, one participant wants the barrel to be spherical to feel better.

- 5 participants prefer thinner needle as 3 of them think thinner needle cause less pain.
- 4 participants state about the form of the barrel. They say if the barrel is small, they can feel more positive to injector.
- 3 participants prefer smaller injector to feel better.
- One participant prefers an injector with soft shape and edges.
- One participant state that he can feel positive if the injector's form is more ergonomic. He suggests that there can be a cavity for holding part to grasp comfortably.

Proportion related statements:

- 11 participants are worried about the length of the needle and they prefer an injector with short needle if it is possible.

Color related statements:

- 12 participants prefer colored injector to feel positive. They prefer blue (8/12), pink (4/12), green (3/12), orange (1/12), yellow (1/12) and white (1/12). Apart from these colors, one participant also suggests to use color of some football clubs or nation's colors.
- One participant wants to see colored injector; however, he does not want color application to threaten his health.
- One participant want to see transparent injector, moreover, another participant think that application of color to injector is a childish idea.
- One thinks that color does not play a significant role on his emotion.

Material related statements:

- 11 participants do not want a transparent barrel as they feel negative about seeing the amount and the color of the liquid medicine. One participant suggests leaving a short area on the barrel for dentist to see the amount of the liquid. On the other hand, 4 participants want to see how much liquid

medicine is put in the barrel, so they prefer a transparent material for the barrel part. P6 think the transparency of the barrel is important as the dentist should see the liquid if there are air bubbles inside.

- 5 participants suggest using high quality material for the barrel part. 3 of them prefer transparent material such as glass or plastic.

Graphical elements related statements:

- 5 participants state that they feel positive if there are some patterns or textures on the barrel part of the injector. Healthy tooth images (1/5), butterfly images (1/5) and some cartoon characters (2/5) can be applied on the barrel part.
- 2 participants suggest that if the writings and lines on the barrel are printed with laser, positive emotions can evoke and the injector can have high-tech appearance. Another participant state that:

"The writings on the barrel should be more original. Therefore, I think that the injector has designed carefully and feel positive."

Texture related statements:

- 2 participants mention that if there is embossed surface for the barrel part, positive emotion can evoke.

Mechanism related statements:

- 11 participants think that injector whose needle is invisible make them feel more comfortable. They prefer the needle of the injector being activated in mouth just before the treatment. One of the participants imagines an operation like stamping instead of using injector.
- 3 participants desire an application that would apply medicine under the gum with one shot.
- One think that using a computer interface associated with the injector make him feel positive. Another participant who think that technological attitude is

beneficial, suggests a digital indicator that show the amount of the liquid medicine.

4.3.2 Forceps

During the interview, forceps was given as the second instrument. As for the injector, the same questions were asked to the participants.

In the first question, participants were asked to define their feelings towards the given forceps. Similar to injector, according to their answers, all the feelings towards forceps are negative and fear has the most prominent feeling among participants (Figure 4-4).

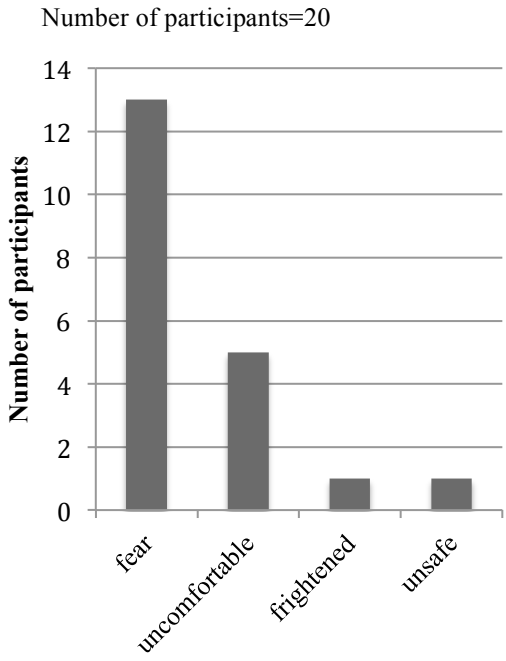


Figure 4-4 Participants' Feelings Towards Forceps

In the second question, participants mentioned the exact reason of why they felt these feelings. Participants feel negative towards forceps because of non-medical

appearance of the forceps (8/20), being metal (7/20), sharp edges of beak (4/20), and being huge (1/20).

According to the results, 8 participants feel negative due to non-medical appearance of the forceps. They think that the forceps resembles to pliers or combination pliers (7/8) and nutcracker (1/8). One participant states:

"This instrument reminds me of a nutcracker to me. It can hurt or break my teeth. I am frightened."

7 participants say that they feel negative, as the instrument is totally made of metal. 4 participants remark that they feel negative since forceps has sharp edges that hold teeth. Also, one participant states that the instrument creates a negative feeling due to its huge dimensions.

In the third question, participants were asked to analyze the instrument's product visual attributes in terms of form, proportion, color, material, texture, etc.

Form:

There are 25 statements about the form of the forceps. 22 of them are negative whereas three of them are positive feelings (Table 4-3). 14 participants think that the instrument has non-medical appearance as a negative feeling creator. While 3 of them resemble the instrument to nutcracker, 11 participants say that it seems like a pliers or combination pliers. Two participants state that:

"While nails and screws are used with combination pliers, I fear when I think this instrument is related with teeth."

Although 2 participants think that they feel positive, as the instrument seems like a nutcracker, 1 participant thinks entirely opposite. Only 1 participant feels positive since the form of the instrument is completely suitable for its function.

5 participants think that the form of the instrument is extremely big. Moreover, 2 of them come to the conclusion that the treatment is quite serious since the length of the instrument is too long and so they are worried even more.

2 participants feel negative since the instrument cannot be sterilized well due to the mechanism at the rotation part of forceps. Moreover, another participant feels negative as he/she thinks that the beak part of the instrument can cause damage instead of dental treatment. In addition to negative statements, having an ordinary hand-tool form creates negative impression on 3 participants.

Table 4-3 Number of Participants' Statements Towards Forceps' Product Visual Attributes

Forceps' Visual Attribute	Number of Positive Statements	Number of Negative Statements
Form	3	22
Proportion	6	9
Color	3	8
Material	12	17
Texture	5	6

Proportion:

Participants have made 15 statements about the proportion of the forceps. There are six positive and nine negative statements (Table 4-3).

According to 13 participants, the handle part of the forceps is quite long compared to full instrument. 8 out of 13 participants feel negative as more force is applied due to the length of the handle. On the contrary, 5 of them (5/13) feel positive because this length provides ease of use, and the instrument is designed for reaching teeth, especially at the backside. In addition, one of the participants thinks that it seems like

a medical instrument due to its long handle and small beak part that makes he/she feels positive.

Color:

11 statements about color of the forceps are received. 8 out of 11 statements are negative, whereas the rest 3 statements are positive (Table 4-3). 8 participants mention that they feel negative because of metallic color of the forceps. 6 participants mention their negative feelings are because of gleaming of the metallic color. The rest of the participants who feel negative (2/8) mention that they feel negative because metallic color reminds them mechanical tool (1/8) and creates feeling of incomplete material (1/8). On the other hand, 3 participants feel positive due to metallic color and glitter of the material. Even, one of these participants thinks that gleaming color reminds hygiene.

Material:

29 statements about material of the forceps have been made. 17 out of these statements are negative and 12 of them are positive (Table 4-3). In positive statements, 6 of the participants think that use of steel create high quality. One of them mentions that this material gives confidence. Moreover, 5 participants mention that metal instruments create feeling of more hygiene and make them feel more positive. Also, one out of 5 participants, the instrument should be hygienic since it is used in medical area.

On the other hand, 6 participants mention that they have doubt about the hygiene of the forceps since they are metal and reusable and this makes them feel negative. Another 4 participants feel anxious because of the hardness of the material. 2 of these participants think that such hard material may even break their teeth and thus feel more negative. The other 2 participants feel negative, because more force can be applied due to metal material. Even, one of them is anxious due to use of metal material on human. Additionally, one participant feels negative because of gleaming

of the metal. The other participant feels anxious about the sterilization of a metal instrument.

Texture:
Same numbers of positive and negative statements are received about texture of the forceps (Table 4-3). In the positive statements, it is mentioned that texture, removes ordinary appearance (2/5), increases smooth look of the instrument (2/5) and creates an image of thought on the instrument (1/5). All of these effects create positive feelings on 5 participants. 6 participants who make negative statements, express that patterns on the handles of the instrument are disturbing (5/6), remind grater (2/6) and combination pliers (1/6).

In the last question, participants were asked for design suggestions that make them feel more positive about the forceps than before.

Form related statements:

- 4 participants remark that they do not want to see the beak part. They suggest an instrument that is foldable and dentist can open the beak part inside the mouth.
- 3 participants suggest a handle that can have finger rings where dentist can put his finger inside the holes like a scissors. They think that these finger holes would make the instrument very comfortable, and evoke safe feeling from the participants.
- 2 participants do not want a forceps with sharp edges especially at the beak part. Another participant suggest that the beak part of the forceps can be thinner to make him feel better.
- One participant mentions that the forceps should have distinctive appearance. Moreover, other two participants do not want the instruments to resemble combination pliers or pliers. On the other hand, other two participants mention that they can feel positive if the instrument looks like an animal such

as bird, in addition form of the beak part can be like a bird's beak as fits its name.

- For hygienic concern, one imagines an instrument in which the handle and the beak part are demountable and the beak part is disposable.
- Another participant suggest spring between two handle as he believes the spring provide dentist a more controlled operation.

Proportion related statements:

- 7 participants want shorter handle for the forceps as they find the handle too long when considering the beak part. They believe that with a short handle, dentist can apply less force, which is associated with less pain.
- Although 7 participants find the beak part smaller compared to the handle part, another 2 participants are still worried about the beak part and suggest that they would feel better if the beak part is smaller than before.

Color related statements:

- 10 participants prefer colored forceps to feel positive. They prefer blue (7/10), green (3/10), pink (3/10), white (3/10), black (2/10), orange (1/10), yellow (1/12), and cream (1/10). Two participants mention that using red color on forceps make them feel negative as it is striking.
- 2 participants think that color does not play a significant role on his emotion.
- 2 participants mention that the forceps should be colored to feel positive because metallic color reminds them of mechanical tool. In addition, according to the opinions of two participants having colorful cases put on the forceps handle would make them feel better. One of them thinks that this kind of change may distract her/his attention.
- 2 participants prefer a dim colored instrument, as they feel negative due to glitter of the metallic color. However just one participant wants to see shiny instrument to feel better.

Material related statements:

- 11 participants mention that they can feel better if the handle of the forceps is covered with a plastic or rubber material. One of them thinks that different material on handle creates a smooth appearance. On the other hand, two of 11 participants also mention that if the handle is covered with rubber or plastic material, then the instrument exactly look like a combination plier. However they believe the application of plastic on handle removes the cold appeal of metal and makes them feel better even if it looks like combination plier.
- 3 participants prefer plastic material for the forceps as they think that they can have a smoother treatment with a plastic forceps. However, one participant points that a tough plastic material should be chosen for the forceps.
- 2 participants mention that plastic material keep bacteria because of its pores on the surface that make them feel negative to instruments so they do not prefer plastic material for the forceps.
- For hygienic concerns 4 participants prefer disposable forceps. Moreover, 3 participants would like to see the opening of the package of the forceps in front of their eyes due to reusable metal forceps.

Texture related statements:

- 5 participants think that using a professional approach to the texture on the forceps increase the reliability of the instruments. One out of 5 participants wants to see the manufacturing information about the forceps on it. That kind of information on the forceps gives positive feeling to him/her.
- One thinks that using a shape like bird wing can be another solution for feeling better.
- One thinks that the texture on the forceps does not affect him/her emotion.
- Another participant suggests a simpler texture on the forceps handles.

Mechanism related statements:

- One thinks that a new technological feature can be added to the instrument. He imagines a monitor where the dentist can see his applying force

magnitude. This makes the dentist apply a standardized treatment that gives him comfort.

4.3.3 Drill

In the first question, participants were asked to define their feelings towards the shown drill. Similar to injector and forceps, according to their answers, all the feelings towards drill are negative. Fear and feeling uncomfortable have the most prominent feelings among participants (Figure 4-5).

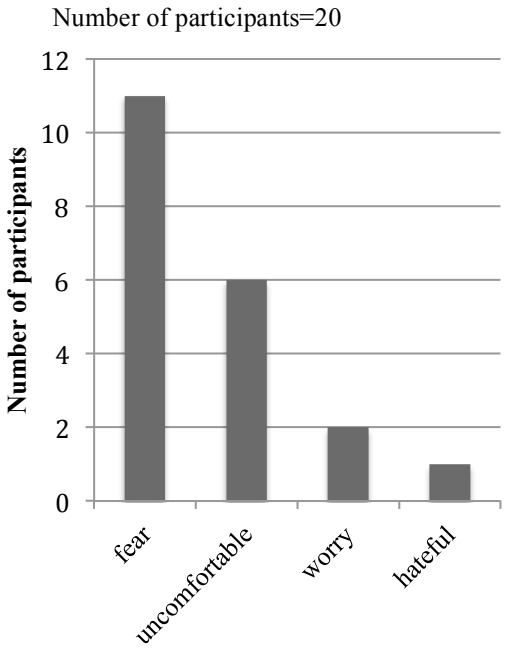


Figure 4-5 Participants' Feelings towards Drill

In the second question, participants mention the exact reasons of why they feel these feelings. 15 out of 20 participants feel negative due to drill's sharp needle. The others mention being metal (2/5), resembling a hammer (2/5) and disturbing sound (1/5) as the reasons for feeling negative.

In the third question, participants were asked to analyze the instrument's product visual attributes in terms of form, proportion, color, material, texture, etc.

Form:

22 statements have been made about the drill's form. 8 of these statements are negative, whereas 14 of them are positive (Table 4-4). 4 participants state slightly curved form of the drill makes them feel nice. One out of 4 participants say that they feel positive because they think that ergonomics are considered in the design of the instrument. Another 3 of the participants think that they are satisfied with the size of drill. One thinks that due to the slightly curved form of drill, the needle is left behind, and this condition gives the impression that it is much smaller, and he/she thinks positively about it.

Table 4-4 Number of Participants' Statements Towards Drill's Product Visual Attributes

Drill's Visual Attribute	Number of Positive Statements	Number of Negative Statements
Form	14	8
Proportion	4	7
Color	3	17
Material	7	3
Texture	11	5
Graphical elements	1	-

Another participant associates the form to a giraffe's neck, and feels positive about it. On the other hand, 4 of the participants thinks that the tool is like a mechanical device due to its form, and one of these 4 participants resembles it to a hammer, whereas 2 of these 4 participants resemble it to a drill that is used for non medical purposes. Another one feels as if the instrument will go to the deepest end of his/her throat due to its curved shape.

2 participants think that the instrument poses a risk because of its sharp needle. Another 2 participants feel positive about the small needle. They even feel that due to its smallness the dentist can only check the teeth and it cannot hurt. Another 3 participants feel positive about the drill because it does not look like something ordinary, it has its own distinctive geometry and this uncommon form makes them feel positive.

Proportion:

11 statements about proportion of the drill are received. 7 out of 11 statements are negative, whereas the rest 4 statements are positive (Table 4-4).

3 participants mention the positive effect of the long handle considering the whole instrument. The reasons of positive feelings are due to appearance of practical handling for dentists (2/3) and accessibility to anywhere inside mouth (1/3). In addition, another participant feels better because he/she finds the needle too small compared to the overall size of the instrument. On the contrary, 5 participants think that handle part is too thick and 2 out of 5 participants feel uncomfortable because of the disproportion of the needle and the head part.

Color:

Participants have made 20 statements in total about color of the drill. 17 out of 20 statements are negative, whereas the rest 3 statements are positive (Table 4-4). Only 3 participants are glad due to its dim color whereas another 12 participants think that this rusty and darkening colored drill elicits negative emotions. 9 out of these 12 participants mention that this rusty appearance of the drill make them anxious in terms of hygiene. The reasons for these negative feelings can also be the worn appearance of the drill (2/12), its grey color (2/12), or its being metal (2/12). Moreover, one of them tells that this corroded appearance make him/her feel like it is an uncompleted instrument and this situation disturbs him/her.

Material:

Participants have made 10 statements about the material of the drill. There are 7 positive and 3 negative statements (Table 4-4). According to positive statements, 6 participants are glad that the drill is metal due to its high-quality appearance (3/6) and hygienic appearance (3/6) of the material. However, another 3 participants feel uncomfortable about metal usage for the drill. One of them (1/3) think that metal is not associated with hygiene. Another participant (1/3) worries about the hardness of the material and he/she thinks that the drill can break his/her tooth by accident. The other participant (1/3) feel negative, because more force can be applied due to metallic material.

Texture:

Participants have made 16 statements about texture of the drill. 11 out of 16 statements are positive, whereas the rest 5 statements are negative (Table 4-4). 6 participants mention that the texture gives high quality appearance for the drill. Another 3 participants like the square formed texture on the drill. One of them thinks that these textures provide dentist to use the drill carefully and for this reason he/she feels safe and pleasant. On the other side, 4 participants think the texture of the drill has negative effects due to its resemblance to snakeskin (1/4), hygienic concerns (3/4) and worn appearance (1/4).

Graphical elements:

Only one statement about graphical elements on the drill was made. One participant state that handwriting styles on the handle surface is associated with professional appearance that makes him/her feel positive.

In the next question, participants were asked for design suggestions that would make them feel more positive than before.

Form related statements:

- 6 participants prefer a drill with a thinner form. Another participant wants to see a smaller drill to feel better.
- One mentions that he/she can feel positive if the instrument resembles an elephant's trunk.
- One participant mentions that the drill looks like a mini camera as if it is used only for checking the teeth.
- One participant wants the needle of the drill to be thicker and shorter like a circular shape if it is possible.

Proportion related statements:

- Two participants prefer a drill with thinner (1/2) and smaller (1/2) needle to evoke positive emotions.
- One participant wants a drill whose handle part is thicker as he/she thinks that this thinner drill may go to the deepest end of his/her throat.

Color related statements:

- 10 participants prefer colored drill to feel positive. They prefer blue (5/10), green (4/10), white (3/10), cream (2/10), pink (1/10), purple (2/10), black (1/10), yellow (1/10).
- 4 participants prefer a dim colored instrument, as they feel negative due to gleaming of the metallic color and they find the instruments unqualified. However just 2 participants want to see shiny instrument to feel better and safe. Moreover they believe hygienic appearance of the drill can be provided with glitter of the metallic color.
- 4 participants prefer to color only the handle part of the drill, as they do not want color application to threaten their health.
- One participant suggests coloring the writings on the handle part to feel better and make the instrument professional.

Material related statements:

- 9 participants mention that they can feel better if the handle of the drill is covered with a plastic or rubber material. Two of them think that different material on handle creates a smooth appearance. They believe the application of plastic on handle removes the cold appeal of metal usage.
- For hygienic concerns 4 participants prefer disposable drills. Moreover, 2 participants would like to see the opening of the package of the drills in front of their eyes because they do not believe this instrument could be made disposable.
- One participant prefers different material except from metal for the drill as they think that they can have a smoother treatment with another material. On the other side 2 participants do not prefer plastic for the drill due to hygienic concern and primitive appearance of the material. One of them mentions that plastic material keep bacteria because of its pores on the surface that make them feel negative to drill.
- For hygienic concern, one imagines an instrument in which the handle and the head part are separable and the head part is disposable.

Texture related statements:

- 2 participants prefer linear textures instead of square shaped texture. Another one thinks that the existing texture is appropriate with the metal structure. After the covering handle part with plastic material, he/she also suggest using linear textures for the handle part.

Graphical elements related statements:

- 5 participants state that they feel positive if there are some graphical elements on the handle part of the drill. Handwriting style writings printed with laser (5/7), healthy tooth images (1/7), butterfly and flower images (1/7) can be applied on the handle part. However, one of the participants does not prefer flower patterns on drill, as he/she believes this texture removes professional appearance of the drill.

Mechanism related statements:

- 14 participants think that drill whose needle is invisible make them feel more comfortable. They prefer the needle of the drill being activated in mouth just before the treatment.
- One participant thinks that a new technological feature can be added to the instrument. He imagines a monitor where the dentist can see how much he/she goes deeper inside tooth. This machine can warn the dentist if he/she goes deeper. This makes the dentist apply a standardized treatment that gives him comfort. Therefore, participants mention that they feel safe and positive.
- One participant suggests that textured part can be elastic and dentist change its shape according to situation inside the mouth. This feature provides him/her flexibility during the treatment. Therefore the participant can think that this instrument is professional and pain less.
- Another participant suggests a drill handle with an adjustable length.

4.4 Conclusion and Discussion

This study aimed to understand which product visual attributes have influence on the emotional reactions of patients and how the appearance of dental instruments should be to decrease negative emotions of patients. An interview was conduct with 20 participants. All interview texts were coded thematically and all the statements gathered from the participants were collected in a pool regardless of the participants of the statements as total numbers of the statements for each instrument were considered for the analyses.

The analysis of the Main Study shows that:

- Participants' emotions towards the three instruments are totally negative.
- The results show that form, proportion, color, material, texture and graphical elements are the main instruments' product visual attributes that affect the emotions of participants.

- Unpleasing appearance, ordinary appearance, unsafe appearance, non-medical appearance, low quality appearance and unhygienic appearance of instruments are the most mentioned qualities which have negative effects on participants' emotions.
- Participants associate non-medical appearance and unsafe appearance with form of the instruments.
- Low quality appearance and unhygienic appearance are generally associated with material of the instruments.
- Fear, anxiety and uncomfortable are the most prominent feelings of participants towards the instruments.
- Changes in instruments' product visual attributes may increase positive feelings in participants. Smaller and thinner instruments, colored instruments, plastic covered instruments or disposable ones, graphical elements on instruments' surfaces can have positive effects on patients' emotions towards dental instruments.

To sum up, in the main study, it was found that negative emotions of participants are dominant towards dental instruments. Instruments' product visual attributes– form, proportion, color, material, texture and graphical elements- have both positive and negative on participants' emotions. According to results of the main study, conscious changes in product visual attributes of dental instruments might decrease negative emotions of participants. In the final chapter, conclusion of the research study will be presented.

CHAPTER 5

CONCLUSION

This final chapter starts with brief overview of the literature review study. Then the answers of research questions are presented by considering findings from the literature study, two preliminary studies and the main study. Moreover, recommendations for designers and further studies are stated.

5.1 State of the Literature

The aim of this thesis was to investigate the emotional reactions of the patients to the dental instruments and explore which product visual attributes and related qualities trigger these emotions. For this purpose, literature review study benefited from different fields such as; literature related with the dental instruments for the analysis of patients' emotions towards these instruments; literature on the medical device design and user's emotion in medical area; and the literature about the product emotions and product appearance.

First of all, the feelings of patients towards dental treatments and reasons of these feelings were investigated. Measurement techniques for the dominant emotion, -dental fear- were explained and dental fear management techniques for both dentist and patients were stated. And then, brief information about dental treatments and their related instruments were presented.

And then, in order to learn to what extent emotions were taken into consideration in the process of dental instrument design, the factors that have influence on dental instrument design were investigated.

Lastly, product appearance and product emotion literature were investigated. To

analyze how dental instruments can affect patients' emotions, it was searched that how people response to product appearance. And, at the end of the literature review section subjective and objective measurements for people affective response to product appearance were stated.

5.2 Research Questions Revisited

In this section the research questions, which were presented in Scope of the Study section in Chapter I are tried to be answered through the state of literature, the findings from preliminary studies and main study.

The main research question of this thesis study is as follows:

- What are the influences of product visual attributes on the emotional reactions of the patients to the dental instruments?

Before answering the main research questions, sub questions are going to be revisited.

Sub question 1: What is dental fear and what are the reasons of dental fear?

Sub question 2: Which methods are applied to decrease dental fear?

Answers to these questions were found in literature review study. In Chapter 2, Section 2.1, emotions in dentistry environment, dental fear and the reasons of dental fear were analyzed. Dental fear that is the most dominant negative emotion in dentistry is defined as an emotional reaction of patients aroused by specific stimulus such as needles, drilling. Fear of pain, embarrassment, learning from others' previous experience, bad dental treatment experiences, fear of the unknown, and dental procedure and instruments were mentioned as the reasons of dental fear in literature.

To decrease dental fear, some management techniques were found in literature. Pharmacological interventions, dentists' techniques, patients' techniques, and arrangements of environmental factors were presented to make patients overcome dental fear. Pharmacological interventions substantially are used to manage anxiety

of patients by giving drugs. Dentists' techniques -tell-show-do, voice control, non-verbal communication, reinforcement and distraction techniques- were explained where as pain control, communicate with dentist, sedation, therapy, distraction and relaxation techniques were presented as patients' techniques to make themselves calm. Besides these techniques, listening music during dental treatments or odor of dentistry environment were found as influencing factors for patients' emotions.

Sub question 3: What are general design requirements of medical hand tools?

The related literature was reviewed to answer this question. In Chapter 2, Section 2.3.2, general requirements for medical hand tools designs were presented. As dental instruments are regarded as medical hand tools, the requirements were analyzed to see the requirements for dental instruments. According to findings from literature review, the criteria such as tool size, applied forces, variety of handle shapes, weightiness, surface, material and texture affect design of the tools.

Sub question 4: Which factors are taken into consideration in the process of medical device design?

Sub question 5: To what extent emotions are taken into consideration in the process of medical device design?

In the literature review study, the factors which have influence on medical device design were described into six groups; functionality, ergonomics, technological development, aesthetic appeal, universal design and design for emotion. After explaining these factors in the literature review section, design for emotion in medical area was presented. It was found that regarding emotional reactions of users and considering probable relation between medical device and user are the latest approaches in medical device design. As the reviewed literature do not give enough information about design for emotion in dentistry, it was analyzed for medical device area from a general perspective. However, it was found that there are some noteworthy approaches only for the dental injector in the last few years. This may be an indicator that design for emotion started to be considered as a factor in dental instruments' design.

Sub question 6: Is there a relationship between seeing the dental instruments in the previous treatments and patients' negative feelings?

Answer to this question could not be found in the literature review study. As it was investigated in the literature review study, negative emotions of patients are found to be dominant in dentistry. From the first preliminary study, it was also concluded that negative emotions towards dental instruments are dominant. However, previous dental experiences might be effective for patients' evaluations about appearance of dental instruments. To understand the effects of previous experience on patients' emotions towards dental instruments, second preliminary study was conducted. In the second preliminary study, participants were asked to define whether they have seen the instruments in their previous dental treatments or not. Spearman correlation test was used to conduct analysis. According to the results, participants may feel negative towards only four of 17 instruments -vitalometer, drill, elevator, and periodontal hand tools- because of their previous experiences. According to this result, it can be said that seeing dental instruments in previous dental treatments of the participants has little effects on what they feel towards the dental instruments. Namely, there are no significant differences between the feelings of participants who have experienced dental instruments and the feelings of participants who have not experienced dental instruments.

Sub question 7: How might the dental instrument's visual attributes be to decrease the negative emotions of patients?

Injector, forceps and drill, which were found as the most seen instruments and create more negative emotions in the second preliminary study, were investigated in the Main Study. Participants were asked to state the instruments' product visual attributes that make them feel negative and positive, and to state how might the instruments' product visual attributes be to make them feel more positive towards the instruments. According to the Main Study results, patients could feel more positive by changing product visual attributes of the dental instruments and all the participants agreed that the appearance of the dental instruments triggered negative emotions. This study revealed that product visual attributes - form, proportion, color,

material, texture and graphical elements- are effective on participants' emotions towards dental instruments. For each instruments participants suggested some changes for these product visual attributes to feel more positive. Shortly, it may be explained that smaller and thinner instruments, colored instruments, plastic covered instruments or disposable ones, graphical elements added instruments can have positive effects on patients' emotions towards dental instruments.

So, after revisiting the sub-questions of the thesis, the conclusions related with the main research question are presented in the following paragraphs.

Main question: What are the influences of product visual attributes on the emotional reactions of the patients to the dental instruments?

The literature review study revealed that product appearance has effect on user's emotions. Users evaluate visual attributes of the products at first sight and evoke responses to the form of products. From the literature review study, it was found that the visual unity of a product consists of color, texture, material, form, proportion, texture, graphics, geometry, dimension, and ornamentation.

The results of the preliminary studies and main study are valuable to show product visual attributes influencing the emotional reactions of the patients to the dental instruments. By the first preliminary study presented in Chapter 3, it is concluded that form, proportion, material, color and texture of dental instruments are effective on participants' emotional responses. Moreover, 13 related qualities of product properties were gathered from content analysis. These are unsafe appearance, pleasing appearance, non-medical appearance, safe appearance, unpleasing appearance, ordinary appearance, distinctive appearance, disturbing sound, ease of use, unhygienic appearance, low quality appearance, professional appearance and hygienic appearance. Moreover, all instruments' groups were evaluated in terms of their product visual attributes. Besides Desmet's Premo emotions used in the study, seven feelings were gathered from content analysis of the participants' statements. They are feeling pleasant, fear, anxiety, safe, unpleasant, disgust and feeling unsafe.

Besides negative feelings, positive feelings were also outcomes of the study. The relationship between these feelings and related qualities of product properties were also defined.

From the second preliminary study, three instruments were selected as study materials for the Main Study. As presented in Figure 5.1, instruments that create more negative emotions and the instruments of which possibility to be seen are higher were found out. According to the results of the second preliminary study, injector, forceps and drill were selected to study.

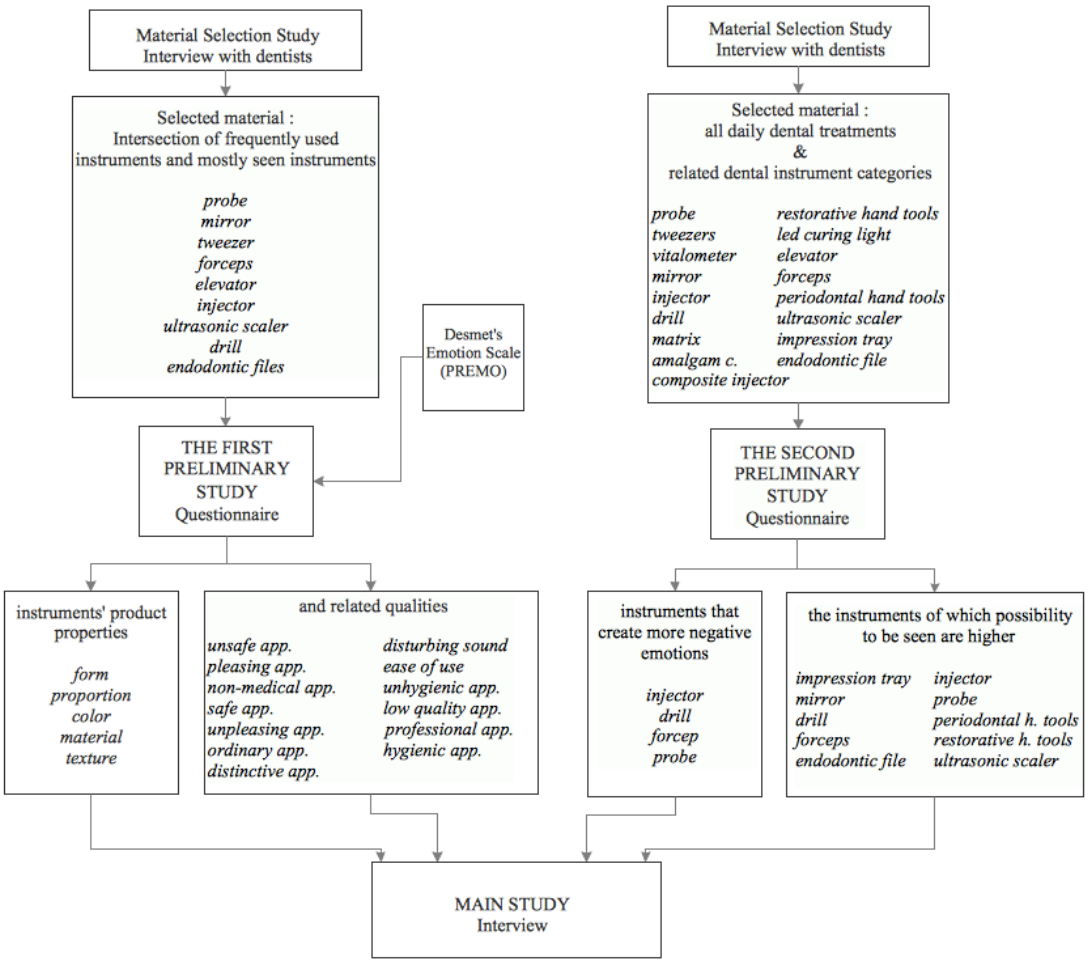


Figure 5-1 Diagram-Presentation of Research Studies

Besides the product visual attributes– form, proportion, color, material and texture- which were revealed from the first preliminary study, graphical elements were also mentioned in the Main Study. Moreover, in the Main Study, as the underlying reasons of negative emotions of participants, unsafe appearance, unhygienic appearance, unpleasing appearance, non-medical appearance, low quality appearance and ordinary appearance were listed. The instruments' product visual attributes, related qualities and design suggestions from these research studies may constitute a precious data for industrial designers.

5.3 Recommendations for Designers

The results of the three studies can be taken into consideration in the process of dental instrument design. The ergonomics and the functionality of dental instruments were excluded from this study, as they might be subjects of other research studies since such studies require literature reviews with different perspectives and methodologies.

The findings of the research studies may help dental instrument designers to design for emotion. The other factors influencing dental instruments' design such as functionality, ergonomics, universal design principles should support design for emotion in dental instruments' design process.

General recommendations on dental instruments are listed below.

- The effects of dental instruments' form, proportion, material, color, texture and graphical elements may be evaluated as they may have both negative and positive effects on patients' emotions.
- Handles, body parts and end parts of dental instruments may be considered in terms of their proportionalities and forms. For example, according to participants, thinner and shorter needle for injector may decrease pain perception for patients. Moreover, bigger barrel part of injector may cause

increase in pain perception because much more liquid medicine is going to penetrate and the penetration time increase. Another example is that for forceps, patients may associate longer handle with much pain so the length and thickness of handle may be considered. As the handle length of dental instruments may be decreased provided that it meets the requirements of hand dimension of user population (%95 percentile).

- Results show that, materials of dental instruments have influences on the perception of safe/unsafe appearance, high/low quality appearance and hygienic/unhygienic appearance of dental instruments. For example, covering handle parts of dental instruments with plastic may increase the perception of safety as plastic covered handles may provide dentists safer operations. On the other hand, some plastic materials may keep bacteria because of their pores on the surface. As it is stated before in general design requirements for dental instruments, non-porous material should be preferred in order to protect from bacteria and the material should be appropriate to sterilize by gas, chemical and heat. Plastics may be used provided that they can be sterilized.
- Color of dental instruments may have both positive and negative effects on patients' emotions. For example, dim colored forceps and drill may increase positive emotions on patients. Blue, pink and green are most mentioned colors that may result in positive emotions. Another example is that barrel part of injector may be colored because seeing amount and color of liquid medicine may make patients feel uncomfortable.
- It can be concluded from the study that texture and graphical elements of dental instruments have effects on patients' emotions. Conscious changes in texture and graphical elements may increase positive emotions of patients. For example, manufacturing and brand information about dental instruments may be written with laser on handle of them, which may create high quality appearance for the instruments.
- It is observed that participants may resemble dental instruments with familiar products. Familiar instruments may evoke more negative emotions as patients

may associate the instruments with their previous experience. For example, same shaped injectors are used in many clinics and patients may associate the injector with pain. However in dentistry, dentists use spray for dental anesthesia before injection, which reduce pain. Therefore, dental instruments that do not resemble familiar products, namely which have distinctive appearance may evoke positive emotions on patients.

- Non-medical appearance of dental instruments may make patients feel both positive and negative. Therefore, designers should be careful if they aim to resemble dental instruments to specific products. For example, if dental instruments look like something dangerous such as pliers or drill, patients may feel more negative. Or if dental instruments look like something harmless or innocent such as toy, candy, bird or etc, patients may feel more positive.
- Technological innovations for dental instruments may create positive effect on patients' emotions. It may be considered whether technological innovations may be achieved or not for dental instruments. For example, electronic indicators on instruments may provide them to be perceived as professional instruments and make patients feel positive.
- Hygienic appearance of dental instruments may have positive effect on patients' emotions. Disposable instruments may create more hygienic perception; however, for some treatments patients may think that disposable instruments are not strong enough for their function. Therefore, disposability of dental instruments may be investigated according to their function. On the other hand, hygienic appearance may be provided with closed package for the instruments which are reusable and package of instruments may be opened in front of patients' eyes in terms of hygienic concerns.
- Patients may feel safer if they do not see sharp edges of dental instruments. For example, the needle of injector and drill may be activated in mouth just before the treatment. Moreover, sharp edges may be avoided if it is possible. Or sharp edges may be hidden from patients during treatment.

5.4 Limitations of the Study

The study of emotional response of patients towards dental instruments is unique as there is no other study worked on this subject in the literature.

The first and the second preliminary studies were carried out with pictures of the dental instruments. The pictures of the instruments were from one viewpoint. Although using Internet images in the preliminary studies could be thought as a limitation for the study since it did not support the researcher to show different views of the instruments, it could be counted as an advantage that in the preliminary studies, many instruments could be provided to participants. Otherwise, it would be difficult to find nearly 40 instruments. In the Main Study, participants were given three real-physical instruments to evaluate.

In this study, the relationship between product appearance and individual's emotion were studied with dental instruments. Considering two questionnaires and one interview, 240 participants attended to the study. The results of this study reflect the emotions of 240 participants. Although the number of participants is sufficient to decide instrument related factors that affect patients' emotion, there may still be other factors.

In the first study, words provided in the Desmet's Premo emotion scale were used. It was difficult to find set pairs of adjectives for the study. Although Premo is product emotion measurement instrument that supports a designer to evaluate and manipulate the emotional impact of his design, in the first preliminary study it was used to provide emotion words to participants. The results from Desmet's Premo scales were only used to see the frequency of positive and negative emotions towards dental instruments. In the second study participants were asked to define their feelings with their words. However, due to lack of emotions scale that is appropriate for medical devices, participants might have difficulties to define their feelings towards dental instruments.

For the Main Study, material selection was done by considering the findings of the second preliminary study. Different findings could be gathered if another three instruments were selected for the Main Study.

A further limitation of the study is omitting the effects of environmental factors in dentistry. Although environmental factors in dentistry may also affect the patients' emotions, the thesis only focuses on the effects of instruments' product visual attributes which may influence patients' emotions in dentistry.

5.5 Recommendations for Further Studies

Similar research studies can be conducted with the patients' just after their dental treatments. In the first study, it was tried to ask patients to attend the questionnaire just after their dental treatments. However, some dentists did not let the author to conduct the study with their patient just after their dental treatments and also patients were not able to speak or were angry because of the stress of their dental treatments.

Similar studies can be conducted with dentists to get their observations and opinions about patients' fear. Although it is not appropriate to ask dentists about patients' feelings, dentists can have opportunity to see patients' reactions during the treatment if there is a reaction towards dental instruments. Therefore, their experiences can be investigated.

Moreover, for this study, daily dental treatments were selected to study on. There are also surgical treatments and numerous related dental instruments. Similar studies might be conducted for other dental treatments and dental instruments. Furthermore, a specific treatment and its related instruments can be selected for another study. Likewise, a specific instrument and its variations can be investigated.

For the Main Study injector, forceps and drill were studied as they were found the most seen instrument during the treatments and as the instruments creating negative

emotions at most. Similar study can be conducted with the instruments that create positive emotions at most. Thus, it can be investigated which instruments' product visual attributes and related qualities make patients feel more positive.

To sum up, the fearful appearances of dental instruments have negative effect on patients' emotions. As also given in the introduction of the thesis, Participant 8 stated that although he knew that he would not feel much pain during tooth extraction treatment, he felt anxious because of the appearance of the dental instruments. Similar statements are gathered from the outcomes of all studies conducted for the thesis. So, product appearances of dental instruments have enormous influence on patients' emotions. With little certain changes in dental instruments' designs, their fearful appearance may be modified. It is assumed that the findings of this study would contribute to the research on visual attributes of products influencing emotional reaction of patients to dental instruments.

REFERENCES

ABCs of Dental Anxiety, Fear and Phobia. (n.d.). Retrieved March 20, 2013, from http://bangalore dentistonline.com/dental_faq_main/dental_phobia.htm

ACCUPAL is new alternative anesthesia delivery system. (n.d.). Retrieved July 20, 2013, from http://www.dentistryiq.com/articles/de/2008/07/accupal-palatalinjection syst.html

Alexander, L. (2013, October 21). Healthcare design firm creates user-friendly auto-injector rheumatoid arthritis patients. Retrieved July 20, 2013 from http://healthydebate.ca/opinions/scout

Armfield, J. M. (2010). How Do We Measure Dental Fear and what are we measuring anyway? *Oral Health & Preventive Dentistry*, *8*(2), 107-115.

Berggren, U., and Carlsson, S. G. (1986). Qualitative and quantitative effects of treatment for dental fear and avoidance. *Anesthesia progress*, *33*(1), 9–13. Retrieved April 13, 2013, from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid= 2175435&tool=pm centrez&rendertype=abstract

Birmingham Hip Resurfacing System. (2007). *Smith & Nephew* [Brochure]. Retrieved June 20, 2013 from http://www.smith-nephew.com/professional/ products/all-products /bhr-birmingham-hip-resurfacing/

Bitterman, N. (2011). Design of medical devices--A home perspective. *European Journal of Internal Medicine*, 22(1), 39-42

Blijlevens, J., Creusen, M. E. H., and Schoormans, J. P. L. (2009). How consumers perceive product appearance: The identification of three product appearance attributes. *International Journal of Design*, 3(3), 27-35.

Bloch, P. (1995). Seeking the Ideal Form: Product Design and Consumer Response. *Journal of Marketing,* 59, 16-29.

Botney, R., Privitera, M. B., Berguer, R., & Radwin, R. G. (2008). Hand Tool Design. In Weinger, M. B., Wiklund, M. E., and Gardner – Bonneau, D. J.(Eds.), Handbook of Human Factors in Medical Device Design (645-714). New York, USA: CRC Press.

Chang, C.C. (2008). Factors influencing visual comfort appreciation of the product form of digital cameras. *International Journal of Industrial Ergonomics,* 38, 1007-1016.

Chang, W. C. and Wu, T. Y. (2007). Exploring types and characteristics of product forms. *International Journal of Design*, 1(1), 3-14.

Chapman, H. R. and Kirby, N. C. (1999). Dental fear in children--a proposed model. *British dental journal*, *187*(8), 408–12.

Chhibber, S. (2009). *Patient centered innovation in medical device design.* Retrieved May 20, 2013, from Ephmra website: http://www.ephmra.org/pdf/EphMRA %202009%20Conference%20Shayal %20Chhibber%20Final.pdf

Chu, P. Y., Chen, L.C., Wei, W. L. and Chien, Y. H. (2011). Identifying emotional factors for quantitative evaluation of perceived product values, *African Journal of Business Management*, 5(14), 5698-5709.

Cientifica, S. D. I., Coletiva, S., Brasileira, A., Saúde, D. P., and Janeiro, R. De. (2011). Redalyc Art in the inclusion of children with special needs in dentistry Art in the inclusion of children with special needs in dentistry. *Ciência & Saúde Coletiva*, *16*(1), 747–753.

Cohen, S. L. (n.d.). *Names of Dental Tools.* Retrieved April 13, 2013, from http://www.ehow.com/ about_5460078_names-dental-tools.html

Creusen, M. and Schoormans, J. (2005). The Different Roles of Product Appearance in Consumer Choice. *Journal of Product Innovation Management*, 22(1), 63–81.

Crilly, N., Moultrie, J., and Clarkson, P. J. (2004). Seeing Things: Consumer Response to the Visual Domain in Product Design. *Design Studies*, 25(6), 547-577.

Crilly, N., Moultrie, J., and Clarkson, P.J. (2009). Shaping things: intended consumer response and the other determinants of product form. *Design Studies*, 30(3), 224-254.

Çetin, A. (2004). *Applying Product Design Methods to Medical Device Design With a Case Study on Home Care Devices.* M. Sc. thesis submitted to İzmir Institute of Technology. Retrieved January 20, 2013, http://library.iyte.edu.tr/tezler/master/ endustriurunleritasarimi/T000449.

Demir, E. (2008).The field of design and emotion: concepts, arguments, tools, and current issues. *Journal of the Faculty of Architecture*, 25(1), 135-152.

Demir, E., Desmet, P. and Hekkert, P. (2009). Appraisal patterns of emotions in user-product interaction. *International Journal of Design,* 3(2), 41-51.

Demirbilek, O. and Sener, B. (2003). Product design, semantics and emotional response. *Ergonomics*, *46*(13-14), 1346–60.

Dental Instruments Setup. (n.d.). Retrieved May 20, 2012, from http://www.sweethaven.com/sweethaven/MedTech/Dental/DentSetups/default.asp

Dental Phobia. (n.d.). Retrieved May 20, 2012 from http://www.floss.com/fh_men_phobia.html

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

DESMET, P.M.A. (2007). Nine Sources of Product Emotion, *Proceedings of the International Association of Societies of Design Research Conference*, 12-15 November 2007, The Hong Kong Polytechnic University School of Design, Hong Kong.

Desmet, P and Dijkhuis, E. (2003). A wheelchair can be fun: a case of emotion-driven design. *Proceedings of the International Conference on Designing Pleasurable Products and Interfaces,* Pittsburgh, Pennsylvania, USA. New York.

Desmet, P.M.A., Hekkert, P., and Hillen, M.G. (2004). Values and emotions; an empirical investigation in the relationship between emotional responses to products and human values. *Proceedings of the fifth European Academy of Design conference*, Barcelona, Spain. In press.

Desmet, P.M.A., Overbeeke, C.J. and Tax, S.J.E.T. (2001). Designing products with added emotional value: development and application of an approach for research through design. *The Design Journal*, 4(1), 32-47.

Dino chair kid's dental chair. (n.d.). Retrieved January 25, 2013, from http://www.dinochair.com/news/?p=19

Doerr, J., Kerkow, D. and Landmann, D. (2008). Supporting Requirements Engineering for Medical Products - Early Consideration of User-Perceived Quality, In: Association for Computing Machinery (ACM): 30th International Conference on Software Engineering. ICSE'2008. Los Alamitos : *IEEE Computer Society*, 639-647.

Elde, K. M. (2012). *Clinical management of the adult patient with dental anxiety* . (Masters Thesis). Universitetet i Tromsø. Retrieved July 20, 2013, from http://hdl.handle.net/10037/4240

Endodontic Instruments and Their Uses. (n.d.). Retrieved July 20, 2013, from http://www.columbia.edu/itc/hs/dental/endo/client_edit/lectures/Instruments.html#extirpating

Feine J. S., Awad M. A., and Lund J. P. (1998). The impact of patient preference on the design and interpretation of clinical trials. *Community Dent Oral Epidemiol*, 26, 1-5.

Folkmann, M. N. (2010). *Encountering the Unknown* . Retrieved July 20, 2012, from http://www.dcdr.dk/uk/material/mind-design/no-29/md29-encounteringtheunknown.pdf

Foreman, P. A. (1988). Practical Patent Management: The Integrated Approach. *Anest Prog*, 35, 19-25.

From an everyday dentist to entrepreneur. (2010). Retrieved April 20, 2013, from http://www.dentaltribune.com/articles/business/usa/3284_from_an_everyday_dentist_to_entrepreneur.html

Ginnow-Merkert, H. Beyond Cosmetics. Design in the Age of Information: A Report to the National Science Foundation (NSF): 171-174.

Gotzsch, J. (2006). Product Talk. *Design Journal,* 9 (2), 16-24.

Hmud, R., and Walsh, L. J. (2009). Dental anxiety: causes, complications and management approaches. *Journal Of Minimum Intervention In Dentistry*, *2*(1), 67-78. Retrieved from http://www.micompendium.org/journal/index.php/JMID/article/viewFile/31/29

Hsiao, K.A., and Chen, L.L. (2006). Fundamental dimensions of affective responses to product shapes. *International J. of Industrial Ergonomics* 36, 553–564.

Hsu, S. H., Chuang, M. C., and Chang, C. C. (2000). A semantic differential study of designers' and users' product form perception. *Industrial ergonomics*, *25*, 375–391.

Jaakkola, S., Rautava, P., Alanen, P., Aromaa, M., Pienihakkinen, K., Raiha, H., Vahlberg, T., Mattila, M.L., and Sillanpaa, M. (2009). Dental fear: One single clinical question for measurement. *Open Dent.* J, 3, 161–166.

Jordan, M. (2008). Bringing medical devices home. *Medical Device & Diagnostic Industry Magazine,* 30(2), 62-67.

Jordan, P. (2000). Designing Pleasurable Products: An Introduction to the New Human Factors. *Taylor and Francis*, London.

Keating, M. T. (2011). How relevant is the patient's social culture in the development of *Registered Dental Hygienist*, *31*(7), Retrieved June 30, 2012, from http://www.rdhmag.com/articles/print/volume-31/issue-7/features/fear-and-anxiety-in-the-dental-environment.html

Khalid, H. M. and Helander, M. G. (2006). Customer emotional needs in product design. *Concurrent Engineering Research and Applications*. 14(3),197–206.

Klages, U., Sadjadi, Z., Lojek, L. D., Rust, G., and Wehrbein, H. (2008). Development of a questionnaire measuring treatment concerns in regular dental patients. *Community Dentistry and Oral Epidemiology*, 36(3), 219-227.

Kongprasert, N., Brissaud, D., Bouchard, C., Aoussat, A., and Butdee, S. (2009) The customer-oriented bag matrix to support the design leather bags, *The CIRP Manufacturing System, Grenoble, France*, June 5-6.

Kossack, M., Gellatly, A., and Jandrisits, A. (2007). Industrial Design and Human Factors: Design Synergy for Medical Devices. In: Jacko, Julie A. (ed.) *HCI International 2007 - 12th International Conference* - Part IV 2007, 489-498

Krochak, M. and Friedman, N. (1998). Using a precision-metered injection system to minimize dental injection anxiety. *Compend Contin Educ Dent*, 19, 137-146.

Kubovy, M. (1999). On the Pleasures of the Mind, In: Kahneman, D., Diener, E. and Schwarz, N. (eds.), Wellbeing: The Foundations of Hedenic Psychology, New York, Russell Sage Foundation, pp 134–154.

Lam, K. (2013, July 08). *Cutting through the hype – will a "medical tricorder" really replace doctors?* Retrieved August 20, 2013, from http://healthydebate. ca/opinions/scout

Laurans, G., Desmet, P.M.A., and Hekkert, P.P.M. (2009). Assessing Emotion in Interaction: Some Problems and a New Approach. In: A. Guenand (Ed.), *Proceedings of the 4th International conference on Designing Pleasurable Products and Interfaces*, Compiegne, France.

Lishan, X., Boucharenc, C., Chiuan, Y. C., and Choolani, M. (2007). A Review of Healthcare Devices – Moving Design From Object to User. *Proceedings of the*

International Association of Societies of Design Research (IASDR) Conference "Emerging Trends in Design Research", Hong Kong.

Liu, M. (2011). The Dentist / Patient Relationship: The Role of Dental Anxiety. *CMC Senior Theses*. Paper 277. Retrieved June 20, 2013, from http://scholarship.claremont.edu/cmc_theses/277

Locker, D., Liddell, A., and Shapiro, D. (1999). Diagnostic categories of dental anxiety: a population-based study. *Behaviour Research and Therapy*, 37, 25-3.

Lowe, A. (2010). The cutting edge of dental instruments. *Vital* 7, 33-35.

Martin J. L., Norris B. J., Murphy E., and Crowe J. A. (2008). Medical device development: The challenge for ergonomics. *Applied Ergonomics*, 39(3), 271–283.

McDonagh, D., Bruseberg, A., and Haslam, C (2002). Visual Product Evaluation: Exploring Users' Emotional Relationships with Products. *Applied Ergonomics: Human Factors in Technology and Society,* 33(3), 231-240.

Money A.G., Barnett J., Kuljis J., Craven M.P., Martin J.L., and Young T. (2011). The role of the user within the medical device design and development process: medical device manufacturers' perspectives. *BMC Medical Informatics and Decision Making*, 11, 15.

Murphy, M. G., Fields, H. W., and Machen, J. B. (1984). Parental acceptance of pediatric dentistry behavior management techniques. *The American Academy of Pediatric Dentistry*, *6*(4), 193-198. Retrieved May 15, 2013, from http://www.aapd.org/assets/1/25/Murphy-06-04.pdf

Nagamachi, M. (1995). Kansei Engineering: A new ergonomic consumer oriented technology for product development, *International Journal of Industrial Ergonomics,* 15, 3-11.

National Patient Safety Agency. (2010). Design for patient safety: User testing in the development of medical devices. National Reporting and Learning Service, National Patient Safety Agency (NPSA), London.

Olszewska, I., and Zarow, M. (2003). Does music during dental treatment make a difference ? *Dent Res 2*, *82*(7), B–351.

Oosterink, F. M. D., De Jongh, A., and Hoogstraten, J. (2009). Prevalence of dental fear and phobia relative to other fear and phobia subtypes. *European journal of oral sciences*, *117*(2), 135–43.

Park, J.H., Stoel, L., and Lennon, S.J. (2008). Cognitive, affective, and conative responses to visual simulation: the effects of rotation in online product presentation. *Journal of Consumer Behaviour*, 7, 72-87.

Pohjola, V. (2009). Dental fear among adults in Finland. *Oulun Yliopisto*. Retrieved February 20, 2013, from http://herkules.oulu.fi/isbn9789514292385/isbn9789514292385.pdf

Pohjola, V., Lahti, S., Suominen-Taipale, L., and Hausen, H. (2009). Dental fear and subjective oral impacts among adults in Finland. *European journal of oral sciences,* 117, 268-272.

Porritt, J., Marshman, Z., and Rodd, H. D. (2012). Understanding children's dental anxiety and psychological approaches to its reduction. *International journal of paediatric dentistry / the British Paedodontic Society [and] the International Association of Dentistry for Children*, *22*(6), 397–405.

Raciene, R. (2004). Dental Fear Among Teenagers. Individual Anxiety Factors. Stomatologija, *Baltic Dental and Maxillofacial Journal,* 6, 118-121.

Rubin, J.G., Slovin, M., and Krochak, M. (1988) The psychodynamics of dental anxiety and dental phobia. *Dent Clin North Am*, 32(4), 647-56.

Salmela, M., Aronen, E. T. and Salanterä, S. (2011), The experience of hospital-related fears of 4- to 6-year-old children. *Child Care Health Dev* 37:719.

Sawyer D. (1997). *Do It By Design: An Introduction to Human Factors in Medical Devices*. FDA.

Saxena P, Gupta SK, Newaskar V, Chandra A. (2013). Advances in dental local anesthesia techniques and devices: An update. *Natl J Maxillofac Surg,* 4, 19-24

Scherer K. R. (2005b). What are emotions? And how can they be measured? *Social Science Information,* 44, 693–727.

Schifferstein, H.N.J. (2010) From salad to bowl: the role of sensory analysis in product experience research. *Food Quality and Preference,* 21, 1059-1067.

Schuller, A. A., Willumsen, T., and Hoist, D. (2003). Are there differences in oral health and oral health behavior between individuals with high and low dental fear? *Community Dent Oral Epidemiol,* 31(2), 116-21.

Serra-Negra, J., Paiva, S.M., Oliveira, M., Ferreira, E., Freire-Maia, F., and Pordeus, I. (2012). Self-reported dental fear among dental students and their patients. *Int J Environ Res Public Health.* 9(1), 44-54.

Seva, R. R., Gosiaco, K. G. T., Santos, M.C. E. D. and Pangilinan, D. M. L. (2011). Product Design Enhancement Using Apparent Usability and Affective Quality. *Applied Ergonomics*, 42, 511-517.

Seva, R., Duh, H. B. L., and Helander, M. H. (2005). Development of a conceptual model of product emotionin the pre-purchase context. In: Proceedings of HCI International. Las Vegas, USA.

Sharples, S., Martin, J., Lang, A., Craven, M., O'Neill, S., and Barnett, J. (2012). Medical device design in context: A model of user–device interaction and consequences. *Displays*, 33(4-5), 221–232.

Shieh, M. D. and Yang, C. C. (2008). Multiclass SVM-RFE for product form feature selection. *Expert Syst. Appl.* 35, 531-541.

Stouthard, M. E. A., Hoogstraten, J., and Mellenbergh, G. J. (1995). A Study On The Convergent and Discriminant Validity of The Dental Anxiety Inventory. *Behaviour research and therapy*, 33(5), 589–595.

Teixeira, M.B. and Bradley, R. (2003). *Design controls for the medical device industry*. New York: Marcel Dekker.

Toet, A., Smeets, M.A., Van Dijk, E., Dijkstra, D., and Van Den Reijen, L. (2010). Effects of Pleasant Ambient Fragrances on Dental Fear: Comparing Apples and Oranges. *Chemosens Percept*, 3(3-4), 182-9.

Wu, W., Lan, L. W., Chen, Y., and Lee, Y. (2011). Kansei Product Design for New Product Development- Duo-theme DEMATEL Approach. *International Journal of Kansei Information*, *2*(2), 61–70.

Yang, C.C. (2011). A classification-based Kansei engineering system for modeling consumers' affective responses and analyzing product form features. *Expert Systems with Applications,* 38(9), 11382-11393.

Yoshida, T., Milgrom, P., Mori, Y., Nakai, Y., Kaji, M., Shimono, T., and Donaldson, A. N. (2009). Reliability and cross-cultural validity of a Japanese version of the Dental Fear Survey. *BMC oral health*, *9*, 17.

Zen Cordless Prophy. (n.d.). Retrieved August 25, 2013, from http://www.kartendesign.com/paradigm-shifting/standing-up-for-patients/zen-cordless-prophy/

APPENDIX A

MATERIAL SELECTION STUDY OF THE PRELIMINARY STUDY I INTERVIEW SCHEDULE

A.1 Original in Turkish Language

Değerli Katılımcı,

Bu görüşme Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü'nde yürüttüğüm ve hastaların diş hekimliği aletlerine dair duygusal deneyimlerini inceleyen yüksek lisans tez çalışmasına veri toplamak amacı ile yapılmaktadır.

Görüşmede size diş hekimliliği tedavileri ve bu tedavilerde kullanılan aletler hakkında sorular soracağım. Yaklaşık 15 dakika olan görüşmede vereceğiniz cevaplar sadece akademik amaçlar için kullanılacak ve görüşme yapılan kişinin ismi -istenmediği takdirde- tamamen gizli tutulacaktır.

Yapılacak görüşmeyi ses kayıt cihazı ile kaydetmem sizin için uygun mudur? Kaydı görüşmemiz esnasında istediğiniz zaman kesebilir, görüşme sonunda iptal edebilirsiniz.

Katkılarınız için şimdiden çok teşekkür ediyorum.

Kıvılcım Çınar Okuşluğ
ODTÜ Endüstri Ürünleri Tasarımı Bölümü
Yüksek Lisans Öğrencisi

KATILIMCIYA AİT BİLGİLER

1- Adınız Soyadınız

2- Yaşınız

3- Cinsiyetiniz

4- Uzmanlık alanınızı belirtir misiniz?

SORULAR

1-Hangi diş hekimliliği tedavileri her gün uygulanmaktadır?

2- Az önce belirttiğiniz tedaviler her klinikte uygulanabilir mi?

3- Size göre hangi diş aletleri daha sık kullanılmaktadır?

4- Tedavi sırasında hastaların hangi diş aletlerini görebileceğini düşünüyorsunuz?

A.2 English Translation

Dear Participant,

This interview is conducted to gather data for the thesis study that I have been going on Middle East Technical University, Department of Industrial Design, and which analyzes emotional experience of patients towards dental instruments.

In the interview, you will be asked questions about dental treatments and instruments which are used in these treatments. The interview will last about 15 minutes and the answers you will give will be kept strictly confidential, your name will not be mentioned without your approval.

Is it appropriate to record this interview with a voice recorder? You can stop the voice recorder during the interview, or cancel it at the end of the interview.

Thank you in advance for your contribution.

Kıvılcım Çınar Okuşluğ
METU Department of Industrial Design
Graduate Student

PARTICIPANT'S INFORMATION

1- Your name

2- Your age

3- Your gender

4- Please indicate your area of specialization?

QUESTIONS

1-Which dental treatments are daily routine treatments in dentistry?

2- The treatments that you just listed can be applied in any dental office?

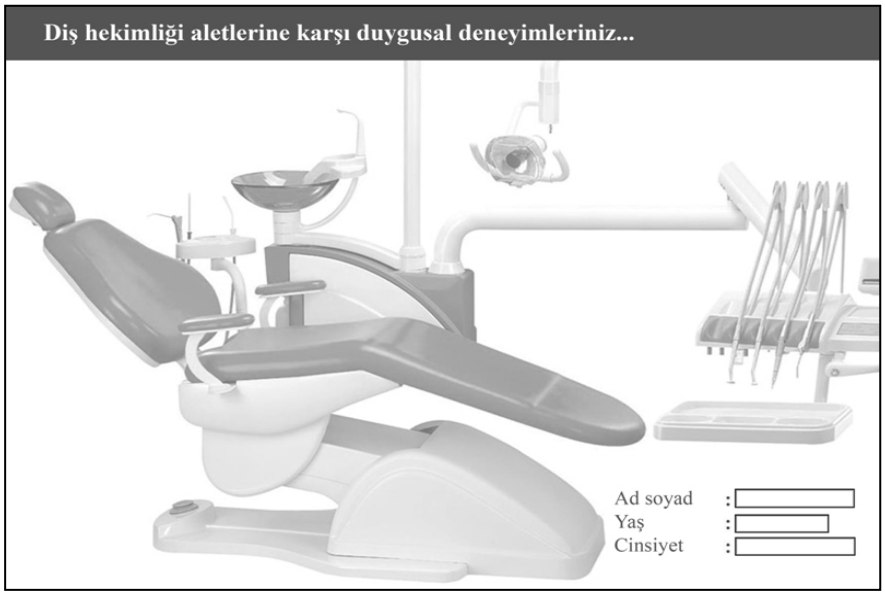
3- Which dental instruments do you think are used frequently?

4- Which instruments do you think can patients notice during dental treatments?

APPENDIX B

QUESTIONNAIRE OF THE PRELIMINARY STUDY I

B.1 Original in Turkish Language



Giriş

Değerli Katılımcı,

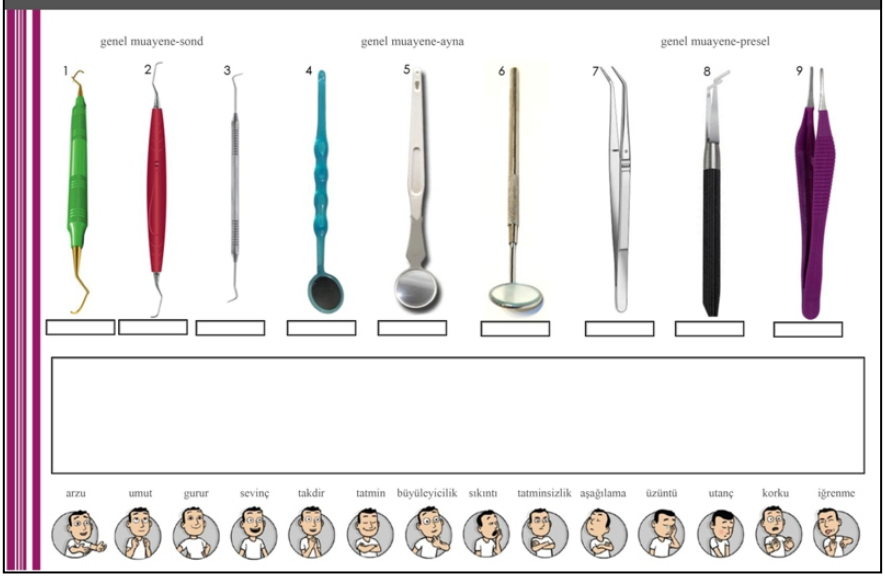
Bu anket Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü'nde yürüttüğüm ve hastaların diş hekimliği aletlerine dair duygusal deneyimlerini inceleyen yüksek lisans tez çalışmasına veri toplamak amacı ile yapılmaktadır.

Bu çalışma, sizin diş hekimliği aletlerine yönelik duygusal deneyimlerinizi tespit etmeyi amaçlayan sorulardan oluşmaktadır. Ankette diş hekimlerinin kullandığı farklı ürün özelliklerine sahip aletlere karşı olan duygularınızı her bir alet için sayfanın alt kısmında verilen ifadeleri kullanarak tanımlamanızı beklemekteyim. Ayrıca her sayfada verilen aletler içerisinden en az 3 aleti seçip, hangi ürün özelliklerinden dolayı bu şekilde hissettiğinizi açıklar mısınız?

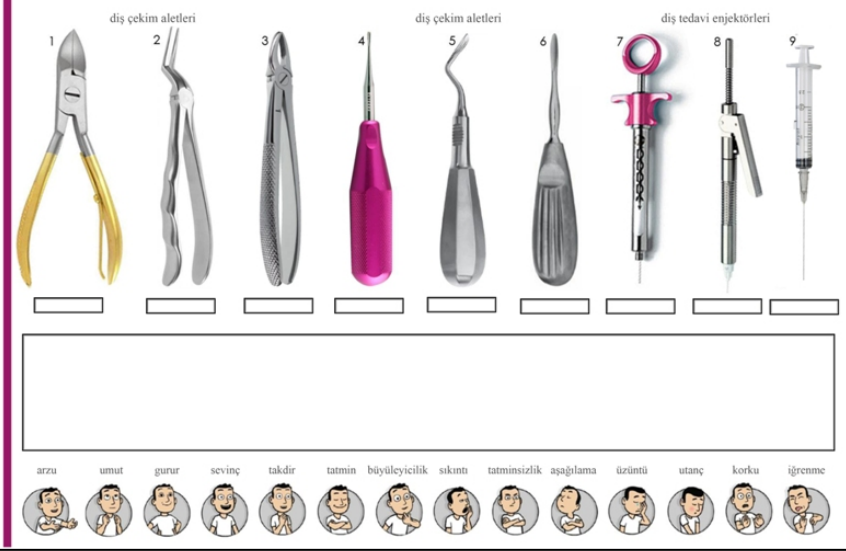
Katkılarınız için şimdiden çok teşekkür ediyorum.

Kıvılcım Çınar Okuşluğ
ODTÜ Endüstri Ürünleri Tasarımı Bölümü
Yüksek Lisans Öğrencisi

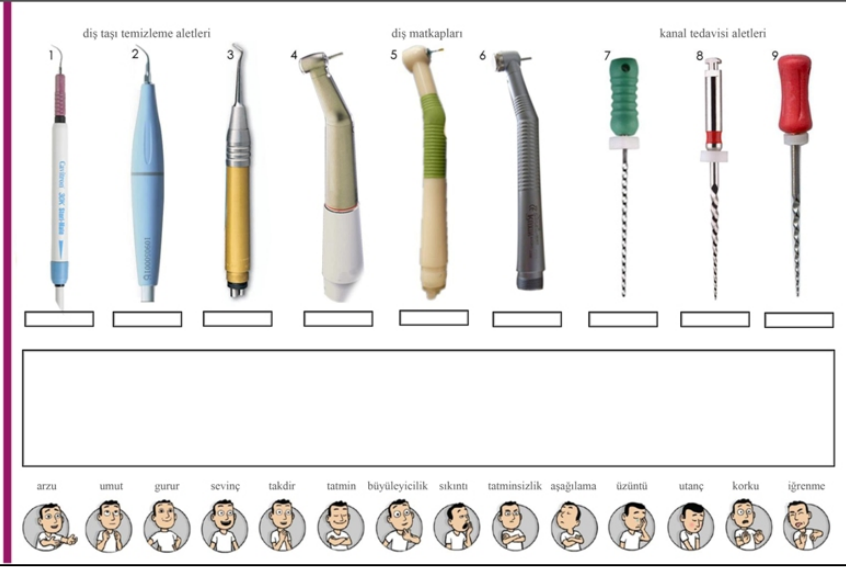
Aşağıdaki tüm aletlere karşı olan duygusal deneyimlerinizi sayfanın en altında verilen ifadeleri göz önünde bulundurarak her bir alet için seçiniz. Ayrıca bu aletler arasından en az üç alet için, hangi ürün özelliklerinden dolayı bu şekilde hissettiğinizi aletlerin numaralarını belirterek aşağıdaki kutucuğa yazınız.



Aşağıdaki tüm aletlere karşı olan duygusal deneyimlerinizi sayfanın en altında verilen ifadeleri göz önünde bulundurarak her bir alet için seçiniz. Ayrıca bu aletler arasından en az üç alet için, hangi ürün özelliklerinden dolayı bu şekilde hissettiğinizi aletlerin numaralarını belirterek aşağıdaki kutucuğa yazınız.

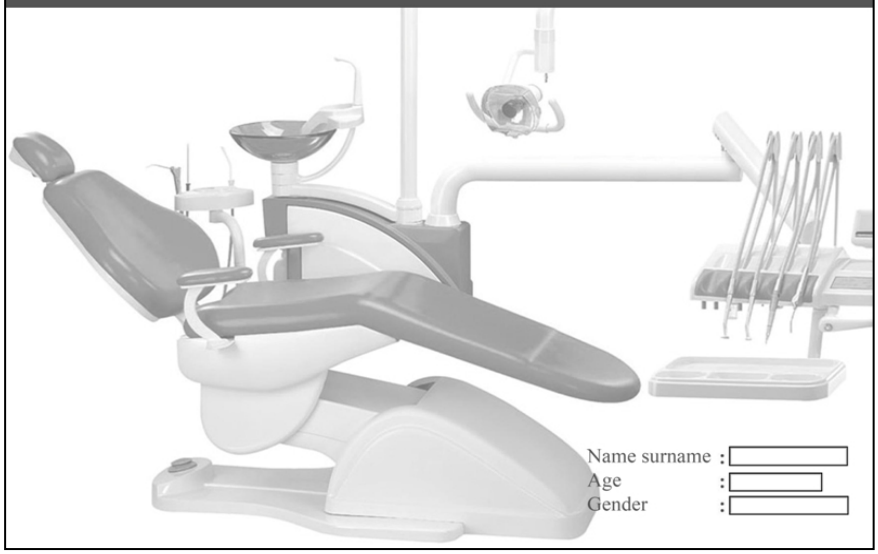


Aşağıdaki tüm aletlere karşı olan duygusal deneyimlerinizi sayfanın en altında verilen ifadeleri göz önünde bulundurarak her bir alet için seçiniz. Ayrıca bu aletler arasından en az üç alet için, hangi ürün özelliklerinden dolayı bu şekilde hissettiğinizi aletlerin numaralarını belirterek aşağıdaki kutucuğa yazınız.



B.2 English Translation

Your emotional experience towards dental instruments...



Name surname :
Age :
Gender :

Introduction

Dear Participant,

This questionnaire is conducted to gather data for the thesis study that I have been going on Middle East Technical University, Department of Industrial Design, and which analyzes emotional experience of patients towards dental instruments.

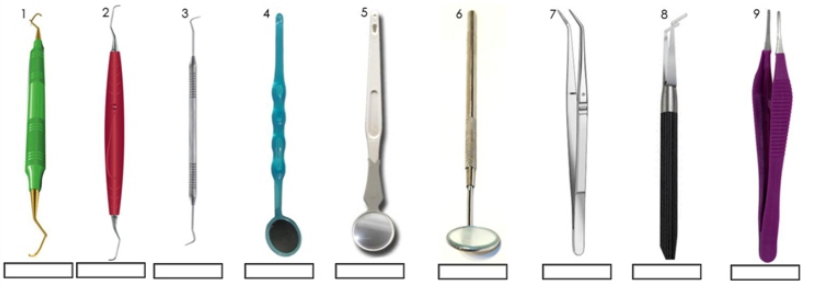
This questionnaire consists a number of questions which aim to find out your emotional experience towards dental instruments. In the questionnaire, you are expected to select one emotion for each instrument considering given emotions at the bottom of pages. In addition, could you explain why you select these emotions by referring instruments' product properties at least for three instruments in each page?

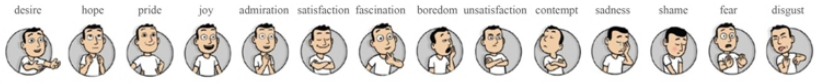
Thank you in advance for your contribution.

Kıvılcım Çınar Okuşluğ
METU Department of Industrial Design
Graduate Student

Please select your emotions towards each instrument below, considering the expressions given at the bottom of the page. In addition, please explain why you select these emotions by referring instruments' product properties at least for three instruments and write reasons by defining the number of instruments in given boxes below.

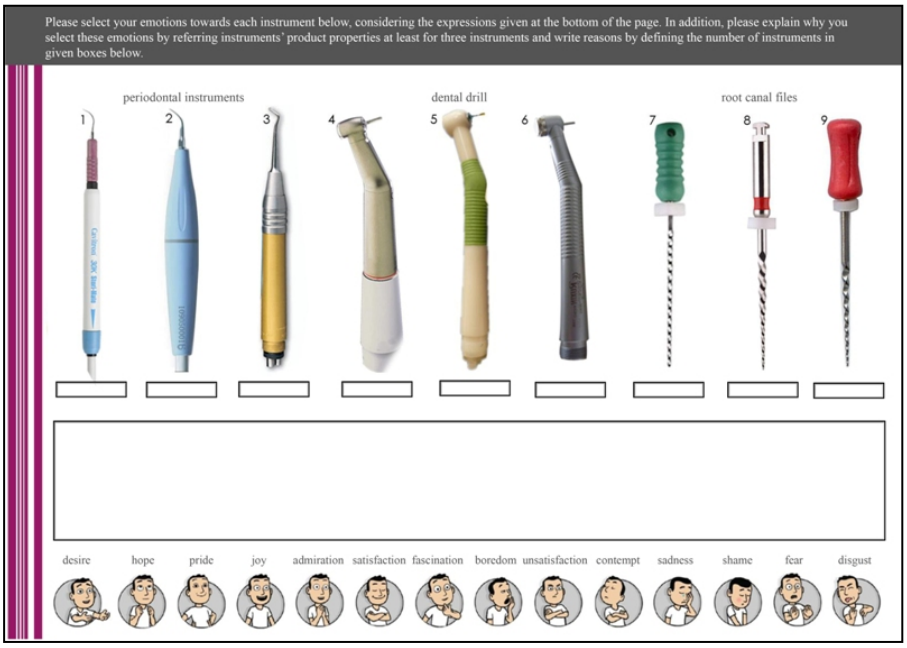
general diagnosis-probe | general diagnosis-mirror | general diagnosis-tweezers





Please select your emotions towards each instrument below, considering the expressions given at the bottom of the page. In addition, please explain why you select these emotions by referring instruments' product properties at least for three instruments and write reasons by defining the number of instruments in given boxes below.

tooth extraction instruments | tooth extraction instruments | dental injectors


Please select your emotions towards each instrument below, considering the expressions given at the bottom of the page. In addition, please explain why you select these emotions by referring instruments' product properties at least for three instruments and write reasons by defining the number of instruments in given boxes below.
periodontal instruments
dental drill
root canal files
1
2
3
4
5
6
7
8
9
desire
hope
pride
joy
admiration
satisfaction
fascination
boredom
unsatisfaction
contempt
sadness
shame
fear
disgust

APPENDIX C

EXAMPLE OF A DATA ANALYSIS DOCUMENT OF THE PRELIMINARY STUDY I

data coding of study I.xlsx

	Age	Emotion	Instrument number	Comments	Product properties	Related qualities	Feelings	Positive/or negative
2	58	Desire	5	Dişçi aleti gibi durmuyor. Ayrıca acı hissi uyandırmayacak bir alet.	form	non-medical appeal	feeling safe	+
3	24	Desire	6	hem muayene aleti olmasından hem de profesyonel görünümlerinden arzulanıyor	form	professional appearance	feeling pleasant	+
4	26	Desire	9	Rengi ve hatları çok sevimli, can yakmaz bir alete benziyor	form	safe appeal	feeling safe	+
5	37	Desire	16	Pembe renk ve şekil arzu hissi uyandırdı.	color	pleasing appearance	feeling pleasant	+
6	31	Contempt	4	Plastiğe benzemesi olması ve tasarımının diğerlerine oranla daha basit olması.	form	ordinary appearance	feeling unpleasant	-
7	25	Contempt	9	Renginden ötürü beğenmedim. Çok kaba duruyor ayrıca.	form	unpleasing appearance	feeling unpleasant	-
8	23	Fascination	6	makyaj ayna setine ait bir parça gibi duruyor.	form	non-medical appeal	feeling pleasant	+
9	26	Pride	4	Şekere benzeyen alet, rahatlama hissi ile birlikte bir gurur vesilesi oluşturdu	form	non-medical appeal	feeling safe	+
10	26	Pride	7	şık ve ince göründüğü için , herhangi bir renge de sahip olmadığı için hijyen hissi uyandırdı bende. Bu sebeple gururu seçtim.	color	hygienic appearance	feeling safe	+
11	27	Disgust	1	renginin yeşil olması, diğerlerine göre kalın olması, ucunun sarı ve diğerlerine göre uç başlangıcının kalın ve uzun olmasından dolayı	color	unpleasing appearance	feeling disgust	-
12	25	Disgust	24	Ürünlerin titreşimli, büyük ve geniş olması sebepleriyle iğrenme duygusunu oluşturmaktadır.	vibration	disturbing sound	feeling disgust	-
13	26	Fear	24	rengi ürkütücü,sanki yarı canlı gibi duruyor,dişçi kullanırken hakimiyeti kaybedebilir hissi veriyor	color	unsafe appeal	feeling anxiety	-
14	25	Fear	24	metalik rengi ve şekli dolayısı ile korkutucu	color	unsafe appeal	feeling fear	-
15	26	Fear	1	belki plastik olmamasına rağmen plastik gibi gözüküyo renkten dolayı. Ağzıma girecek bişeyin dediğim gibi paslanmaz çelik, porselen gibi bişey olması daha güven verir bana. Hem de bu ürün kaliteli bi tasarım ofisinden fabrikadan	material	unsafe appeal	feeling unsafe	-
16	40	Fear	1	Ürünün metal olması ve ucunun sivri olmasından dolayı güvensiz hissettim.	material	unsafe appeal	feeling fear	-
17	24	Fear	16	Farklı formundan dolayı normal iğneden daha çok acı verecekmiş hissine kapıldım.	form	distinctive appearance	feeling unsafe	-
18	31	Fear	18	Bildiğimiz klasik tip enjektör tasarımı olması bende korku yaratıyor.	form	ordinary appearance	feeling fear	-
19	37	Fear	18	Klasik enjektör görüntüsü ve iğnenin ucunun tüm iğneye göre çok uzun oluşu korku hissi yarattı.	proportion	unsafe appeal	feeling fear	-
20	26	Fear	27	Daha şık ve işlevsel duruyor. Tutma yerinin incelmesi doktorun alet üzerindeki hakimiyetini arttırıcı duruyor.	form	ease of use	feeling safe	+
21	40	Fear	27	Ucunun metal olması, canımın acıyacağı hissi ve ucunun sivri olması bende endişe yaratıyor.	material	unsafe appeal	feeling anxiety	-
22	24	Fear	1	renk açısından daha pozitif bir etki yaratacağı ve psikolojik açıdan duyguları azaltacağı veya insanın hislere daha hazırlıklı olabilmesini	color	pleasing appearance	feeling pleasant	+

Figure C-1 Excel Sheet of Data Analysis of the Preliminary Study I

APPENDIX D

COMPARISON RESULTS FOR THE INSTRUMENTS IN THE PRELIMINARY STUDY I

Table D-1 Significance of Product Visual Attributes for the Instruments Given in the Preliminary Study I

	Form (+)	Form (-)	Proportion (+)	Proportion (-)	Color (+)	Color (-)	Material (+)	Material (-)	Texture (+)	Texture (-)
 Probe Design 1	7.7	92.3	0.0	100.0	50.0	50.0	0.0	100.0	0.0	0.0
Probe Design 2	53.8	46.2	0.0	100.0	72.2	27.8	50.0	50.0	0.0	0.0
Probe Design 3	41.4	58.6	0.0	100.0	50.0	50.0	50.0	50.0	0.0	0.0
 Mirror Design 1	78.6	21.4	0.0	0.0	91.3	8.7	30.0	70.0	33.3	66.7
 Mirror Design 2	82.4	17.6	37.5	62.5	50.0	50.0	20.0	80.0	0.0	0.0
 Mirror Design 3	92.0	8.0	50.0	50.0	25.0	75.0	80.0	20.0	0.0	0.0
 Tweezers Design 1	48.1	51.9	7.7	92.3	40.0	60.0	55.6	44.4	0.0	0.0
Tweezers Design 2	57.1	42.9	0.0	100.0	62.5	37.5	0.0	100.0	100.0	0.0
 Tweezers Design 3	81.3	18.8	100.0	0.0	86.1	13.9	100.0	0.0	100.0	0.0

	Form (+)	Form (-)	Proportion (+)	Proportion (-)	Color (+)	Color (-)	Material (+)	Material (-)	Texture (+)	Texture (-)
 Forcep Design 1	44.4	55.6	0.0	100.0	75.0	25.0	50.0	50.0	0.0	0.0
 Forcep Design 2	50.0	50.0	10.0	90.0	0.0	0.0	33.3	66.7	100.0	0.0
 Forcep Design 3	7.7	92.3	33.3	66.7	0.0	0.0	0.0	100.0	0.0	0.0
 Elevator Design 1	43.8	56.3	28.6	71.4	84.6	15.4	33.3	66.7	0.0	0.0
 Elevator Design 2	25.0	75.0	0.0	100.0	33.3	66.7	33.3	66.7	0.0	0.0
 Elevator Design 3	15.0	85.0	0.0	100.0	0.0	0.0	12.5	87.5	0.0	100.0
 Injector Design 1	76.2	23.8	25.0	75.0	85.7	14.3	0.0	100.0	0.0	0.0
 Injector Design 2	57.9	42.1	40.0	60.0	0.0	0.0	0.0	100.0	0.0	0.0
 Injector Design 3	15.0	85.0	0.0	100.0	0.0	0.0	50.0	50.0	0.0	0.0

	Form (+)	Form (-)	Proportion (+)	Proportion (-)	Color (+)	Color (-)	Material (+)	Material (-)	Texture (+)	Texture (-)
Ultrasonic scaler design 1	69.0	31.0	16.7	83.3	60.0	40.0	40.0	60.0	0.0	0.0
 Ultrasonic scaler design 2	83.3	16.7	30.0	70.0	95.5	4.5	0.0	100.0	0.0	0.0
 Ultrasonic scaler design 3	92.3	7.7	0.0	100.0	90.9	9.1	93.8	6.3	0.0	0.0
 Drill design 1	100.0	0.0	9.1	90.9	20.0	80.0	0.0	100.0	0.0	0.0
 Drill design 2	57.9	42.1	0.0	100.0	69.2	30.8	18.2	81.8	100.0	0.0
 Drill design 3	38.5	61.5	0.0	100.0	0.0	100.0	47.8	52.2	100.0	0.0
Endodontic file design 1	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	0.0
 Endodontic file design 2	38.5	61.5	5.9	94.1	66.7	33.3	50.0	50.0	0.0	0.0
Endodontic file design 3	25.0	75.0	0.0	100.0	33.3	66.7	0.0	100.0	0.0	0.0

APPENDIX E

MATERIAL SELECTION STUDY OF THE PRELIMINARY STUDY II INTERVIEW SCHEDULE

E.1 Original in Turkish Language

Değerli Katılımcı,

Bu görüşme Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü'nde yürüttüğüm ve hastaların diş hekimliği aletlerine dair duygusal deneyimlerini inceleyen yüksek lisans tez çalışmasına veri toplamak amacı ile yapılmaktadır.

Görüşmede size diş hekimliliği tedavileri ve bu tedavilerde kullanılan aletler hakkında sorular soracağım. Yaklaşık 15 dakika olan görüşmede vereceğiniz cevaplar sadece akademik amaçlar için kullanılacak ve görüşme yapılan kişinin ismi -istenmediği takdirde- tamamen gizli tutulacaktır.

Yapılacak görüşmeyi ses kayıt cihazı ile kaydetmem sizin için uygun mudur? Kaydı görüşmemiz esnasında istediğiniz zaman kesebilir, görüşme sonunda iptal edebilirsiniz.

Katkılarınız için şimdiden çok teşekkür ediyorum.

Kıvılcım Çınar Okuşluğ
ODTÜ Endüstri Ürünleri Tasarımı Bölümü
Yüksek Lisans Öğrencisi

KATILIMCIYA AİT BİLGİLER

1- Adınız Soyadınız

2- Yaşınız

3- Cinsiyetiniz

4- Uzmanlık alanınızı belirtir misiniz?

SORULAR

1-Hangi diş hekimliliği tedavileri rutin olarak uygulanmaktadır?

2- Rutin uygulanan tedavilerde kullanılan aletler hangileridir?

3- Sizce bu diş aletleri nasıl gruplandırılmalıdır?

E.2 English Translation

Dear Participant,

This interview is conducted to gather data for the thesis study that I have been going on Middle East Technical University, Department of Industrial Design, and which analyzes emotional experience of patients towards dental instruments.

In the interview, you will be asked questions about dental treatments and instruments which are used in these treatments. The interview will last about 15 minutes and the answers you will give will be kept strictly confidential, your name will not be mentioned without your approval.

Is it appropriate to record this interview with a voice recorder? You can stop the voice recorder during the interview, or cancel it at the end of the interview.

Thank you in advance for your contribution.

Kıvılcım Çınar Okuşluğ
METU Department of Industrial Design
Graduate Student

PARTICIPANT'S INFORMATION

1- Your name

2- Your age

3- Your gender

4- Please indicate your area of specialization?

QUESTIONS

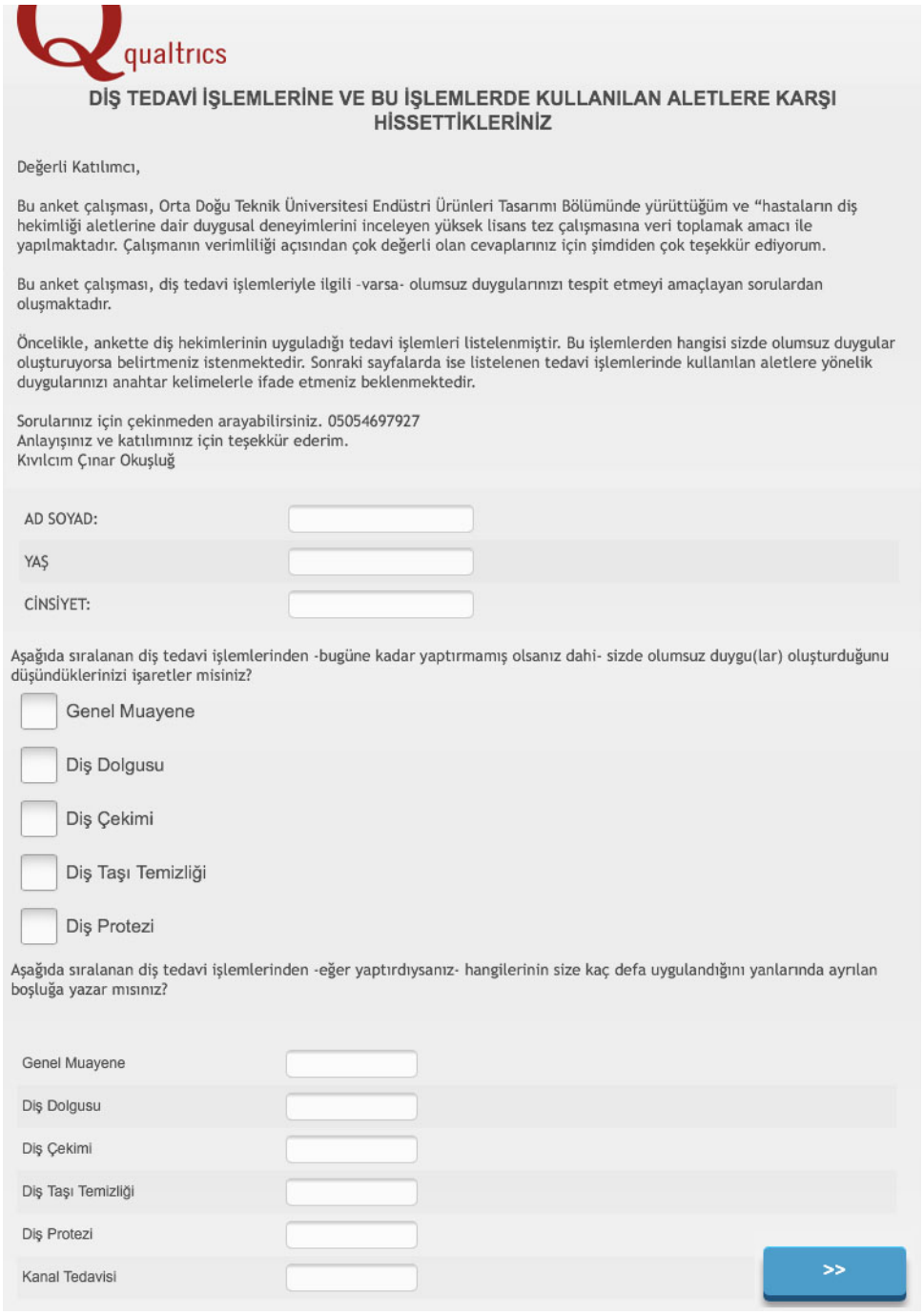
1- Which dental treatments are daily routine treatments of dentist?

2- Which dental instruments are used in these dental treatments?

3- How do you think these dental instruments should be categorized?

APPENDIX F

QUESTIONNAIRE OF THE PRELIMINARY STUDY II



qualtrics

DİŞ TEDAVİ İŞLEMLERİNE VE BU İŞLEMLERDE KULLANILAN ALETLERE KARŞI HİSSETTİKLERİNİZ

Değerli Katılımcı,

Bu anket çalışması, Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümünde yürüttüğüm ve "hastaların diş hekimliği aletlerine dair duygusal deneyimlerini inceleyen yüksek lisans tez çalışmasına veri toplamak amacı ile yapılmaktadır. Çalışmanın verimliliği açısından çok değerli olan cevaplarınız için şimdiden çok teşekkür ediyorum.

Bu anket çalışması, diş tedavi işlemleriyle ilgili -varsa- olumsuz duygularınızı tespit etmeyi amaçlayan sorulardan oluşmaktadır.

Öncelikle, ankette diş hekimlerinin uyguladığı tedavi işlemleri listelenmiştir. Bu işlemlerden hangisi sizde olumsuz duygular oluşturuyorsa belirtmeniz istenmektedir. Sonraki sayfalarda ise listelenen tedavi işlemlerinde kullanılan aletlere yönelik duygularınızı anahtar kelimelerle ifade etmeniz beklenmektedir.

Sorularınız için çekinmeden arayabilirsiniz. 05054697927
Anlayışınız ve katılımınız için teşekkür ederim.
Kıvılcım Çınar Okuşluğ

AD SOYAD:

YAŞ

CİNSİYET:

Aşağıda sıralanan diş tedavi işlemlerinden -bugüne kadar yaptırmamış olsanız dahi- sizde olumsuz duygu(lar) oluşturduğunu düşündüklerinizi işaretler misiniz?

- Genel Muayene
- Diş Dolgusu
- Diş Çekimi
- Diş Taşı Temizliği
- Diş Protezi

Aşağıda sıralanan diş tedavi işlemlerinden -eğer yaptırdıysanız- hangilerinin size kaç defa uygulandığını yanlarında ayrılan boşluğa yazar mısınız?

Genel Muayene

Diş Dolgusu

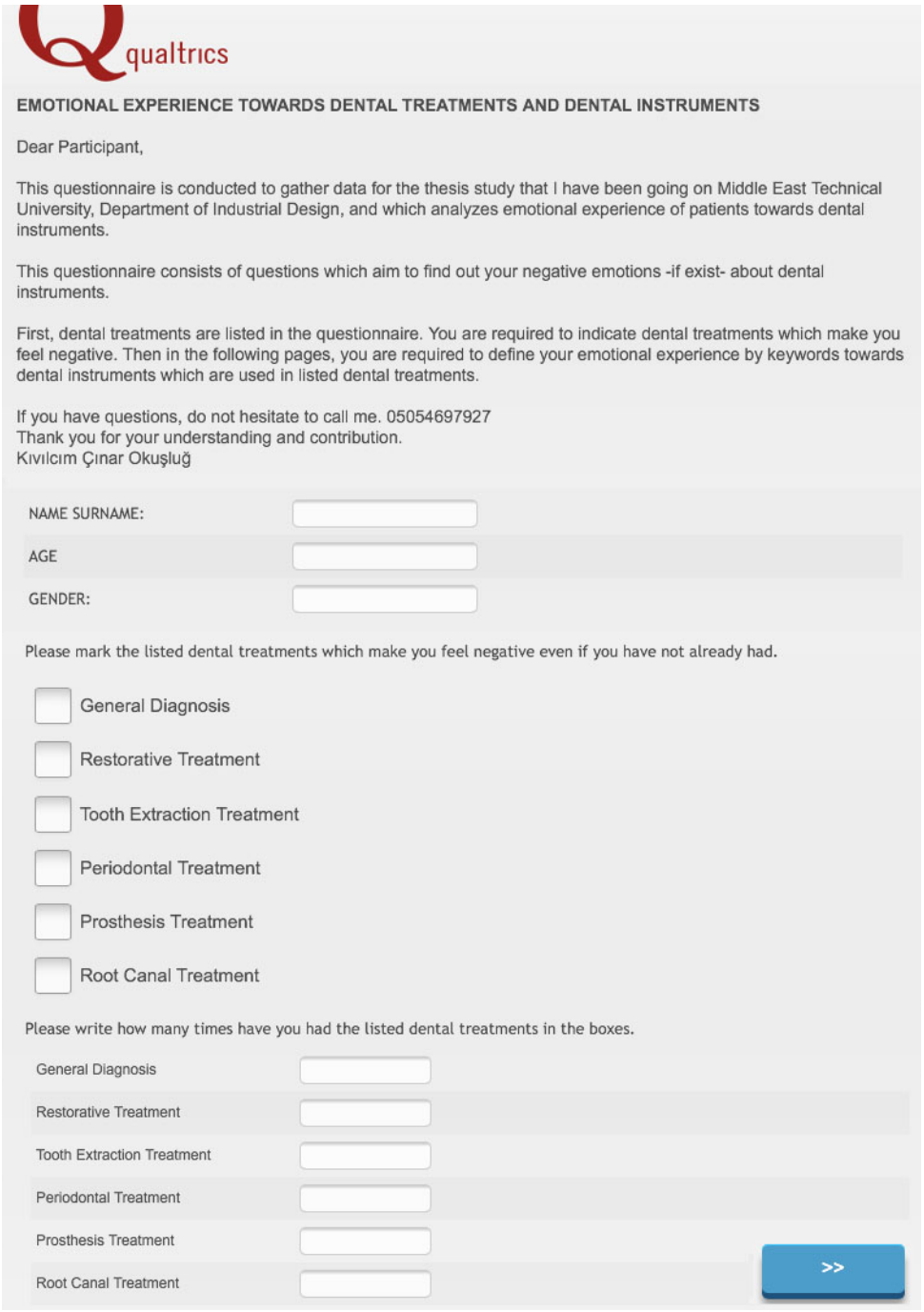
Diş Çekimi

Diş Taşı Temizliği

Diş Protezi

Kanal Tedavisi

>>



EMOTIONAL EXPERIENCE TOWARDS DENTAL TREATMENTS AND DENTAL INSTRUMENTS

Dear Participant,

This questionnaire is conducted to gather data for the thesis study that I have been going on Middle East Technical University, Department of Industrial Design, and which analyzes emotional experience of patients towards dental instruments.

This questionnaire consists of questions which aim to find out your negative emotions -if exist- about dental instruments.

First, dental treatments are listed in the questionnaire. You are required to indicate dental treatments which make you feel negative. Then in the following pages, you are required to define your emotional experience by keywords towards dental instruments which are used in listed dental treatments.

If you have questions, do not hesitate to call me. 05054697927
Thank you for your understanding and contribution.
Kıvılcım Çınar Okuşluğ

NAME SURNAME:

AGE

GENDER:

Please mark the listed dental treatments which make you feel negative even if you have not already had.

- General Diagnosis
- Restorative Treatment
- Tooth Extraction Treatment
- Periodontal Treatment
- Prosthesis Treatment
- Root Canal Treatment

Please write how many times have you had the listed dental treatments in the boxes.

General Diagnosis

Restorative Treatment

Tooth Extraction Treatment

Periodontal Treatment

Prosthesis Treatment

Root Canal Treatment

>>

GENEL MUAYENE sırasında kullanılan ürünler

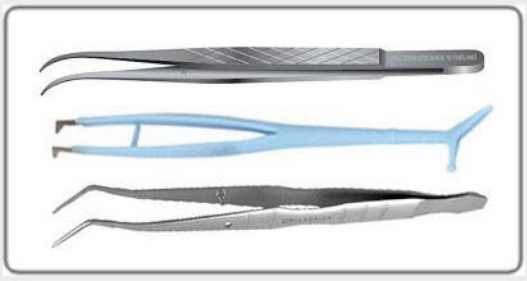
GENEL MUAYENE yaptırdıysanız, aşağıda görselleri verilen ürün gruplarından muayene sırasında kullanıldığını hatırladıklarınızı işaretler misiniz?

Aşağıdaki her bir ürün grubunun dış görünüşlerinin -bugüne kadar hiçbir tedavinizde kullanılmamış olsa dahi- size hissettirdiklerini anahtar kelimeler kullanarak yanlarındaki boşluğa yazar mısınız?

Instruments related to GENERAL DIAGNOSIS

If you have already had GENERAL DIAGNOSIS, could you mark the instruments which you have seen during the treatment?

Could you write your emotional experience by keywords towards appearance of dental instrument categories given below, even if they have not used in your treatments?



>>

DİŞ DOLGUSU sırasında kullanılan ürünler

DİŞ DOLGUSU yaptırdıysanız, işlemler sırasında kullanıldığını hatırladığınız ürün gruplarını işaretler misiniz?

Aşağıdaki her bir ürün grubunun dış görünüşlerinin -bugüne kadar hiçbir tedavinizde kullanılmamış olsa dahi- size hissettirdiklerini anahtar kelimeler kullanarak yanlarındaki boşluğa yazar mısınız?

Instruments used in RESTORATIVE TREATMENT

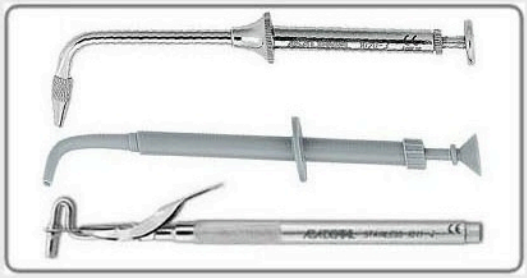
If you have already had RESTORATIVE TREATMENT, could you mark the instruments which you have seen during the treatment?

Could you write your emotional experience by keywords towards appearance of dental instrument categories given below, even if they have not used in your treatments?

☐

☐

☐




ARTISTE
FLOW-IT ALC


LED.SYTECH

>>

DİŞ ÇEKİMİ sırasında kullanılan ürünler

DİŞ ÇEKİMİ yaptırdıysanız, işlemler sırasında kullanıldığını hatırladığınız ürün gruplarını işaretler misiniz?

Aşağıdaki her bir ürün grubunun dış görünüşlerinin -bugüne kadar hiçbir tedavinizde kullanılmamış olsa dahi- size hissettirdiklerini anahtar kelimeler kullanarak yanlarındaki boşluğa yazar mısınız?

Instruments used in TOOTH EXTRACTION TREATMENT

If you have already had TOOTH EXTRACTION TREATMENT, could you mark the instruments which you have seen during the treatment?

Could you write your emotional experience by keywords towards appearance of dental instrument categories given below, even if they have not used in your treatments?

☐

☐

☐

>>

DİŞ TAŞI TEMİZLİĞİ sırasında kullanılan ürünler

DİŞ TAŞI TEMİZLİĞİ yaptırdıysanız, işlemler sırasında kullanıldığını hatırladığınız ürün gruplarını işaretler misiniz?

Aşağıdaki her bir ürün grubunun dış görünüşlerinin -bugüne kadar hiçbir tedavinizde kullanılmamış olsa dahi- size hissettirdiklerini anahtar kelimeler kullanarak yanlarındaki boşluğa yazar mısınız?

Instruments used in PERIODONTAL TREATMENT

If you have already had PERIODONTAL TREATMENT, could you mark the instruments which you have seen during the treatment?

Could you write your emotional experience by keywords towards appearance of dental instrument categories given below, even if they have not used in your treatments?

☐

☐

>>

DİŞ PROTEZİ sırasında kullanılan ürünler

DİŞ PROTEZİ yaptırdıysanız, işlemler sırasında kullanıldığını hatırladığınız ürün gruplarını işaretler misiniz?

Aşağıdaki her bir ürün grubunun dış görünüşlerinin -bugüne kadar hiçbir tedavinizde kullanılmamış olsa dahi- size hissettirdiklerini anahtar kelimeler kullanarak yanlarındaki boşluğa yazar mısınız?

Instruments used in PROSTHESIS TREATMENT

If you have already had PROSTHESIS TREATMENT, could you mark the instruments which you have seen during the treatment?

Could you write your emotional experience by keywords towards appearance of dental instrument categories given below, even if they have not used in your treatments?

>>

KANAL TEDAVİSİ sırasında kullanılan ürünler

KANAL TEDAVİSİ yaptırdıysanız, işlemler sırasında kullanıldığını hatırladığınız ürün gruplarını işaretler misiniz?

Aşağıdaki her bir ürün grubunun dış görünüşlerinin -bugüne kadar hiçbir tedavinizde kullanılmamış olsa dahi- size hissettirdiklerini anahtar kelimeler kullanarak yanlarındaki boşluğa yazar mısınız?

Instruments used in ROOT CANAL TREATMENT

If you have already had ROOT CANAL TREATMENT, could you mark the instruments which you have seen during the treatment?

Could you write your emotional experience by keywords towards appearance of dental instrument categories given below, even if they have not used in your treatments?

☐

☐

☐

>>

APPENDIX G

SPSS ANALYSIS RESULTS

G.1 Question 1

Is there a relationship between seeing the instruments in previous dental treatments and feeling negative for patients?

Table G-1 Results of Spearman Correlation Analysis between Instruments' Possibility to be Seen and Participants' Emotions

S: Participants who have seen instruments during their previous dental treatments
NS: Participants who have not seen instruments

Visibility of INSTRUMENTS * Emotions towards INSTRUMENTS Crosstabulation

Instruments	Probe		Mirror		Tweezers		Vitalometer		Injector		Drill		Matrix		Amalgam carrier		Composite injector	
Participants	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
Negative Emotions	80	19	19	0	21	34	13	15	70	39	83	27	8	81	12	27	11	48
Neutral Emotions	13	3	56	2	25	29	12	52	6	4	4	5	4	25	23	40	7	47
Positive Emotions	5	0	43	0	8	3	3	25	1	0	0	1	0	2	9	9	0	7
Pearson Chi-Square Asymp. Sig. (2-sided)	,556		,337		,106		,003		,728		,036		,675		,375		,363	
Ordinal by Ordinal Spearman Correlation	,055		,049		,163		-,288		-,002		-,222		,053		,118		-,116	
Approx. Sig.	,550[c]		,593[c]		,075[c]		,001[c]		,987[c]		,015[c]		,567[c]		,198[c]		,206[c]	

Visibility of INSTRUMENTS * Emotions towards INSTRUMENTS Crosstabulation

Instruments	Restorative hand tools		Led curing light		Elevator		Forceps		Periodontal hand tools		Ultrasonic scaler		Impression tray		Endodontic file	
Participants	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
Negative Emotions	49	34	8	14	26	45	62	37	45	28	36	34	5	55	29	52
Neutral Emotions	19	14	30	46	3	40	9	11	13	27	15	29	4	47	6	28
Positive Emotions	3	1	7	15	0	6	1	0	4	3	4	2	0	9	2	3
Pearson Chi-Square Asymp. Sig. (2-sided)	,798		,802		,001		,243		,012		,112		,671		,142	
Ordinal by Ordinal Spearman Correlation	,011		-,028		-,351		-,112		-,226		-,107		-,049		-,142	
Approx. Sig.	,906[c]		,758[c]		,000[c]		,222[c]		,013[c]		,245[c]		,594[c]		,123[c]	

G.2 Question 2:

Is there a relationship between feeling negative and positive towards dental instruments and number of treatments?

Table G-2 Results of Spearman Correlation Analysis between Number of Dental Treatments and Participants' Emotions

A: Participants who have not experienced related dental treatment
B: Participants who have experienced related dental treatment one-four times
C: Participants who have experienced related dental treatment more than four times

How many times have participants experienced related dental treatment * Emotions towards INSTRUMENTS Crosstabulation

Instruments	Probe			Mirror			Tweezers			Vitalometer			Injector			Drill		
Participants	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Negative Emotions	0	54	45	0	12	7	0	33	22	0	18	10	26	52	31	24	57	29
Neutral Emotions	0	6	10	0	30	28	0	24	30	0	34	30	3	6	1	4	2	3
Positive Emotions	0	1	4	0	19	24	0	4	7	0	9	19	0	1	0	1	0	0
Pearson Chi-Square Asymp. Sig. (2-sided)	,166			,380			,161			,048			,621			,161		
Ordinal by Ordinal Spearman Correlation	,166			,123			,174			,220			-,093			-,096		
Approx. Sig.	,070[c]			,180[c]			,057[c]			,016[c]			,315[c]			,298[c]		

How many times have participants experienced related dental treatment * Emotions towards INSTRUMENTS Crosstabulation

Instruments	Matrix			Amalgam carrier			Composite injector			Restorative hand tools			Led curing light			Elevator		
Participants	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Negative Emotions	24	45	20	14	22	3	18	28	13	20	45	18	7	11	4	21	35	15
Neutral Emotions	5	12	12	12	27	24	8	29	17	8	14	11	13	40	23	14	23	6
Positive Emotions	0	20	0	3	10	5	3	2	2	1	0	3	9	8	5	3	3	0
Pearson Chi-Square Asymp. Sig. (2-sided)	,180			,013			,217			,110			,155			,604		
Ordinal by Ordinal Spearman Correlation	,163			,252			,125			,116			-,018			-,111		
Approx. Sig.	,075[c]			,006[c]			,173[c]			,208[c]			,842[c]			,228[c]		

How many times have participants experienced related dental treatment * Emotions towards INSTRUMENTS Crosstabulation

Instruments	Forceps			Periodontal hand tools			Ultrasonic scaler			Impression tray			Endodontic file		
Participants	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Negative Emotions	31	52	16	24	40	9	23	37	10	55	5	0	49	31	1
Neutral Emotions	7	8	5	20	17	3	21	20	4	47	3	1	24	8	2
Positive Emotions	0	1	0	1	4	2	1	4	1	9	0	0	3	2	0
Pearson Chi-Square Asymp. Sig. (2-sided)	.680			.181			.360			.679			.384		
Ordinal by Ordinal Spearman Correlation	.026			-.072			-.105			-.047			-.064		
Approx. Sig.	,719[c]			,433[c]			,255[c]			,612[c]			,490[c]		

G.3 Question 3:

Is there a relationship between feeling negative and positive towards dental instruments and gender of participants?

Table G-3 Results of Spearman Correlation Analysis between Gender of Participants and Participants' Emotions

M: Men
W: Women

GENDER * Emotions towards INSTRUMENTS Crosstabulation

Instruments	Probe		Mirror		Tweezers		Vitalometer		Injector		Drill		Matrix		Amalgam carrier		Composite injector	
Participants	M	W	M	W	M	W	M	W	M	W	M	W	M	W	M	W	M	W
Negative Emotions	54	45	10	9	28	27	14	14	58	51	58	52	51	38	25	14	30	29
Neutral Emotions	11	5	33	25	31	23	29	35	7	3	8	1	14	15	33	30	33	21
Positive Emotions	1	4	23	20	7	4	23	5	1	0	0	1	1	1	8	10	3	4
Pearson Chi-Square Asymp. Sig. (2-sided)	,157		,920		,660		,004		,393		,060		,690		,318		,440	
Ordinal by Ordinal Spearman Correlation	-,005		,008		-,082		-,221		-,115		-,147		,078		,138		-,061	
Approx. Sig.	,953[c]		,929[c]		,371[c]		,015[c]		,213[c]		,108[c]		,418[c]		,133[c]		,507[c]	

GENDER * Emotions towards INSTRUMENTS Crosstabulation

Instruments	Restorative hand tools		Led curing light		Elevator		Forceps		Periodontal hand tools		Ultrasonic scaler		Impression tray		Endodontic file	
Participants	M	W	M	W	M	W	M	W	M	W	M	W	M	W	M	W
Negative Emotions	46	37	11	11	38	33	55	44	40	33	37	33	33	27	43	38
Neutral Emotions	18	15	40	36	25	18	10	10	22	18	27	17	26	25	21	13
Positive Emotions	2	2	15	7	3	3	1	0	4	3	2	4	7	2	2	3
Pearson Chi-Square Asymp. Sig. (2-sided)	.976		.379		.863		.597		.993		.370		.330		.548	
Ordinal by Ordinal Spearman Correlation	.014		-.111		-.029		.021		-.007		-.030		-.033		-.044	
Approx. Sig.	,876[c]		,229[c]		,750[c]		,824[c]		,942[c]		,749[c]		,718[c]		,633[c]	

APPENDIX H

INTERVIEW SCHEDULE OF THE MAIN STUDY

H.1 Original in Turkish Language

DİŞ ALETLERİ DEĞERLENDİRME ÇALIŞMASI

Merhaba,

Bu görüşme Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü'nde yürüttüğüm ve hastaların diş hekimliği aletlerine dair duygusal deneyimlerini inceleyen yüksek lisans tez çalışmasına veri toplamak amacı ile yapılmaktadır.

Yaklaşık 30 dakika sürecek olan görüşmede size diş hekimliği tedavilerinde kullanılan üç adet alet göstereceğim. Bu ürünlerin ürünsel özellikleriyle ilgili sorular sorup, aletleri değerlendirmenizi isteyeceğim. Vereceğiniz cevaplar sadece akademik amaçlar için kullanılacak ve görüşme yapılan kişinin ismi -istenmediği takdirde- tamamen gizli tutulacaktır.

Yapılacak görüşmeyi ses kayıt cihazı ile kaydetmem sizin için uygun mudur? Kaydı görüşmemiz esnasında istediğiniz zaman kesebilir, görüşme sonunda iptal edebilirsiniz.

Katkılarınız için şimdiden çok teşekkür ediyorum.
Kıvılcım Çınar Okuşluğ
ODTU Endüstri Ürünleri Tasarımı Bölümü
Yüksek Lisans Öğrencisi

KATILIMCIYA AİT BİLGİLER

1- Adınız Soyadınız
2- Yaşınız
3- Cinsiyetiniz?
4- Daha önce yaptırdığınız diş tedavilerini belirtir misiniz?

☐ Genel Muayene ☐ Diş Çekimi ☐ Protez
☐ Diş Dolgusu ☐ Diş Taşı Temizliği ☐ Kanal Tedavisi

ENJEKTÖR

Bu aletin daha önce diş tedavilerinizde kullanıldığını görmüş müydünüz? ☐ Evet ☐ Hayır

1- Aletin dış görünüşüne yönelik duygularınızı belirtir misiniz?

2- Aletin hangi görsel özelliklerinden dolayı bu şekilde hissettiğinizi açıklar mısınız?

3- Aletin size olumlu ve olumsuz hissettiren görsel özelliklerini değerlendirir misiniz?
(Şekli, ölçüsel orantısı, rengi, malzemesi, dokusu vb. özellikleri açısından)

4- Alete karşı daha olumlu hissetmeniz için hangi görsel özelliklerini değiştirmek isterdiniz?

DİŞ ALETLERİ DEĞERLENDİRME ÇALIŞMASI

DAVYE

Bu aletin daha önce diş tedavilerinizde kullanıldığını görmüş müydünüz? ☐ Evet ☐ Hayır

1- Aletin dış görünüşüne yönelik duygularınızı belirtir misiniz?

2- Aletin hangi görsel özelliklerinden dolayı bu şekilde hissettiğinizi açıklar mısınız?

3- Aletin size olumlu ve olumsuz hissettiren görsel özelliklerini değerlendirir misiniz?
(Şekli, ölçüsel orantısı, rengi, malzemesi, dokusu vb. özellikleri açısından)

4- Alete karşı daha olumlu hissetmeniz için hangi görsel özelliklerini değiştirmek isterdiniz?

MATKAP

Bu aletin daha önce diş tedavilerinizde kullanıldığını görmüş müydünüz? ☐ Evet ☐ Hayır

1- Aletin dış görünüşüne yönelik duygularınızı belirtir misiniz?

2- Aletin hangi görsel özelliklerinden dolayı bu şekilde hissettiğinizi açıklar mısınız?

3- Aletin size olumlu ve olumsuz hissettiren görsel özelliklerini değerlendirir misiniz?
(Şekli, ölçüsel orantısı, rengi, malzemesi, dokusu vb. özellikleri açısından)

4- Alete karşı daha olumlu hissetmeniz için hangi görsel özelliklerini değiştirmek isterdiniz?

H.2 English Translation

EVALUATION OF DENTAL INSTRUMENTS

Dear Participant,

This interview is conducted to gather data for the thesis study that I have been going on Middle East Technical University, Department of Industrial Design, and which analyzes emotional experience of patients towards dental instruments.

In the interview, which will last about 30 minutes, three dental instruments will be shown. You will be asked questions about instruments' product properties and evaluate the instruments. Answers you will give will be kept strictly confidential, your name will not be mentioned without your approval.

Is it appropriate to record this interview with a voice recorder? You can stop the voice recorder during the interview, or cancel it at the end of the interview.

Thank you in advance for your contribution.
Kıvılcım Çınar Okuşluğ
METU Department of Industrial Design
Graduate Student

PARTICIPANT'S INFORMATION

1- Your name
2- Your age
3- Your gender
4- Please indicate previous dental treatments that you have already had?

☐ General Diagnosis ☐ Tooth Extraction ☐ Prosthesis Treatment
☐ Restorative Treatment ☐ Periodontal Treatment ☐ Root Canal Treatment

INJECTOR

Have you seen the instrument in your previous dental treatments? ☐ Yes ☐ No

1- Could you indicate your feelings towards this instrument?

2- Could you explain the reasons of your feelings by referring instruments' product properties?

3- Could you evaluate the instrument's product properties which make you feel positive and negative? (in terms of form, proportion, color, material, texture, etc.)

4- Which instrument's product property would you like to change to feel positive towards the instruments?

EVALUATION OF DENTAL INSTRUMENTS

FORCEP

Have you seen the instrument in your previous dental treatments? ☐ Yes ☐ No

1- Could you indicate your feelings towards this instrument?

2- Could you explain the reasons of your feelings by referring instruments' product properties?

3- Could you evaluate the instrument's product properties which make you feel positive and negative? (in terms of form, proportion, color, material, texture, etc.)

4- Which instrument's product property would you like to change to feel positive towards the instruments?

DRILL

Have you seen the instrument in your previous dental treatments? ☐ Yes ☐ No

1- Could you indicate your feelings towards this instrument?

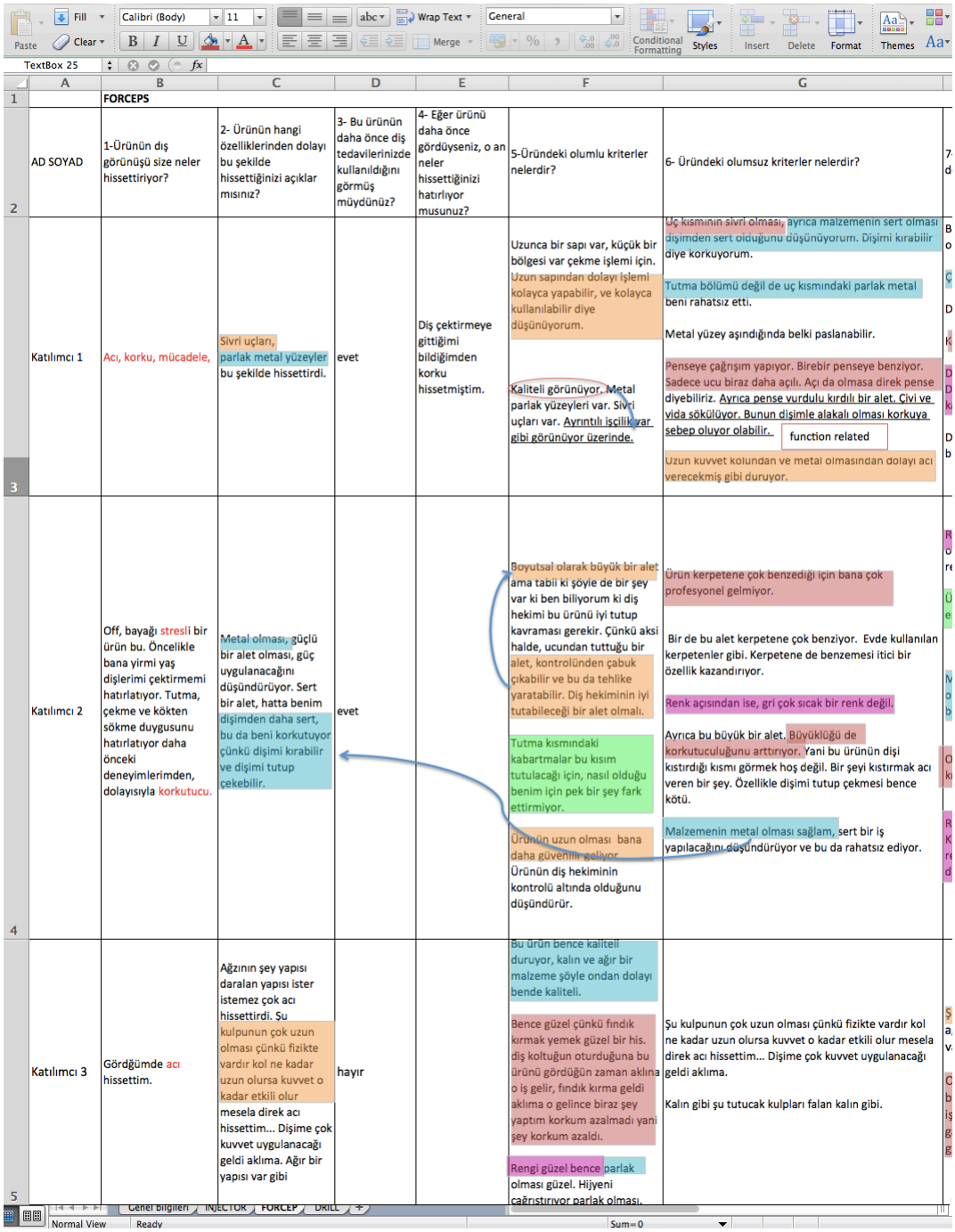
2- Could you explain the reasons of your feelings by referring instruments' product properties?

3- Could you evaluate the instrument's product properties which make you feel positive and negative? (in terms of form, proportion, color, material, texture, etc.)

4- Which instrument's product property would you like to change to feel positive towards the instruments?

APPENDIX I

A SAMPLE DATA ANALYSIS SHEET OF THE MAIN STUDY



	A	B	C	D	E	F	G
1		FORCEPS					
2	AD SOYAD	1-Ürünün dış görünüşü size neler hissettiriyor?	2- Ürünün hangi özelliklerinden dolayı bu şekilde hissettiğinizi açıklar mısınız?	3- Bu ürünün daha önce diş tedavilerinizde kullanıldığını görmüş müydünüz?	4- Eğer ürünü daha önce gördüyseniz, o an neler hissettiğinizi hatırlıyor musunuz?	5-Üründeki olumlu kriterler nelerdir?	6- Üründeki olumsuz kriterler nelerdir?
3	Katılımcı 1	Acı, korku, mücadele,	Sivri uçları, parlak metal yüzeyler bu şekilde hissettirdi.	evet	Diş çektirmeye gittiğimi bildiğimden korku hissetmiştim.	Uzunca bir sapı var, küçük bir bölgesi var çekme işlemi için. Uzun sapından dolayı işlemi kolayca yapabilir, ve kolayca kullanılabilir diye düşünüyorum. Kaliteli görünüyor. Metal parlak yüzeyleri var. Sivri uçları var. Ayrıntılı işçilik var gibi görünüyor üzerinde.	Uç kısmının sivri olması, ayrıca malzemenin sert olması dişimden sert olduğunu düşünüyorum. Dişimi kırabilir diye korkuyorum. Tutma bölümü değil de uç kısmındaki parlak metal beni rahatsız etti. Metal yüzey aşındığında belki paslanabilir. Penseye çağrışım yapıyor. Birebir penseye benziyor. Sadece ucu biraz daha açılı. Açı da olmasa direk pense diyebiliriz. Ayrıca pense vurdulu kırdılı bir alet. Çivi ve vida sökülüyor. Bunun dişimle alakalı olması korkuya sebep oluyor olabilir. function related Uzun kuvvet kolundan ve metal olmasından dolayı acı verecekmiş gibi duruyor.
4	Katılımcı 2	Off, bayağı stresli bir ürün bu. Öncelikle bana yirmi yaş dişlerimi çektirmemi hatırlatıyor. Tutma, çekme ve kökten sökme duygusunu hatırlatıyor daha önceki deneyimlerimden, dolayısıyla korkutucu.	Metal olması, güçlü bir alet olması, güç uygulanacağını düşündürüyor. Sert bir alet, hatta benim dişimden daha sert, bu da beni korkutuyor çünkü dişimi kırabilir ve dişimi tutup çekebilir.	evet		Boyutsal olarak büyük bir alet ama tabii ki şöyle de bir şey var ki ben biliyorum ki diş hekimi bu ürünü iyi tutup kavraması gerekir. Çünkü aksi halde, ucundan tuttuğu bir alet, kontrolünden çabuk çıkabilir ve bu da tehlike yaratabilir. Diş hekiminin iyi tutabileceği bir alet olmalı. Tutma kısmındaki kabartmalar bu kısım tutulacağı için, nasıl olduğu benim için pek bir şey fark ettirmiyor. Ürünün uzun olması bana daha güvenilir geliyor. Ürünün diş hekiminin kontrolü altında olduğunu düşündürür.	Ürün kerpetene çok benzediği için bana çok profesyonel gelmiyor. Bir de bu alet kerpetene çok benziyor. Evde kullanılan kerpetenler gibi. Kerpetene de benzemesi itici bir özellik kazandırıyor. Renk açısından ise, gri çok sıcak bir renk değil. Ayrıca bu büyük bir alet. Büyüklüğü de korkutuculuğunu arttırıyor. Yani bu ürünün dişi kıstırdığı kısmı görmek hoş değil. Bir şeyi kıstırmak acı veren bir şey. Özellikle dişimi tutup çekmesi bence kötü. Malzemenin metal olması sağlam, sert bir iş yapılacağını düşündürüyor ve bu da rahatsız ediyor.
5	Katılımcı 3	Gördğümde acı hissettim.	Ağzının şey yapısı daralan yapısı ister istemez çok acı hissettirdi. Şu kulpunun çok uzun olması çünkü fizikte vardır kol ne kadar uzun olursa kuvvet o kadar etkili olur mesela direk acı hissettim... Dişime çok kuvvet uygulanacağı geldi aklıma. Ağır bir yapısı var gibi	hayır		Bu ürün bence kaliteli duruyor, kalın ve ağır bir malzeme şöyle ondan dolayı bende kaliteli. Bence güzel çünkü fındık kırmak yemek güzel bir his. diş koltuğun oturduğuna bu ürünü gördüğün zaman aklına o iş gelir, fındık kırma geldi aklıma o gelince biraz şey yaptım korkum azalmadı yani şey korkum azaldı. Rengi güzel bence parlak olması güzel. Hijyeni çağrıştırıyor parlak olması.	Şu kulpunun çok uzun olması çünkü fizikte vardır kol ne kadar uzun olursa kuvvet o kadar etkili olur mesela direk acı hissettim... Dişime çok kuvvet uygulanacağı geldi aklıma. Kalın gibi şu tutucak kulpları falan kalın gibi.

Figure I-1 Coding Example Sheet for the Main Study