CONSTRUING PRODUCT MATERIALS:
DEVELOPING SENSO-ATTITUDINAL MAPS THROUGH REPERTORY GRID TECHNIQUE

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ABSTRACT

CONSTRUING PRODUCT MATERIALS: DEVELOPING SENSO-ATTITUDINAL MAPS THROUGH REPERTORY GRID TECHNIQUE

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Designing material and product experiences is a complex process that requires a comprehensive understanding over subjective dimensions such as cultural and psychological backgrounds of the individual, multisensory relations, and product contexts. It is becoming more essential for a designer to understand how materials are perceived. There is a growing need for designers to achieve information sources that represent idiosyncratic data of the user anticipations towards perceived material qualities in particular contexts. This research investigates attitudinal approaches of individuals towards perceived product material qualities. Theoretically grounded on the Personal Constructs Psychology, an explorative mixed methods research is designed for revealing how individuals construe interactions with physical materials on different product contexts as idiosyncratic statements. For this, two separate experiments with different product contexts (eight computer mouses and eight water bottles as stimuli) are carried out with the participation of 60 Industrial Design students from ESTU Department of Industrial Design. Repertory Grid Technique is utilized to collect construed meanings as elicited bipolar personal attitudes, to evaluate the sensory relevancies of the elicited attitudes and to evaluate the product context through elicited attitudes. A total of 60 idiosyncratic repertory grids are collected. In the first step of data analysis, individual attitudes are categorized as common attitudes through content analysis. In the second step, quantitative relationships between the products and attitudes are analyzed through multivariate statistics based on participant ratings. In the third step, the sensory and attitudinal findings of the research are transferred into Senso-Attitudinal Maps (SAM). Cluster cards and product cards are developed as supplementary tools for the SAM. It is expected that the SAM can be used as a reference in designing materials and product experiences.

Keywords: Repertory Grid Technique (RGT), Materials Experience, Product Design, Five Senses, Senso-Attitudinal Maps

ÖZ

ÜRÜN MALZEMELERİNİ ÇÖZÜMLEME: REPERTUAR ÇİZELGESİ TEKNİĞİ İLE DUYU-TUTUMSAL HARİTALARIN GELİŞTİRİLMESİ

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Malzeme ve ürün deneyimi tasarımı, kültürel ve psikolojik arkaplan, çoklu duyusal ilişkiler ve ürün bağlamı gibi öznel boyutlar üzerinde kapsamlı bir anlayış gerektiren karmaşık bir süreçtir. Bir malzemenin ne olduğundan ziyade nasıl algılandığı tasarımcı için daha önemli hale gelmektedir. Tasarımcıların, kullanıcıların belirli bağlamlar içerisinde algıladıkları malzeme özelliklerine karşı geliştirdikleri yaklaşımları hakkında kişiye özgü verileri yansıtan bilgi kaynaklarına erişmeye gereksinimleri giderek artmaktadır. Bu araştırma algılanan malzeme özelliklerine karşı bireylerin tutumsal yaklaşımlarıyla ilgilenmektedir. Bireylerin farklı ürün bağlamlarındaki fiziksel malzemeler ile olan etkileşimlerini kişiye özgü ifadeler olarak nasıl çözümlediklerini ortaya çıkarmak amacıyla, teorik olarak Kişisel Yapılar Kuramı üzerine dayandırılmış bir keşifsel karma metot araştırması tasarlanmıştır. Bunun için, ESTÜ Endüstriyel Tasarım Bölümü'nden 60 endüstriyel tasarım öğrencisinin katılımı ile farklı ürün bağlamlarında (sekiz adet bilgisayar faresi ve sekiz adet su matarası) iki ayrı deney tasarlanmıştır. Çözümlenmiş anlamların ortaya çıkarılmış çift kutuplu kişisel tutumlar olarak toplanması, ortaya çıkarılan tutumların duyular ile ilişkilerinin saptanması, ve ürün bağlamının ortaya çıkarılan tutumlar üzerinden değerlendirilmesi için Repertuar Çizelgesi Tekniğinden faydalanılmıştır. Deneylerin sonucunda toplam 60 adet kişiye özgü repertuar çizelgesi elde edilmiştir. İlk aşamada, kişisel tutumlar içerik analizi yöntemi ile ortak tutumlar halinde sınıflandırılmıştır. İkinci aşamada, ürünler ile tutumlar arasındaki nicel ilişkiler çok değişkenli istatistik yöntemleriyle analiz edilmiştir. Üçüncü aşamada, araştırmanın duyusal ve tutumsal bulguları Duyu-Tutumsal Haritalar (DTH) olarak sunulmuştur. Karşılaştırma kartları ve ürün kartları, DTH'yi tamamlayıcı bir şekilde geliştirilmiştir. DTH'nin malzeme ve ürün deneyimi tasarımında referans olarak kullanılabilmesi beklenmektedir.

Anahtar Kelimeler: Repertuar Çizelgesi Tekniği (RÇT), Malzeme Deneyimi, Ürün Tasarımı, Beş Duyu, Duyu-Tutumsal Haritalar

This thesis is dedicated to my family

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ABBREVIATIONS

RGT	**:** Repertory Grid Technique
PCP	**:** Personal Constructs Psychology
SAM	**:** Senso-Attitudinal Maps

CHAPTER 1

INTRODUCTION

1.1 Problem Background

There was a time when craftspeople spent years to become a master on specific materials. Invention of a new material took decades until chemists built-up ways to investigate materials systematically and expedited the exploration of materials, and consequently, an issue emerged with the revolutionary technological developments in materials science as everyday new materials are being developed in such a pace that it is becoming impossible to have profound knowledge on this immense variety of materials (Miodownik, 2015). It is getting difficult to have a command on the experiential aspects of materials as the diversity is increased. For a long time, materials served humanity with their technical properties. With the realization of human factors materials came to be regarded as essential design elements to elicit meanings and create experiences with both their tangible and intangible qualities (Ashby & Johnson, 2003; Karana, Pedgley & Rognoli, 2014; Manzini, 1986). The remarkable standpoint on non-technical characteristics of materials became a center of attraction for many scholars and thus this developed a new perspective on the evaluation of materials in design processes. As pointed out, beyond-technical qualities of materials are being used to design experiences, namely materials experience (Karana, et al., 2014). Beyond-technical qualities of materials are qualities that are shaped upon cultural values, meanings and associations, which are highly subjective in nature. A current problem on designing experiences is the subjective nature: experiences are series of moments that are shaped by unique individual characteristics (such as emotions, culture, etc.) and that change over time and context (Hassenzahl, Diefenbach, & Göritz, 2010; Coxon, 2015).

Experiences are formed through a series of highly dynamic factors. Considering the unpredictability disposition of experience, the designer cannot pre-determine but only foster the relationship between the user and the artefact (Grimaldi, 2015). Experience is created after human cognition makes sense of the signals that are received and sent by sensory organs. Human centered approach claims that meaning is the construction of reality in the individual's brain (Krippendorff, 2006). So a materials experience should be grounded on target users' construing rather than the predictions of the designer to be able to design experiences properly. Also, understanding sensory relations during an interaction would increase the chance of triggering predefined material experiences while estimating how the users can become aware of that interaction.

1.2 Statement of the Problem

The approach of this thesis is concerned with the exploration of individuals' construing of perceived material impressions that they are perceptually aware of, and the identification of how these construings are expressed subjectively. Being aware of something can be both focal (attentional) and peripheral (inattentional), and they work collaboratively in perceiving (Gennaro, 2008). A matter or a property can be perceived even without an attentional focus. In other terms, a material can be perceived both consciously and sub-consciously, and both perceptual processes contribute to the experience of materials.

Measurement of experience is a complex process. Broadly, two general measurement methods are used in measuring experiences, which are objective measurement methods and subjective measurement methods. Objective measurement methods are mostly concerned with the relationships between the objective parameters of material properties and perceived material properties. Often, objective measurement methods are found limited in understanding the latent structure of experiential aspects and capturing in-depth information about the experiences of individuals. Moreover, objective measurements are mostly limited with basic material samples, which most of them do not reflect everyday experiences. Our everyday experiences are shaped through the sensory interactions with complex materials and products.

On the other hand, subjective measurement methods are used for exploring in-depth information about the personal experiences of individuals. Compared to objective measurement methods, subjective measurements do not require highly technological devices, but require extra effort and time investment on collecting subjective data.

Repetitive experience on the things or events enable individuals to develop anticipations towards them. Knowing that experiences shape the interactions in between the user and the material (as the person and the environment), it would be useful to refer to the field of psychology in understanding these interactions. Kelly (1955/1963) postulated the Psychology of Personal Constructs (hereinafter PCP) theory, in which each individual is accepted to be having a unique construction system of experiences, and thus perceiving the world differently depending on these constructs. Moreover for PCP, perception (as interaction) is the instrument of the individual in exploring his/her surrounding.

As Raskin (2002, p. 1) states, “the constructivist psychologies theorize about and investigate how human beings create systems for meaningfully understanding their worlds and experiences”. Constructivism, in the philosophical manner, accepts that knowledge is not acquired, but constructed. In psychology, as accepted by many, George Kelly pioneered the usage of constructivism in clinical psychology, namely personal constructivism (Chiari & Nuzzo, 2003). With personal constructivism Kelly developed the theory of personal constructs, which accepts that each person has his or her own unique pyschological construct and this enables an individual way of understanding the world (Chiari & Nuzzo, 2003; Fransella, Bell, & Bannister, 2004; Fransella & Neimeyer, 2005). Kelly (1955/1963) claimed that if a person’s construct system can be construed, that person’s understanding of the world can be understood. To construe a personal construct, Kelly developed the Repertory Grid Technique (hereinafter RGT). Briefly, RGT is a technique that investigates anticipations of people towards specific issues by using similarities and contrasts (Fransella, et al., 2004). Utilising such a methodology that investigates the psychology of users can help in deconstructing experiences. Moreover, such a methodology can be used to explore user-material interactions.

1.3 Aim and Objectives of the Study

This thesis aims to explore the individuals' construing of user-material interactions and look for meaningful relationships that can be used as a reference for designing material experiences. Kelly's PCP fulfills the needs of this exploratory study. First of all, Kelly is a clinical psychologist who was influenced by Dewey's pragmatism (Butt, 2004; Paris & Epting, 2015). His technique relies on practice, and it can be derived into an instrument to investigate user-material interactions. Secondly, RGT is a versatile measurement technique, which is able to collect both qualitative and quantitative data about the inquiry. RGT is frequently used in many fields, particularly in consumer preferences and behavorial studies. However, RGT is an open and versatile method that is suitable for both qualitative and quantitative approaches. This research is a mixed methods study that benefits from the strengths of both qualitative and quantitative approaches for a better understanding of the research problem (Creswell & Clark, 2018). The four objectives set for this research are as follows:

- To investigate idiosyncratic attitudinal expressions of individuals towards perceived material qualities.
- To explore commonalities between the elicited attitudes and investigate sensory relevancies.
- To explore latent structure of the common elicited attitudes.
- To investigate relationships between the attitudes and the sample products.

Based on these objectives, meaningful relationship patterns will then be searched for, with the goal of representing them as a supplementary source for experience design processes.

This research is structured on investigating hands-on explorations with real products and materials. Experiencing materials in a realistic environment is expected to provide useful feedback that can contribute to the practice. For this research, eight different computer mouses and eight different water bottles were selected to be used as stimuli in two separate experiments. It was expected that the computer mouses would generate more visual, tactile and auditory feedback, whereas the water bottles would evoke more gustatory and olfactory experiences compared to other sensory modalities. It is assumed that both product types address different sensory experiences, and investigation of these differences could provide insights into how individuals construe their interactions with materials. The research is based on the following questions:

- How do individuals construe material qualities that they perceive through sensory interactions in their own statements?
- How are senses, perceived material qualities, and individuals' attitudes related to each other?
- How can attitudinal and sensory information be merged to develop senso-attitudinal maps?

1.4 Contributions to the Knowledge and Audience of the Thesis

The outcomes of this research are believed will contribute to design practice, education and research. Mapping of relationships between attitudinal approaches towards perceived material qualities would be beneficial as a supportive guide in designing experience through material properties. The relationships of perceived material properties could give insights about trigger points, which evoke associations or meanings that create experiences on the users. Same material qualities are perceived differently in another context; therefore material experiences differ on various product types. Also, a clear understanding of perceptual interactions could be achieved by studying a material embodied on a specific product type.

Maps could be used as a source for multisensory feedback. The more senses a designer can reach, the more successful the intended message is received by the users. Gathering multisensory data is a challenging process, and the literature lacks multisensory studies that deal with feedback from five senses. Also, it is assumed that the maps can be interpreted in understanding the sensory relevancies of attitudinal approaches towards materials on specific product types, and therefore encourage design students to design multisensory experiences and inspire design professionals to design successful product experiences.

1.5 Thesis Structure

The thesis is structured in eight chapters.

Chapter I introduces the problem background, thesis aim and research questions, the scope of the research, contributions to knowledge, and structure of the thesis.

Chapter II is about the theoretical framework of the research, containing the literature review on materials and material properties in general. In the first section, a broad literature review on materials and design is made. The technical and psychological aspects of materials and material properties are described and reviewed through the examples from literature. In the second section, sensory studies about material properties are reviewed. This section contains literature review on both single sense (unimodal) and multisensory (multimodal) investigations of material properties. The last section contains literature review on materials experience.

Chapter III is about the methodology of the research. In this chapter, the methodological background of the research and the underlying philosophical framework are described. Kelly’s Theory of Personal Constructs and the fundamental postulates are given. The Repertory Grid Technique is described in reference to the 11 corollaries. The proposed approach of structured interviews is introduced. The practical aspects of the technique are explained.

Chapter IV reintroduces the aim and the objectives of the research. The research questions that lay foundations for the research methodology are posed. Later, the design of the experiment and the environmental setting are described. The data collection methods and role of the researcher are described, the pilot and main studies and their procedures are explained in detail.

Chapter V presents the data analysis methods and procedures. This mixed methods study contains both qualitative and quantitative data. In this chapter, both qualitative and quantitative analysis procedures are explained separately for each experiment. The data is analyzed using basic statistics and prepared for further multivariate statistics. In the last section, sensory relevancies of personal evaluations are examined and the themes created within both experiments are compared.

Chapter VI and VII present the dimension reduction procedures of the data and the analysis results of the relationships between the selected elements and the elicited attitudes. Chapter VI is dedicated to the first experiment with computer mouses and Chapter VII is dedicated to the second experiment with water bottles. A large amount of data is collected through two experiments and the data is reduced in dimension for a clear interpretation. In these chapters, phases of dimension reduction are described in detail. The relationship between the participant evaluations and the selected products are investigated in three sections. These sections investigate attitude-attitude, attitude-element, and element-element relationships.

Chapter VIII is the concluding chapter that consists of the discussions over the findings of the research. The discussions evolve around the idiosyncratic attitudinal approaches of individuals, common attitudes and sensory relevancies, latent structure of the findings, and relationships between the attitudes and products. The arguments lead to the development and presentation of the Sensory-Attitudinal Maps (SAM) that represent the interrelations of attitudinal approaches alongside their sensory relevancies. The supplementary cluster and product cards developed as further outcomes of the research are also introduced.

CHAPTER 2

THEORETICAL FRAMEWORK OF THE RESEARCH

This chapter includes a comprehensive literature review on materials in design, with the aim of building a theoretical framework for the thesis. The first part of the chapter contains introductory information related to materials in design, beginning with a brief history of materials and the developments in materials culture over years. The chapter continues with the comparisons of how engineers and designers embrace materials through different perspectives in classification and selection activities. Following a general introduction of the materials literature, a detailed literature review of materials in design is then presented from the perspective of designers. The increasing role of materials in user centric design is shown with examples, and the foundations of materials experience are presented with a basis on human factors, products and meanings. In the final part of the chapter, sensory evaluation studies about materials are reviewed. This includes both objective and subjective approaches over measuring how individuals perceive material properties. Sensory studies are reviewed in detail represented through five basic senses (vision, haptics, audition, olfaction and gustation) separately, and multisensory studies are reviewed in the final. Multisensory studies contain crossmodal and multimodal interactions of sensory modalities in perceiving material properties.

2.1 Materials: Definition and History

Humans have always taken an eager interest in materials for thousands of years. “Our species – *homo sapiens* – differs from others most significantly, perhaps, through the ability to design – to make things out of materials – and in the ability to see more in an object than merely its external form" (Ashby & Johnson, 2014, p. 3). At first, *Homo Habilis* shaped materials to produce tools for fulfilling their physiological needs like gathering food and staying warm; then they built homes and protected themselves with them. Alongside of our beings, our cultures, on the other hand, were also shaped by the material usages (Martinon-Torres, 2008; Maze, 2007; Manzini, 1986). Martinon-Torres (2008) explained that the influence of materials on socio-cultural conditions and interactions within a society can be observed as different cultures had different approaches on the same material such as shaping iron arrowheads in different ways. Further, Martinon-Torres (2008) admitted that investigating materials have always provided detailed information about understanding human behaviors during that era. Materials that were explored in prehistoric societies have a massive influence on humanity, such that the ancient ages were represented with the names of the materials found in those ages (Gupta, 2015; Maze, 2007). In the first million years of the first appearance of humans, five basic materials (wood, rock, bone, horn and leather) were used to make tools and in the early Neolithic era, the usage of new materials (such as clay, wool, plant fibers) were emerged (Manzini, 1986, p. 37). From the ancient times to today, materials have always been used to fulfill human needs. The pursue for exploring and using new materials to fulfill more complex needs has developed societies, so that humans' behaviors towards materials gradually changed over time.

In the middle ages, artisans and crafts both handled materials to express themselves and created symbolic meanings through materials to communicate with the viewers (Anttila, 2009; Pöllänen, 2011). Self expression was likely possible for the adept craftspeople that had mastery with a specific material. In a system called 'guilds', the craftspeople needed to work with a master, until they became capable of creating crafts or arts by themselves (Epstein, 1998). This was an educational process where the apprentice learned through replicating the master's work. It was not permitted for an apprentice to express his/her creativity until he/she became the master. Becoming adept at a specific material required years of experience of tinkering with that material. Nimkulrat (2010, p. 75) stated that hand-working with a material gives the craft the enhanced feel of the qualities of that material and therefore creates inspiration. The artist and the craftsperson, they both had deep connections with materials; from the apprenticeship to the mastery.

Making and designing were not regarded as separate actions in pre-industrial societies (Cross, 2008). The maker was also the designer and this individual effort on producing was a slow-going process. As the living standards of humans have increased, societies have requested a faster production for the fulfillment of their needs (Bayazit, 2004). As new division of professions have emerged, craft practice slowly evolved into an act of design with the separation from art (Epstein, 1998; Friedman, 1997/2015) and formed as a profession with the emergence of the Industrial Revolution (Friedman, 2000). According to Bayazit (2004), mass production required standard and uniform products and the relationship between material use and the maker became weaker. During this transition period from craftsperson to designer, the hand-working with materials was altered. One major reason for this alteration was the pace of development in materials science as many new materials have emerged frequently to be used by designers. The designer needed to be capable of understanding more than one material in mass production. In mass production, mechanical designers had to deal with more than 200.000 materials (Ashby, 2011). Figure 2.1 represents the evolution of materials over time.

In his map about the evolution of materials, Ashby (2011, p. 1) demonstrated how the importance of materials changed over time. The relative importance of natural materials (such as stone and wood) has dramatically decreased until the midst of 20th century, whereas the importance of metals has increased critically. Industrialization encouraged engineers and scientists to pursue searching for new materials. The flexibility of polymers enabled developing work-specific plastics that can replace other materials and innovations in composites made lighter and stronger materials available (Ashby, 2011).

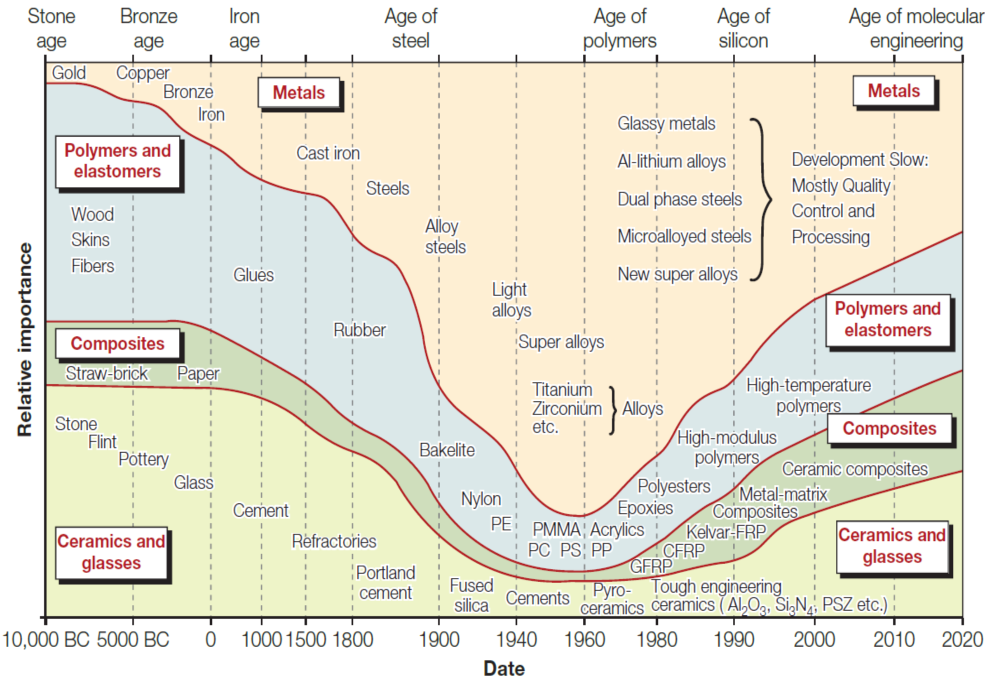

Figure 2.1. The evolution of materials over time (Ashby, 2011, p. 1)

With the improvements on production technologies, manufacturing speed has gathered a massive pace and replaced the traditional order-based production system (Bayazit, 2004). The requirements of industrialization and mass production changed the way of approaching towards materials. In the early years of industrialization, designing was accepted as a technical activity concerned with mechanical issues, and in engineering design, the major focus was the performance related aspects of materials (Cross, 2008; Peck, Kandachar, & Tempelman, 2015). Wright (1998) stressed that designers focus on choosing materials depending on their appropriateness for production and that this was a cost-based view where the cheapest solution will be the best option. The cheapest materials with adequate technical aspects were preferable for the design projects.

2.2 Classification

Materials are classified depending on their similar properties and usually categorized as engineering materials and natural materials (Ashby, 2011). For Ashby (2011), engineering materials are human made materials that are gathered from nature as substances and they can be classified as the families of metals, polymers, ceramics and elastomers. Natural materials are also obtained from nature, yet they do not need to be processed like engineering materials, and also material families can be combined to create hybrid materials (Ashby, 2011).

Classification of materials does not have a standard structure[1], yet they are broadly classified in four or five groups. Lesko (2008) categorized materials in four groups as metals, plastics, rubber/elastomers and natural engineering materials, whereas Ashby and Jones (2005) classified materials into five major categories as natural materials, metals and alloys, composites, polymers, and ceramics and glasses. As can be seen in Table 2.1,each material class consists of candidate materials that are similar in terms of their atomic properties.

Classification of materials is also an evolving process as new materials emerge every moment. More recently, Ashby (2017) categorized materials in five basic classes as metals, ceramics, glasses, elastomers and polymers, and offered another class as hybrids (composites, sandwiches etc.) that consist of combinations of basic material classes. Material classes are formed based on similar technical aspects such as material properties, processes and applications (Ashby, 2017).

Technical properties of materials are objective numerical values that are measured in controlled environments. Every material is identified and recognized through their characteristic ranges of values (Ashby, 2011). Measurable, comparable and objective

[1] Cardwell, Cather and Groák (1997) offered a material classification method based on familiarities. Many other classes of materials are also offered such as smart materials (Gupta, 2015), sustainable and multi-purpose materials (Peters, 2011), and these material classes are mostly purpose specific.

properties such as hardness, thermal conductivity and refraction index are defined as technical properties. In general[2], designers need to consider the property classes of materials (such as economic, general, physical, mechanical, thermal, electrical and magnetic, environmental interaction, production and aesthetic properties) during their material selection activities (Ashby & Jones, 2005). Each property class has sub-classes to consider, such as aesthetic properties consisting of color, texture and feel aspects, whereas production properties including joining and finishing.

Table 2.1 Classification of materials. Adapted from Ashby and Jones (2005, p. 3)

Material Class	**Candidate Materials**
Metals and Alloys	Iron and steels / Aluminium and its alloys / Copper and its alloys / Nickel and its alloys / Titanium and its alloys
Polymers	Polyethylene (PE) / Polymethylmethacrylate (Acrylic and PMMA) / Nylon, alias polyamide (PA) / Polystyrene (PS) / Polyurethane (PU) / Polyvinylchloride (PVC) / Polyethylene terephthalate (PET) / Polyethylether ketone (PEEK) / Epoxies (EP) / Elastomers (NR)
Ceramics and Glasses	Alumina (Al_2O_3) / Magnesia (MgO) / Silica (SiO_2) / Silicon carbide (SiC) / Silicon nitride (Si_3N_4) / Cement and concrete
Composites	Fiberglass (GFRP) / Carbon-fiber reinforced polymers (CFRP) / Filled polymers / Cermets
Natural Materials	Wood / Leather / Cotton, wool and silk / Bone

Material engineers and scientists conduct various measurement tests (such as hardness tests, stress-strain tests) to identify the materials' physical and chemical limitations. These values are then presented as datasheets to inform engineers, designers, stakeholders, and so on. Sources about material properties and material selection are also presented as textbooks (Ashby & Jones, 2005; Gupta, 2015) and

[2] Sustainability is an another material property which is accepted as a technical factor (Ljungberg, 2007; Zhou, Yin, & Hu, 2009). Pollution, over-consumption, resource utilization and over-population of materials are some of the problems that are discussed through sustainability of materials. The role of critical materials (Peck, et al., 2015) are also discussed as a technical quality. Availability of rare earth materials and supply risks are evaluated through economical facts.

digital databases[3], that contain detailed information about technical properties of materials. The objective nature of technical values is useful for designers since they can make comparisons in order to find the optimum material choice for their designs.

Materials and manufacturing process selection is the integral part of a design activity (Thompson, 2007). In mass manufacturing, the product needs to be carefully designed to eliminate fails and flaws during the production process. Dowlatshahi (2000) stresses that most of the manufacturing fails occur because of poor material choices. Designers need to be equipped with adequate materials knowledge to eliminate production flaws. Broadly, traditional manufacturing methods of materials are grouped in four categories as forming, cutting, joining and finishing (Lesko, 2008; Thompson, 2007). Forming consists of liquid state (i.e. casting, injection molding), plastic state (i.e. rolling, forging) and solid state (i.e. bending) forming processes. Cutting processes are activities made by tools or machinery to divide materials into parts, and joining consists of welding and soldering. Lastly, finishing processes involve treating the surface of the materials. A summary of traditional manufacturing processes can be seen in Table 2.2.

Table 2.2 Traditional manufacturing methods. Adapted from Lesko (2008, p. 14)

Forming	**Cutting**	**Joining**	**Finishing**
Liquid State	Sheet Cutting	Solder-Braze	Formed
Plastic State	Chip Forming	Weld	Abrasive-Cut
Solid State	Non-Chip Forming	Adhesive	Coatings
	Flame-Laser	Mechanical	

[3] Some example digital material databases are CES Selector (http://www.grantadesign.com/) and MatWeb (http://www.matweb.com/).

2.3 Materials Selection

Both designers and engineers consider materials selection activities through different perspectives during their product design processes. Engineering tends to focus on technical aspects, whereas designers are concerned mostly with expressive and aesthetic values of materials (Karana, Hekkert, & Kandachar, 2008).

Ferrante, Santos and Castro (2000) explain that materials selection is a highly engineering activity with a limited concern of aesthetics. Engineers use merit indices to find most the appropriate materials for production. Selection activity is a formal and systematic process, and the major focus is on cost reduction (Ferrante et al., 2000) and functionality (Wright, 1998). Engineering materials selection also focuses on making the optimum selection that meets technical requirements such as pyhsical-chemical properties and manufacturing limits to enhance performance (Zha, 2005). Wright (1998) stated that functionality is the most important material attribute and in his screwdriver design example, he explained that the electric insulation and good-grip functions are evaluated through their materials' price.

Karana, et al. (2008) represent an overview of different material properties that are found to be effective in engineering based materials selection processes (Table 2.3). As can be seen from the overview, engineering perspective mostly focuses on technical aspects during material selection.

Ashby, Cope and Cebon (2013) defined a four-step strategy to select the final material from all available materials and these engineering based steps are: translate requirements, screen using constraints, rank using objective, and seek documentation. The design requirements are identified in the first phase, and improper materials are eliminated afterwards. Later materials that fit best are clarified and in the final phase, an in-depth investigation is carried out on considered candidate materials. Summary of the material selection strategy can be seen in Table 2.4.

Table 2.3 Review on effective qualities in materials selection literature. Adapted from Karana, et al., 2008, p. 1083

Study	**Effective material qualities in selection**
Materials (1967)	Mechanical properties / Cost
Patton (1968)	Service requirements / Fabrication requirements / Economic requirements
Esin (1980)	Production requirements / Economic requirements / Maintenance
Ashby (1992)	General properties / Mechanical properties / Thermal properties / Corrosion-oxidation
Lindbeck (1995)	Mechanical properties / Physical properties / Thermal properties / Wear / Corrosion-oxidation
Budinski (1996)	Chemical properties / Physical properties / Mechanical properties / Dimensional properties / Business issues
Manganon (1999)	Physical factors / Mechanical factors / Processing and fabricability / Life of component factors / Cost and availability / Codes, statutory and other / Property profile / Processing profile / Environmental profile
Ashby & Johnson (2002)	General attributes / Technical attributes / Eco-attributes / Aesthetic attributes
Ashby (2005)	General properties / Mechanical properties / Thermal properties / Electrical properties / Optical properties / Eco-properties / Environmental resistance

Materials selection is a difficult phase that requires expertise on materials (Ipek, Selvi, Findik, Torkul, & Cedimog, 2013; Sapuan, 2001). According to Sapuan (2001) design engineers tend to select materials that they are familiar with. Previous experience with the materials help design engineers to make certain material selections, and this activity is defined as knowledge-based selection (Sapuan, 2001). However, they consult digital material libraries when they are in need of further knowledge about the properties of a new material which they have never used before. Ipek, et al. (2013) point out that it is not possible for an engineer to become expert on all kinds of materials; so the engineers consult material experts within a knowledge-based expert system. A knowledge-based expert system is an interactive digital system providing information based on expert feedbacks. The system is helpful for engineers to screen and filter materials easier and to find the optimum material solutions.

Table 2.4 Summarized material selection strategy (Ashby et al., 2013)

Phase	**Definition**	**Example**
Translate requirements	function constraints objectives free variables	role of the component cost, stiffness min/max aspects other decisions
Screen using constraints	eliminate materials that cannot do the job	attribute limits such as maximum service temperature
Rank using objective	find the screened materials that do the job best	material indices
Seek documentation	research the family history of top-ranked candidates	descriptive information through printed or digital media

The idea of screening and ranking traditional materials that have been used in production for years are evolving with the developments in artificial intelligence (Jahan, Ismail, Sapuan, & Mustapha, 2010). Every moment, new materials are replacing the old ones, since they are technically superior such as being more durable and lighter. Jahan, et al. (2010) underline that using artificial intelligence methods (such as computer simulations or mathematical programming) are more flexible than traditional methods (such as textbooks) and computers are helpful in *analyzing* the growing number of materials, and engineers prefer to use such methods in contemporary selection processes.

It can be said that engineers' material selection is highly systematic and strictly limited by manufacturing constraints, and few decisions on materials are negotiable. Also, materials selection methods are shifting from knowledge-based systems to multi criteria selection supported by digital media. Ashby and Johnson (2014) emphasized that the diversity between technical and industrial design material selection activities is distinct. In materials screening and selection processes, both perspectives investigate materials from general to specific. However, technical limits are the major focus in technical design, whereas expressive values are important for industrial designers (Ashby & Johnson, 2014). A comparison between two disciplines can be seen in

Table 2.5 Comparison of material selection activities between technical designers and industrial designers (Adapted from Ashby & Johnson, 2014, p. 39)

Phase	**Technical Design**	**Industrial Design**
Limited understanding of material options (from 100.000 materials to 10-50 materials)	Create limits for mechanical, thermal, and other technical attributes	Outline desired aesthetics, behavior, perception and association
Increasing knowledge or possible materialization of the product (from 10-50 materials to 5-10 materials)	Model technical performance and evaluate results	Explore sample collections, looking at analogous products and experiences
Final selection of material(s) and manufacturing process(es) (from 5-10 materials to 1-2 materials)	Create working prototypes, virtual and real, based on a detailed CAD database	Create surface prototypes by 3D visualization in a digital file

Material considerations of industrial designers differ from the engineering perspective. Not only fulfilling the technical requirements of products, but also the expectations of the consumers need to be satisfied with the materials selection (Ljungberg & Edwards, 2003). It is beyond technical. Defining the role that the material will play in a product is a challenging process (Pedgley, Rognoli, & Karana, 2015). According to Kesteren (2010), both tangible (physical) and intangible (non-physical) properties of materials are involved in industrial designers' materials selection activities. However, available information sources are lacking in providing intangible material properties data.

In her study, Kesteren (2008) investigated the information needs of product designers in materials selection and she divided her findings into four themes as the need for comparable information, product issues, multiple detail levels, and material samples. The first theme is about comparing materials' objective technical properties to fulfill performance related needs of products. Comparing materials is a method that has been used by engineers for many years (Cross, 2008; Sapuan, 2001). Secondly, information related product issues are about the life cycle of the materials on products during usage. Thirdly, multiple detail levels are about the level of material detail, from more general to more specific, dividing information needs in the whole design process. Designers need general information (i.e. material family) about materials at the start and more specific information (i.e. technical limitations, material type) in the later phases of product design. Lastly, Kesteren (2008) stressed that physical samples are important since datasheets do not provide enough information about everyday performance of the products. Material samples are useful information sources to be experienced by designers in material selection activities.

Kesteren (2008) categorized the information sources of product designers during their material selection activities as general material applications (experience, testing and example products), independent sources (databases, samples and textbooks) and materials on supply (advisors, internet search, samples and magazines/brochures). In addition to that, stakeholders (such as clients, users, and manufacturers and vendors) also influence the material considerations of designers (Pedgley, 2009). Pedgley (2009) emphasized that clients are mostly strategic and consider commercial issues, whereas manufacturers' and vendors' major concerns are about manufacturability and supply. On the other hand, users provide experiential and perceptual feedback, and being in the middle of these stakeholders, designers choose materials on a circumstantial basis based on feedback from the mentioned stakeholders (Pedgley, 2009). Designers should be aware of these factors to make proper material choices.

Material samples as physical information sources are often used as a reference for observing real life performance of materials. The technical properties of materials are measured in controlled environments and under certain conditions. As Kesteren (2008) stated, companies mostly show their best results on their material tests and materials embodied on products perform differently in real life settings, so the information sources need to be supported with product related material information. Further, Tanaka and Horiuchi (2015) revealed that the perception of material qualities differ between the images and the physical samples of materials. In this context, it may be confusing for the viewer to perceive material qualities from a printed or digitally shown media. Physical material libraries offer product samples along with material samples and these libraries enable a useful environment for designers to experience materials through physical and psychological interactions (Akin and Pedgley, 2015; Miodownik, 2007). Furthermore[4], the viewers could benefit by both experiencing the raw materials and their embodied forms on products.

As mentioned above, designers need to understand how materials are perceived and experienced by users and technical databases fail to satisfy these needs. According to Pedgley (2010), the information needs of industrial designers for material selection is often neglected. Some scholars investigated the expressions and evaluations of users about perceived material qualities to develop various information sources about materials' expressive qualities (Zuo, 2010; Rognoli, 2010; Karana, 2010).

Zuo (2010) introduced a database with a focus on aesthetic and sensory perception of material textures based on the findings from his previous studies. This on-line database (namely material-aesthetics) consisted subjectively described visual and tactual perception of material textures and their relations with objective parameters. Four dimensions were developed for identifying perceived texture qualities as geometrical, physi-chemical, emotional, and associative dimensions, and designers could investigate perceptual characteristics of material textures through these dimensions (Zuo, 2010).

Rognoli (2010) developed a model of expressive sensorial characterization of materials to be used for design education. The model is structured on the comparison of differences between subjective (perceived) and objective (measured) properties of materials. Through tactile and photometric evaluations, texture, touch, brilliancy and transparency were defined as the fundamental sensory dimensions for the model, and three sensorial maps (density, thermal conductivity and Young's modulus) were

[4] Material libraries could also be designed and used for promoting specific aims such as sustainability. For example, a circular material library is proposed to promote the use of recycled materials (Virtanen, Manskinen, & Eerola, 2017).

developed using basic samples of different materials (Rognoli, 2010). This model idea led to another study on material colors, and a chromatic atlas of materials was developed by Rognoli (2010). With the chromatic atlas, the designers are able to design their own cards depending on the technology, material and color parameters provided. A sample of material cards prepared through the chromatic atlas can be seen in Figure 2.2.

Figure 2.2. Sample material cards containing chromatic data (Rognoli, 2010, p. 296)

2.4 Meaning

Karana (2010) investigated how materials obtain their meanings and developed the Meaning of Materials (MoM) Model based on her findings. The MoM Model puts the material in the center and illustrates the material-user and material-product relationships through descriptive items gathered from feedback from the users and literature research (Karana, 2010). Further, Karana (2010, p. 275) classified these items into seven categories as use, manufacturing processes, technical, sensorial, expressive, associative and emotional descriptions. The proposed MoM Model can be used by designers to understand how meanings are attributed to materials and review the user-material-product interactions.

Krippendorff (2006) defined meaning as the reflection of differences between the objective reality and its perceived image and meanings are evoked through sensations. Karana (2010) explained meaning of materials as the thoughts and attributed values related with materials through sensory interactions. In this sense, meanings of materials are accepted with respect to the process of making sense of the perceived material qualities within our psychology.

Material meanings come into existence through various ways. Karana (2010) emphasized that material, product, context and the individual play the roles in meaning creation. Materials contain intrinsic (or innate) meanings such as woods are warm and metals are clean (Ashby & Johnson, 2003), and ceramics are hygienic in dinnerware (Lefteri, 2006). Meanings of materials have a dynamic nature and change over time. Plastics were once perceived as cheap and displeasant; nevertheless, technological developments enabled the production of specialized plastics that are defined as high-tech (Karana, 2012). On the other hand, product designers assign meanings to their products by their material selections (Karana, 2010). In this way, materials may possess new meanings other than their innate meanings. For instance, ceramics in pottery may be perceived as traditional, whereas a ceramic knife may invoke the meaning of high-tech. As Karana and Hekkert (2010) stated, it is quite difficult to understand whether the meaning is created by the product or the material that it embodies in a product context.

2.5 Usability

Designers consider aesthetic and expressive values and meanings to define the materials' role in an artefact to maintain a user-centric approach by focusing on other human factors such as usability and pleasure. The term usability is defined as “capable of being used” and “convenient and practicable for use”[5]. ISO 9241-11:1998 has defined usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (Bevan, Carter, & Harker, 2015, p. 144). During the midst of the 19th century, although usability was once favored by the manufacturers as a marketing tool, it was stuck between the boundries of the technical perspective of traditional engineering approaches (Cross, 2008; Jordan, 2000). Ashby and Johnson (2014) express that materials have an important role on design ergonomics and usability. Aluminum alloys made it possible to produce lighter products that are easy to lift, whereas a high-tech plastic could be molded with a grippy surface that reduces slipperiness.

Pleasure, on the other hand, is another value highly related to usability (Desmet & Hekkert, 2007; Hassenzahl, 2008; Jordan, 1999). Jordan (2000) defines four themes of pleasure achieved through product use, which are physio-pleasure, socio-pleasure, psycho-pleasure and ideo-pleasure. Physio-pleasure is achieved through physical interactions such as touching or seeing, and socio-pleasure is evoked through the products that could start a social interaction with others (Jordan, 2000). Moreover, for Jordan, psycho-pleasure is about emotions and cognitivity, and ideo-pleasure is related to users’ values. A product made of sustainable materials would conceive ideo-pleasure on the user sensitive to nature.

Positive affection through the usability of a design creates pleasure on users. Consumers like or dislike the products they use; so the pleasure of the user needs to be positioned at the center of human factors (Ljungberg & Edwards, 2003; Norman, 2013). The smooth handling of a pen may evoke pleasurement in the user. However, if the pen suddenly stops writing, the user may become frustrated. As a consequence

[5] Merriam-Webster (2017) https://www.merriam-webster.com/dictionary/usability

of positive events, the user could be emotionally affected (Picard, 1997) and may become attached to the product (Schifferstein & Zwartkruis-Pelgrim, 2008).

Janlert and Stolterman (1997) observed that people talk and think over objects as if they have human-like characters. A car could be referred to as "reliable", whereas a vase could be "stylish". People tend to attribute human characteristics to the products and this attribution creates product personalities (Govers & Schoormans, 2005; Jordan, 2000). Ashby and Johnson (2003) stress that product personality is comprised of aesthetics, associations and perceptions; and every aspect on a product, even a small joint detail is part of product personality.

Creation of product personality is a powerful tool to create meaningful relationships between the user and the product (Battarbee & Mattelmäki, 2004; McDonagh, Bruseberg, & Haslam, 2002). Govers and Schoormans (2005) mention that consumers tend to buy products with personalities similar to theirs. The conformity of user-product personalities are found to be having a positive effect on consumer choices and therefore elicit positive experiences.

2.6 Experience

Experiences are evoked through interactions with our surroundings. Hassenzahl (2010, p. 8) defined an experience as "an episode, a chunk of time that one went through—with sights and sounds, feelings and thoughts, motives and actions; they are closely knitted together, stored in memory, labeled, relived, and communicated to others". In other words, experiences are series of moments mostly shaped by sensations and emotions, and shape our personality.

Experience has a beginning and an end, and it has a unique nature which is influenced by time and context (Coxon, 2015). Coxon also states that each experience is individual, and it is not expected to have the same experience identically twice. Experience is subjective, context dependant and temporal (Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009). Each individual has a large number of aspects (i.e.

cultural background, educational background) that shape and influence his/her experience. Although experiences are unpredictable series of events, designers need to create designs that stimulate users' senses and put them under desired affections. Experience patterns have the centric role in designing experiences (Hassenzahl, 2010). Categorization of experiences is a challenging process due to its highly subjective nature. It is not possible to separate emotion and experience as they are indistinguishable (McCarthy & Wright, 2004). According to Hassenzahl, et al. (2010), experiences can be categorized through their relations with the basic psychological needs. A narrowed model of six important psychological needs is suggested by Hassenzahl et al. (2010), which are autonomy, competence, relatedness, popularity, stimulation, and security. However, in their categorization attempt, Hassenzahl and his colleagues stressed that categorization of experiences is still a difficult process as the experience descriptions of individuals are not homogeneous.

Experiences are also evoked through products. Hassenzahl (2010) suggested that products are perceived through two major dimensions as pragmatic and hedonic. Pragmatic dimension is related with “do goals” (utility and usability) and can be questioned through “what” and “how”; whereas hedonic dimension is related to “be goals” (being) that can be questioned through “why” (Hassenzahl, 2010). Hassenzahl, Eckoldt, Diefenbach, Laschke, Lenz and Kim (2013, p. 23) define that a human made artefact consists of “a tangible, material representation, and a set of experiences”. A camera has optics made of high-tech glass in a polymer body (material representation) and it can be used to record explorings of a new city (experience) (Hassenzahl et al. 2013).

According to Pine and Gilmore (1999), experience is highly related to memories (associations), and the role of five senses is crucial in order to offer a successful experience. This approach stresses that companies are not only selling services or products (tangible), but also they market experiences (intangible) to their consumers.

The concepts usability and experience are structurally similar as they are both results of the interactions between the product and the user (Desmet & Hekkert, 2007). According to Desmet and Hekkert (2007), usability is regarded as a source of product experience. Product experience is achieved through interactions between the user and the product. Human-product interactions could be instrumental, non-instrumental and non-physical (Desmet & Hekkert, 2007). Desmet and Hekkert introduced a framework of product experience (Figure 2.3). In their framework, Desmet and Hekkert (2007) divided product experience into three categories: Aesthetic experience (fulfillment of hedonic needs through senses), experience of meaning (memories, associations, cognitive issues), and emotional experience (the change in emotional state that affects our behaviors). According to their hierarchical status, emotional experience is triggered by meanings and aesthetics. Aesthetic experience is evoked through sensory feedback (Hekkert, 2006). Experience of meaning is related to the cognitive process, where meanings are generated through interpretation, recognition and association (Desmet & Hekkert, 2007). The product experience framework can be understood better with an example. The user enjoys hearing the trigger sound of his professional camera during photo shooting (aesthetic experience). As the user becomes attached to the camera, he remembers the moments he recorded on a touristic visit (experience of meaning). The quality of resolution and the lightness of the camera satisfies the user (emotional experience).

As can be seen from the example, the levels of product experience are mostly related with materials' properties and their affections (i.e. sound, weight). User characteristics, design features, time, and context of use are other factors that influence the experience elicited through material properties (Karana, Pedgley, & Rognoli, 2015), alongside aesthetics, meanings and emotions.

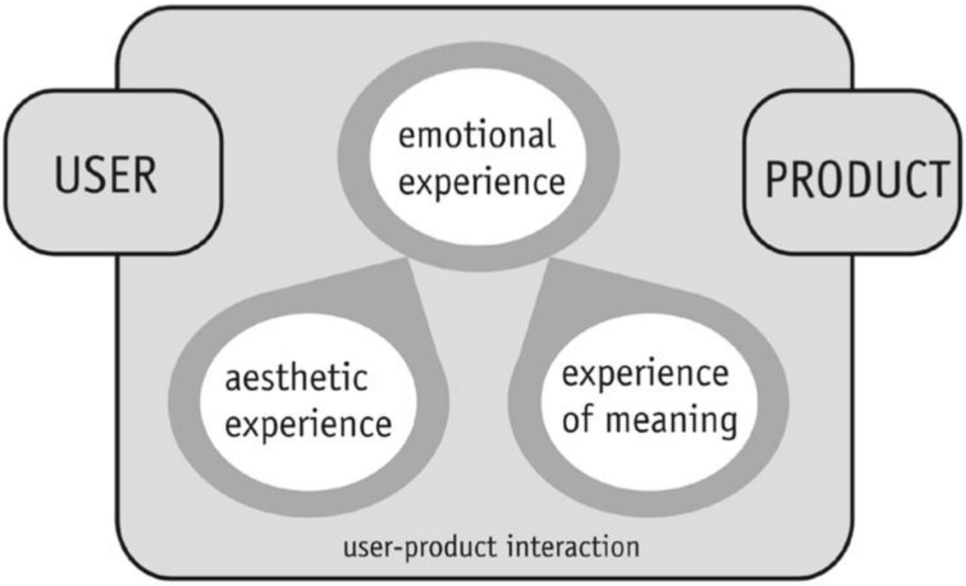

Figure 2.3. Framework of product experience (Desmet and Hekkert, 2007, p. 4)

The use of materials play the central role in experiencing products (Karana, 2009, Jordan, 2000). The experience of materials is created through interactions between the user and the material. Following the acknowledgement of the product experience, the term "materials experience" was first coined by Karana, Hekkert and Kandachar (2008) to describe the experience generated "with and through" materials (Karana, et al., 2014). Materials, as themselves or in product forms, contain meanings and evoke emotions by interacting with users (Ashby and Johnson, 2003; Hekkert and Karana, 2014; Manzini, 1986). According to Karana, Hekkert and Kandachar (2009), the perception of sensorial properties of materials varies as users interact with materials in different ways and through different sensory modalities. It is claimed that the materials are experienced as a situational whole (product context, and experiential and cultural background of the individual) and therefore the experiences differ among individuals (Giaccardi & Karana, 2015; Law et al., 2009).

Depending on their sensorial properties, materials are being used to create desired experiences. Materials experience could be both positive and negative (Karana, Pedgley, & Rognoli, 2014). In the automobile industry, the door closure sound[6] is carefully designed as it expresses the car's characteristics, and in one study, the pleasant experience is described as gentle, deep and heavy (Kuwano et al, 2006). In another example, Schifferstein (2008) explains that the drinking experience is heavily influenced by the cup's material. In his study, he investigates how hot and cold drinks are experienced through cups with similar shapes yet made of different materials. The results show that the stimuli created by the cups greatly affect the emotional state of the user (i.e. glass and ceramic cups were found to be the most pleasant, whereas the foam cup was the least).

Giaccardi and Karana (2015) proposed the framework of materials experience. The framework consists of the intersections (encounters, performances and collaborations) between materials, people and practices. Encounters are described as the first interactions between the person and the material, and performances are defined as the repeating encounters with the same material, whereas collaborations are defined as the repeating performances (Giaccardi & Karana, 2015). The framework of materials experience can be seen in Figure 2.4.

Giaccardi and Karana (2015) suggested four levels of materials experience, which are sensorial, interpretive, affective, and performative. Sensorial level consists of the interactions through senses (such as seeing or touching a material) and sensing of the material property (such as rough or smooth), and interpretive level consists of the judgement of sensorial level (such as judging smoothness as elegant) (Giaccardi & Karana, 2015). To continue, Giaccardi and Karana (2015) explained that affective level is related to the creation of emotions and their affections (such as fascination or dissappointment), and performative level covers the relations within individual anticipations towards materials through the affections generated in all other levels.

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6 A collection of car door closing sounds from different brands: http://www.soundsnap.com/tags/car_door_close

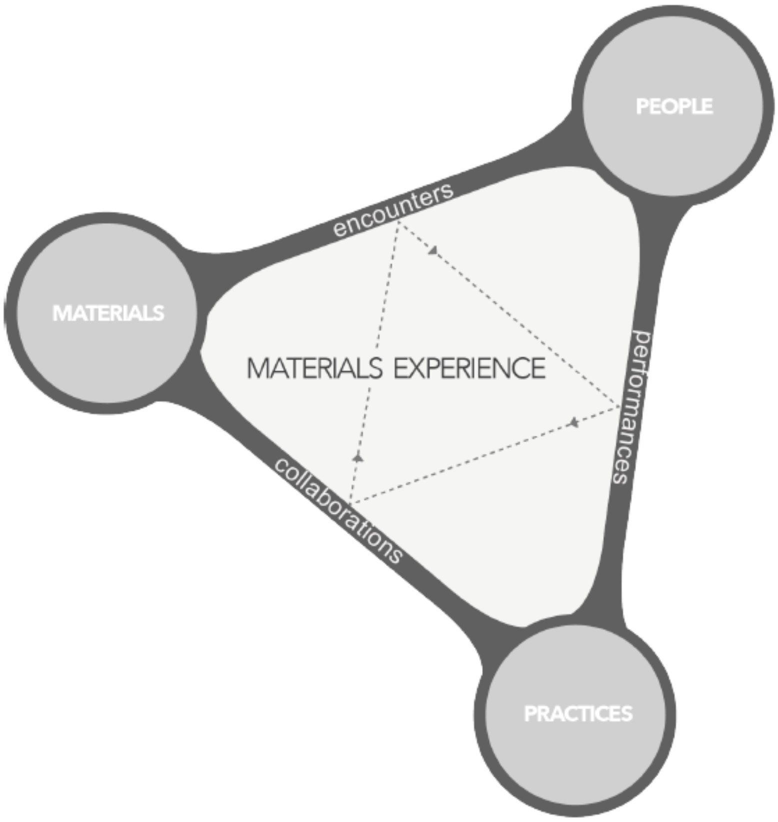

Figure 2.4. Framework of materials experience (Giaccardi and Karana, 2015; p. 2450)

Hands-on explorations of a material help to reveal its experiential qualities (Pedgley, Rognoli, & Karana, 2015; Schifferstein & Wastiels, 2014). Experiencing materials through physical interactions have their origins in Bauhaus. In Bauhaus, the theory of contrast[7] was used to encourage students to experience materials by themselves (Feininger, 1960). Students investigated materials in workshops, where they manipulated them physically. Nimkulrat (2012) investigated how hands-on material interactions reveal tacit knowledge and can be used as a thinking process through a practice-led design research, where the expressive qualities of paper string were

[7] Johannes Itten's "theory of contrasts" included practice-led research applications such as feeling of sensorial contrasts of materials like *rough-smooth* and *soft-hard* through hands-on interactions (Wick, 2000).

explored by embracing it as a textile material. Paper string is an unconventional material for knitting textiles. According to Nimkulrat (2012) physical interactions invoked creativity by the experiential knowledge attained from the process. In another example, a practical investigation on silver revealed new opportunities for that material in terms of creative expressive meanings (Niedderer, 2012). Niedderer (2012) pointed out that silver is recognized as rigid. However, she evoked various emotions including joy and surprise on the users by designing a non-traditional flexibility detail with silver that she explored through practice. It can be said that hands on applications are found to be fruitful for the designer to understand materials' experiential qualities personally.

2.7 Language

Self-understanding of experiential qualities of materials is helpful in designing experiences through materials, yet it is limited in communicating with others due to the subjectivity. It was also necessary to organize subjective user descriptions about perceived material qualities in order to develop new languages (lexicons, vocabularies or concepts) for a better communication between the stakeholders. Snelders and Schoormans (2004) underline that users' expectations of the new design are quite abstract for designers and companies to understand. The users may want an "attractive" product, yet it is not obvious what makes users feel attracted to the product. It is regarded as an actionability problem, where "actionability" is defined as the particular actions needed to be taken by the companies to achieve user expectations in designing new products (Snelders & Schoormans, 2004, p. 803). To solve actionability issues in designing new products and experiences, the attitudinal approaches of individuals would support designers in understanding how a desired experience is formed. The expressive aspects of materials are used to define designerly needs. On the other hand, scientists and designers carry out interdisciplinary work to develop materials with desired technical and sensorial properties, defining expressive aspects of materials in a common way that would enable different disciplines to understand each other Wastiels, Schifferstein, Heylighen, & Wouters, 2012; Wongriruksa, Howes, Conreen, & Miodownik, 2012; Wilkes, et al., 2015).

Georgiev and Nagai (2011) developed a framework to generate comparable values of meanings through associations and interpretations. The framework of in-depth impressions and created meanings in human-material tactile interactions can be seen in Figure 2.5. Lexical representation is a way of describing a particular concept using fewest words (Özcan & van Egmond, 2012, p. 42). In the lexical representation example of a luxury shoe, *luxury* is the most distinct aspect of the *shoe*. Georgiev and Nagai (2011) generated lexical meaning networks, in which vocabularies were gathered from free verbal expressions through tactile interactions with several materials. To give an example, when cork is imagined through tactile interaction, in-depth impressions such as *bottle*, *sunshine*, *calm* and *natural* were elicited and meanings were created such as *soft*, *wood*, *country* and *warm*. By investigating correlations between in-depth impressions and generated meanings, Georgiev and Nagai (2011) found out that meanings of materials depend on the product type and the usage, not on the materials themselves.

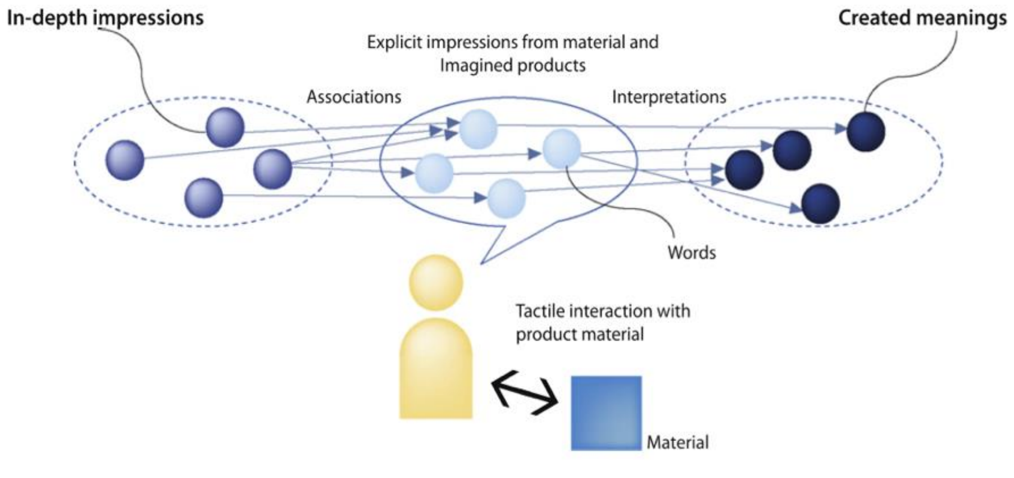

Figure 2.5. Framework of in-depth impressions and created meanings in human-material tactile interactions (Georgiev & Nagai, 2011, p. 4232)

Considerations over developing new materials became a cross disciplinary work as experts from various fields contribute to the process (Ferrante, Santos, & Castro, 2000). Materials have been developed mostly in laboratories by material scientists and the material stimuli is important for the communication between the designers and the material scientists (Wilkes, et al., 2015). The diversity of technical and experiential languages of materials creates difficulty on lingual comprehension between disciplines. Further, technical professionals express themselves in a formal and objective language, whereas designers tend to use a more heuristic and subjective style, and a proper language is needed that can bridge the technical and non technical definitions of materials together (Wongsriruksa, et al., 2012). For example, Wongriruksa, et al. (2012) investigated the relationships between technical parameters of sample material surfaces with the psychophysical features and found out that perceived hardness was correlated with elastic modulus. In parallel to that, Wilkes, et al. (2015) found correlations between technical parameters and some experiences such as perceived roughness, warmth and bitterness; yet they found it quite harder to find correlations with many qualities such as healthiness and naturalness. Understanding psychophysics is crucial to develop new material experiences, however pyschometrics should be adopted complementarily with ethnographic approaches (Wilkes et al., 2015). Figure 2.6 represents the diagram of factors that influence material experiences.

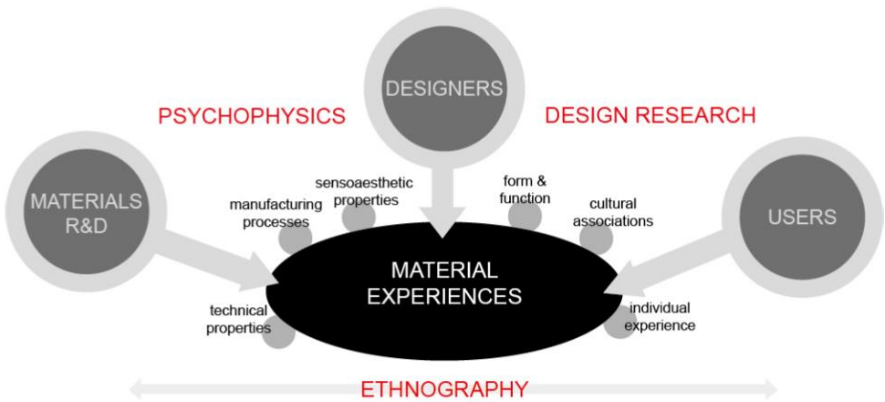

Figure 2.6. Diagram of factors that contribute to material experiences (Wilkes et al., 2015; p. 1236)

2.8 Sensory Evaluation of Materials

Sensory evaluation studies (in regards to material properties research) consist of psychophysical studies, also regarded as neuroscience. Psychophysics is the explanation of perceptual experience in quantified measurements (Dzhafarov, 2001). The relationships between the objective data (material properties) and the subjective outcome (perception) are investigated through psychophysical examinations. Investigation of the perception of surface roughness can be a tactile psychophysics study, whereas the perception of sourness can be a gustatory psychophysics study.

Psychophysics has been studied for centuries[8], from ancient times to our modern day, adopting various methods. Modern psychophysical measuring approaches adopt signal detection theory[9], which can be explained as the measurement of the minimum stimuli difference that affects human perception through a sensory modality.

With his revolutionary utilization of Weber’s law (the quantification of noticable difference in perception) into a logaritmic law of sensation, Fechner is regarded as the father of psychophysics in the modern era (Robinson, 2010). According to Robinson, Fechner puts emphasis on both the inner psychophysics (introspective) and the outer psychophysics; yet his assumptions over inner psychophysics were neglected. Fechner explains that the outer psychophysics are only the approximation of sensory measurement, yet inner psychophysics are beyond physics and science, and reaches “to the mind’s interpretation of sensation” (Robinson, 2010, p. 425). So it can be understood from Fechner that the psychology of a person should not be ignored in the sensory evaluation of materials.

On the other hand, there is an emerging rise on developing computer vision systems measuring material qualities through images (Adelson, 2001; Sharan, Liu,

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[8] Whether systematic or not, psychophysical studies have been held for centuries, from Aristoteles, 350 BC, to Fechner, 1860 (Sekuler, 1965).

[9] For detailed information on signal detection theory, see Weber (1978) and Fechner (1966)

Rosenholtz, & Adelson, 2013). The major motivation for such studies is to generate objective and reproducible reports through computers. Sharan et al. (2013) admit that computational material recognition, the ability of discriminating or identifying materials, would be useful in many scenarios such as assisted driving and visual quality evaluation in production. Read (2015) points out that measuring material qualities through digital media is complementary[10] to human psychophysics studies.

About sensory dominance in product experiences, Schifferstein (2006, p. 42) explains that "the relative importance of the different modalities is likely to depend on the type of product and on the task performed". Audition can be regarded as the most important sensory modality in experiencing a sound, whereas gustation and olfaction are the most dominant sensory modalities in tasting. The explanation of Schifferstein (2006) is supported by the hypothesis of modality appropriateness, where the most suitable sensory modality overwhelms a particular perceptual experience (Welch & Warren, 1980). Another hypothesis about sensory dominance is the attentional sensation, where the attended sensory modality is dominant in a particular perceptual experience (Posner, Nissen, & Klein, 1976). The dominant sensory modality can be switched to another one if the attention is directed.

Although it can be emphasized that sensory dominances occur in perceptual experiences, user-product interactions require all kinds of sensory information (Baumgartner, Wiebel, & Gegenfurtner, 2013; Schifferstein H. N., Otten, Thoolen, & Hekkert, 2010; Krishna, 2010). The richer sensory interactions the user would have, the richer experience they will achieve.

Yanagisawa and Takatsuji (2015, p. 39) explain user-material sensory interactions with a surface texture example as follows:

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[10] Read (2015) also stresses that experimenting with animal subjects is another related area of research which contributes to human psychophysics research.

In order to design the surface texture of a product, a designer needs to grasp the relationship between the surface's physical attributes, as design parameters, and the customer's psychological response to the surface. This response could be described as how the costumer or user perceives the quality of a product's surface in relation to the particular sensory modality by which the user interacts with the product.

Understanding both single-sense and multisensory interactions with materials would be beneficial in designing sensory experiences. However, the nature of sensory experience is qualitative; and objective sensory measurements may not adequately explain it (Gardner & Johnson, 2013a). Gardner and Johnson (2013a; p. 455) explain the problematic nature of sensory experience as;

> … we receive electromagnetic waves of different frequencies, but we see them as colors. We receive pressure waves from objects vibrating at different frequencies, but we hear sounds, words, and music. We encounter chemical compounds floating in the air or water, but we experience them as smells and tastes. Colors, tones, smells, and tastes are mental creations constructed by the brain out of sensory experience. They do not exist as such outside the brain.

It can be inferred from the passage that sensory input is transformed into sensory experience through the processing of the brain. To understand the aspects of sensory experience, it would be useful to review how basic senses work solely and how they collaborate in generating sensory experiences through both objective and subjective perspectives.

2.8.1 Vision

Vision is one of the most dominant sensory modalities in discriminating materials and perceiving visual qualities. A certain amount of visual stimuli is needed for sensing through the eyes. In technical terms, "for human vision it is the electromagnetic radiation in a one-octave wide band centered on a wavelength around 550 nm" (Westheimer, 2008, p. 1).

Visual perception of a material requires perceiving and recognizing physical properties of a material through visual stimuli and when stimuli (light rays) reach the viewer's retina after hitting the surface of a material, a retinal image forms and neural processing occurs afterwards (Komatsu & Goda, 2018). Retinal image is the two dimensional projection of a real world object that is viewed (Anderson, 2011). Processing of retinal image is crucial for visual analysis. Anderson (2011) emphasizes that visual analysis consists of three levels of visual processes, which are low-level, mid-level and high-level vision. Low-level vision measures the retinal images, and provides only a small amount of information about environmental aspects, mid-level vision interprets and transforms measurement of retinal image into a representation (such as a surface or a material) in a compatible way, and high-level vision merges the outputs from other levels, and is concerned with complex processes such as object recognition, spatial relationships and attentional features (Anderson, 2011).

According to Komatsu and Goda (2018), three main factors influence light rays and these factors are illumination environment (direct or indirect), object shape and optical properties. Light rays either hit the material directly (by the light source), or indirectly (by reflecting from another object), optical properties enable the material to absorb some portion and reflect remaining light and the shape of the material scatters the light. With the influence of these three factors, a retinal image occurs by the light rays that reach to the retina. Figure 2.7 represents the forming process of retinal image.

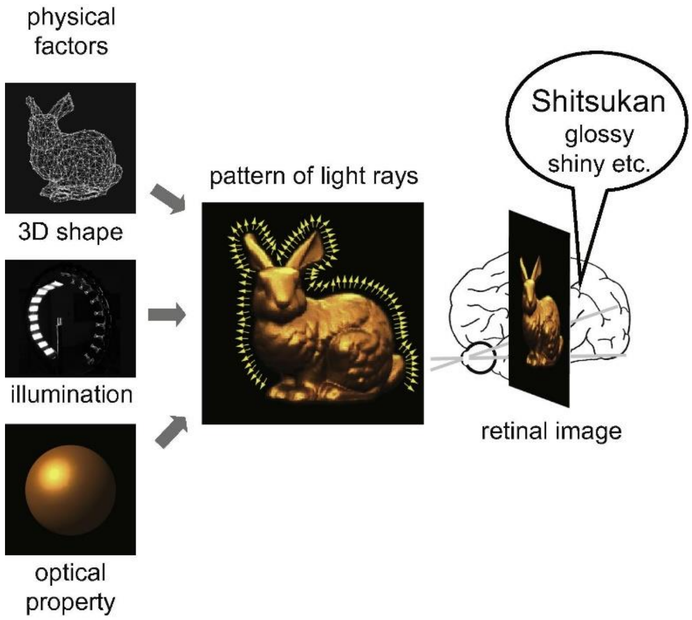

Figure 2.7. Physical factors influencing the forming of retinal image (Komatsu & Goda, 2018, p. 331). The term Shitsukan refers to *the sense of quality* in Japanese

Recognition of material properties and material categorization through vision is a very rapid process. Sharan, Rosenholtz, and Adelson (2009) point out that human visual categorization processes in less than 40 miliseconds. Moreover, visual features play main role in the recognition of materials in daily life compared to non-visual features (Nagai, et al., 2015). Visually inferred material qualities are regarded as the surface qualities such as roughness, glossiness, lightness, colour and opacity.

Fleming (2014) emphasizes that other than recognizing and categorizing materials, we also form material impressions through its properties. Without touching a surface, we can still feel how it feels like when touched by simply viewing that surface. According to Fleming (2014), visual impressions also help the viewer in perceiving an unfamiliar material. Investigating the visual properties of material appearances is a complex process as measuring is affected by many variables (Chadwick & Kentridge, 2015; Komatsu & Goda, 2018; Leloup, Pointer, Dutré, & Hanselaer, 2010). Even still the factors that influence visual perception of surface properties (such as roughness) often remain unrevealed.

The texture properties of a material can be defined when the surface of that material is illuminated and the patterns of the surface are statistically approximated (Padilla, Drbohlav, Green, Spence, & Chantler, 2008). Thus we can relate a material surface with another. According to Fleming (2014) vision is responsible for the categorization and discrimination of materials. Our subjective experience enables us to classify materials at a glance. Studies suggest that the estimation of material classes has strong correlations with the representations of different material classes on mind (Fleming, Wiebel, & Gegenfurtner, 2013; Goda, Tachibana, Okazawa, & Komatsu, 2014; Hiramatsu & Fujita, 2015; Komatsu & Goda, 2018). In their experiment with 130 material images from 10 material classes and nine observers, Fleming, et al. (2013) found out that the subjects successfully categorized materials through vision; even the unknown materials were expressed with their similarity to a material quality in the same material class that the observers had previously experienced. Also, even without a tactile interaction with a material, we can still generate ideas about tactile surface qualities such as hardness, roughness or stickiness (Fleming, 2014).

Leloup, et al. (2010) suggest that color, gloss, texture and translucency are four areas to be researched in vision studies. Color is a material quality that is an essential aspect for vision. Hue (the description of the color to discriminate from others, such as green, yellow or blue), lightness (used for discriminating dark color from a light color) and saturation (the intensity of the color) are regarded as the features of color related to the appearance (Gordon, Abramov, & Chan, 1994; Stuart, Barsdell, & Day, 2014). The appearance of colors are identified through these features. Furthermore, color order systems[11] were developed to describe colors (Gordon, et al.,1994).

The estimation of a material's perceived color is a challenging process as many elements (such as material qualities, light spectrum and the orientation of light) affect

[11] Some color order systems are CIE, Munsell and NCS. Further and detailed information regarding colour systems can be found in Akbay (2013).

the way the stimuli reach the eyes of the observer (Boyaci, Doerschner, & Maloney, 2004; Brainard & Maloney, 2004; Maloney & Brainard, 2010). As Brainard and Maloney (2004) stress, traditional research areas covered the relationships between color and illumination constancy through flat shaped samples, yet contemporarily, there is an increasing interest over investigating color through three dimensional shapes in real world situations (Wichmann, Sharpe, & Gegenfurtner, 2002; Yoonessi & Zaidi, 2010). Further, Tanaka and Horiuchi (2015) state that two methods are adopted in recent studies in investigating vision; using real materials and using images of materials. According to Tanaka and Horiuchi, perceiving qualities decrease in material images and representations without color compared to perceiving through physical materials. Richer data can be provided in studies with real materials.

Yoonessi & Zaidi (2010) investigated material color changes in real life settings over 26 materials (including woods, rocks and some natural materials such as banana and leaf). The color changes over specific situations (such as decaying, drying and rusting) were compared, and it was found out that human recognition over color changes plays a critical role over classifying and identifying material surfaces (Yoonessi & Zaidi, 2010). Similarly, Wichmann, et al. (2002) found out that color is a member of memory representation, and humans identify material properties better with color.

Other areas of contemporary vision research include investigating color through image data and exploring the function of color through material qualities rather than the spectra (Ling & Hurlbert, 2004; Wiebel, Valsecchi, & Gegenfurtner, 2013; Yang & Maloney, 2001; Zaidi, 2011). Image data is the visual representation of the material, not the physical sample itself. The images can be a photograph of a real material, or a digital rendering of that material. Wiebel, et al. (2013) found out that color is used as a useful predictor for discrimination of objects; and chromatic information is more important in identifying materials rather than objects.

Reflectance, luminance and transparency are critical aspects in visual perception of materials[12]. Reflectance properties (such as gloss and lightness) are used to discriminate materials. Reflectance estimation of a material is a learned knowledge through everyday situations, and unnatural conditions (such as lighting from behind or below) cause problems in perceiving reflectance (Fleming, Dror, & Adelson, 2003). Gloss, physically, is an optical property that "results from directionally selective light scattering at the front surface of a material" (Leloup et al., 2010; p. 2046). In simple terms, gloss is the capability of light reflection of a surface. Physical gloss (measured with glossmeter) and perceived gloss are two different processes. Leloup et al. (2010) found out that illumination of the material's environment affects perception of gloss. Additionally, highlights (specular reflections) are affectual in the discrimination of material surfaces. Surfaces with more highlights were discriminated faster and more accurately compared to surfaces with less highlights in the study of Sakai, Meiji and Abe (2015).

Lightness and brightness, are often regarded as synonymous when illumination is uniform, yet they can be discriminated when different illumination types are available (Kingdom, 2011; Sharan, Li, Motoyoshi, Nishida, & Adelson, 2008). Kingdom (2011) defines lightness as "the perceived reflectance of a material surface" (p. 653) and brightness as "the perceptual correlate of perceived luminance" (p. 655).

The perception of transparency has strong relationships with the luminance of the material and the background of the viewing direction. As the luminance decreases, the perception of transparency diminishes (Singh & Anderson, 2002). The distortion field also affects the perception of transparency. The perceived distortions on a textured background through the refraction index of a material are heuristically

[12] For a collection of studies on the perception of reflectance, illumination and transparency, see Gilchrist (1994).

calculated by the brain in evaluating the transparency of that material (Fleming, Jäkel, & Maloney, 2011).

Developments in computer graphics enabled us to notice that we make errors in evaluating brightness and lightness while producing realistic digital representations (Kingdom, 2011). For this, Kingdom (2011) admits that we need a better understanding of illumination, reflectance and transparency, which are regarded as important layers in decomposing an image. These layers are formed by sub-level physical factors, such as ambient level and non-uniform illumination (i.e. shadows and spotlights) are the physical dimensions of illumination, whereas transmittance, reflectance, dispersion and specular reflection are the physical dimensions of transparency (Kingdom, 2011). A framework for physical dimensions of achromatic visual experience can be seen in Figure 2.8.

In daily activities, materials are visually experienced under different viewing conditions. Changes in viewing conditions such as illumination, object shape and viewing angle affect the perception of materials, and our minds make it possible to achieve perceptual stability (material constancy) under different conditions (Tsuda, Fujimichi, Yokoyama, & Saiki, 2020). Thus, we are able to recognize materials properly. Tsuda et al. (2020) emphasize that everytime a material is perceived, a comparison is made with the previously perceived version of that material through a memorizing process, namely visual working memory. Visual working memory allows visual information to be actively extended over time in the absence of sensory input (Chun, 2011, p. 1407). However, the capacity[13] of visual working memory is limited to a number of features. According to Luck and Vogel (1997), the capacity of visual working memory is limited to any four features (e.g. shape, colour, surface quality, etc.). Chun (2011) emphasizes that visual working memory is highly related

[13] The capacity of short term mental storage is also measured through contexts other than vision and the results vary. For an extensive review on short term mental storage capacity, see (Cowan, 2000).

with attention, and can be regarded as a bridge between perceptual and cognitive processes.

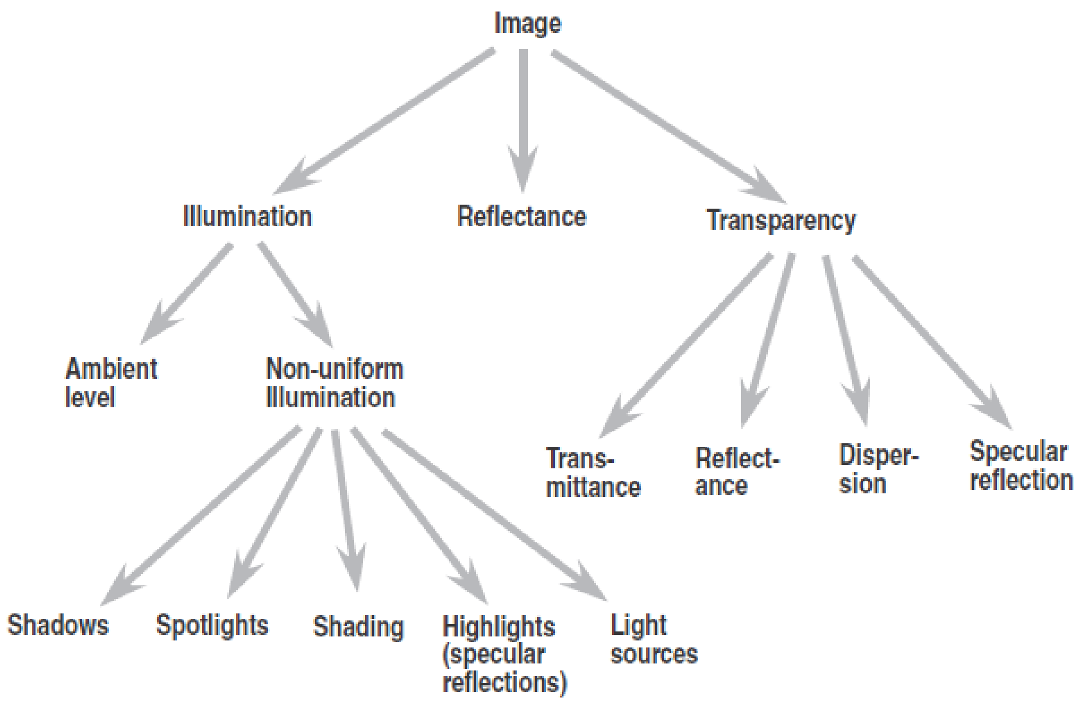

Figure 2.8. Physical dimensions of achromatic experience (Kingdom, 2011; p. 653)

Alongside the studies that investigate physical aspects of vision, psychophysical studies are also available in the literature (Fenko, Schifferstein, & Hekkert, 2010; Ling & Hurlbert, 2004; Wastiels, Schifferstein, Heylighen, & Wouters, 2012; Wastiels, Schifferstein, Wouters, & Heylighen, 2013; Wright, 1962). Psychophysical studies contain one or several dimensions of which correlations with vision are investigated. Generally, a physical property is represented as a visual stimulation, and the subjective expressions are elicited and analyzed. Fenko, et al. (2010) investigated if visual perception affects the feeling of warmth. It was found out that both vision and haptics contribute equally in experiencing warmth. Ling and Hurlbert (2004) found correlations between color and perceived size, yet the effects were not clear to predict. Wright (1962) investigated the relationships between color and warmth and weight, and found out that white is perceived cooler than black. Again in another study, the relationship between color and warmth was investigated, and Wastiels, et al. (2012) found out that color and roughness have no correlations in between; yet color affects the perception of warmth more than roughness.

2.8.2 Haptics

All sensory interactions through touching[14] are accepted as haptics. If our body contacts with another object, it is the act of touching (Kaas, 2008). Our body is covered with skin that is capable of transmitting somatosensory stimuli to the brain. Kaas (2008, p. xxxiii) explains the sensing through touch as "contact deforms the skin in ways that convey information to the brain about the identity of external entities; their size, shape, compliance, texture, and temperature". Touching is not an action specified to hands or fingers, however some parts of the body are more sensitive in tactile perceptions such as fingertips (Ackerley, Saar, McGlone, and Backlund Wasling, 2014; Rice & Albrecht, 2008).

Gardner and Johnson (2013b) explain that the factors that stimulate tactile sensation could be a mechanical force, a heat exchange or a chemical effect; or a combination of these. Two general methods are preferred to measure tactile perception, which are active and passive touch experiments (Wongsriruksa et al., 2012; Gardner, 2010; Lederman, 1981). In active touch, the hand manipulates the object, and in passive touch, the object stimulates the skin. Lederman (1981) expresses that both active and passive touch experiments present similar results. According to the subject reports in their experimental study about perceived smoothness and roughness, Meenes and Zigler (1923) claimed that the rough-smooth dimension is realized with touch with motion, and the properties of pressure (unevenness) are identified by stable motion. Tiest (2010) underlines that roughness and slipperiness are surface properties, and

[14] Although kinesthetic and somesthetic sensing can be divided, they would be taken together under haptics in this thesis (Meilgaard, Civille, and Carr, 2016)

can be perceived without movement, yet compliance and coldness are bulk properties, and movement is required for perceiving them.

Discrimination of physical properties of materials and measuring affective sensations of perceived material properties are popular topics among scholars in tactile studies (Okamoto, Nagano, & Yamada, 2013). Pasqualotto, Ng, Tan and Kitada (2020) mention that two types of touch are enabled when touching materials, one is used for discriminating physical aspects of materials (discriminative touch) and the other is used to experience associated sensation (affective touch). Pasqualotto, et al. (2020) investigated the relationships between softness and pleasantness and the influence of compliance over affective sensation and found out that object compliance heavily influences pleasantness.

Okamoto, et al. (2013) reviewed 18 studies on dimensions of tactile perception and stated that softness, fine roughness, macro roughness, friction and warmness are the five major dimensions in perceiving tactile properties of materials. Roughness, compliance, coldness and slipperiness are regarded as dominant factors in tactile perception (Klatzky, Pawluk, and Peer, 2013; Tiest, 2010). Each factor is sensed in a particular way. Okamoto, et al. (2013) also emphasized that they were unable to find a study covering all five dimensions due to the complexity issues with sample selection.

In another study, the relations between the affective and sensory dimensions of tactile perception of materials are investigated and six dimensions are developed (Drewing, Weyeli, Celebi, & Kaya, 2018). These dimensions are fluidity, roughness, deformability, fibrousness, heaviness and granularity. Drewing, et al. (2018) also investigated whether the relations between developed dimensions are universal or depend on the learning background of the participants. They compared the evaluations of two different populations (one with more outdoor experience and the other with less outdoor experience) and found out that the results were quite similar. Drewing, et al. (2018) mention that the findings are based on a relatively small population and larger sample sets should be used for more reliable results.

One of the most frequently used dimensions, physical roughness, “refers to height differences that occur in the profile of a surface”, and roughness perception is affected by various elements such as friction and pressure (Wongsriruksa, et al., 2012, p. 238). In rough surfaces, the distribution of pressure is irregular on the skin during a static contact, and vibration occurs between the skin and the surface when the interaction is dynamic (Tiest, 2010, p. 2775). Human skin is very sensitive in perceiving surface roughness. Even “vibrations as weak as 1 μm in amplitude” can be tactually sensed (Gardner, 2010, p. 4). Moreover, if the spatial difference between dots on a surface is below 200 μm, that surface is accepted as fine; and if difference is above 200 μm, the surface is regarded as coarse (Hollins & Bensmaïa, 2007). Perceived roughness has a strong correlation with the geometry of the surface elements. An interesting finding shows that if the distance between contiguous dots on the surface is larger than 2-3 millimeters, the roughness perception starts to decrease (Klatzky, Lederman, Hamilton, Grindley, & Swendsen, 2013).

In their investigation about the relationship between roughness and pleasantness dimensions, Etzi, Spence, and Gallace (2014) found out that soft materials are regarded as pleasant, and roughness refers to unpleasant. Etzi, et al. (2014) also compared the tactile sensation of the forearm and the hand. Findings showed that the perception of pleasure increased on the forearm compared to the hand. The difference may have been caused by the type of sensory receptors located on different body areas.

Compliance is the flexibility of the material, and can be defined through elastic modulus (Wongsriruksa, et al, 2012, p.239). According to Tiest (2010), stiffness is another way of identifying compliance. The pressure distribution on skin is the major influencer on the perception of compliance, yet how pressure distribution affects perception of compliance is still unrevealed (Tiest, 2010).

Slipperiness is simply regarded as “the feeling of grip” or, in other words, the gliding quality of a surface (Schreiner, Rechberger, and Bertling, 2013, p. 27). Schreiner et al. (2013) found that the friction value of the surface has no influence on perceived slipperiness. Rather, skin properties (such as moisture and the aging factors), play the major role in perceived slipperiness. Grierson and Carnahan (2006) found out that the perception of slipperiness is more accurate when the touching skin is in motion during the interaction.

Coldness is identified as “thermal sensation of lack of heat” (Meilgaard, Civille, & Carr, 2016, p. 248). Tiest (2010) claims that tactile coldness depends on the heat exchange capabilities of a material under room temperature, not the temperature of the material itself. If the heat extracts from hand to the material, the material is perceived as cold. A material’s heat capacity increases as it gets thicker, so if a material gets thicker, it will be perceived colder at room temperature; yet the effects are reversed at 40°C (Tiest, 2010).

According to Klatzky and Metzger (1985), haptic identification of materials is a very fast and accurate way (especially in identifying familiar materials), and global shape and texture are the dominant variables in identifying materials. An adept rug dealer can evaluate the quality of the fabric by just touching the product surface (Katz, 1989). His previous experience on such surfaces allows him to recognize materials through memory.

Other introspective and psychological studies about tactile perception are also available in the literature (Chen, Shao, Barnes, Childs, & Henson, 2009; Meenes & Zigler, 1923; Neumann, Müller, Falk, & Schmitt, 2016; Zampini, Mawhinney, & Spence, 2006). Chen, et al. (2009) state that touch perception has correlations with more than one physical attribute. In their study, Chen, et al. (2009) tested 37 surface textures with 18 subjects through their respective expressions with the semantic differential scale. Findings revealed various correlations amongst dimensions, such as warmth perception correlated with softness, and dryness correlated with roughness. Okamoto, et al. (2013) underlined that psychological experiments are limited, mostly due to the insufficient number of chosen adjective labels, and the inadequate number of material samples.

2.8.3 Audition

Audition is the sensory modality to hear the mechanical vibrations as sounds. The ear takes the major role in both collecting and processing the sounds around. Processing of sound[15] is a highly complex process, as sound is captured from air to the fluid in the ear, then converted to electrical signals as inputs for brain (Dallos & Oertel, 2008; Oertel & Doupe, 2013). As sound processing is a sensitive process, Oertel and Doupe (2013) point out that the auditory system can detect time differences even as small as 10 μs. Yost (2008) stresses that humans can hear sounds in the frequency range between 20 Hz to 20000 Hz, and hearing is most sensitive to the frequency values between 1-4 kHz (Hudspeth, 2013). Moreover, Hudspeth (2013) admits that humans can tolerate 120 dB at loudest.

Recognition of material sounds rely on elasticity, density, dimensional qualities (such as shape and size), and the coefficient of material friction (acoustic damping), which is unique to each material (Klatzky, Pai, & Krotkov, 2000; Lemaitre, Grimault, & Suied, 2018). Elasticity[16] influences the sound properties of a material as it affects the speed of sound in a material, and frequency decreases with elasticity (Klatzky, et al., 2000). Further, Klatzky, et al. (2000) point out that acoustic damping is related to sound decay over time and does not depend on the geometry of material.

In four different auditory experiments over 300 sound pairs, Klatzky, et al. (2000) found that decay is more affective than frequency in material classification through sound (n=50). In identifying artificial non-material sounds, the decay parameter was the primary predictor amongst all four materials (rubber, wood, glass and steel) used in the study, and labeling a sound as *glass* or *rubber* is highly correlated with

[15] An extensive review of the auditory perception literature can be seen in Watson (1996).
[16] While also regarded as stiffness, elasticity is defined through Poisson's ratio or Young's modulus for isotrophic linear materials (Klatzky et al., 2000, p. 400).

frequency, as labeling of *glass* increases with *frequency* and labeling of *rubber* decreases with *frequency* (Klatzky, et al., 2000).

As sound is characterized through physical frequency, physical intensity and temporal properties, the processing of frequency and perception of pitch are the crucial expository features of sound (Lemaitre, et al., 2018; Yost, 2008). Pitch is not a feature that is carried by the sound; it is the subjective attribute of perceiving of sound. Lemaitre, et al. (2018) emphasize that sounds we encounter in our daily lives can be classified broadly as periodic sounds and non-periodic sounds. Periodic sounds (such as speech, musical instruments and products with rotating sections) are repetitive and create pitch perception, yet non-periodic sounds (such as clashing sound of two materials, falling sound of a tree) do not create pitch perception and random non-periodic sounds are called *noisy* (Lemaitre, et al., 2018). In addition to that, Hirsh and Watson (1996) emphasize that complex sounds are recognized as patterns, and patterns of patterns. An acoustic entity can be recognized by referring to a material or an object, yet many patterns of sounds are not identified with tangible objects (Hirsh & Watson, 1996).

Loudness and *timbre* are other subjective aspects of sound (Lemaitre, Grimault, & Suied, 2018; Yost, 2008). According to Yost (2008), loudness, as a magnitude measure, is the characteristic quality of vibration, and is used for the discrimination of sounds other than frequency. Timbre can be explained by overtone (sub or upper frequencies that are heard together with the main frequency) and is used for discriminating two sounds where they carry similar pitch qualities (Yost, 2008). As dimensions of timbre, high frequency sounds are perceived as *bright* or *sharp*, low frequency sounds are perceived as *dull*; and slow modulation (around 4 Hz) is perceived as *fluctuating* and fast modulation (around 70 Hz) is perceived as *rough* (Lemaitre, et al., 2018).

In an earlier study, Solomon (1959) investigated psychological dimensions of sounds through 20 different sonar recordings. Fifty different bipolar adjectives were ranked by 50 subjects to develop dimensions about sound perception. Seven dimensions of sound were generated through factor analysis. Each dimension consisted of five bipolar adjectives depending on their loading scores. These dimensions are *magnitude*, *aesthetic-evaluative*, *clarity*, *security*, *relaxation*, *familiarity* and *mood*. Table 2.6 represents these dimensions with adjectives

Table 2.6 Psychological dimensions of sound (Adapted from Solomon, 1959, p. 493)

Factor I	**Factor II**	**Factor III**	**Factor IV**
heavy-light	beautiful-ugly	clear-hazy	mild-intense
large-small	pleasant-unpleasant	definite-uncertain	gentle-violent
rumbling-whining	good-bad	even-uneven	calming-exciting
wide-narrow	pleasing-annoying	concentrated-diffuse	safe-dangerous
low-high	smooth-rough	obvious-subtle	simple-complex
Factor V	**Factor VI**	**Factor VII**	
relaxed-tense	definite-uncertain	colorful-colorless	
loose-tight	familiar-strange	rich-thin	
soft-hard	wet-dry	happy-sad	
gentle-violent	active-passive	deliberate-careless	
mild-intense	steady-fluttering	full-empty	

Pleasantness and *power factors* (such as powerful, weak) are regarded as the significant elements in defining semantic qualities of product sounds (Bisping, 1997; Kleiner, & Gärling, 2002; Özcan & van Egmond, 2012; Västfjäll, Kleiner, & Gärling, 2003; Västfjäll, Gulbol). Västfjäll, et al. (2002) found out that liking (*pleasantness*) decreases as *loudness* increases in the evaluation of vehicle interior sounds. Similarly, a total of 30 passenger car power window systems were investigated through 70 participant evaluations, and findings show that *annoyance* increases when *intensity*, *pitch* and/or *frequency* are high (Lim, 2001).

Özcan and van Egmond (2012) postulated a hierarchy between perceptual processes, and cognitive and emotional responses. The hierarchical structure of basic product sound semantics can be seen in Figure 2.9. Furthermore, Özcan and van Egmond found relationships between the sounds and the positive and negative emotions within five factors (*attention*, *roughness*, *familiarity*, *temporal constancy* and *smoothness*). Mechanical sounds were found to be perceived as *high pitch*, *sharp* and *fast*, and regarded as *unpleasant*; whereas *loud* was correlated with *powerful*. Moreover, Özcan and van Egmund (2012) emphasized that the implications of impact sounds over emotions are not significant as alarm or cyclic sounds, so further research needs to be carried out in order to investigate semantic associations of these types of sounds.

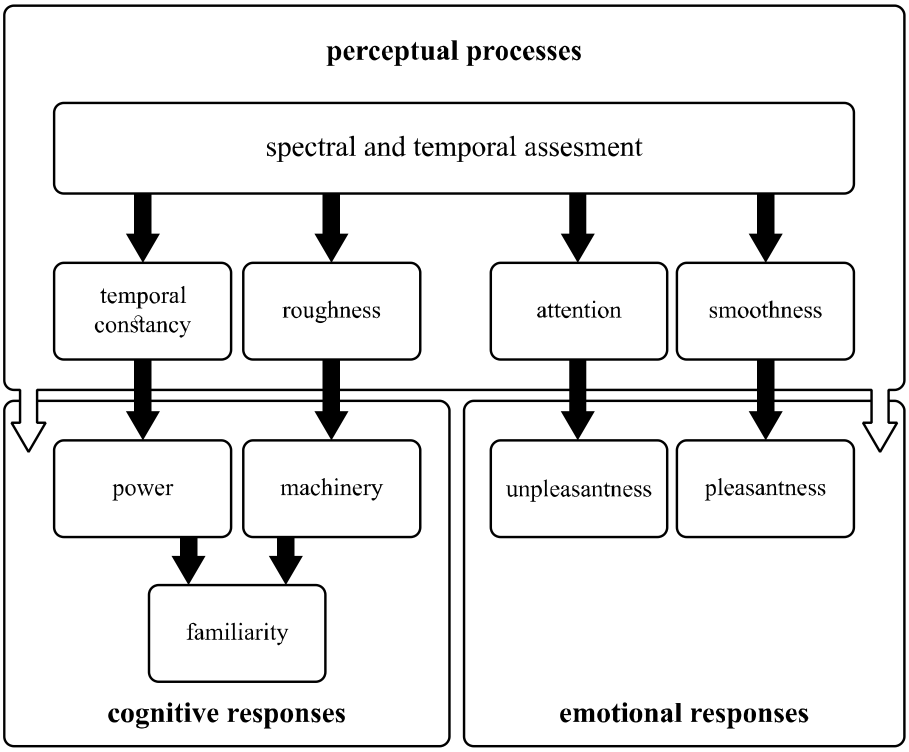

Figure 2.9. Hierarchical structure of basic product sound semantics (Adapted from Özcan and van Egmund, 2012; p. 51)

Haverkamp (2017) points out that three types of material sounds should be taken into consideration in assessing quality through auditory perception of products. These sound types are created by rubbing of two or more materials, intentionally knocking on materials with hand, and sliding the finger on the material surface. In his study on the auditory evaluation of nine different steering wheel materials with an artificial finger[17], Haverkamp (2017) found out that the perceived quality of a material on steering wheels is high when the sound *roughness* is low and *sharpness* is high.

Other than the automotive industry, specific product sounds were investigated throughout the literature, such as hand-held power tools (Horvat, Domitrović, & Jambrošić, 2012), air conditioners (Susini, McAdams, Winsberg, Perry, Vieillard, Rodet; 2004), refrigerators (Jeon, You, & Chang, 2007), electric toothbrushes (Zampini, Guest, & Spence, 2003), notebooks (Beltman, Doherty, Salskovc, Corriveauc, Gabela and Baugh; 2008), and vacuum cleaners, shaving machines and spray cans (Hülsmeier, Schell-Majoor, Rennies, & van de Par, 2014). Listening to pre-recorded product sounds is the most preferred procedure in the evaluation of auditory perception literature. Semantic Differential method (Osgood, Suci, & Tannenbaum, 1957) was preferred mostly in measuring meanings in perceptual qualities of sound.

Horvat, et al. (2012) studied 7 circular saws, 9 power drills and 11 jigsaws through 32 listeners' evaluations over the dimensions such as *pleasantness*, *safety*, *quality*, *proper functioning*, *desire to buy* and others. The sound of idling and stopping stages of each product were listened to separately by the participants, and the evaluation differences over these stages were measured. *Loudness*, *sharpness* and *amount of fluctuations* were the objective parameters of the sound samples, and as the sounds got *louder* the perception of *unpleasantness* and *danger* were evoked (Horvat, et al., 2012). No significant difference was noticed about the perception of *robustness* and *power* for the sample products.

Susini, et al. (2004) investigated motor and ventilator sound of various air conditioners and their perceptual qualities with 50 listeners. Susini et al. (2004) found out that *preference* decreases with the increase in *loudness*.

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[17] Artificial fingers are frequently used to capture material surface sounds in an objective way. In Haverkamp (2017), the artificial finger is made of steel with a leather tip (which mimics skin), weighs 140 grams (which mimics fingertip pressure) and is slided over material surfaces at a constant speed.

In another study, refrigerator sound quality characteristics were investigated in a real life setting of a Korean apartment (Jeon, You, & Chang, 2007). Jeon et al. (2007) used 24 adjective pairs in three factors as *booming* (*booming-dry, trembling-flat, etc.*), *metallic* (*stimulating-soft, sharp-dull, etc.*) and *discomforting* (*loud-quiet, irritating-not irritating, etc).* The objective parameters were chosen as loudness, sharpness, fluctuating strength, tonality and N10 (ten percent loudness). The findings revealed that the booming factor is correlated with tonality, the metallic factor is correlated with loudness and sharpness, and the discomforting factor is correlated with loudness and N10.

Beltman, et al. (2008) conducted a survey on the perceived quality of notebook sounds with 207 listeners and a strong correlation was found between *annoyance* and *loudness.* As the working sound (through components such as fan and hard disk) of a notebook gets *louder*, it is perceived as more *annoying*.

A similar result was found in a study about the sound of electric toothbrushes, where perceived roughness and pleasantness has a relationship with the intensity and the frequency spectrum of the products (Zampini, et al., 2003). According to the participant judgements, increase in loudness created unpleasantness during the use of electric toothbrushes.

Vacuum cleaners, shaving machines and spray cans were investigated based on their sound qualities, and findings show that high quality perception is correlated with *stationary* sounds rather than *spluttering* sounds for sprays, *powerful* and *functional* sounds for vacuum cleaners, and *precise* and *fast* sounds for shavers (Hülsmeier, et al., 2014).

Although it may be inferred from above that the increase in *loudness* always creates *unpleasantness*, some examples may result as the opposite (Keiper, 1999). Froman (1953; cited in Zampini, et al., 2003, p. 932) illustrates an example of the marketing failure of a food mixer that was not working *loud* enough and therefore perceived as *not powerful enough*. *Silentness,* in some cases, might not be the proper aspect for auditory perception. So it can be inferred that auditory perception is context specific, and may change in different contexts. +In their explorative study about the sound of rolling office chairs, Dal Palù, Lerma, Actis Grosso, Shtrepi, Gasparini, De Giorgi and Astolfi (2018) recorded the rolling sounds of the wheels of a high quality chair and a low quality chair on different floor materials, which were PVC, ceramic and wood. Recorded sounds were evaluated through 26 adjectives. Although rolling sounds of wheels were perceived differently as *smooth* on wood, *rough* on ceramic and *dull* on PVC, no significant difference about sound perception was found between two different wheels (Dal Palù, et al., 2018).

Not only product sounds, but also food sounds are being investigated by some researchers (Chauvin, Younce, Carolyn, & Swanson, 2008; Endo, Ino, & Fujisaki, 2016; Vickers, 1983; Vickers & Wasserman, 1980, Zampini & Spence, 2010). An interesting study investigates biting and chewing sounds and seeks for correlations with perceived qualities (Vickers, 1983). Fifty-two subjects evaluated recorded biting and chewing sounds through 10 sound quality descriptors (such as *crackly*, *pitch*, *crisp* and *pleasant*), and *crispy*, *crunchy*, *crackly* and *brittle* were found to be most closely associated (although the relationship is weak) with *pleasantness* in 16 food types used in the study (Vickers, 1983). Recorded biting and chewing sounds of fresh turnip is also graded as the most *unpleasant* sound. Further, Zampini and Spence (2004) mention that *crispness* is positively correlated with *crunchiness* and negatively correlated with *cohesiveness*.

“An important task is to find what people perceive in the context of spatial features of different modes of reproduced sound” (Berg & Rumsey, 1999, p. 59). For introspective studies about auditory perception, Repertory Grid Technique (RGT; see Section 3.3) is used basically to explore subjective elicitations of participants (Berg & Rumsey, 1999; Choisel & Wickelmaier, 2006; Cunningham, 2010; Grill, Flexer, & Cunningham, 2011; Martens & Kim, 2007; Berg & Rumsey, 2006). In their study, Berg and Rumsey (1999) used RGT to explore subjective auditory evaluations about sound reproducing systems among 18 participants. Each participant was analyzed individually with simple inspection methods (grids were not compared through advanced statistical methods), and *authenticity/naturalness*, *lateral positioning/source size, envelopment* and *depth* were found as common elicited constructs among participants in the study. In another study with RGT, Grill, Flexer and Cunningham (2011) experimented 20 textural sounds with 16 participants and identified 10 major bipolar constructs. *Natural/artifcial*, *high/low*, *smooth/coarse*, *tonal/noisy* and *static/dynamic* are some of the constructs discovered in the study. RGT is preferred mostly in eliciting individual expressions about chosen sounds in auditory perception studies (Francombe, Mason, Dewhirst, & Bech, 2014).

Acoustical profiling is a method used for identifying sound qualities of a product from a selection of word descriptors (Lyon, 2003). In his study about acoustical profiling of vacuum cleaners and washing machines, Lyon (2003) used 62 words as a library of sound descriptors, and 15 sound experts (including musicians and psychoacousticians) evaluated product sounds depending on these descriptors. Lyon (2003) focused on a specific sound on a product and created sound metrics of that sound to be profiled by experts. A schematical representation of Lyon's method can be seen in Figure 2.10.

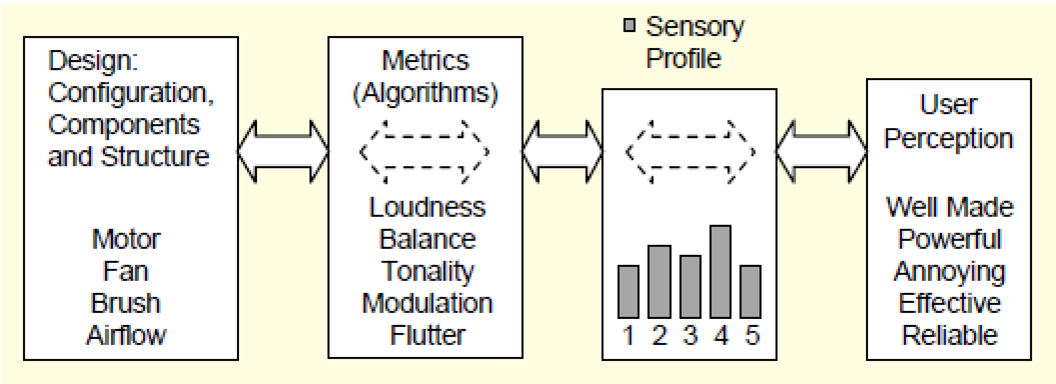

Figure 2.10. Transition process from design to perception (Lyon, 2003, p. 22)

As can be seen from the literature of auditory evaluation, the majority of product sound research focuses on working or processing component sounds of products (such as vacuuming sounds of vacuum cleaners, cutting sounds of shavers, engine sounds of automobiles) and these sounds are not directly linked to the material of the product. To evaluate sound perception, various sounds of products are recorded and measured with objective parameters, and then compared with listeners' subjective judgements through various methods. Some of the sound evaluation methods are method of adjustment (listener controls the stimuli), method of tracking (listener controls the direction of the stimuli), magnitude estimation (assigning numbers to the perceived magnitude), yes-no procedure (deciding on the presence of a signal), two-interval forced choice (deciding in which interval the signal is), adaptive procedures (adaptation to increases and decreases) and comparison of stimulus pairs (Fastl & Zwicker, 2007, pp. 8-10).

In most cases, the sound qualities of materials (other than mechanical or cyclic sounds) are neglected as they are difficult to measure or record. For example, it would be easier for a researcher to record the engine sound of a vacuum cleaner than record the contact sound of the vacuuming part when it meets the floor during vacuuming. Both engine and contact sounds contribute to the overall auditory experience of the vacuum cleaner, so investigating real life auditory interactions would be more appropriate in the auditory evaluation of product materials even though it is a complex process.

2.8.4 Olfaction

Experiencing of an odor starts after odorant molecules are detected by olfactory sensory neurons in the nose, then transduced and refined in the olfactory bulb as signals and processed in the olfactory cortex (Buck & Bargmann, 2013; Engen, 1982; Touhara, 2008). According to Engen (1982) flow rate of the inhaling is a crucial factor in perceiving odors, and it is estimated that between 5-10% of the air in normal breathing reaches to the olfactory epithelium to get detected, as the amount can raise no more than 20% in higher flow rates. The percentage of olfactory detection is low as most of the odorant molecules stick to the walls of nasal cavity when breathing.

The human olfactory system is capable of detecting more than 10000 odorants, and olfactory specialists (such as highly trained perfume experts) are capable of discriminating more than 5000 type of odorants (Buck & Bargmann, 2013). Each odorant has a specific and unique structure at the molecular level. According to Touhara (2008, p. 527) “The receptor theory postulates that there are receptor sites for odorants and that odor perception occurs only when the structure of an odorant molecule and the binding site match”. Metaphorically, the matching of the odorant molecule and the binding site is like putting puzzle parts in pieces where they fit. Figure 2.11 represents the schematical view of binding process of odor molecules.

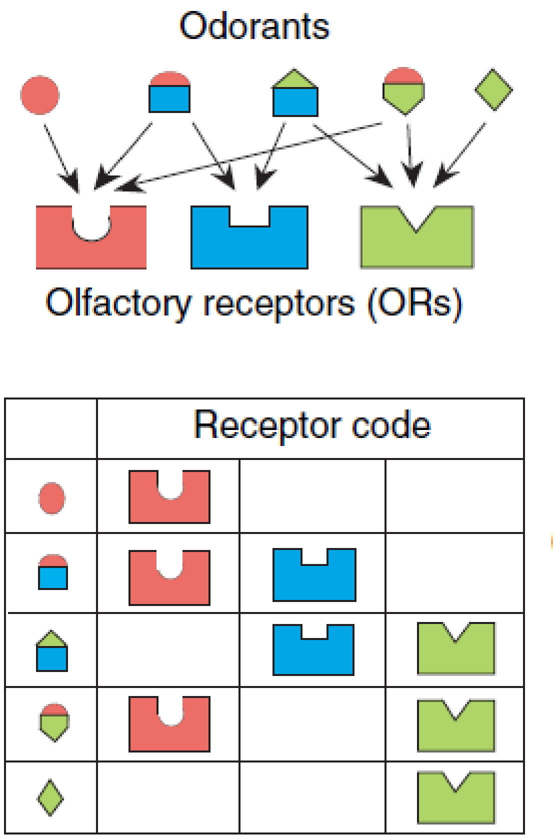

Figure 2.11. Combination of a receptor code for an odorant (Touhara, 2008, p. 536)

Compared to receptor numbers of other type of sensory modalities, olfactory perception requires huge numbers of receptors due to the vast number of chemical odour molecule types (Axel, 2005). In color perception, wavelength is the only stimulation, and in hearing, frequency is the sole variable so not as many receptors as in olfaction are required for perception in those sensory modalities (Johnson, Khan, & Sobel, 2008; Axel, 2005). Johnson, et al. (2008) represent olfactory perception in three phases as detection, discrimination and identification. The hierarchical relationships between these three phases vary: an olfactory detection may occur without discrimination and identification, or olfactory discrimination can be done without identificiation (Johnson, et al., 2008, p. 825).

Olfactory identification requires detection, and once the olfactory percept matches with the olfactory memory, then it can be semantically labeled by the perceiver (Johnson, et al., 2008). In contrast with the other chemical sense, gustation (in which the evoking emotions of pleasure and disgust towards taste is encoded in the brain from birth and therefore not learned), odour images in olfactory perception are mostly learned (Shepherd, 2006). As Shepherd (2006) states, odour images represent odour molecules that interact with olfactory receptors.

Humans are capable of perceiving thousands of different odors through olfactory systems (Doty, 2015; Axel, 2005). Dealing with a large number of odour types and categories is highly complex in nature, and the many attempts of psychological olfactory research focused on investigating odours by degrading them in a few simple dimensions (Beauchamp & Bartoshuk, 1997). Oversimplifying of odor categorization may bring problems within. Many odour systems[18] such as Linnaeus, Henning, Zwaardemaker, Crocker and Henderson, and Amoore Table 2.7), have been proposed yet none of them was found satisfactory to meet the expectations of various fields (Batty, 2010b). According to Lawless (1997) combinations of odour chemicals are learned through pattern categorizations, and these categorizations differ in various fields of expertise, such as winetasters and perfume experts. As an example, *balsamic odours* carry *wooden notes* and *vanilic smells* in perfumes, and also some wines may carry *vanilla related notes*; although the *vanilic smells* are directly related to both fields of expertise, an association of *smells like wood* does not make sense when tasting wines. Lawless (1997) also admits that olfactory

[18] For a detailed review of odour systems, please see Harper, Bate-Smith, & Land (1968).

perception is directly related to emotional responses, which shape reactions against odours. So it can be said that the categorization of odours is highly context or background (such as expertise, personality) specific.

Table 2.7 Universal odour system proposals (Shepard, 2016, pp. 76-79)

Linnaeus (1765)	**Henning (1924)**	**Zwaardemaker (1925)**	**Crocker and Henderson (1927)**	**Amoore (1970)**
Aromatic	Flowery	Ethereal	Fragrant	Ethereal
Fragrant	Fruity	Aromatic	Acid	Camphorous
Ambrosial	Putrid	Balsamic	Burnt	Musky
Alliaceous	Spicy	Amber-musk	Caprylic	Floral
Goat-like	Burnt	Alliaceous		Minty
Foul	Resinous	Empryeumatic		Pungent
Nauseating		Hircine		Putrid
		Repulsive		
		Nauseous		

As a perfumer, Thiboud (1991/1994) has established objective and subjective adjectives in odour classification. If an odour can be referred to with adjectives well known by everyone, these adjectives are accepted as objective, and subjective adjectives are divided into categories as subjective quality (such as fresh, woody, clear and clean), subjective ambience (such as young, feminine and sporty) and subjective functional (such as refreshing, calming and stimulating) (Thiboud, 1991/1994, p. 255). Thiboud also underlines that subjective adjectives are elicited through perfumer’s experiences about odours, and the creation of a perfume can be associated with many concepts such as forms (i.e. round, square) and music (i.e. dull, stringent). As a specific context of the perfumer’s perspective, it can be seen that a vast number of odour elements and their combinations can be used to create olfactory experiences.

Batty (2010a) emphasises that olfaction solely remains incapable in representing a particular object in daily life. Instead, olfaction is informative and relates to spatial odour awareness, as detecting if an odour exists at a certain space (Batty, 2010a). Localizing odor sources through olfaction is a highly developed sensory capability of animals. There is a belief that humans can also localize odors by smelling in a very limited fashion, and this can be achieved within laboratory conditions (Batty, 2010b). Yet, this belief has been proven wrong by recent scientific findings, stating that primates (including humans) also have a good sense of smell like other animals (Bisulco & Slotnick, 2003; Laska, Seibt, & Weber, 2000; Shepherd, 2004). Shepherd (2004) underlines that compared to rats, the human olfactory system is superior in perceiving food (i.e. fruits, plants) and floral (i.e. floral scents, perfumes) odours and weaker in survival (i.e. predator, prey) and social (i.e. territory, mating) odours. Humans have a highly sensitive olfactory system, as an olfactory odorant can be perceived as low as in the concentrations of 0.2 ppb (part per billion), which can be explained as three drops of odorant in an olympic swimming pool (Johnson, et al., 2008). One of the lowest measured tresholds for human olfactory perception is 0.77 ppt (part per trillion) with isoamyl perceptan (Nagata & Takeuchi, 1990). Tresholds for the human olfactory perception is represented in .

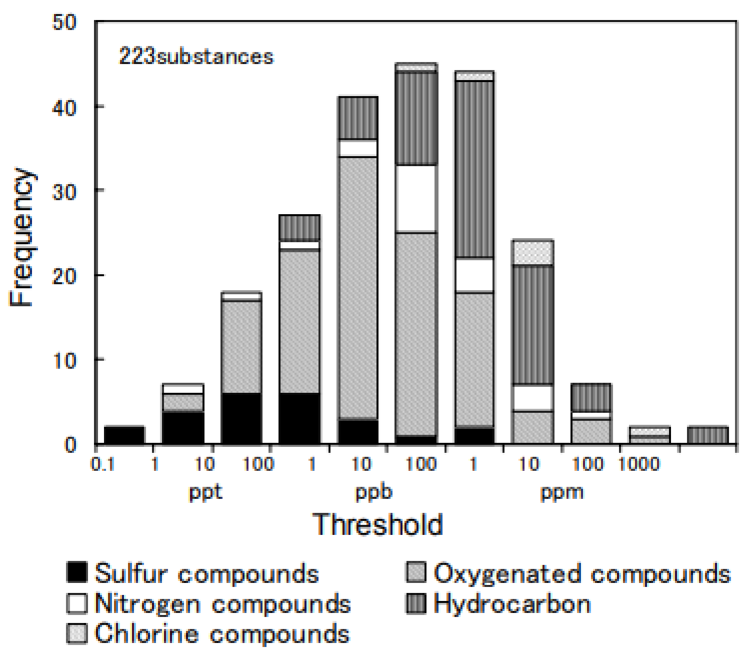

Figure 2.12. Distribution of perceivable olfactory tresholds for humans (Nagata & Takeuchi, 1990, p. 120)

Smell, odour and source are defined as concepts in approaching olfactory experience (Aasen, 2018; Batty, 2010b). Odour is defined as the group of molecules generated by the object, source is the object that gives odour off, and smell is an aspect in olfactory perception (Aasen, 2018).

Olfactory experience does not rely only on the chemical properties of the odor, but also depends on the pattern of olfactory stimuli (Batty, 2010b; Lawless, 1997). Being recognized as patterns, complex odour patterns can be degraded as single experiences (such as the *smell of coffee),* and an encounter with an undefined or uncategorized smell could be linked to a previous superordinate category as a subordinate category (such as *aromas of coffee - dark roasted*) (Lawless, 1997). On the other hand, concentration levels of chemical components cause variations in olfactory perception of odours such as high concentration of diphenyl menthane smells like oranges, and low levels of same substract smells like geranium (Batty, 2010b).

About perception based odour classification, Kaeppler and Mueller (2013) reviewed 28 studies, and found out four factors that influence the outcomes, which are individual differences, stimuli characteristics, approaches of data collection, and methods of data analysis. Individual differences depend on the perceptual ability, odour terminology and age of the subjects. Compared to non-professional subjects who tend to provide poor verbal labels about odours, experts provide more detailed and specific verbal definitions and their definitions are in aggreement with other experts (Kaeppler & Mueller, 2013; Lawless, 1997). According to Lawless (1997) people without proper training over odour classification will not discriminate odours well. In the food industry, describing olfactory differences is found to be arguably limited compared to other modalities as it is more difficult and complex because olfactory perception requires bigger thresholds of change in stumili (Lawless, 1997). On the other hand, Kaeppler and Mueller (2013) emphasize that memories about odours are recognized suddenly in a sensory interaction, and even when one is unable to express his perception (mostly untrained subjects), one can explain one's perception through gained experience (such as pleasant through a hedonic experience, relaxing through an effectual experience, and baking through an activity based experience). This frequently happens when the subject lacks verbal knowledge about odours. Free choice profiling (FCP) and flash profiling (FP) techniques are verbal based sensory profiling methods that do not require special training (Mattei & Montet, 2015, p. 1072). Subjects individually evaluate products presented to them with their own verbal expressions in both techniques.

The most famous method for sensory discrimination of odours is the triangle (or triadic) test (Doty, 2015; Wise, Olsson, & Cain, 2000; Lawless, 1997). In the triangle test, three odours are presented to subjects and they are asked which two of them are similar in between and different than the third. Lawless (1997) underlines that triangle odour tests are difficult in nature, especially when perceivers have to deal with multidimensional stimuli. Often, the dyadic (where two elements are compared) repertory grid procedure (Kelly, 1955/1963) is preferred when subjects have difficulties with the triangle test (McEwan & Colwill, 1988). As consumers compare products in their everday situations, the forced comparison approach of the repertory grid technique can be grasped easily in comparing odours, and in depth data can be reached by the interviewer. On the other hand, as a structured free choice profiling technique, the repertory grid procedure takes longer time than the usual unstructured free choice profiling procedures.

Various stimuli delivery methods are being used for olfactory detection tests such as olfactometers, sniffing jars (filled with odours), and assumed threshold model (Johnson et al., 2008). Sniff duration around 420 ms is found to be accurately high (90%) for the discrimination of different odours (Johnson et al., 2008). In the assumed threshold model, measurement of olfactory perception is mostly carried out through threshold detection, where olfactory stimuli gradually increases until perception occurs (Doty & Laing, 2015; Lawless, 1997). To specify thresholds, Doty and Laing (2015) mention that the ascending concentration test (combined with forced choice tests) and the staircase procedure[19] are the most common techniques, and threshold detection is used for discrimination of specific odours (through comparing) and component identification.

In any measurement type that depends on perceivers' reports, the olfactory adaptation of the perceiver should be considered. Olfactory adaptation can be explained as the linear decrease in olfactory perceiving threshold during constant stimulation (Johnson et al., 2008). The density of olfactory perception decreases at least by 30 percent after the moment of experiencing a scent (Mather, 2018). Adaptation can be used as an advantage, especially in the perception tests where different odours are used and need to be switched frequently.

Doty and Laing (2015, p. 233) point out that *strength*, *hedonics* (i.e. *pleasantness*) and *quality* are the psychological attributes of odours, and quality assesment of odours are found to be more stable and hedonics are more variable and idiosyncratic. Pleasantness is the primary dimension investigated in the literature of olfactory perception (Rouby & Bensafi, 2002). Rouby and Bensafi (2002) mention that pleasantness is related with the odour intensity, and high intensity of odours are perceived as unpleasant.

Another study investigates the relationships of *pleasantness*, *familiarity* and *intensity* of odours through molecular structures of the odorants (Keller & Vosshall, 2016). Keller and Vosshall found out that large and complex structures of odorants and molecules that have oxygen atom in their structure were perceived as more pleasant, yet odorants containing sulfur (which also has highest rank in perceived intensity), an acid or an amine group atom were perceived as less pleasant. Familarity was found as an important aspect in describing smells and subjects tended to label unfamiliar odours as chemical (Keller & Vosshall, 2016).

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[19] In the staircase procedure, olfactory stimuli ascends if the subject guesses the odour wrong and descends if the subject guesses the odour correctly. The average of reversals are taken as the threshold for the experiment (Lawless, 1997, p. 130).

In a semantic study about odours, 146 descriptors were obtained according to 150 subjects' semantic reports through 10 odorants (Dravnieks, 1982). Some of these semantic descriptors were *heavy, fragrant, aromatic, chemical, medicinal, warm, rubbery, metallic* and *sharp* (Dravnieks, 1982). The full list of semantic odour qualities are represented in Figure 2.8.

Table 2.8 Semantic odorr quality evaluation chart of Dravnieks
(Keller & Vosshall, 2004)

Materials	Chemicals	Outdoors	Fruits	Foods	Spices
dry, powdery	sharp, pungent, acid	hay	cherry, berry	buttery, fresh	almond
chalky	sour, acid, vinegar	grainy	strawberry	caramel	cinnamon
cork	ammonia	herbal, cut grass	peach	chocolate	vanilla
cardboard	camphor	crushed weed	pear	molasses	anise, licorice
wet paper	gasoline, solvent	crushed grass	pineapple	honey	clove
wet wool, wet dog	alcohol	woody, resinous	grapefruit	peanut butter	maple syrup
rubbery, new	kerosene	bark, birch	grape juice	soupy	dill
tar	household gas	musty, earthy, moldy	apple	beer	caraway
leather	chemical	cedarwood	cantaloupe	cheesy	minty, peppermint
rope	turpentine, pine oil	oakwood, cognac	orange	eggs, fresh	nut, walnut
metallic	varnish	rose	lemon	raisins	eucalyptus
burnt, smoky	paint	geranium leaves	banana	popcorn	malt
burnt paper	sulphidic	violets	coconut	fried chicken	yeast
burnt candle	soapy	lavender	fruity, citrus	bakery, fresh bread	black pepper
burnt rubber	medicinal	laurel leaves	fruity, other	coffee	tea leaves
burnt milk	disinfectant, carbolic				spicy
creosote	ether, anaesthetic				
sooty	cleaning fluid, carbona				
fresh tobacco smoke	mothballs				
stale tobacco smoke	nail polish remover				

Foul	Common	Common	Meats	Vegetables	Body
fermented, rotten fruit	sweet	sweaty	meat seasoning	fresh vegetables	dirty linen
sickening	fragrant	cool, cooling	animal	garlic, onion	sour milk
rancid	perfumery	light	fish	mushroom	sewer
putrid, foul, decayed	floral	heavy	kippery, smoked fish	raw cucumber	fecal, manure
dead animal	cologne	warm	blood, raw meat	raw potato	urine
mouse-like	aromatic		meat, cooked good	bean	cat urine
	musky		oily, fatty	green pepper	seminal, like sperm
	incense		sauerkraut		
	bitter		celery		
	stale		cooked vegetables		

Associations are used to learn and memorize odours (Keller & Vosshall, 2016; Herz, 2002). Herz (2002) points out that odours influence the mood of a person and evoke associations. Emphasizing that pleasant odours evoke positive moods, Herz (2002) also mentions that the familiarity (the frequency of encounter) of an odour plays a role in the type of association that evokes in odour perception. Experiencing the coffee odour frequently may evoke hedonic experiences (such as *pleasant, soothing* or *alerting*) instead of specific associations that are the result of a rare encounter (Herz, 2002, p. 163). Various methods can be adopted in order to assess odours.

Barwich (2014) emphasizes that four elements should be determined in order to measure olfactory perception. These elements are submodality, sensory content, process and units. Each measurement process follows different procedures. Olfactory measurement processes can be seen in

Table 2.9 Steps of olfactory perception measurement
(Adapted from Barwich, 2014, p. 264)

Submodality	**Expression**	**Perception**	**Units**
Threshold	Odor detection	Response	Concentration units
Intensity	Odor strength	Sensitivity, adjustment	Comparison
Persistence	Odor duration	Acclimation	Exposure time
Hedonic tone	i.e. pleasant-unpleasant	Attitude	Ranking
Character	i.e. sweet-bitter	Discrimination	Verbal descriptions

Odors can also be used to direct the focus of the perceiver to the visual object (Seo, Roidl, Müller, & Negoias, 2010). In their research, Seo et al. (2010) used eye tracking systems to investigate participants' attention changes in products with odors and without odors. Participants' selective attention (such as focusing for a longer time) were enhanced with olfactory priming compared to non-odor conditions (Seo et al., 2010).

Regarded as a lower sense for decades, the importance of olfaction is recently being recognized for many researchers. The potential of odours could be used not only for food and drink industries, but also in products to influence moods, draw attentions, evoke associations and create experiences for the users.

2.8.5 Gustation

Gustation is the other chemical sense alongside olfaction. Taste buds detect tastes as the tastant dissolves in saliva, which is created with stimuli from taste, chewing, smell and the texture of the food (Matsuo & Carpenter, 2015). Then the signals are processed as taste information and sent to the gustatory cortex and hypotalamus.

Human gustatory system can discriminate five basic tastes, and these tastes are sweet, sour, bitter, salty and umami (Snyder, Sims, & Bartoshuk, 2015; Matsuo & Carpenter, 2015; Buck & Bargmann, 2013). Taste[20] and flavour are different, as taste is basic and related to the five qualities of gustatory system, and flavour has a rich content and consists of the outputs from gustatory, somatosensory and olfactory systems (Buck & Bargmann, 2013, p. 727). Gustation and retronasal olfaction[21] are fundamental systems of flavour perception, yet the brain creates expectations of the flavour through signals from vision and orthonasal olfaction[22] beforehand (Spence, 2020).

Five basic tastes can be defined as follows (Matsuo & Carpenter, 2015; Buck & Bargmann, 2013, pp. 726-732; Cardello & Wise, 2008):

- Sweet tastes (sugars, saccarins, etc.) are associated with food high in caloric content.
- Umami tastes (monosodium glutamate) are associated with amino acids and indicators of protein.
- Bitter tastes (nicotine, cafeine, alkaloids, etc.) have wide array of compounds are often found in poisonous plants and indicators of toxic substance.
- Salty tastes (containing Na^+, K^+, Cl^-, and HCO^{3-}) are related with electryolyte balance and detected by specific ionic channels, and sodium chloride (NaCl) is the principal salty tastant.
- Sour tastes are associated with acidic food and beverages, creating reflex salivation and also helping humans to protect themselves from spoiled foods.

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[20] Taste can also be defined as all of the perceptions that are created when foods are taken into the mouth (DeSimone, Dubois, & Lyall, 2015). DeSimone et al. (2015) also emphasize that although five tastes are accepted as essential tastes, there are other tastes that exist, such as astringent, cooling, hot, prickle and fatty.
[21] Retronasal olfaction occurs during the swallowing phase, where the air in the mouth passes through the back of the nose/throat.
[22] Orthonasal olfaction occurs during inhaling.

Metallic taste was considered as a basic taste in the 1880s, yet Stevens, Smith and Lawless (2006) suggested that metallic taste is slightly different than basic tastes but is not a basic taste. In their study, Stevens et al. (2006) used ferrous sulfate ($NaSO_4$) as the tastant, which subjects (n=47) evaluated its quality in both nose open and nose closed conditions separately. Results showed that metallic taste was found as unpleasant and not sweet by the subjects, and both gustatory (tongue) and olfactory systems (retronasal smelling) play role in multimodal perceiving of metallic taste (Stevens et al., 2006).

Cardello and Wise (2008) explain the basics of taste experience under six headlines:

- Taste adaptation[23] occurs in the first 60 seconds (adaptation period) after the tastant is perceived through the gustatory system, as the intensity of the taste starts to decrease. After the stimulus is removed, the intensity of taste fades away in 30 seconds (recovery period).
- Allesthesia effect is the increase in pleasantness of the taste of a food if consumed when the person is hungry. However, if the same food or beverage is consumed frequently over time, the liking of that food decreases with sensory specific satiety effect.
- Taste supression[24] occurs when different ingredients are consumed together as a complex taste, the intensity of perceived taste of each ingredient is lower compared to consuming each ingredient separately.

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[23] In situations of consuming two different products with similar tastes one after the other (e.g. tasting honey after sugar), the perceived intensity of the second taste is significantly decreased and this effect is known as cross adaptation of taste. Contrary to this, when two different food products with different tastes are consumed one after the other (e.g. tasting honey after lemon), this increases the perceived intensity of the second taste, and this effect is called cross enhancement of taste (Cardello & Wise, 2008, pp. 95-96).

[24] Cardello and Wise (2008) mention that taste supression effect varies on different tastes. In a combination of bitter and salty tastes, the bitterness is supressed and salty taste remains unaffected; combining bitter with sour enchances taste with appropriate ratios, where salty and sour tastes supress themselves in high concentrations but enhance each taste in low concentrations.

- Crossmodal interactions occur between the other senses and the taste sensation. Odours (olfaction) can change the taste experience of a food. Gustatory experience also influences the perception of a product in other senses, as the viscosity of a beverage is perceived higher as the intensity of sweetness increases.
- Some taste experiences are innate. Before birth, human taste receptors are formed and infants have innate preference towards sweet tastes.
- Some taste experiences are learned.

In her review about the psychophysical advances about taste perception, Bartoshuk (2000) underlines that the advancements in measuring taste perception have started with the discovery of taste blindness in the 1930s. In early times, substances like PTC (phenylthiocarbamide) which carry both olfactory (sulphurous odor) and taste stimuli, and PROP (6-n-propylthiouracil) that carries only gustatory stimulation were used to measure perception diversities among subjects. Using PTC and PROP samples in measuring taste perception led to classify tasting capabilities of subjects as non-tasters, tasters (medium) and supertasters, as a finding in tasting PTC (Hall, Bartoshuk, Cain, & Stevens, 1975), where tasters perceived greater bitterness compared to non-tasters. Similar to measuring olfactory perception, the estimation of the treshold in measuring taste perception took major focus for many years.

Classical measurement methods of taste sensation were consisted of asking if the tastant is perceived by the subject (Doty, 2019; Snyder et al., 2015). The concentration of the tastant is determined depending on the subjects' reports, which were simple answers as yes or no. Doty (2019) underlines that taste sensation measurement methods have been improved in years, and recently, chemical taste thresholds and electro-gustometry are the most preferred measurement methods. In the chemical taste threshold method, the subject tries to distinguish the taste of water and the tastant, the concentration is decreased if the subject can correctly distinguish tastes twice, and is increased if the subject fails to distinguish once (Snyder, et al., 2015, p.753). On the other hand, in electrogustomery, low levels of electricity is applied to the specific parts of the tongue as a gustatory stimuli, which evokes salty and sour tastes (Snyder, et al., 2015, p.754). Snyder and colleagues also mentioned that electrogustometry is a portable method and usage of chemical substances is not necessary, yet sweetness and bitterness sensations can not be evoked through electrical current.

Threshold measurement methods can only provide the least amount of stimuli that can be perceived, and direct scaling methods can measure intensity of sensation levels (Snyder, et al., 2015). In magnitude estimation, the intensity of the sensation is estimated depending on ratios (twice of the first number means two times more intense taste, or half of the first number means half intensity) determined through subject reports (Snyder, et al., 2015). Magnitude estimation was usable for individual measurements and it was not possible to investigate diversity among different people with this method since only the ratios can be determined. Magnitude matching (or crossmodality matching) is another method to define thresholds, basically by generating matches between two different modalities such as olfaction and taste (Marks, Stevens, Bartoshuk, Gent, Rifkin & Stone, 1988). Most frequently, audition is used as the standart modality, and the other modality is tested. According to the theory, if there is a meaningful correlation between sound perceptions of two different hearers, their other modality perceptions can be comparable (Marks, et al., 1988). To give an example, the same amount of increase in loudness (audition) is compared with the amount of increase in perceived intensity of the bitterness (gustation). Keeping the sound as the standart modality, magnitude matching has helped to understand that aging influences oflaction more than gustation in terms of perceiving disorders (Bartoshuk, 2000).

Category scales are other methods of measuring taste sensation (Snyder et al., 2015). Natick 9 point scale is developed for measuring basic food preferences. Green, Shaffer and Gilmore (1993) have developed a scale, namely Labeled Magnitude Scale (LMS), which contains adjective labels as nothing (on the bottom), barely detectable, weak, moderate, strong and strongest imaginable (on the top). The strength of LMS is that this method can provide comparable data depending on real life experiences of subjects (Green, Dalton, Cowart, Rankin & Higgins, 1996). Other category scales, global Labeled Magnitude Scale (gLMS) and Global Intensity Scale (GIS) are similar to LMS, yet in LMS the strongest sensation depends on "imagination" and in gLMS and GIS, the strongest sensation depends on "experience" of the subjects (Snyder et al., 2015). A list of example labeled category scales can be seen in Figure 2.13.

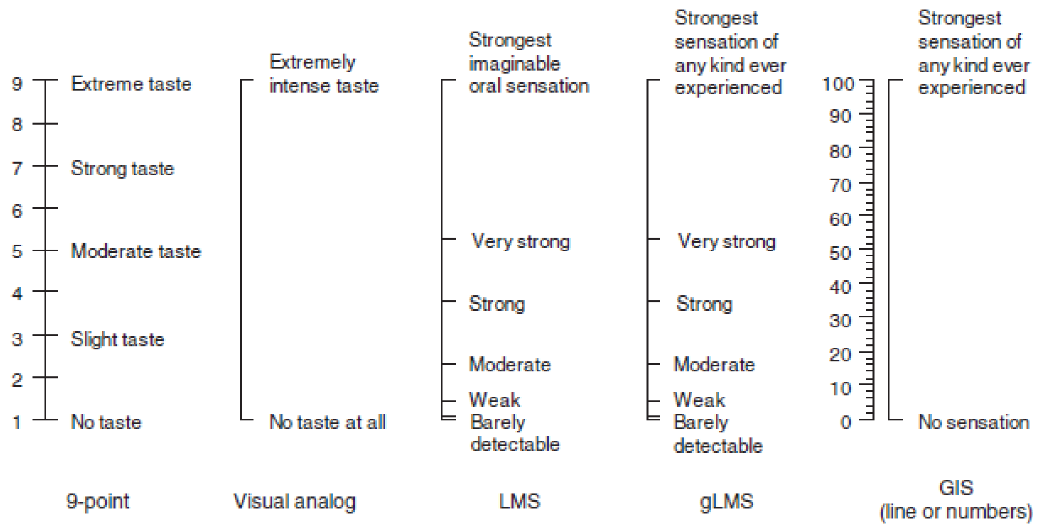

Figure 2.13. Examples of labeled category scales of taste sensation (Snyder, et al., 2015, p. 758)

Hedonic scales (such as like/dislike) can be combined with both magnitude matching and labeled scales. As an example, Labeled Affective Magnitude (LAM) scale (Schutz & Cardello, 2001) is a hedonic scale that is used for measuring food likings and dislikings. As previously emphasized in labeled scales, the intensities in hedonic scales vary depending on the experienced or imagined taste sensations. LAM and Labeled Hedonic Scale (LHS) depend on strongest imaginable and Hedonic general Labeled Magnitude Scale (gLMS) and Hedonic GIS depend on experiened intensities. The examples of hedonic scales can be seen in Figure 2.14.

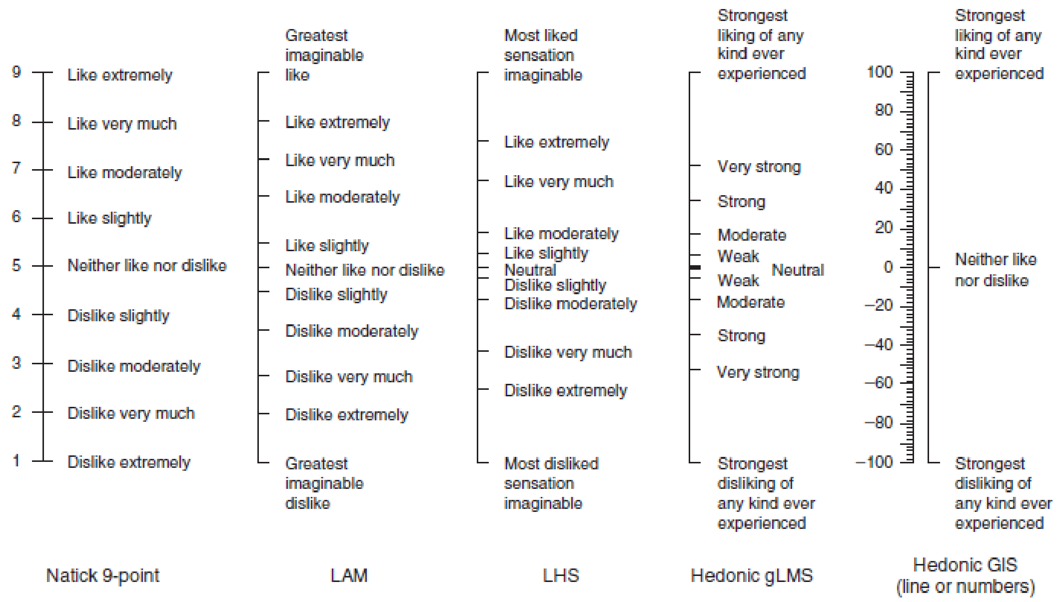

Figure 2.14. Examples of utilized hedonic scales of taste sensation (Snyder, et al., 2015, p. 761)

In their study on sensory characterization methods of food products, Varela and Ares (2012) reviewed contemporary sensory descriptive analysis methods that are regarded as flexible and easy to use. Reviewed methods are sorting, flash profiling, projective mapping, CATA questions, intensity scales, open ended questions, attribute elicitations, polarized sensory positioning and paired comparison. In their review, the evaluation types, vocabularies usages, preferred statistical methods and the limitations of the methods are listed (Varela and Ares, 2012). It can be seen from the review that Multi Dimensional Scale, and Principal Components are used more frequently, and the vocabularies used in these studies are either elicited by the assessors or provided by the researchers. A summary of the review can be seen in Table 2.10.

Quantitative Descriptive Analysis (QDA) is a method for investigating sensorial quaities of food flavours (Stone, Sidel, Oliver, Woolsey, & Singleton, 1974; Varela & Ares, 2012). QDA is an introspective method, where trained panelists are used to elicit perceptual meanings and scoring these meanings (Stone, et al., 1974). In an introspective study using QDA, *refreshing* was a descriptive multisensory dimension to be measured (Labbe, Gilbert, Antille, & Martin, 2007). Labbe, et al. (2007) figured out that the key drivers of *refreshing* are the perception of cold (trigeminal), mint (olfactory), acid (taste) and thickness (texture).

Table 2.10 Summary of the properties of reviewed methodologies (Varela & Ares, 2012, p. 906)

Method	Type of evaluation	Vocabulary	Statistical method	Limitations
Sorting	Classification of samples based on their similarities and differences	Elicited by the assessors or provided by the researcher	MDS, DISTATIS or FAST (MCA and MFA)	All samples should be presented simultaneously
Flash profiling	Ranking of samples on a set of selected attributes	Elicited by the assessors	GPA	Two sessions are required All samples should be presented simulteaneously
Projective mapping or Napping®	Generating samples on a two-dimensional map according to their similarities and differences	Elicited by the assessors	MFA	All samples should be presented simulteaneously It could be difficult to understand for naïve consumers
Check-all-that-apply (CATA) questions	Selection of terms from a list that are appropriate to describe the samples	Provided by the researcher	Cochran Q test, MCA, MFA	The design of the attribute list could strongly affect the responses Not recommended for evaluating very similar samples
Intensity scales	Rating the intensity of a set of attributes using scales	Provided by the researcher	ANOVA, PCA	Lack of consensus in consumers' responses
Open-ended questions	Verbal description of the samples	Elicited by the assessors	Content analysis, Chi-square and MCA	Difficulties for analyzing verbal descriptions
Preferred attribute elicitation	Ranking of attributes according to their importance and rating of products using structured scales	Elicited by the assessors	GPA	A round-table discussion is necessary All samples should be presented simultaneously
Polarized sensory positioning	Evaluation of global differences between samples and a set of fixed references	Not gathered in the original method It could be elicited by the assessors	MDS or PCA	Stable and readily-available references are needed Selection of the references could strongly affect the results
Paired comparison	Paired comparisons between samples in a set of attributes	Provided by the researcher	LSLR	Complicated experimental design

Food research literature contains various methods to create verbal descriptors that can be used as dimensions in sensory research (Reed, Mainland, & Arayata, 2019; Machiels & Karnal, 2016; Masson, Delarue, Bouillot, Sieffermann, & Blumenthal, 2016). Masson et al. (2016) compared six qualitative methods (sorting task, repertory grid method, word association and sentence completion, image association, self explanation, and focus group) to elicit subjective descriptions about eight different cups. The number of associations were highest for the word association and sentence completion method, whereas the repertory grid method focused on subjects' perceptions about cups, therefore produced fewer elicitations (Masson et al., 2016). Repertory grid method is regarded as a time consuming interviewing method for eliciting subjective descriptors, yet it can provide meaningful and explainable dimensions (Russell & Cox, 2003). Throughout six different methods, Masson et al. (2016) generated subjective attributes of cups such as original, classical, beautiful, old style, premium, and handy. Reed et al. (2019) analyzed nearly 400,000 reviews about food products on an online retailer website and developed categories depending on word counts. These categories are taste related (e.g. sweet, bitter), texture (e.g. light, hard, rough), smell (e.g. aroma, scent), health (e.g. organic, safe) and price (e.g. cheap, value). In another study about fruit juices, level of processing, freshness, naturalness, healthiness, attractiveness, quality, taste profile and purchase intention were some other dimensions that were found as choice determinants in food products (Machiels & Karnal, 2016).

Suzuki and Park (2018) state that having positive information about the food before and after tasting influence gustatory experience differently. If positive information about the food is given after tasting, this information influences gustatory experience more than given before tasting (Suzuki & Park, 2018). So it can be assumed that any previous positive experience with the material of the food container may enhance the gustatory experience. This assumption can be supported with the findings of a consumer research study (experimenting with orange juices with different colours and product information), where product information had little effect on taste perception compared to the color of the beverages and the previous experience of the subjects (Hoegg & Alba, 2007). Moreover, labeling foods as organic creates increased taste perceptions and is associated with being healthy, yet this effect has no use on unhealthy foods (Nadricka, Millet, & Verlegh, 2020). To understand the influence of product information on gustatory experience, a novel physiological taste manipulation methodology can be used (Litt & Shiv, 2012). Litt and Shiv (2012) used miraculin[25] to manipulate subjects' capabilities of perceiving a specific taste (sour) in tasting wines. As the subjects were unaware that their taste perception was manipulated, their beverage evaluations were affected by the impressions of product information.

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[25] Miraculin is a natural subtstance gathered from the fruit of *Synsepalum dulcificum* (miracle fruit), and can be used to block one's awareness of sour taste for 30-60 minutes (Litt and Shiv, 2012).

Emotional responses about taste perception can be used as an indicator about food preference and liking (Samant, Chapko, & Seo, 2017). Samant, et al. (2017) used a few emotional response measurement methods, which are self reported emotions (EsSense 25[26]), facial expressions analysis (measuring emotions[27] through photo frames), and physiological autonomic nervous system measures (measuring emotions through sweat gland activity), to investigate relationships between the taste intensity and the emotional response. Low and high concentrations of sweet, sour, bitter and salty samples were tested with subjects, and findings revealed that subjects disliked tastes with high intensity and their preference values were low (Samant et al., 2017). Also positive emotions were evoked when the tastes were liked, such as active, good, nostalgic and satisfied, and negative emotions were evoked when the taste were disliked, such as disgust, fear and sadness.

Temperature and mechanical stimulation are other influencers on taste perception (Green & Nachtigal, 2012; Cruz & Green, 2000; Green & Frankmann, 1987). On a study about the investigation of cooling effects on taste, Green and Frankmann (1987) tested how the temperature influences four basic tastes (sour, sweet, bitter, salty). Findings showed that the decrease in temperature (from 36°C to 28°C and 20°C) caused significant drop in perceived sweetness (sucrose) and bitterness (caffeine), yet had no effect on the perception of saltiness (NaCl) and sourness (citric acid). In addition to that, Green and Frankmann (1987) compared whether the tongue's or the tastant's temperature influences the perceived taste more, and they found out that the tongue's temperature affects taste perception more than the tastant's. If the tastant's temperature is cold enough to change the tongue's temperature, the perception of taste is manipulated. Also, Spence and Carvalho (2019) point out that the temperature of the drink causes difference on the experience

[26] EsSense 25 (Samant, Chapko, & Seo, 2017) is the simplified (utilized with 25 emotions) version of EsSense Profile (King & Meiselman, 2010), an emotional profiling method used for food associations (consisting of 39 emotions).
[27] Seven basic universal expressions can be measured with iMotions software, and these emotions are joy, anger, suprise, fear, contempt, disgust and sadness (Samant, Chapko, & Seo, 2017).

of the taste, as the aroma of hotter drinks flows away quicker than colder drinks. In another study, it was found out that applying different temperatures on different parts of the tongue evokes basic taste sensations (Cruz & Green, 2000). Cruz and Green (2000) revealed that heating up the anterior egde of the tongue evokes sweetness and cooling down the same area creates sourness and/or saltiness perception. Temperature changes also create certain taste perceptions on the rear part of the tongue, yet it is different from the front of the tongue. On mechanical stimulation of taste, Green and Nachtigal (2012) found out that additional mechanical movement of tongue (active tasting) enhances the perception of umami taste of monosodium glutamate (MSG). Taste perceptions other than MSG were not affected by the mechanical movements, and this occurs as it is assumed that the rear part of the mouth is more sensitive to MSG (Green & Nachtigal, 2012). The temperature and mechanical movements of the tongue should be taken into consideration in gustatory studies as they have significant effects on taste perception.

Somatosensory (consists sensory receptors of temperature, pain etc.) sensations also influence the taste perception, as many sensorial interactions happen when a food is put into the mouth (Howes, Wongsriruksa, Laughlin, Witchel, & Miodownik, 2014). Howes, et al. (2014) asked thirty subjects to experience nine different sticks made of polystyrene, rough polystyrene, stainless steel, copper, rough copper, birch, balsa, glass and silicone by putting them into their mouths with a weighted ABS handle, and freely move the stick without bending or biting Figure 2.15. represents the stimuli sticks and the weighted handle. Then the subjects were asked to rate each stick depending on perceived hardness, warmth, roughness, bitterness, sweetness, sourness and saltiness. Howes, et al. (2014) found no significant correlations between perceptions and adjectives, yet they only found that materials were divided into two categories of "soft and warm" and "hard and cold". In the second experiment of the same study, another blindfolded eight subjects were asked to experience the same sticks one at a time and answer various questions to define verbal descriptors, and taste descriptors (e.g. earthy, metallic, chemical), somatosensory descriptors (e.g. tough. slippery, solid) and dominant sensation descriptors (e.g. rubbery, weird, synthetic) were elicited (Howes, et al., 2014). Free profiling method was used in the second experiment as subjects used their own words to describe their sensory responses, and interestingly, some non-food descriptors were elicited in taste descriptors section, and only four of the chosen adjectives for experiment one were mentioned as dominant sensations (hardness, warmth, roughness and bitterness). This explains that using a structured model (such as basic tastes model) may fall short in identifying oral sensations as many flavor descriptors are mentioned in the study.

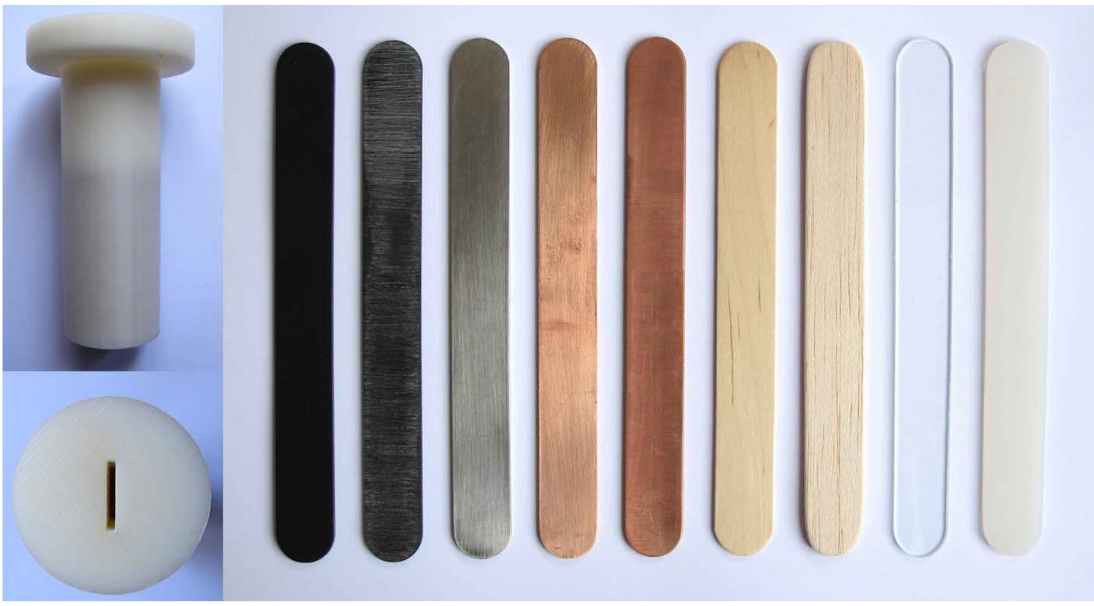

Figure 2.15. The weighted ABS handle (on the left) is used to hold the sticks. Stimuli sticks made of different materials (on the right) those are used in the study (Howes, et al., 2014, p. 3)

The taste of materials also influence the taste of food and beverages (Piqueras-Fizsman, Laughlin, Miodownik, & Spence, 2012). In their experiment with thirty subjects, Piqueras-Fizsman, et al. (2012) investigated the infleunce of the taste of four metal spoons plated with gold, zinc, copper and stainless steel over the taste of sweet, sour, bitter, salty and plain samples. Subjects tasted each tastant with all four spoons in eyes-closed situation. Results show that zinc and copper spoons have metallic taste, and they have increased the perceived bitterness taste of all food samples, the perceived sweetness of sweet samples and the perceived saltiness of sour, salty and plain samples (Piqueras-Fizsman et al., 2012). A similar study was carried out with seven different metal spoons, yet the spoons were evaluated by their metallic taste (Laughlin, Conreen, Witchel, & Miodownik, 2011). In comparison of zinc, copper, gold, silver, tin, stainless steel and chrome plated spoons, thirty two subjects tasted each spoon separately in blindfolded condition and evaluated the spoons through the adjectives of cool, hard, metallic, strong, bitter, unpleasant, salty and sweet (Laughlin, et al., 2011). The spoons used in the study can be seen in Figure 2.16. Laughlin, et al. (2011) found out that the taste of zinc and copper were perceived as metallic, strong, bitter and unpleasant, yet they revealed no significant statistics about other materials used in the experiment. It can be inferred from both studies that copper and zinc have a distinct taste that can influence the taste of food and beverages.

Figure 2.16. Electroplated metal spoons used in the study (Laughlin et al., 2011, p. 629)

The container highly influences the gustatory experience of the food or drink (Lefebvre & Orlowski, 2018; Maggioni, Risso, Olivero, & Gallace, 2015; Schifferstein, 2009; Spence & Carvalho, 2019). Spence and Carvalho (2019) admit that both physical (such as colour, weight and geometry) and psychological qualities (such as aesthetics, and culture) of the vessel of the drink affect gustatory experience of the taster. Maggioni, et al. (2015) figured out that the perceived pleasantness of mineral water decreases as the weight of the plastic bottle increases. In contrast to that, Piqueras-Fiszman and Spence (2012a) reported that heavier wine bottles are perceived more expensive and better quality. In another study, the weight of the serving dish with yoghurt is investigated through perceived satiety, and when the yoghurt is served with a lighter container, it is perceived less satiating and less dense than when served in a heavier container (Piqueras-Fiszman & Spence, 2012b). It can be inferred that the influence of the perceived weight of the container over taste perception varies depending on the content and the context. As a physical quality, the geometry of the vessel causes differences in experience of the taste as the aroma intensity gets higher with the increase in diameter. If the aperture of the vessel gets narrower, the nose will not be able to get in the container and therefore the taster will not be able to smell the aroma properly to contribute to the gustatory experience (Spence & Carvalho, 2019). Moreover, short and narrow vessels are found to be bitter, aromatic and intense; and wider diameters are correlated with sweetness. On the other hand, in their study about the influence of container shapes over perceived sweetness and price of soft drinks, Arboleda and Arce-Lopera (2020) used bottle silhouettes with various sizes. They found out that bottle-perceived sweetness increases with the decrease in height and increase in size of the lower part, and perceived price increases as the lid gets higher and the shape becomes more curved.

2.8.6 Multisensory Evaluation of Material Properties

We perceive our environments through a complex processing through the combination of all our senses (Kayser, Petkov, Augath, & Logothetis, 2005). Each sense plays a different role in perceptual processes. Audition is the dominant modality in judgements of temporal events (temporal rate and pattern), whereas vision is dominant in spatial tasks (object shape and size, and orientation) (Lederman, Klatzky, Morgan, & Hamilton, 2002). Perception can be unimodal, or multimodal/multisensory. If more than one sense is involved in perception, it is a multisensory perception. Inclusion of multiple sense modalities in perception increases the possibility of detecting sensory data of the interested event or object (Stein & Stanford, 2008).

Haverkamp (2017) underlines that unimodal investigation is stronger in defining small differences, yet multisensory studies represent daily life experiences and therefore reflect more practical outcomes. Product designers need to understand the nature of multisensory interactions between users and products to design product experiences. The product designer has to know how people use and perceive the products and how their senses cooperate in forming experiences (Schifferstein & Spence, 2008). To understand multisensory interactions on product experiences, two complementary studies were carried out. Schifferstein and Cleiren (2005) conducted split modality tests, which subsume unimodal perception, and investigated the weighted dominance of each sense in identifying six different products including a tennis ball, a boiled egg and a bread. According to verbal reports of the subjects, vision and haptics were found equally weighted in providing identification information about the products, followed by audition and olfaction (Schifferstein & Cleiren, 2005). In the other study, one sense was blocked in identfying six product samples including a toothpaste, an electric boiler and a toothbrush (Schifferstein & Hekkert, 2007). Subjects reported that most of the information was gone when vision was blocked, therefore vision was reported to be the most informative sense followed by touch (Schifferstein & Hekkert, 2007). Overall, vision was found to be the most dominant sense in user-product interactions where audition and olfaction plays lesser roles on identifying products.

In a study on creating digital sounds for enhancing the perception of visual representations of materials through touchscreen devices, both digital and physical affections of audition were compared (Martin, Weinmann, & Hullin, 2018). Martin, et al. (2018) used four experimental methods as *visual* (material photos), *static audiovisual* (material photos with prerecorded material sounds), *dynamic audiovisual* (material photos with interactively generated digital sounds) and *full-modal* (physical interaction with real materials) conditions in the evaluation of 12 adjective pairs (such as *roughness*, *brightness*, *expensiveness* and *beautifulness*). According to the 19 participants' evaluations, Martin, et al. (2018) found out that digital auditory cues did not affect the material perception in the representation of materials compared to the physical interactions with real materials. As a result, evaluation of sensory feedback from representations of materials were found to be quite limited compared to the interactions with real materials.

Multiple senses interact in experiencing products we encounter in our daily lives that consist of different material combinations, complex shapes, various functions and more. Within multisensory interactions, crossmodal interplay of senses are observed. Yet, the terms multisensory and crossmodal are different. Crossmodal refers to the influence of a sensory modality to the other sensory modality with the presence of the same stimulation (Stein & Stanford, 2008).

In a crossmodal interaction, the stimulation from a sensory modality influences the perception evoked by another sensory modality (Bayne & Spence, 2015; Spence, 2011). Broadly there are two phenomena that exist in crossmodal sensory interactions as synesthesia and crossmodal integration (Sagiv & Ward, 2006).

Synesthesia is phenomenon that occurs if a stimulation in one sensory modality evokes a sensorial experience in another and non-stimulated sensory modality (Cytowic, 2002; Haverkamp M. , 2013; Sagiv & Ward, 2006). Cytowic (2002) defines synesthesia as *parallel sensation*, which is a unique condition and should not be confused with the common metaphoric speech (such as the warmth of a color). As Haverkamp (2013) states, most of the genetic synesthesia types, namely genuine synesthesia, can be seen in low percentages of the population. An example of synesthetic sensations can be hearing as colours, where a synesthetic perceiver identifies tones with colors. Synesthesia can be found between various sensory combinations (e.g. sound-vision, vision-touch, odor-taste). Genuine syneshetia types among 871 internet survey reports can be seen in Table 2.11.

Phenomenonal side of synesthesia is frequently studied through multisensory psychophysics. In a synesthetic study on pitch and shape, high pitch sound was associated with jagged and sharp shapes and low pitch sound was associated with smooth and rounded shapes (Marks, 1987). Similar results were acquired as the word sound of “bouba” was associated with rounded shapes and “kiki” was associated with angular edges (Ramachandran & Hubbard, 2001). If the arm is visible to the perceiver, the arm becomes more sensitive to tactile stimuliation (Kennett, Taylor-Clarke, & Haggard, 2001). This occurs as a result of visual-tactile synethesia, as there is no visible tactile parameter to increase the sensitivity of tactile sensation. Moreover, in an odor-taste synesthesia study, a tasteless odor was added into a sucrose and perceived sweetness was increased (Stevenson & Boakes, 2004). Stevenson and Boakes (2004) also mentioned that vanilla odor is frequently perceived as sweet, where sweetness is a term related with taste.

Table 2.11 Statistics of synesthesia types and percentages among 871 internet survey reports. Adapted from Haverkamp (2013, p. 294)

Allocation	**Primary Perception**	**Secondary Perception**	**Percentage of Mentioning**
Grapheme -> Color	Visual	Visual	64.9%
Time Unit -> Color	Symbolic	Visual	23.1%
Musical Sound -> Color	Auditory	Visual	19.5%
Generic Sound -> Color	Auditory	Visual	14.9%
Phoneme -> Color	Auditory	Visual	9.2%
Music Note -> Color	Visual	Visual	9.0%
Odor -> Color	Olfactory	Visual	6.8%
Taste -> Color	Gustatory	Visual	6.3%
Sound -> Taste	Auditory	Gustatory	6.1%
Pain -> Color	Somatosensory	Visual	5.5%
Personality -> Color (Aura)	Visual	Visual	5.4%
Touch -> Color	Tactile	Visual	4.0%
Sound -> Touch	Auditory	Tactile	3.9%
Vision -> Taste	Visual	Gustatory	2.8%
Vision -> Sound	Visual	Auditory	2.6%
Temperature -> Color	Somatosensory	Visual	2.5%
Orgasm -> Color	Somatosensory	Visual	2.1%
Emotion -> Color	Somatosensory	Visual	1.6%
Sound -> Smell	Auditory	Olfactory	1.6%
Vision -> Touch	Visual	Tactile	1.5%
Touch -> Taste	Tactile	Gustatory	1.1%
Vision -> Smell	Visual	Olfactory	1.1%

Synesthetic dinner[28] is an interesting example on taste experience, where diners experience spherificated foods (Velasco, Michel, Youssef, Gamez, Cheok & Spence, 2016). Spherification is used to block retronasal olfactory sensation, where the food is covered with a mineral based transparent layer through a special treatment. Four coloured spheres were presented to the diners, and they were asked to taste salty first, then bitter, then sour and lasty sweet. Diners put spheres in order depending on their color associated taste experiences. When tasters put the spheres into their mouths, the flavor spread. Without olfactory cues before tasting, this method gives the taster an unexpected and different taste experience.

Crossmodal integration is the synthesizing of information delivered by different sensory modalities (Stein & Stanford, 2008), or "the unity of senses" (Marks, 1987, p. 384) and more broadly, "crossmodal correspondence" (Spence, 2011, p.971). The presence of a crossmodal integration can be mentioned if an input from a sensory modality influences (could be enhancing or dampening) the information processing of another sensory modality (Small, 2004). Crossmodal integration of senses is about the intersensory interactions that happen when the data from different senses reach the brain simultaneously or near-simultaneously, and the brain processes these multisensory data as coming from the same source (Keetels & Vroomen, 2012). This happens if the synchrony between sensory data can be achieved, and then the event can be perceived as one and multisensory. Otherwise, without a synchrony between senses, sensory feedbacks are perceived as separate events (Keetels & Vroomen, 2012). As an interesting fact, Keetels and Vroomen (2012) point out that light (visual) moves around 300000 kilometers per second, and sound (auditory) moves around 0,33 kilometers per second, and somehow the brain makes them perceived as a whole, such as perceiving the mimics and lip movements (visual) and the speech (auditory) in a synchronized fashion. To adjust the arrival timing of various sensory

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[28]Synesthesia by Kitchen Theory can be visited on https://www.kitchen-theory.com/synaesthesia-by-kitchen-theory/

feedback, neural systems process the stimuli in different times[29], such as processing of sound being faster than processing of visual feedback[30].

The crossmodal integration between visual and tactile sensory systems refers to visiotactile (or visuo-haptic) integration (Goda, Yokoi, Tachibana, Minamimoto, & Komatsu, 2016; Fujisaki & Nishida, 2009; Amadi, Malach, Hendler, Peled, & Zohary, 2001). Goda et al. (2016) mentioned that in some situations, we can recognize non-visual characteristics (e.g. hardness) of a material by just looking at them. Our previous crossmodal visiotactile experience helps us to recognize some non-visual material properties (such as tactile roughness, hardness and weight) through vision (Goda et al., 2016). In an earlier study, Klatzky, Lederman and Reed (1987) compared tactile interactions without vision and tactile interactions with vision, and found out that texture is discriminated easier with tactile sensation without vision, and shape and size parameters are discriminated better when tactile and visual modalities are used together. According to Guest and Spence (2003) visual and tactile systems works separately and fundamentally contribute with similar feedback in roughness perception. When vision is involved in a tactile exploration, the amount of hand movements becomes lesser in tactile exploration and lesser amount of data will be achieved through tactility (Klatzky et al., 1987). The reason for this could be the contribution of visual feedback to the tactile exploration, as less amount of hand movements are required to discriminate a tactile parameter. In another experiment, Amadi et al. (2001) tested the subjects through four different conditions as touching somatosensory objects, touching somatosensory textures, viewing visual objects, and viewing visual textures; during

[29] Compared to other sensory modalities, olfaction is the slowest sense in terms of processing the sensory stimuli, which approximately takes 400 ms, ten times slower than visual processing (40ms) (Herz & Engen, 1996, p. 301).

[30] Synchronization of auditory and visual feedback from a speaking person works best if the speaker is positioned between 10-15 meters away from the hearer. Auditory perception is faster if the speaker is closer than 15 meters, and visual perception is faster if the speaker is more than 15 meters away (Keetels & Vroomen, 2012, p. 148). Similarly, the distance from fingers to the brain (tactile) is relatively longer than the distance between the nose and the brain (olfactory), so again, the brain has to deal with the signal traveling times to perceive a synchronic multisensorial event.

these interactions, subjects' brains were viewed through functional MRI, and it was detected that haptic interactions activated visual areas of the brain. Such activation also occured through visual imagery (Sathian & Zangaladze, 2002; Amadi et al., 2001). In a more recent study, areas of brain related to visual processing was found to be also processing when haptic explorations of objects were made (Lacey & Sathian, 2014). Two different kinds of visual imagery systems function during haptic explorations, as object imagery (containing surface properties of objects such as shape, color, brightness) and spatial imagery (containing component parts, spatial transformations, yet without surface properties) (Lacey & Sathian, 2014). These visual imagery types define the individual approaching of visiotactile explorations of an object and therefore influence the performance of object recognition. According to Lacey and Sathian (2014), during tactile exploration, if the perceiver is familiar with the object, object imagery takes role, and if the object is unfamiliar, spatial imagery takes role. In other terms, if we have experienced an object or a material before, we tend to evaluate the surface properties directly in tactile interaction and our previous visual experience is involved in that interaction.

In a multisensory interaction, the crossmodal integration between audition and vision is called audiovisual (Fujisaki & Nishida, 2009; Maccora, Indovino, Baschi, Paladino, Talamanca, Cosentino, Giglia and Brighina, 2013; Shams, Kamitani, & Shimojo, 2000). In the interplay of audition and vision on a multisensory percept, in contrast with the popular belief that vision dominates the other senses in multisensory perception, Shams, et al. (2000) have discovered that audition can manipulate vision. In their experiment, they presented a single flash with beeping sound to the subjects and when more than one beeping sound was provided each time the flash appeared, subjects perceived the single flash as multiple flashes. This manipulation is called sound induced flash illusion, and the method can be used to manipulate other parameters such as flashing pattern's shape and texture (Shams, et al., 2000). Other famous audiovisual manipulations are the ventriloquist and McGurk effects[31].

Another interesting audiovisual experiment was conducted with random combination of a material's image with another material's impact sound (Fujisaki, Goda, Motoyoshi, Komatsu, & Nishida, 2014). The aim of this study was to find out how material perception changes when an unnatural impact sound is heard while receiving the visual stimuli of a material. Fujisaki, et al. (2014) used six different material representations in an animation[32] (visual stimuli), where a hand is hitting the object with a digitally rendered stick, and eight recorded real material impact sounds are heard (auditory stimuli) when the stick hits the material in the animation. According to audiovisual test results, when wood image was accompanied with wood impact sound, subjects perceived the material as wood; yet when wood impact sound was accompanied with glass image, glass was perceived as plastic (vision induced change) (Fujisaki, et al., 2014). Moreover, when glass sound was presented with glass image, glass was perceived as glass; however when glass image was coupled with vegetable sound, glass was perceived as plastic (auditory induced change) (Fujisaki, et al., 2014). According to Fujisaki, et al. (2014), the brain combines visual and auditory material category judgements together, as audiovisual judgement, rather than relying on each sensory modality separately. So if a material is glossy and transparent, and has high pitch and sharp sound qualities, the material is likely to be glass, and therefore it can be fragile. Representation of material property related category perception can be seen in Table 2.12.

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[31] McGurk effect is a vision induced auditory (speech) perception, in which the sound of some words (e.g. "ba" and "da") are being perceived differently as a result of misleading lip movements, and the ventriloquist effect is about perceiving a sound as coming from a different source than where it should be originating from (Shimojo & Shams, 2001).

[32] Fujisaki, et al. (2014) created a digital animation, where an object with the chosen material texture is being hit with a wooden stick held by a digitally rendered hand.

Table 2.12 Material property related category perception
(Adapted from Fujisaki, et al. (2014, p. 17)

Sensory Modality	**Perceived Quality**	**Material Category Perception**
Visual Judgement	glossy and transparent	could be glass, plastic
Auditory Judgement	high pitch and sharp	could be glass, ceramic, metal
Audiovisual Judgement	glossy and transparent high pitch and sharp	likely to be glass

Crossmodal integrations between auditory and tactile modalities refer to audiotactile multisensory interactions (Caclin, Soto-Faraco, Kingstone, & Spence, 2002). Audiotactile interactions mostly occur in a space close to the head, and within that space, any other auditory signal may interrupt audiotactile perception (Kitagawa & Spence, 2006). The combination of tactile sensation in the mouth and sounds created when biting crispy food (such as an apple or a potato chip) is another feedback for an audiotactile interaction that influences taste perception (Zampini & Spence, 2004). Zampini and Spence (2004) also emphasize that if the tactile and auditory stimuli come from the same spatial location (e.g. from inside the mouth), the tactile sensation becomes stronger. Audiotactile interactions were investigated through fMRI images of animal subjects during sensory interactions, and Keyser, et al. (2005) found out the processing of sound in auditory cortex is influenced by the simultenaous processing of tactile stimuli. The perception changes depending on the timing of both the auditory and the tactile feedback. Parchment-skin illusion is an interesting example, when recorded sound of rubbing hands are manipulated (high frequency boost and high frequency cut applied separately) and listened by the subjects while rubbing their hands, different tactile perceptions (roughness/smoothness or wetness/dryness) are created (Jousmäki & Hari, 1998; Champoux, Collignon, Bacon, Lepore, & Zatorre, 2011). If the frequency of the recorded hand rubbing sound (auditory) is increased, the perceived roughness/wetness (tactile) of the skin of hand is decreased, the skin is perceived as smooth/dry (Jousmäki & Hari, 1998; Champoux, et al., 2011). In addition to that, Jousmäki and Hari (1998) found out that if the sound is delayed more than 100 ms, parchment-skin illusion diminishes, as appropriate timing is required between the tactile and auditory stimulation while rubbing the hand. Similar results were obtained in another research, where tactile tap counts were misperceived with the manipulation of tapping sound (Bresciani, Ernst, Drewing, Bouyer, Maury and Kheddar, 2014). Bresciani, et al. (2004) explain that even in a complex multisensory interaction, such as knocking on a door while hearing the conversation of neighbours, our central nervous system matches the related sensory stimuli together in a vast number of incoming stimuli. In short, if auditory and tactile interactions happen simultaneously in a close distance to the head, an audiotactile sensation occurs (Kitagawa & Igarashi, 2005; Caclin, et al., 2002). Although the brain adjusts audiotactile stimuli through physical interactions with objects correctly, digital audiotactile responses (such as reaction times) should be designed carefully to avoid perception mistakes.

Various other combinations of crossmodal sensory integrations can be seen in the literature, such as visual-olfactory (Morrot, Brochet, & Dubourdieu, 2001; Gottfried & Dolan, 2003; Small, 2004), tactile-olfactory (Demattè, Sanabria, Sugarman, & Spence, 2006) and visual-gustatory (Haverkamp, 2013).

On tactile-olfactory crossmodal integration, lemon odors increased perceived softness of a fabric, compared to animal like odors (Demattè, et al., 2006). Subjects evaluated cotton fabrics in a blindfolded condition and their perception of softness were induced by olfactory stimulation. Demattè, et al. (2006) also found out that lemon odors were found to be significantly pleasant (85%), and in contrast, animal like odors were found to be significantly unpleasant (86%).

Vision and gustation are also related through multisensory integration (De Araujo & Simon, 2010). De Araujo and Simon (2010) reported that visual stimuli activates gustatory cortex (especially insula and operculum; brain regions related with gustation). Food images were represented and gustatory activation was viewed through fMRI. Haverkamp (2013) gives an example as certain colors themselves represent foods and tastes. It is the iconic connection that associates foods through colors (Haverkamp, 2013, p. 240). Color labeling are mostly preferred in confectionary products. Through iconic connection, we connect yellow with lemon, and therefore association of sourness may arise. Figure 2.17 represents some examples about iconic connections between color and foods.

Figure 2.17. Some examples of color-food associations (Haverkamp, 2013, p. 240)

On visual-olfactory crossmodal integration, the color of a white wine was transformed into red with an odourless and tasteless substance, and tested through olfaction with 54 subjects (Morrot, et al, 2001). Morrot, et al. (2001) used lexical analysis and found that white wine was perceived as red wine when colored with red. Changing visual attribute (color) of wine misinstructed olfactory perception. Gottfried and Dolan (2003) underline that identification of odors through only olfaction is a difficult process and an odor-related semantic information makes identification process stronger. Haverkamp (2013, p. 241) mentions about a color wheel developed by Karl-Heinz Bork, a perfume designer, where he positioned four basic smell categories in the middle as light, heavy, green (freshly cut green plants) and floral (flower scents). Each scent is represented with the associated color (Figure 2.18). Faster and more accurate identifications of odors were made by the subjects in bimodal (vision and olfactory) conditions compared to unimodal conditions.

Perception of surface roughness, on the other hand, is an example for multisensory perception. Perception of surface roughness is a result of a trimodal[33] (visual, tactile and auditory) process (Lederman, Klatzky, Morgan, & Hamilton, 2002). Tactile and auditory evaluation of surface roughness has been investigated. Lederman (1979) underlined that tactile judgement completely dominates auditory judgement in

[33] Guest, Catmur, Lloyd and Spence (2002) admitted that olfaction may also have a role in identifying surface roughness.

perceiving surface roughness with bare finger, and if both auditory and tactile feedback are available, his subjects tended to rely on their tactile sensation more than auditory. Also, the auditory feedback from touching a rough surface is relatively weak as ambient sounds are always in our daily life environments. Moreover, Lederman (1979) also mentioned that tactile and auditory evaluations of surface roughness is similar, yet not identical. Two decades later, Lederman, et al. (2002) investigated auditory and tactile sensations in perceiving surface roughness with touch-only, audition-only and touch-audition experiments. This time, Lederman, et al. (2002) used a rigid probe instead of bare finger to evaluate surface roughness, and obtained new findings; the vibration created between the probe and the surface is received both by the hand and the ears, and the estimated effect of auditory feedback in judging surface roughness was 38% compared to tactile dominance, which was 62%.

Figure 2.18. Scent-color wheel by Karl-Heinz Bork. Colors represent the color associations of scents (Haverkamp, 2013, p. 242)

Alongside these studies, visual and tactile evaluations of surface roughness have also been compared to understand modality relationships (Whitaker, Simões-Franklin, & Newell, 2008; Lederman & Abbott, 1981). Lederman and Abbott (1981) used nine identical sandpapers (grit values vary from 50 to 220) to be evaluated through visual-only, tactile-only and visual-tactile modalities. Results showed that visual and tactile sensations weighted equally on perceiving the roughness of a texture, and particle size, particle spatial frequency, particle spacing and particle distribution irregularity are the main parameters for both tactile and visual senses, yet reflections and luminosity of the surfaces are vision-only related cues (Lederman and Abbott, 1981). Whitaker, et al. (2008) also emphasized that vision and touch produce similar quantitative results in perceiving roughness, yet the surface quality is processed through different qualitative ways. In addition to that, processing of visual and tactual stimulation is independent from one another and produce complementary feedback, yet they can not be compounded to increase roughness perception (Whitaker, et al., 2008). In short, on perceiving surface roughness, vision and haptics are equally weighted, and haptics is more dominant than audition, yet vision is dominant in macroscopic qualities (e.g. size, shape), and tactile sensation is dominant in evaluating microscopic (e.g. groove spacing, texture irregularity) qualities.

All of the senses are involved in a taste experience. In his review about multisensory taste experience, Spence (2015) emphasized that all senses play a role in experiencing flavours, yet the sense of smell is dominant (regardless of the percentage) in most types of food. Further, Spence (2020) underlines that vision, orthonasal olfaction, audition and haptics play role with different combinations in different stages of flavour expectation. The nature of flavour experience is multisensory and senses other than gustation should not be neglected in designing for the flavour experience. As an example, Spence (2015) mentions that an increasing number of chefs started to use scented dishes or cutlery to create taste experiences. In defining taste experiences, flavour wheels are available for specific product types that can be used as a lexicon of multisensory flavour experience

(Meilgaard, et al., 2016). Figure 2.19 represents an example flavour wheel of spirits. Meilgaard, et al. (2016) suggested that these wheels can be used as sensory snapshots and are usable for measuring or communicationg descriptive qualities of flavours.

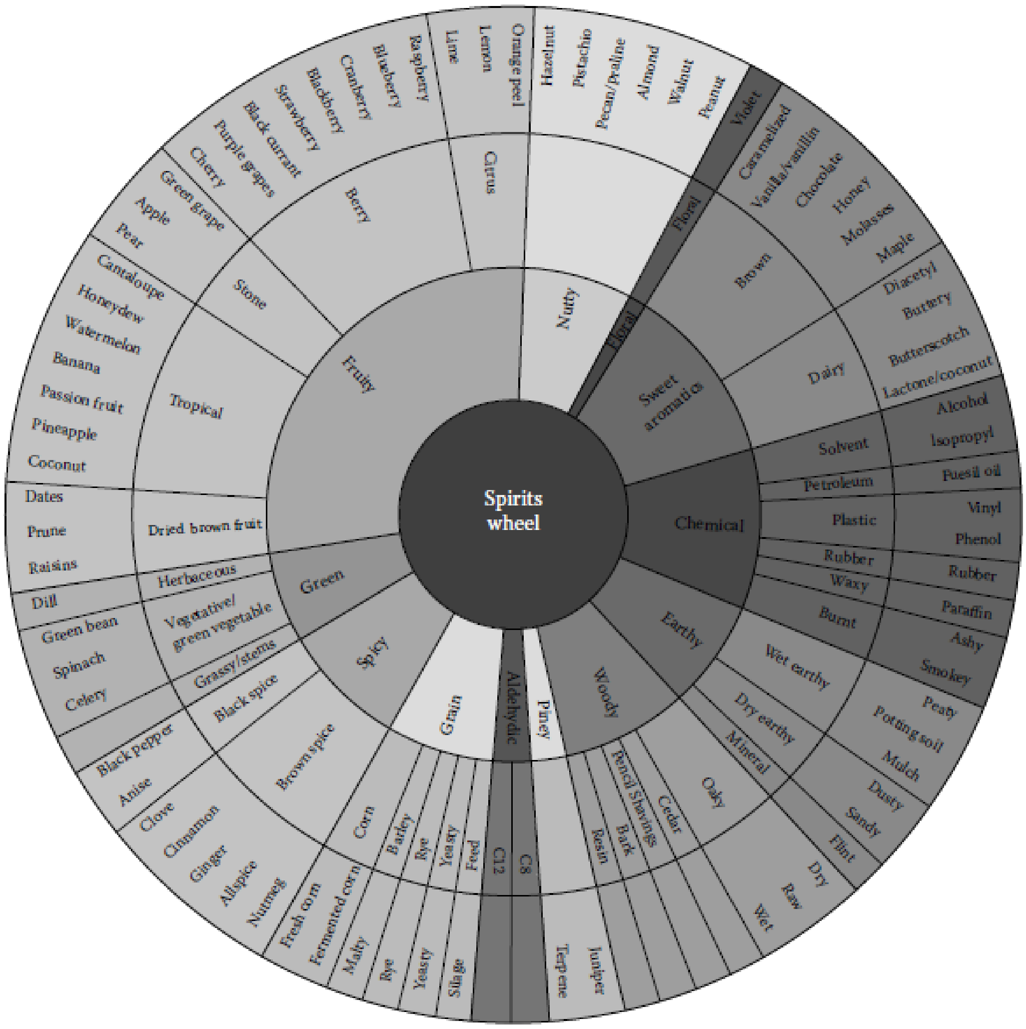

Figure 2.19. An example flavour wheel of spirits (Meilgaard, et al., 2016, p. 230) (Copyright Sensory Spectrum, 2015)

Haptic properties affect gustatory experience (Krishna & Morrin, 2008; Kampfer, Leischnig, Ivens, & Spence, 2017). Krishna and Morrin (2008) emphasize that the consumers which like to touch objects more than others have a better awareness of tactile properties of the food container and their gustatory experience are less likely to be affected by haptics compared to those who are less tactile oriented. On another effect of haptics over taste perception, Kampfer, et al. (2017) investigated the impact of package weight on perceived flavor intensity and willingness to pay. Kampfer, et al. (2017) found out that perceived flavor intensity increases with increase in the weight of the soft drink container and the chocolate box used in the study, and the ratings of the subjects' willingness to pay is higher for heavier containers. It can be inferred from the study that perceived flavor intensity is higher in heavier packages and willingness to pay depends on the flavor intensity in soft drinks and box chocolates.

Visual cues (such as colour, shape and patterns) of the packaging also affect gustatory experience (Deliza, MacFie, & Hedderley, 2003; Ares & Deliza, 2010; Matthews, Simmonds, & Spence, 2019; Rosa, Spence, & Tonetto, 2019). Gustatory experience starts to evolve when consumers first see the product on the shelves, they start to predict about the food, and have *assimilation* or *contrast* effects (Suzuki & Park, 2018; Matthews, et al., 2019). Assimilation effect makes the shift towards the expectation, resulting in contradiction between the expected and the experienced qualities, and contrast effect is the difference between expected and experienced values (Matthews, et al., 2019, p. 1). Angular yoghurt packages are associated with intense tastes (Becker, Van Rompay, Schifferstein, & Galetzka, 2010). In milk desserts products, Ares and Deliza (2010) found out that round shapes (compared to squares) and yellow colours (compared to black and whites) were liked mostly and they were associated with *sweetness*. However, in a study about cookie packages, findings show that cookies in angular packagings were found *sweeter* than those in packages with round shapes (Rosa et al., 2019). Deliza, et al. (2003) claimed that orange packages were perceived *sweeter* than white, white packages were perceived *sharper* than orange, and packages with unordinary sizes (taller, narrower etc.) were associated with *sweetness* lesser than packages with usual sizes. Matthews et al. (2019) investigated sourness/sweetness perception in sorbet, juice and gums packagings, and found out that expected sweetness was associated with pink colours and rounded patterns, and expected sourness was associated with yellow colours and angular patterns. In his review, Spence (2019) emphasizes that color-taste crossmodal correspondences occur in the environment and influence through predictive coding[34]. Reviewed studies prove that the influence of packaging over gustatory experience is highly context specific, and there are no specific relationships between colour and shapes and the taste expectations.

Labbe, Pineau and Martin (2013) investigated visual, tactile and auditory properties of food packaging materials in terms of expected naturalness of dehydrated soups. Labbe, et al. (2013) conducted both unimodal and trimodal experiments with eight different materials (two cardboards, three fabrics and three papers) with potential packaging application to understand the impact of perceptual interactions over naturalness expectation. Twelve trained assessors generated numerous terms, and seven terms were selected to be used as scales, four of which were tactile (suppleness, warmness, roughness and slipperiness) and three of them were auditory (noise pitch, sound homogenity and noise intensity). No terms about visual properties were generated so the visual properties of materials were not assessed in the study. In the experiment, 120 participants evaluated all eight materials in both unimodal (visual, auditory and tactile, separately) and trimodal conditions. Labbe, et al. (2013) found positive high correlations between expected naturalness and roughness, slipperiness and low noise intensity. Also Labbe, et al. (2013) found out that discriminations were better at unimodal condition rather than trimodal, and contribution values of sensory modalities to identify expected naturalness were found as 55% for tactile, 24% for visual and 21% for auditory. The study was not carried out as a real life setting, as material samples were used instead of prototypes of packages, and perceptual interactions were not demonstrated in the study.

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[34] Predictive coding is a brain function theory, which brain constructs explanations rather than extracting knowledge from sensations (Friston, 2018). In simple terms, every brain constructs its own world model depending on the evidences through sensorial interactions.

With its increasing popularity all over the world, coffee has been taking a lot of research interest lately in terms of investigating cup and beverage relationships (Lefebvre & Orlowski, 2019; Spence & Carvalho, 2019; Velasco, Woods, Petit, Cheok, & Spence, 2016). Colour (Dichter, 1964; Guéguen & Jacob, 2012; Carvalho & Spence, 2019), transparency (Van Doorn, Wuillemin, & Spence, 2014), texture (Carvalho, Moksunova, & Spence, 2020), weight (Lin, 2013; Kampfer, Leischnig, Ivens, & Spence, 2017) and shape and size (Van Doorn, Woods, Levitan, Wan, Velasco, Bernal-Torres & Spence, 2017; Carvalho & Spence, 2018) are the major physical qualities of the container that influence taste perception of the beverage.

Some outcomes of selected literature studies may help to understand how wide the array of research scope on multisensory coffee experience is. Lin (2013) found out that heavy containers are perceived as larger in volume. Kampfer, et al. (2017) reported that weight correlated positively with taste intensity. In a research about mugs' influence on taste perception of coffee, association of bitterness increases as the mugs get shorter, association of stronger flavors are greater with narrower mugs and wider mugs increase the perception of sweetness (Van Doorn, et al., 2017).

Van Doorn, et al. (2014) investigated the influence of colour on latte perception, and found that latte was perceived less sweet in white mugs compared to transparent mugs. In another study, 300 cross-cultural subjects were surveyed and cup diameters were found to be correlated positively with expected sweetness and negatively with aromatic taste, where short mugs evoked bitter and intense associations (Van Doorn, et al., 2017). On the influence of cup texture over coffee taste (Carvalho, Moksunova, & Spence, 2020), smooth textures were associated with sweetness, and rough surfaces were associated with acidity. Complementary findings were reported by Van Rompay and Groothedde (2019) as angular texture on coffee mugs enhance the bitterness taste perception.

In a very large scale cross-cultural study, Velasco, Michel, Youssef, Gamez, Cheok and Spence (2016) investigated the correspondence of color and sweetness. Velasco, et al. (2016) put six images of beverages with different colors on an exhibition area, and asked the subjects (n=5322) to choose a color that associated mostly with sweetness. Red colour was regarded as the sweetest in beverage perception, followed by blue. Interestingly, red was significantly separated from other colors in all cultures that participated in the study. Table 2.13 gives the findings in the study.

Table 2.13 Summarized percentage results of the question asked about beverage color associated sweetness. Adapted from Velasco, et al.(2016, p. 90)

Region	**Color**						**N**
	Blue	**Green**	**Orange**	**Purple**	**Red**	**Yellow**	
Africa	21.62	4.05	9.46	18.92	43.24	2.70	74
Asia	17.03	3.47	6.94	28.39	37.22	6.94	317
Europe	20.94	1.87	8.00	22.89	42.03	4.26	1337
North America	28.61	1.77	5.31	11.21	48.08	5.01	339
Oceania	26.67	2.00	4.67	19.33	41.33	6.00	150
South Africa	16.51	0.00	5.50	22.02	51.38	4.59	109
UK	32.58	1.27	5.48	15.64	39.09	5.95	2993
None	0.00	0.00	0.00	0.00	66.67	33.33	3
Total	27.81	1.62	6.22	18.21	40.68	5.47	5322

The influence of coffee mug shape over taste perception was investigated using three different mug shapes as tulip, open and split (Carvalho & Spence, 2018). Including expert and amateur coffee consumers, a total of 287 subjects evaluated shape-taste correspondences, and according to the subjects' reports, roundness was found to be correlated positively with sweetness, where perceived sweetness was highest for split mugs, followed by tulip and then open mugs, also aroma perception was stronger for tulip mugs, where acidity perception was higher for split mugs (Carvalho & Spence, 2018). The mugs used in the study can be seen in Figure 2.20.

Figure 2.20. Three different coffee mugs used in the study (Carvalho & Spence, 2018, p. 318)

In a more recent study, Carvalho and Spence (2019) investigated the correlation between cup colour and expected taste experience over 457 participants. Two types of specialty coffee were tested, and for sweetness, pink coloured mug for Brazilian coffee and yellow coloured mug for Kenyan coffee were reported as sweetest (Carvalho & Spence, 2019). Table 2.14 represents the findings of post-hoc experiment results.

Table 2.14 Post-hoc experiment results on correspondence between cup color and expected taste experience. Adapted from Carvalho and Spence (2019, p. 165)

	Brazilian coffee (high sweetness, low acidity)	Kenyan coffee (low-to-medium sweetness; high acidity)
Acidity	Green (lowest), White > Pink	Pink (highest), White (lowest)
Sweetness	Pink > Yellow > White > Green	Yellow (highest), Pink (Lowest)
Liking	Pink = Yellow > White > Green	Green = Yellow > White > Pink

As can be seen from the selected literature studies, multisensory research have been carried out through specific sensory attributes. It is quite difficult to accomplish a full-modal investigation on any specific material quality, such as surface roughness or brightness. Every perceiver perceives his/her surrounding in his/her own way. Perceiving is subjective. Also, each perceiver is unique in terms of physiological attributes. Longer arms may influence the reaction time of a person in a touching event, depending on the neural chain length that carries sensory data, where the moisture, skin thickness and heat level of the finger also affect tactile sensation. Objective measurement methods frequently fall short in finding significant results due to the subjectivity of the issue. To deal with subjectivity between participants, researchers use various procedures such as magnitude matching and threshold defining. Cultural backgrounds of the participants of the sensory experiments should not be neglected as they also influence test results.

Our everyday experiences are multisensory. We experience our surroundings in a multisensory way and senses can not be isolated and separated when a realistic multisensory behaviour analysis is made (d'Olivo, del Curto, Faucheu, Lafon, Bassereau, Lê, & Delafosse, 2013). A limitation of a multisensory research is that there are many different parameters that affect perception. Countless numbers of dimensions should be taken into consideration in a multisensory evaluation of material properties. Cross modality interplays deeply affect perception. Also as mentioned before, perception of material properties depends highly on the context where the product is situated in.

About interactions between senses, Haverkamp (2017, p. 7) explains how sensory experience is an influentual factor as follows:

> "Interactions between sensory data streams are not just side effects which can be neglected. On the contrary, these interactions essentially determine the multi-sensory impression of all objects and the whole environment. Perception is always multi-sensory. Conscious focusing on single senses does not occur in daily life, but merely under artificial experimental conditions. Even in case of stimulation of single senses, missing modalities can partly be substituted by the perceptual system. Missing data are then estimated from memorized sensory experience."

Previous sensory experiences (past experiences) also influence perception. Therefore, it can be said that any kind of sensory experience may affect our perception. Our perception can either be enhanced or altered, voluntarily (by our directing attention), or involuntarily (such as through crossmodal interactions). Temporality of sensory experiences have to be considered when conducting experiments.

One last thing to consider in a sensory research is the perceptual awareness of the perceiver. In most sensory studies, subjects were tested through specific sensory attributes accepted as the perceiver is already aware of them. It is possible that a user may be unaware of a material property during daily interactions with a product. To deal with this problem, some studies use verbal elicitation phases of the recognized sensory features on the specific context. These verbal elicitation phases consist of various qualitative descriptive methods. Subjective dimensions to be measured can be elicited through these elicitation phases.

As a summary, sensory research produces valuable results that can be used by designers to accomplish their design goals. Most of the phases in perceiving material attributes can be measured quantitatively (Haverkamp, 2013). Figure 2.21 represents the phases depending on their measurability in a perceptual process. Physical stimulus and reactions of the perceiver can be both measured objectively and subjectively. Neuronal activities and physiological processing of stimulus can only be viewed through technological methods such as brain mapping via functional MRI investigations. The most challenging part is to investigate the quality of experience, namely qualia. Qualia is regarded as experience related elementary mental conditions, which construct conscious experience (Cowan, 2008; Kanai & Tsuchiya, 2012; Orpwood, 2017). Qualia can be described with a popular example, as the "redness" of red. It is challenging to investigate qualia, not only because it is highly subjective, but also because it is difficult for a person to describe even his or her own qualia.

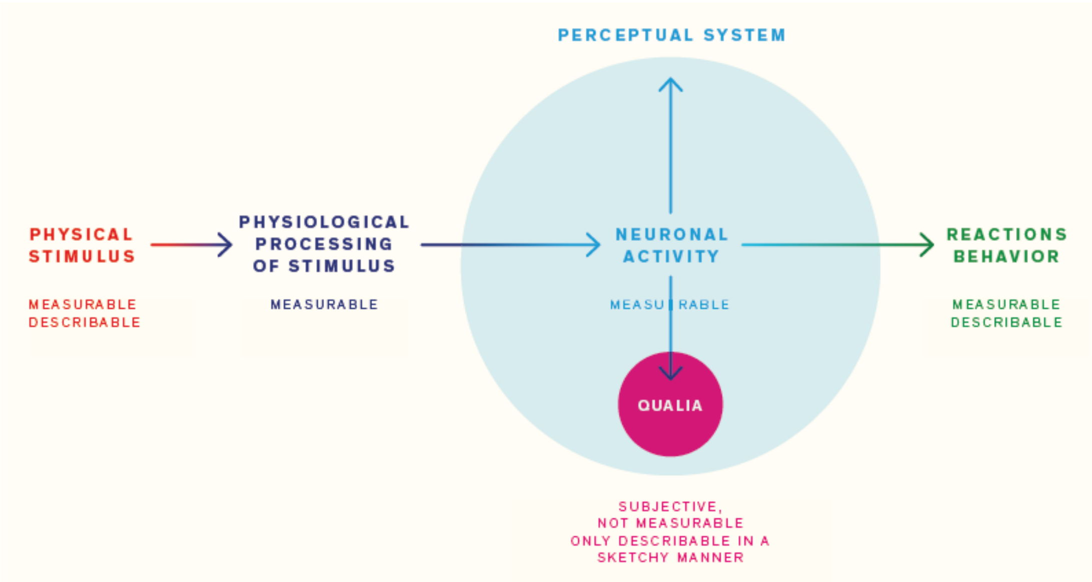

Figure 2.21. Measurability of perceptual qualities (Haverkamp, 2013, p. 113).

CHAPTER 3

METHODOLOGICAL BACKGROUND OF THE RESEARCH

In this chapter, methodological background of the research is explained. This research is grounded on Kelly's theory of personal constructs (1955/1963). The fundamental postulate and all eleven corollaries (i.e. construction, individuality, organization, dichotomy, choice, range, experience, modulation, fragmentation, commonality and sociality) of the theory are briefly described for a better understanding of the theory. Relationships between each corollary and the research topic are discussed through the perspective of materials experience. Furthermore, the data collection tool that is also developed by Kelly, Repertory Grid Technique, is introduced. In the final, terms and definitions, structure and practical aspects (application, elicitation and environmental setting) of the technique are explained in details.

3.1 The Psychology of Personal Constructs

Personal Construct Psychology (hereinafter PCP) was developed by George Kelly in 1955 to investigate patient behaviors in clinical psychology. In the center of his theory, Kelly (1955/1963) accepts every person as a scientist. A scientist puts an inquiry, formulates a theory, and tries to validate it by testing over and over again. Person as scientist, interprets the world in his or her unique way, and develops concepts through repetitive events, and tests these concepts for whether they fit the reality. These concepts, namely constructs, are the representations of reality and used for prediction and validation by the individual (Fransella, Bell, & Bannister, 2004). Kelly's theory accepts that every person has a unique way of seeing the world (Fransella & Neimeyer, 2005), and if a person's way of seeing the world can be construed, his or her psychology can be understood.

Embracing Dewey's idea of pragmatism[35], Kelly's theory of personality was distinguished from traditional psychological theories (Fransella & Neimeyer, 2005; Paris & Epting, 2015). Dewey's belief suggests that there is a need for imagination rather than certainty. PCP focuses on the personal construction of the reality, instead of dealing with reality itself (Butt, 2004). So it can be understood that Kelly's philosophy contains phenomenological aspects rather than realistic. The philosophical foundation of PCP is based on constructive alternativism (Kelly, 1955/1963; Chiari and Nuzzo, 2003). A person constructs his psychological system by construing events he or she experiences everyday. This process is constructive. Kelly (1955/1963) states that there are always alternatives in constructions, as follows: "We assume that all of our present interpretations of the universe are subject to revision or replacement" (p. 15). Every event in the universe is unique to itself, and does not repeat itself identically. As a person construes these events, the person's construct system evolves continuously. Each repetitive event is reconstrued again and again, and if an unexpected thing happens, a former construct may be replaced with a new one.

3.2 Fundamental Postulate and Corollaries

Personal constructs theory consists of a fundamental postulate and eleven corollaries. On his basic theory, Kelly (1955/1963) explains his fundamental postulate as "a person's processes are psychologically channelized by the ways in which he anticipates events" (p. 46). A person interacts with his surroundings, construes events which he can perceive, and develops constructs. Later, he uses constructs as transparent patterns to view through and interact with the world (Kelly, 1955/1963). Metaphorically, constructs resemble the lenses of eye glasses. Looking at the world

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[35] Kelly was influenced by not only Dewey's pragmatism; but also epistemology, mathematics and physics. Fransella and Neimeyer (2005, pp.7-9) discuss these topics in detail.

through eye glasses, if we change their lenses, the world is then viewed differently. We use our construct systems to anticipate events.

3.2.1 Construction Corollary

About **construction corollary**, Kelly (1955/1963, p. 50) states the following: “a person anticipates events by construing their replications”. We give meanings to construed events, and events do not build our construct system, we build our own psychological construct system. Similarities and contrasts are vital in construing in repetitive events. Without similarities, all events would be heterogeneous in a chaotic fashion; yet without contrasts, all events would be similar and discrimination would be impossible in that homogeneous world (Kelly, 1955/1963).

Alongside similarities and contrasts, beginnings and endings of events help to develop anticipations (Kelly, 1955/1963). The sun rises in the morning and sets in the evening. After repetitive risings and settings of the sun, we can define the length of a day. Following weather changes each day, seasons can be identified; and as seasons repeat themselves, we can understand years. By construing repetitive events among days, seasons or years, we can then be able to predict future events. Predictions rely on statistics. Kelly (1955/1963) defines statistical grounding of prediction as the relationship between the number of observed replications and the volume of likenesses in those replications after being construed.

Our anticipation towards materials be discussed in terms of construction corollary. Each interaction with a material makes us construe that event; we develop an understanding (construct) about a material after each repetitive interaction. This construct forms our anticipation towards that material in future encounters. After witnessing many times of the dropping of a glass on the floor shattering them into pieces, we construe these events as glass being brittle. To develop this construct, the chance of breaking of the glass after hitting the ground should be statistically higher than having no damage after impact.

3.2.2 Individuality Corollary

About **individuality corollary**, Kelly (1955/1963, p. 55) states the following: “persons differ from each other in their construction of events”. There are two reasons for this difference. Firstly, as aforementioned, no event in the universe doubles itself as exactly the same repetition. Secondly, anticipation towards the same event differs in between two different persons. As Kelly (1955/1963) states, taking A and B as different people, the roles of A and B can never be exactly the same in the same event. According to Kelly, A experiences B as the external figure, and B experiences A as the external figure. Yet they put themselves separately in the center of this event. Although the roles of A and B are not the same in an event, their separate experiences can contain similarities and contrasts.

Consider that A spent his life in cold climates and B, in contrast to that, in a region that is usually hot. Their anticipations towards a thermally conductive material, an iron pipe, would be different as A would anticipate this material as a cold material, and B would anticipate it as warm. As iron’s thermal conductivity is higher than human flesh, it conducts the environmental temperature faster. An iron pipe under cool weather is experienced as cold when physically interacted with. Conversely, the pipe would be experienced as hot in warm climates. When A and B experience the iron pipe under the same hot climate, both A and B would define the pipe similarly as warm; yet the degree of warmth would be different as they have different construction systems.

3.2.3 Organization Corollary

About **organization corollary**, Kelly (1955/1963, p. 57) states the following: “each person characteristically evolves, for his convenience in anticipating events, a construction system embracing ordinal relationships between constructs”. People not only construct their psychological systems, but also hierarchize their constructs. Constructs are grouped depending on their range of convenience, and there are ordinal relationships between them. Superordinate constructs lie on the top of these hieararchal organizations, and have relationships with their subordinate constructs (Kelly, 1955/1963). Superordinate constructs carry meanings which are more general (such as good vs bad). They subsume subordinate constructs, which carry more specific meanings (such as intelligent vs stupid). A person can link intelligency with goodness, and stupidity with badness in his construct system. The most crucial aspect of construct organization is its self consistency (Kelly, 1955/1963). Without consistency, the construct system would carry no meaningful relationships in between construct groups, therefore we would not be able to develop any anticipation towards events.

We can have predictions over unfamiliar materials for us, relying on the organization of our past materials experiences. The unfamiliar material may contain some aspects that we are familiar with. By referring to our construct organization, relationships in organized construct groups would help us delevop anticipations towards even the most unknown. Consider that a vase is perceived as marble by just viewing from a distance. In our construct system, marble may have been experienced as heavy, cold and precious. After getting closer and starting to have interactions with the vase, we suddenly feel that it is not as heavy and cold as expected. Still, it looks like marble, yet does not feel like marble. Again, we consult our construct organization to find relationships that make sense in defining such a material.

3.2.4 Dichotomy Corollary

About **dichotomy corollary**, Kelly (1955/1963, p. 59) states the following: “a person’s construction system is composed of a finite number of dichotomous constructs”. To form a construct, similarities and contrasts are needed. At least two elements need to be similar and in contrast with the third in terms of an aspect (Kelly, 1955/1963). The aspect should be the same for all corresponding elements. Considering height as the same aspect for three people, say A, B and C; A and B are similar (both tall) in height and contrast with C (short). The construct of height among A.B and C is dichotomous. Yet, if the aspect is not the same for all the elements, it would not be possible to form a construct. Let us try to put another element D, the weather, into the comparison through height. Height is in the range of convenience of a comparison among A, B and C, which are human. However, it does not make any sense to compare D with A, B and C in terms of height. It is irrelevant to express if the weather is tall or short. It does make sense to express that an apple is not an orange, yet it is irrelevant to say the weather is not an orange. Depending on relevancy, a person creates a new construct by referring to the former ones in his psychological system. Therefore, the psychological construct system is not infinite; it is limited to the amount of constituted dichotomous constructs.

As can be understood from above, an important fallacy of relevance in between elements may be the tangibility of elements. As materials are physical substances, there should be no or little relevancy problems expected in a comparison in between. Nevertheless, materials earn different roles on different product types. The use of materials on a certain kind of product type may evoke associations unique to its context. Comparing the glass screen of televisions with glass bottles may lead to some relevancy problems. Broadly, the function of a television screen is to preserve and reflect color qualities precisely. On the other hand, health and gustatory concerns play the major role in glass bottles. Gustatory qualities of a television screen is not convenient in its context. Again, the durability of a windshield of a car can be found similar with a shop window compared to the brittleness of a glass bottle as a contrast, yet makes little sense to our anticipation towards glass as their contexts differ.

3.2.5 Choice Corollary

About **choice corollary**, Kelly (1955/1963, p. 64) states the following: "a person chooses for himself that alternative in a dichotomized construct through which he anticipates the greater possibility for extension and definition of his system". A person anticipates an event by deciding on a pole on a dichotomous construct related to the context. It is a self-awareness process as the individual chooses from alternatives that are open to him (Boxer, 1982). How a tree can be cut depends on such a choice could be an example. Should it be insecure or safe? The person considers that insecure cutting could be faster and make him save some time, yet it is more dangerous than slow and safe cutting as he may injure himself with an uncontrolled blow. He predicts consequences of each act, then decides to choose from alternatives. Kelly (1955/1963) admits that choosing activity is elaborative. It is elaborative since either pole of the construct would result as a different outcome, and this makes people develop their anticipations.

We anticipate materials by choosing either pole of a construct about them. Consider a person's anticipation towards a ring with a diamond. In that person's construct system, diamond is evaluated with its sturdiness. Although he predicts that diamond is sturdy enough to grasp, he also believes that it is extremely precious and should be protected from any surface damage. In an encounter with that material, the person has to make a choice if he is going to grasp the material roughly or pick it up gently because he also believes that such a precious thing should be handled cautiously. He needs to make a choice about how he is going to pick the diamond up. His alternative choices may lead to different results in his interaction with diamond.

3.2.6 Range Corollary

About **range corollary**, Kelly (1955/1963, p. 68) states the following: "a construct is convenient for the anticipation of a finite range of events only". Kelly (1955/1963) admits that a person can relate only a few personal constructs to the everything he faces with. Even the construct with one of the widest range of convenience, good vs bad, may not be appropriate for everything. As a simple example, the construct of big vs small can be applicable in comparing a small tree with a big tree, a small animal with a big animal, or a small house with a big house; yet it does not make any sense to say a big weather or a small weather. A person forms a construct with a limited range of convenience, and the personal usage of this construct can be understood only if we learn how he generalized the concept (Kelly, 1955/1963). To understand this, both poles of a construct, say outgoing vs hostile, should be taken into account together, not separately. If we take the outgoing dimension separately without hostile in this concept, only what is not outgoing does not provide us a clear definition.

The personal experience of material properties may be understood properly if we can learn how these properties are conceptualized by each person. Thinking through the range corollary, range of convenience in material usage could differ the with context of the material usage. Discussing about the gustatory properties of stainless steel may be more relevant on its usage in a kitchen utensil rather than its usage in a truck wheel rim. In addition to that, a property may be construed as traditional in one context and technological in another. Both poles of a construct should be known in order to understand the intended expression. A person expresses a material property as bright. If we take bright as a single concept (without its contrast), it may not be possible for us to understand how the person conceptualized his construct. Does he mean shiny or smart by saying bright? Without the contrast of this expression, the correct understanding of the intended meaning would be difficult. The construct of bright vs dim differs from bright vs silly.

3.2.7 Experience Corollary

About **experience corollary**, Kelly (1955/1963, p. 72) states the following: “a person’s construction system varies as he successively construes the replication of events”. Kelly (1955/1963) admits that a new construct is created when an unexpected event is construed, and the experience is formed if an event is construed successfully. Events themselves do not compose experience, yet our understandings of events do. Successful construing of repetitive events are recorded as experiences, and we try to validate our experiences through our anticipations towards our surroundings. If our validation fails in an anticipation against an event, we reconstrue and obtain a new experience. As Kelly (1955/1963) states, our previous experiences are the basis of our future predictions, and the amount of experience gain depends on the amount of trials of exploration over the situation. Low amount of discovery trials means a low amount of experience gathered throughout the process.

We can infer from experience corollary that the experience of materials is not formed by the material attributes themselves, yet our understanding of material attributes creates experience. So the experience of brittleness of a material is not created by just because of the formation of the atoms. It is the reflection of repetitive trials of exploration that creates experience. A theoretical information, such as reading that a mirror is brittle, would not be counted as an experience unless it is construed in an event. And even though a material is brittle, it may be experienced as unbreakable by some in different situations. So it would be more proper to understand user experiences about materials rather than assigning experience tags on the materials.

3.2.8 Modulation Corollary

About **modulation corollary**, Kelly (1955/1963, p. 77) states the following: "the variation in a person's construction system is limited by the permeability of the constructs within whose ranges of convenience the variants lie". Kelly (1955/1963) puts emphasis on the importance of determinism and freedom in a personal construct system as a person develops his constructs depending on these concepts. If a person is conservative and more likely to stick to his core principles and limits himself in seeing things in the events, his construct system is deterministic. In contrast to that, a person with freedom-based construct system is open for subordinate system changes that occur through daily minor unexpected events. Defining constructs as permeable (being capable of embracing new components), Kelly (1955/1963) admits that a determinist person may not be open for embracing new experiences compared to a person with freedom. A determinist person may strictly limit his anticipation as "this event is bad, and by no means it can be good". As he does not accept any new idea on this process, his construct system will not be changed. On the other hand, a non-determinist person with the same anticipation as "this event is bad" towards the same event would be followed by "it can be good". Furthermore, a construct can be evolved into a new construct. Kelly (1955/1963) gives an example, of which a childhood construct, fear vs domination may evolve into respect vs contempt when maturated. This evolution happens because of the permeability of the construct. Our subordinate systems are more likely to evolve progressively depending on the range of convenience of the events.

Since constructs are permeable, every interaction with a material may add some elements to the constructs in our psychological system. Even the most insignificant interaction may have a minor impact on our experience with the related material. Also, our anticipations towards materials vary depending on how determinist or independent we are. Consider an ancient wooden bridge over a canyon, which has never collapsed. Each time a person walks on that bridge, he hears a cracking sound in each step. The determinist hears the cracking sounds, he walks without fear as he still believes that the bridge will not collapse as it has been existing for decades. For him, wooden bridges are reliable. He does not give any credit to the cracking sounds and he does not embrace any new experience. Conversely, when the same cracking sounds are heard by the independent, his reliance with the material of the bridge may weaken. He starts to walk cautiously and safe. His constructs about the wooden bridge experience has evolved, therefore his anticipations are also evolved.

3.2.9 Fragmentation Corollary

About **fragmentation corollary**, Kelly (1955/1963, p. 83) states the following: “a person may successively employ a variety of construction subsystems which are inferentially incompatible with each other”. Fragmentation corollary is interrelated with modulation corollary. As mentioned before, modulation corollary accepts constructs as permeable, and each minor unexpected event related to the construct makes progressive changes on them. For fragmentation corollary, Kelly (1955/1963) expresses that there needs to be no direct relationship in between the old construct and the new construct. This does not mean that every new construct is incompatible with the previous constructs. Consistency among constructs diversifies in each personal construct system. Some people have more consistent and organized construct systems, yet some have many incompatibilities in their systems. According to Kelly (1955/1963), as the consistency decreases among constructs in a psychological system, the ways of anticipation towards reality becomes more odd.

Fragmentation corollary fits best to the situations of experiencing a same material differently in different contexts. The perception of a same material attribute varies in different contexts. It would not be proper to say universally that glass is easy to break. Glass can be used in breakable form in emergency alerts, it also can be used in non-breakable form in jewellery shop windows. Embracing a new construct about a material experience may not be stacked on the previous construct. Instead, our psychological system captures a new experience as a fragment no matter how inferentially incompatible it is, and uses it when needed. However, inconsistent construct systems may also cause fallacies in anticipations towards materials.

3.2.10 Commonality Corollary

About **commonality corollary**, Kelly (1955/1963, p. 90) states the following: “to the extent that one person employs a construction of experience which is similar to that employed by another, his psychological processes are similar to those of the other person”. As discussed before, a same event can not be experienced identically the same between two separate persons. For commonality corollary, Kelly (1955/1963) expresses that if a same event is construed similarly, the psychological systems of these persons may be similar, therefore their anticipations towards a same event may be similar too. What Kelly emphasized by similarity is not the similarity of experiences, it is the similarity of construction of experiences. Even though a person’s background, way of thinking or worldview is different than the other, they may still construe an event similarly. According to Kelly (1955/1963) people construe events similarly in a culture.

It can be inferred from commonality corollary that people having similar psychological processes construct material experiences similarly. So detecting similarities in anticipations towards material properties can be crucial in order to understand cultural aspects in user-material interactions. A perfect example can be given as the anticipation of Japanese culture towards wood materials. Japanese people find wood material extremely valuable and they have respect to the nature of the material (Mertz, 2016). Also, it is vital for designers to predict user anticipations towards a material property in order to create successful user-material sensorial interactions. Finding similar anticipations towards a material property in the same context may enable designers to develop concepts and establish common grounds for experience design.

3.2.11 Sociality Corollary

About **sociality corollary**, Kelly (1955/1963, p. 95) states the following: “to the extent that one person construes the construction processes of another, he may play a role in a social process involving the other person”. Kelly (1955/1963) explains this corollary with the traffic example, where drivers predict other drivers’ behaviors accurately to drive safely even in the most crowded situation. The drivers’ guessings over other drivers’ behaviors are more than the commonalities or similarities of their psychological system. It is the understanding of others’ roles in the same context (Kelly, 1955/1963).

Like in the traffic example, understanding the role of the user in a user-material interaction would be beneficial for a designer in predicting user behaviors accurately. Retail shop designers understand how customers interact with textiles, so they present textiles on hangers where customers can touch and experience the material. Although there are no written rules such as “touch before buy”, a general conceptualization of customer behaviors were developed to provide a tactile interaction. The role of the user influences his anticipations towards materials in a context. If the role of the user can be understood, the design can easily be adjusted to the needs of that user.

A brief summary of the fundamental postulate and corollaries of Kelly's PCP, and their positioning within the scope of this thesis were provided. According to Kelly's theory, an individual knows much more than he/she can tell (DelMonte, 2011). For Kelly, construing occurs as high levels and low levels of construing. High level construing covers thinking processes where both poles of a construct are distinct, while unconscious construing is comprised of processes such as preverbal, suspension and submergence (DelMonte, 2011; Kelly, 1955/1963). Preverbal construing lies on the bottom level where verbal labels are not available (DelMonte, 2012). In other words, preverbal construing is about things we know, but are unable to tell verbally. As no verbal labeling is made in preverbal construing, conscious thinking for sense-making is unlikely possible. However, DelMonte (2011) explained that there is a potential to generate labels in preverbal construing. In submerging, only one of the poles of a construct is available, and in suspension, incompatible experiences are removed (through forgetting or repression) from the conscious construct system as new constructs are formed (DelMonte, 2011).

Verbal symbolisation is quite limited in lower levels of construing. Schwartz (2000) reported that more than 95% of mental processes occur sub-consciously. Using an approach developed for reaching the below conscious section of the individual's sense-making processes is considered beneficial in understanding latent information of how individuals anticipate materials. To explore mentioned latent information, Repertory Grid technique is adopted.

3.3 Repertory Grid Technique

Kelly (1955/1963) developed the Role Construct Rep Test (hereinafter Rep Test) as an instrument to explore personal constructs, how they are elicited and how they are related to each other. The early uses of Rep Test were to identify how a person deals with specific issues and understand that person's relationships with specific people in a clinical setting (Kelly, 1955/1963). The aim of this instrument was for subjects to make comparisons between particular issues and people in their unique way of construing. Overall, Rep Tests and their procedures will be represented as Repertory Grid Technique (hereinafter RGT).

3.3.1 Terminology

The terms and definitions of the methodology needs to be clarified before progressing to the other aspects of RGT. The main purpose of RGT is to elicit idiosyncratic attitudes towards perceived material properties. Kelly's theory accepts that an individual interprets an event or a situation in his/her personal way and develops anticipations (personal constructs) that are idiosyncratic in nature (Peck, 2015). First of all, a construct has a range of convenience and a focus of convenience (Kelly, 1955/1963, p. 137). If a person finds things that are useful in practice related with a construct, those things lie in the range of convenience of that construct; and if a construct has the uttermost usefulness in dealing with a particular situation, it is the focus of convenience. Each Rep Test has a context, and consists of elements. Elements, are "the things or events which are abstracted by a construct" (Kelly, 1955/1963, p. 137). Context is the particular topic that is in convenience with the elements which took role in that investigation. As an example, in a study about investigating computer mouses (context), elements can be computer mouses with various brands and types in regards with the range of convenience of the context. As previously mentioned in Dichotomy Corollary, constructs have poles. Each construct has two poles that are counterpart of each other. One pole shows the likeness of that construct with the elements, which named as likeness end; and the opposite of that pole is the contrast end (Kelly, 1955/1963, p.137). While exploring likenesses and contrasts of the elements, the first perceived quality (can be either a likeness or a contrast) is named as the emergent pole. The contrast of the emergent pole is defined as the implicit pole.

3.3.2 Structure of RGT

As mentioned before, RGT was developed as an instrument to elicit constructs to understand the psychological system of the subjects. It is a data collection technique, which may contain both qualitative and quantitative data (Bell, 2003). The correlations between the elements and the constructs may provide quantitative data, whereas the elements and the constructs, alone, may represent qualitative data. Kelly (1955/2003) developed repertory grid sheets in order to record elicited constructs. As can be seen in Figure 3.1, a patient's grid sheet was filled with 22 elicited constructs in regards with 19 elements in a clinical application. Depending on their emergent or implicit conditions, constructs were positioned on the right side of the sheet. The elements, which were defined in regards to the investigation topic, were positioned on the left.

Self	Mother	Father	Brother	Sister	Spouse	Ex-flame	Pal	Ex-pal	Rejecting Person	Pitied Person	Threatening Person	Attractive Person	Accepted Teacher	Rejected Teacher	Boss	Successful Person	Happy Person	Ethical Person		CONSTRUCTS	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	SORT NO.	EMERGENT POLE	IMPLICIT POLE
						✓			✓		✓					⊗	⊗	O	1	*Don't believe in God*	*Very religious*
			✓	✓			✓						⊗	⊗	O	✓			2	*Same sort of education*	*Complete different education*
✓		✓	✓	✓	✓			✓	⊗	O	✓	⊗	✓			✓			3	*Not athletic*	*Athletic*
	✓				⊗	⊗	O					✓							4	*Both girls*	*A boy*
✓	⊗	⊗	O	✓	✓		✓						✓	✓	✓	✓	✓	✓	5	*Parents*	*Ideas different*
			✓	O			✓						⊗	✓			⊗		6	*Understand me better*	*Don't understand at all*
	⊗	✓	✓					O					⊗	✓	✓			✓	7	*Teach the right thing*	*Teach the wrong thing*
	✓	O	✓										✓		⊗	⊗	✓	✓	8	*Achieved a lot*	*Hasn't achieved a lot*
			⊗	✓			✓		O				✓	⊗	✓	✓			9	*Higher education*	*No education*
				⊗		✓			⊗					O					10	*Don't like other people*	*Like other people*
✓	✓	✓		⊗	✓		✓			O	✓		✓	✓		✓	✓	⊗	11	*More religious*	*Not religious*
✓	✓	✓	⊗			✓	✓	O	✓	✓	⊗	✓	✓	✓	✓	✓	✓	✓	12	*Believe in higher education*	*Not believing in too much education*
	✓		✓		O				✓	✓	⊗		✓		✓		⊗		13	*More sociable*	*Not sociable*
	O				⊗	⊗						✓							14	*Both girls*	*Not girls*
	✓	O			⊗	⊗						✓							15	*Both girls*	*Not girls*
✓	✓	✓	✓	✓			⊗	O				⊗	✓	✓		✓	✓	✓	16	*Both have high morals*	*Low morals*
⊗			⊗	O	✓		✓		✓		✓	✓	✓	✓			✓	✓	17	*Think alike*	*Think differently*
			✓	✓										✓	⊗	⊗	✓	O	18	*Same age*	*Different ages*
	⊗	⊗		✓						✓	O		✓	✓	✓	✓	✓	✓	19	*Believe the same about me*	*Believe differently about me*
				✓		✓	⊗	⊗	✓	✓	✓	O							20	*Both friends*	*Not friends*
						O	✓						⊗	⊗	✓	✓	✓	✓	21	*More understanding*	*Less understanding*
⊗			✓		O	✓	⊗					✓		✓		✓		✓	22	*Both appreciate music*	*Don't understand music*

Figure 3.1. A sample repretory grid sheet *(*Kelly, 1955/2003; p. 192)

A grid, in its most basic form, contains a topic, elements, constructs and ratings (Jankowicz, 2003). Grids can be utilized in a wide range of fields. As Jankowicz (2003, p. 9) states, repertory grids have general applications (such as decision making, personal likes and dislikes), educational applications (such as lecture evaluation, comparison of curriculums), clinical applications (such as understanding a patient's psychological condition) and occupational applications (such as expert evaluation on products or services, new product development based on consumer reflections). A simple repertory grid template can be seen in Figure 3.2. The sample grid has blank spaces for constructs to be filled on the left side and right side of the sheet. This separation is made to position a pole of the construct on the left, and the other pole of the construct on the right. In the middle of the poles of the constructs, the rating scale is fitted. Each box in the rating scale is related to an element. The subject's ratings about elements will be filled into these blank boxes.

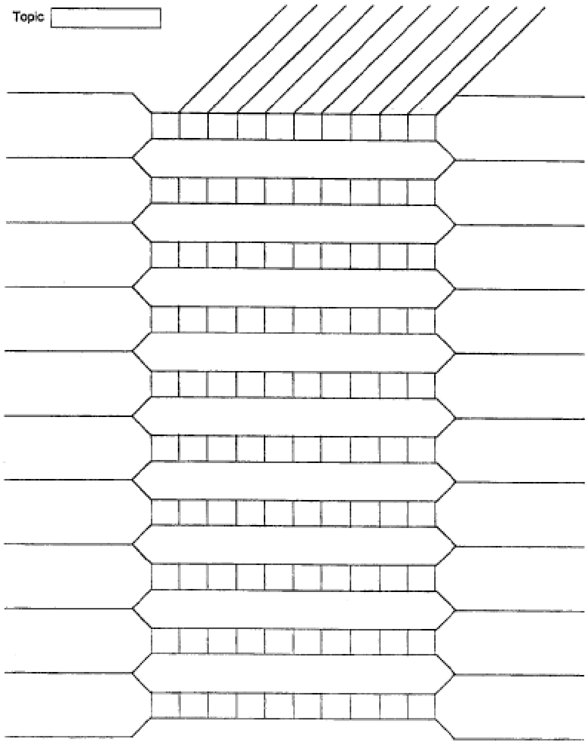

Figure 3.2. A simple grid sheet *(*Jankowicz, 2003; p. 25)

Preparing a grid sheet starts with defining the topic and choosing the elements. A grid is prepared within a specific topic and the investigation is made in order to understand the experience of the subject related to the topic (Jankowicz, 2003). After the topic of the inquiry is clearly defined, the next step is the selection of the elements. The elements should be chosen within the range of convenience of the topic. As an example, in a study where personal hygiene is the topic, choosing toothbrushes as elements would make sense, whereas considering trees as elements would be irrelevant to the topic.

Bell (2003; p. 96) states that the elements choosing phase is very important as various approaches can be adopted for choosing elements such as pre-selected elements, choosing from a list of elements and eliciting elements and constructs alternatively. Most of these approaches are held in clinical applications. Systematic comparison of elements are made to understand the subject's anticipations (Jankowicz, 2003; p. 13). Systematic comparison of elements means that the order of the element pairs were arranged before the study. Balanced incomplete block design is a method to set an equal number of element pairs to be compared in the study (Leach, Freshwater, Aldridge, & Sunderland, 2001). A full random order of element pairs would be problematic as some elements may never be compared in a study.

Bell (1990) stresses that choosing more than seven elements start to cause problems in terms of considering all variations of pairing in a study. In his example about Kelly's sample grid with 24 elements, Bell (1990) points out that more than two thirds of the possible element pairs were not taken into account. A purpose specific elements choosing technique would be proper to meet the expectations of the inquiry.

As the topic and the elements are set, constructs can then be elicited. As discussed before, the constructs represents the person's way of seeing the world (Jankowicz, 2003; Kelly, 1955/1963). By construing elements (as events), the subject elicits constructs. The construct elicitation process should be held carefully in order to capture precise information from the subject (methods about construct elicitation will be discussed in a details in the following section). Ratings section is the last entity of a grid. Although various scales (such as 13-point scale from -6 to +6 or 7-point scale from -3 to +3) have been used frequently, simple ratings (such as 1 to 7) are found to be more practical to be used in computer calculations (Bell, 2003; p. 98).

3.3.3 Application of RGT

Once the grid sheet is prepared for the particular inquiry, RGT can be applied with the subject(s). The task of the personal construct practitioner is to intervene for the subject to elicit constructs (Fransella, 2005). The basic principle of the RGT is to make interviewees construe through the relationships of elements that are presented in a study. RGT does not consist of mainly showing the elements to the subjects and reclaiming their expressions. There would be no detail and in depth understanding of the subject's personal construct system if it only consists subject's self reports. Instead, RGT is an interactive technique and requires interviewing skills. There are two widely used interviewing techniques to increase details in eliciting constructs. These techniques are called laddering and pyramiding (Jankowicz, 2003; Fransella, Bell, & Bannister, 2004).

Laddering is used to elicit superordinate constructs (Fransella, Bell, & Bannister, 2004). Basically, after a construct is elicited, the practitioner tries to dig deeper in the subject's personal hierarchical construct organization by asking "How" and "In What Way". After each answer, a new ladder is revealed. As an example, consider that a subject elicits a construct as "makes me happy" as one pole, and "makes me sad" for the opposite pole. It is not clear what makes him happy in that event, since a person may say this to nearly everything. By using laddering technique, the interviewer may ask "how" or "in what way" that event makes him happy or sad separately. If the interviewee can answer to these questions, say "I feel trustworthy" and "I feel unreliable", this makes the interviewer reveal a ladder of the interviewee's superordinate-subordinate hierarchical construct system. Again, the procedure can be continued by asking “in what way do you feel trustworthy”. This procedure continues until the subject will not be able to answer and create any new construct.

Pyramiding is an interviewing tool to “investigate the variety of a person’s construing” (Jankowicz, 2003; p. 67). In the laddering procedure, only the answer after a laddering question was taken without any variation. In the last example, the construct “makes me happy” can be a result of “feeling trustworthy”. Here in pyramiding, the opposite of “feeling trustworthy” is asked to the interviewee. Let us say the interviewee expresses the opposite of “feeling trustworthy” as “being a loser”. This questioning is repeated with the other pole of the first construct also. Right now it can be understood from the answers that both “feeling unreliable” and “being a loser” make the subject sad. In pyramiding, the relationships between the superordinate constructs and the subordinate constructs are investigated by expanding each pole of the construct separately (Jankowicz, 2003; p. 66).

Both of these interviewing techniques could be used to elicit detailed constructs. They can be used separately, or can be combined. Also there are no strict rules for using both methods. A practitioner can utilize these methods in his/her own way.

3.3.4 Construct Elicitation

There are many ways of construct elicitation techniques available in the literature, varying from full context form (where all elements are presented simultaneously and the interviewee chooses the most similar pair and explains why s/he chose them) to the catch-all question (asking the interviewee about a new construct that can be applied to all elements in the study) (Jankowicz, 2003; pp. 53-54; Marsden & Littler, 2000; Epting, Probert, & Pittman, 1993). Two of these construct elicitation techniques, triading and dyading elicitations, are being used more frequently than their counterparts (Fransella, Bell, & Bannister, 2004; pp. 27-30).

3.3.4.1 Triadic Elicitation

Construct elicitation from triads of elements, namely “minimum context form”, is the basic procedure for Kelly in his clinical applications (Fransella, et al.,2004; Bell, 2003; Jankowicz, 2003). The idea behind triading elicitation is to present three elements and ask the subject to select two of them which are alike in a way that differs from the third (Caputi & Reddy, 1999; Kelly, 1955/1963). Here, the similarity is taken as the emergent pole of the construct. There are two approaches for eliciting the contrast pole of that construct. Difference method is simply the difference of the third element from other two, whereas opposite method is applied by basically asking the opposite of the likeness (Epting, Suchman, & Nickeson, 1971; Yorke, 1978). Both methods can be used to elicit the contrast pole, which is taken as the implicit pole of the construct. As the subject starts to construe elements, the elicited constructs should be recorded on the grid sheet.

Triadic elicitation has advantages as elicited constructs offer a reliable base for analysis, yet it may be difficult to grasp for some subjects (such as children or people with lesser intellectual level) (Keen & Bell, 1980). The intellectual capability of the target subjects should be considered if a triadic elicitation is planned. The grid designer also needs to decide about the number of triads that will be made in an interview. Fransella, et al. (2004) recommend that although there are no restrictions upon deciding on the number of triads, it would be proper to define a period of time. A study with seven elements include a possibility of 35 triads, and with 10 elements the number arises to 135 possible triads (Fransella, et al., 2004; p. 27). An interview that lasts too long may make the process exhaustive.

3.3.4.2 Dyadic Elicitation

Dyadic elicitation is another widely used construct elicitation technique. In dyadic elicitation, a pair of elements are presented to the interviewee and asked if they are alike or different in some way (Fransella, et al., 2004; Jankowicz, 2003; Caputi &

Reddy, 1999). The likeness or the difference stated by the interviewee is accepted as the emergent pole. The implicit pole is obtained through the opposite method as used in triadic elicitation. Like in triadic elicitation, the elicited constructs are recorded on the grid sheet.

Dyadic elicitation is simpler than triadic elicitation as more complex cognitive processes are required in comparing three elements rather than two (Caputi & Reddy, 1999). Also, dyads are used generally when the elements carry complex attributes (Epting, et al., 1993). Dyadic elicitation can be considered as a solution to deal with complicated factors in a personal constructs study.

Both triadic and dyadic elicitation processes have advantages and disadvantages when compared to each other. The RGT practitioner should choose the most appropriate method for the investigation topic. Also, the sample population plays a role in considering both methods.

3.3.5 Environmental Setting

RGT is an interviewing method and the researcher should pay attention to the environmental setting. There are a few features that should be taken into consideration for increasing the efficiency of the technique. As Jankowicz (2003) states, the interviews should be carried out in a quiet environment and protected from disturbance for the estimated duration of the session. Any unexpected disturbance would be harmful for the concentration of the interviewee. Also, a relaxed environment with at least a table and enough seats for the interviewer and the interviewee would be necessary (Jankowicz, 2003). The interviewee should be clearly informed that the focus of the study is the subjective expressions, not the right answers. Also, social skills should be used effectively to maintain a relaxed environment.

CHAPTER 4

THE EXPERIMENT AND RESEARCH METHOD

This thesis intends to explore sensory and attitudinal approaches of individuals towards perceived material properties in product context. There is a deficiency in the materials experience literature in using a psychological approach for exploring attitudinal approaches of individuals in their own statements with their full modal (five sense) sensory relevancies together towards perceived material qualities that individuals are perceptually aware of. A term is offered as senso-attitudinal, which can be described as personal attitudes with their sensory relevancies. Every new sensory interaction with the same product material arises novel impressions that modify previous experiences of the individual with the related product material and this influences the future anticipations towards forthcoming interactions. In this context, a dynamic investigation is needed to explore such a dynamic interplay of attitudinal aspects of individuals.

4.1 Aim and Objectives

For this end, a research is planned that consists of a series of studies with different products to investigate how material experiences and their sensory relevancies change in different contexts. Two different product types were chosen as computer mouses and water bottles to explore how individuals construe perceived material properties. This research intends to capture idiosyncratic attitudinal expressions (personal constructs) of individuals through dynamic full modal interactions with physical material samples in two different product contexts by utilizing Repertory Grid Technique. The objectives for the research are separated into two levels. Broadly, the first level is comprised of exploring individual idiosyncrasies and the second level attempts to investigate relationships between common attitudes.

The first level objectives for the research are defined as:

- to elicit idiosyncratic attitudinal expressions of individuals towards perceived material qualities through construing of the sensible material qualities on specific product types;
- to explore commonalities between the elicited attitudes and investigate sensory relevancies of common attitudes.

The elicitation of the personal expressions in the first level objectives is required to understand the way the individuals give meaning to the material properties they perceive in the product context. Every individual perceives the world in a unique way, therefore each individual has his or her own way of seeing materials. The exploration of common statements would provide insights about common understandings of the perceived meanings. Also, the investigation of the sensory relevancies of elicited personal attitudes would be a reference in describing the sense-attitude relations. In other words, sensory relevancies would provide better understanding of which sensory modalities contribute to each elicited attitude.

The second level objectives include the exploration of the components underlying the attitudes elicited commonly and investigating attitude-product relationships. The second level objectives for the research are defined as:

- to explore latent structure of the common elicited attitudes;
- to investigate relationships between the attitudes and the sample products.

4.2 Research Questions

This research deals with two major research questions:

- How do individuals construe material qualities they perceive through sensory interactions in their own statements?
- How are senses, perceived material qualities and individuals' attitudes related to each other?

It is expected that the adoption of RGT as a method will enable to find the answers to the research questions. This exploratory research relies on a data driven approach. Another research question would then have to be asked after the answers are found for the questions stated above:

- How can attitudinal and sensory information be merged to develop senso-attitudinal maps?

To answer the third question, an experimental design is needed for presenting both qualitative and quantitative data as senso-attitudinal maps. Table 4.1 presents the outline of the aims, objectives and research questions alongside the phases of the study.

Table 4.1 Outline of the aims, objectives and research questions of the study

	PHASES		
	EXPLORATION	EXAMINATION	ILLUSTRATION
AIM	Exploring sensory and attitudinal approaches of individuals towards perceived material properties in product context	Examining the tacit components of the attitudinal approaches of individuals and investigating relationships between the common elicited attitudes and products	Illustrating the attitudinal and sensory information as senso-attitudinal maps
OBJECTIVE	-to elicit idiosyncratic attitudinal expressions of individuals towards perceived material qualities through Repertory Grid Technique -to explore commonalities between the elicited attitudes –to investigate sensory relevancies of common attitudes.	-to explore latent structure of the common elicited attitudes -to investigate relationships between the attitudes and sample products	-to present attitudinal and sensory information together in a practical and interpretative way
RESEARCH QUESTION	How do individuals construe material qualities they perceive through sensory interactions in their own statements?	How are senses, perceived material qualities and individuals' attitudes related to each other?	How can attitudinal and sensory information be merged to develop senso-attitudinal maps?

4.3 Research Approach and Methodology

The way of seeing the world of an individual is unique. It is a psychological process in which each individual has unique experiences and perceptual awareness. To explore in what ways the individuals perceive materials, it is important to adopt an approach to investigate how sensible product material properties are construed by individuals. The research approach should be capable of capturing information that can be used for a better understanding of material experiences. Imperceptable/unnoticable stimuli through improper material decisions is a problem to avoid in eliciting desired experiences in users. Also, sensory feedback would contribute in understanding the relationships between sensory interactions and senso-attitudinal information can be used as trigger points in evoking experiences. So there is a need for a proper research approach fulfilling the mentioned requirements of the research inquiry.

This exploratory mixed methods research primarily adopts the utilization of the Repertory Grid Technique (hereinafter RGT). The RGT developed by Kelly (1955) is a versatile data collection method that contains both qualitative and quantitative approaches within. Although RGT has a wide usage in many fields such as consumer and marketing research, it is mostly used in a limited way mainly for eliciting constructs. The usage of RGT is limited, because the investigation of multiple repertory grids is a highly complex process. Also in the literature of the field of material experience, any adaptation of RGT to investigate sensory and experiential aspects of materials on product samples was not found. The research approach of this thesis is inspired from a color research study, in which multi-attitudinal approaches of color perception are investigated through RGT (Akbay, 2013). In this thesis, RGT was structured to capture both attitudinal and sensory data at the time of the interaction, where the same participants explore and evaluate simultaneously in the same study.

RGT is utilized for this research to explore how perceived material properties in products are construed and how these perceived qualities are verbally expressed as attitudes and to what degree the sensory modalities have role in forming these attitudes. This research is planned to be pursued under controlled conditions as an experiment, and henceforth referred to as experiment throughout this study. This planned experiment aims to discover the relationship between dependent variables (idiosyncratic attitudes) and independent variables (physical samples). RGT interviews are carried out with individuals during sensory interactions with physical product samples as two separate experiments. RGT is applied on two different product types. Eight computer mouses were used in the first experiment, and eight water bottles were used in the second experiment. The research approach is the same for both experiments. RGT is a structured interview method, yet in these experiments, it is utilized for both exploring and collecting the data and rating of the collected data. RGT is capable of transforming qualitative data (in-depth impressions of participants) into quantitative. With the implementation of RGT, this experimental research carries both qualitative and quantitative aspects. The final objective is to transform outputs into mapping of relationships that could serve as a reference in designing material and product experiences. An overview of the research plan can be seen in Figure 4.1.

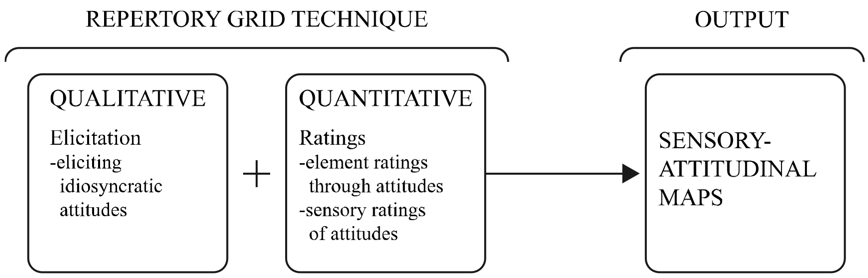

Figure 4.1. Overview of the research plan

4.4 Experimental Design and Tools

This study consisted two experiments. In the first experiment, eight computer mouses were experienced by the participants and their perceived material properties were construed through a structured comparison method, and the elicited constructs were recorded as the idiosyncratic attitudes. Also, the elicited attitudes were evaluated through their relevancies with sensory modalities. The second experiment was conducted with the same procedures explained above, yet only the product context was changed. Eight water bottles were used in the second experiment. For both of the experiments, the same environment and setup were used. Both experiments were carried out in Turkish, as this was the native language of all participants.

4.5 Experimental Environment and Setup

To perform the experiments, a small room was used located at Anadolu University Faculty of Architecture and Design. The experiment room was about 8 m2 in size and had no window. The room is illuminated from the ceiling with a white fluorescent light. Figure 4.2 shows the schematic plan drawing of the experiment room.

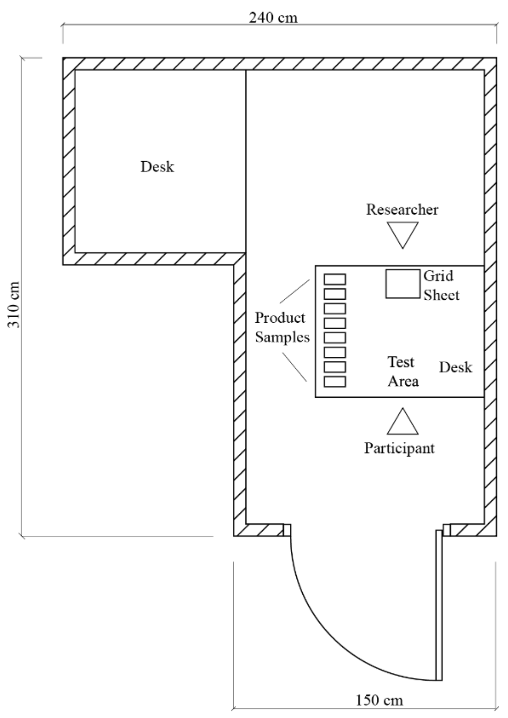

Figure 4.2. Schematic plan drawing of the experiment room

A white desk and two seats were placed in the middle of the experiment room. The seats were aligned opposed so that the researcher and the participant could sit face to face during the experiment. It was expected from the participant to feel relaxed and free to experience products like in an everyday situation, therefore student seats and student desk were preferred. Other than keeping the environmental conditions stable (lighting and heating), it was intended to prepare the experiment set-up as close to everyday situations as possible (Figure 4.3).

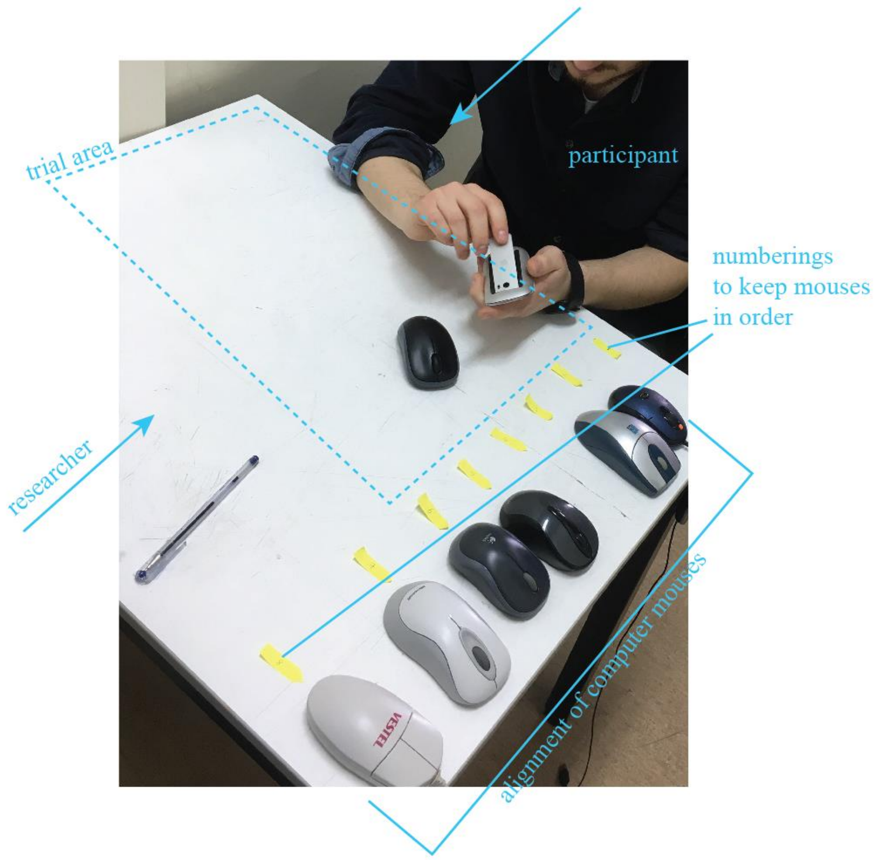

Figure 4.3. Layout of the experiment desk

Figure 4.4 shows the close-up plan of the experiment desk. The elements (here computer mouses) were vertically aligned on the left of the participant and numbered with stickers from 1 to 8. The elements were picked up from the row and placed on the trial area next to the participant. The trial area was the imaginary space where the participant would examine and experience the selected mouse pairs freely. The data sheet was located close to the researcher as the researcher took notes and filled the sheet during the experiment.

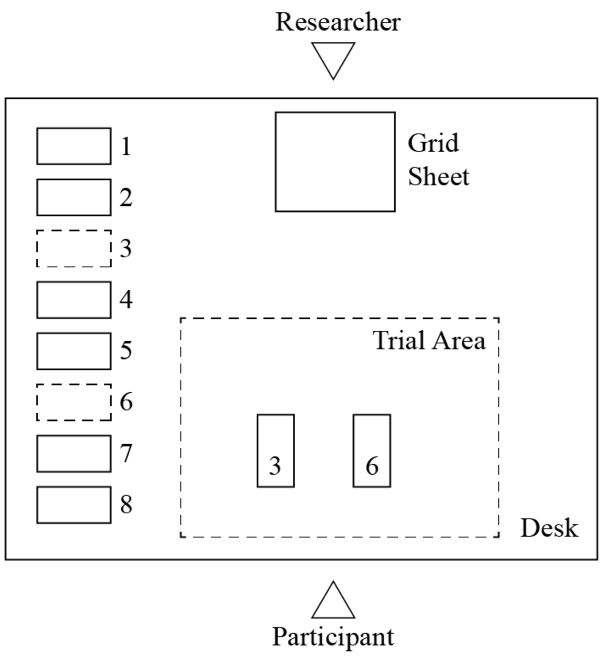

Figure 4.4. Close-up view of the experiment desk

Various tools and equipment were used in the experiment. Olympus Digital Voice Recorder VN-8600PC was used to record voices during the experiments after permissions were granted from each participant. The repertory grid sheets were used for data collection. Structured and empty repertory grid sheet for the experiment with computer mouses (Appendix A) and structured and empty repertory grid sheet for the experiment with water bottles (Appendix B) were used were used by the researcher to fill the generated verbal data and numerical ratings of the participants.

4.6 Product Samples as Stimulants

One major aim of this research is to explore sensory relevancies of elicited attitudes towards perceived material qualities. Physical product samples were used as elements to be studied throughout the experiments. In the experiments, two different sets of products were used as computer mouses and water bottles to investigate personal attitudes elicited through different sensory interactions. It was expected that the computer mouses would generate more visual, tactile and auditory feedback, whereas the water bottles would evoke more gustatory and olfactory experiences compared to other sensory modalities. Therefore, a better understanding of senso-attitudinal information could be possible through two different product contexts.

4.6.1 Computer Mouses (Experiment 1)

As important everyday objects, computer mouses were selected for this experiment. As Atkinson (2007) states, the computer mouse has become an everyday object decades ago and earned a place in society where people never stop and consider about using them. Basically, a computer mouse is a pointing device that detects two dimensional movements and transforms these movements into graphical interface. Computer mouses generally are operated with the hand, controlled with the wrist and its functions are controlled through buttons and wheels via fingers. Invented by Engelbart in 1963, mass manufacturing of computer mouses started around the 1980s, and today we are surrounded by a vast amount of computer mouses. There are many types of computer mouses (optical, wireless, trackball, mechanical etc.) made to serve for different specific purposes such as gaming, three dimensional modeling and so on. The reasons for choosing computer mouses for the first experiment is that they contain material combinations, they have vast number of different designs and they are easy to obtain everyday objects. In the selection of computer mouses, the criteria was to find products with similar purpose of use and similar functions. For this, it was avoided to choose specific purpose products (such as gaming mouses) that carry many functions. The chosen computer mouses vary depending on their size, the technology they have, their brands and the materials they are made of.

The experiment did not require computer mouses designed for specific purposes. The major intention in this experiment was to discover idiosyncratic attitudes of individuals towards perceived computer mouse material properties. Eight different computer mouses were selected for the first experiment. Selected computer mouses and their general aspects can be seen in Table 4.2 and Figure 4.5.

Table 4.2 General aspects of selected computer mouses for the first experiment

								
Producer	Apple	A4 Tech	A4 Tech	Logitech	A4 Tech	Logitech	Microsoft	Vestel
Type	Optical	Optical	Mechanical	Optical	Optical	Optical	Optical	Mechanical
Connection	Bluetooth	Wired	Radio Frequency	Radio Frequency	Radio Frequency	Radio Frequency	Radio Frequency	Wired

4.6.2 Water Bottles (Experiment 2)

Water bottles were chosen as product for the second experiment. Water bottles have an increasing role in our daily lives. Simply, water bottles are used to transfer liquids (mostly water) for personal use. When mobile, they are mostly carried in bags, and during usage, fingers are used mostly to open their caps, and the water is drunk directly from the filling hole with the contact of the lips and the tongue. They are produced in various sizes and they have various functions such as preserving temperature and being light. Water bottles became a popular everyday object, and there is an increasing trend in carrying a water bottle in travelling from a place to another. According to a report[36] about water bottles, the value of the reusable water bottle market has reached over 8 billion dollars. Growing environmental concerns have major effect on the increase of preferring reusable water bottles over of those

[36] The report is provided by FACT.MR based on a market study, that held over reusable water bottle market in 2018 (https://www.prnewswire.com/news-releases/reusable-water-bottles-market-valued-at-over-us-8-billion-in-2018-reveals-fact-mr-study-819835744.html)

Figure 4.5. The computer mouses selected for the Experiment 1

made of PET. Countless types of water bottles designs are available in the market. Also, water bottles are fashion products that reflect trends and various meanings.

One major reason for choosing water bottles as the sample product for the second experiment is the expectation of eliciting chemosensory feedback through the drinking experience. Two main criteria were defined for the selection of the water bottles. Firstly, they should have the same capacity. The capacity of water bottles were chosen as 500ml. Secondly, there should be variety in the materials that they are made of. A total of two metal (aluminum and stainless steel), four polymer (polypropylene, tritan and styrene acrylonitrile/SAN) and two glass water bottles were chosen. Eight different water bottles were selected for the second experiment. The water bottles and their general aspects can be seen in Table 4.3 and Figure 4.6.

Table 4.3 General aspects of the selected water bottles for the second experiment

								
Producer	Btwin	Tarrington	Quechua	PF Conc.	Kilic	N/A	Voit	Voit
Size	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml	500ml
Base Material	PP	PP	PC	Tritan	Glass + Silicone	Glass + PC	Stainless Steel	Aluminium

4.7 Sampling Strategy and Participants

The major part of the experiments is qualitative and the explored information is grounded in the views of individuals. The procedures of purposive sampling strategy was used in selecting participants for the experiments within this mixed methods research (Creswell & Clark, 2018). Neither pursuing for true information, nor false, the aim of the experiments was to obtain rich data from participants. Therefore, it was considered important to find informed users who also have command on material terminology. As informed users, design students were considered to be more familiar with design features rather than common users, and therefore could

Figure 4.6. The water bottles selected for the Experiment 2

verbalize perceived qualities easier. Both homogeneous sampling and critical case sampling strategies were used for the participant selection, as it is useful for researching with limited resources and gathering high level of detail through small number of cases (Creswell & Clark, 2018; Patton, 2015). The participants were selected from among industrial design students, which is a homogeneous group. Furthermore, Creswell and Clark (2018) recommend a sample size between 20 to 30 if the study is a grounded theory project. The specifications for the sampling was set as follows:

- Being an undergraduate/graduate industrial design student,
- Being a student for at least six semesters,
- Having successfully completed the "MLZ219 Malzeme" (Materials) undergraduate must course.

4.7.1 Sample Population for Computer Mouses

The experiment with computer mouses was based on voluntary participation. Considering the sampling specifications, Anadolu University Department of Industrial Design[37] was decided as the sample set. Industrial design students were also forming a homogeneous group with their similar backgrounds. Thirty five students were invited to participate in the experiment separately. Five students could not attend or missed the experiment due to various reasons. The experiment was conducted with 30 industrial design students. It was inquired from the participants whether they had any particular sensorial impairment (auditory, visual, olfactory, gustatory and tactile). All the participants verbally stated that they had no sensorial problems that they were aware of. Gender of the participants were kept equal as 15 participants were male and 15 participants were female. The ages of the participants

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[37] In 2018, Anadolu University was divided into two universities, and the Department of Industrial Design was moved to Eskisehir Technical University. Data collection was completed before 2018.

varied from 20 to 27, the mean age of the sample group was 22,73. Each participant had at least three years of industrial design education background since the Materials course was lectured in the third year of the curriculum. The design education background of participants differed from 3 years to 6 years, and the mean design education duration was 4,1 years. Table 4.4 demonstrates the gender, age and years of education distributions of the participants.

Table 4.4 Demographic information of the sample population for the experiment with computer mouses

Number of Participants		Age (Years)			Education Experience (Years)		
Male	Female	Min.	Max.	Mean	Min.	Max.	Mean
15	15	20	27	22,73	3	6	4,1

4.7.2 Sample Population for Water Bottles

The experiment with water bottles was also based on voluntary participation. A total of 32 industrial design students were invited to the experiment, and two meetings were canceled due to the absence of the participants. Students who participated in the first experiment were not invited to the second experiment. Same procedures were followed as the first experiment. The experiment was conducted with 30 participants, composed of 15 male and 15 female design students. Participant ages ranged from 21 to 26, and the mean value was 22,8. The participants educational experience ranged from 3 to 6, where mean value was 3,8 years. The demographic information of participants can be seen in Table 4.5.

Table 4.5 Demographic information of the sample population for the experiment with water bottles

Number of Participants		Age (Years)			Education Experience (Years)		
Male	Female	Min.	Max.	Mean	Min.	Max.	Mean
15	15	21	26	22,8	3	6	3,8

4.8 Pilot Study

A pilot study was conducted to test the utilized data collection instrument (repertory grid sheet) and collect the preliminary data to compare the efficiency of dyadic and triadic procedures. Repertory Grid Technique (RGT) allows researchers to investigate participants on dyadic or triadic trials. On dyadic procedures, two elements are presented and the participants are asked if two elements are alike or different (See Section 3.3.4.2). On triadic procedures, three elements are shown to the participants and the participants are asked to select two of them which are alike in a way that differs from the third (See Section 3.3.4.1). It was expected in the pilot study to consider whether dyadic or triadic procedures should be chosen. The efficiency of dyadic and triadic can be measured against time. It was expected to observe average durations for the interviews through the pilot study. Also, although the repertory grid sheet was utilized for the research objectives, further improvements could be required. The requirements for improvement could be determined through the pilot study. The aims of the pilot study are listed below:

- To gain experience on interviewing with RGT;
- To estimate the duration of sessions and adjust the number of rounds in each session;
- To compare the dyadic and triadic procedures; and
- To optimize the data collection sheets.

Repertory grids optimized for computer mouses were used in this pilot study to collect data. For the pilot study, repertory grid sheets contained the images of the eight elements (computer mouses), and two evaluation sections to be filled through two different scales. The repertory grid sheet utilized for the pilot study consisted of two pages, where the first page contained the informative section, elicited constructs and elements ratings section, and the second page consisted of sensory evaluation section alongside elements information. Figure 4.7 presents a sample repertory grid sheet filled in an interview.

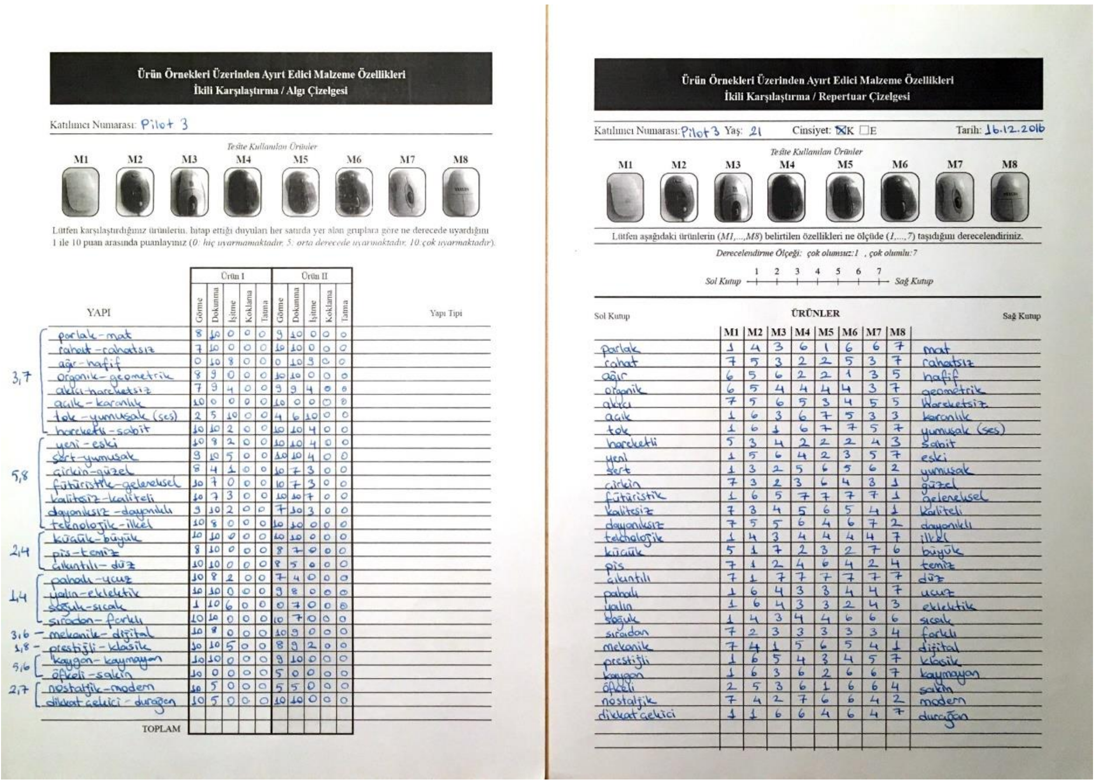

Figure 4.7. Sample repertory grid sheet for the pilot study. First page is on the left and second page is on the right. The sheet was utilized for dyadic procedure, and completed in the pilot study.

4.8.1 Triadic Pilot Trials

In the triadic pilot trials, the triadic procedure of Kelly (1955/1963) was followed. Broadly, three elements (here computer mouses) were presented to the participant to be evaluated in triads. The participants were informed about the research and the details about the experiment were given. Eight computer mouses (elements) were placed on the table next to the participant. Randomly predetermined three elements were picked from the mouse set and put in front of the participant. The researcher asked “How are two of these similar and the third one different?” to the participant. Each first elicited definition was written on the emergent (left pole) section on the grid and the contrast of this definiton was asked to complete the construct. The opposite definition was written on the implicit (right pole) section. The interview negotiation techniques (such as laddering and pyramiding) were used to help the participant express idiosyncratic definitions. Each expressed definiton was captured by the researcher and noted on the grid sheet. After the elicitations were finished, the participant was asked to rate the degree of senses contributed in the forming of each construct. The participant rated the sensory modalities through an 11-point scale (0 meaning "not involved" and 10 meaning "extremely involved"). Furthermore, the participant was asked to rate each element individually in terms of the elicited bipolar adjective sets. A seven-point scale was used (1= extremely left pole, 4= neutral and 7= extremely right pole) to rate each element. After the ratings were completed, the round was finalized for the selected elements and they were put back where they were picked from. The same procedure was continued for the following round with another set of randomly selected three elements. This process continued until the elicitations were found to be saturated or upon the participant's request. Two participants (participants 1 and 2) took part in the pilot study using the triadic procedure. Interview details can be seen in Table 4.6.

4.8.2 Dyadic Pilot Trials

For the dyadic pilot trials, again, the participants were informed about the research and the details about the experiment were given. Eight computer mouses (elements) were placed on the table next to each participant. Randomly predetermined two elements were picked and put in front of the participant. The researcher asked "Are they similar or different?" to the participant. The participant answered whether the two products were similar or different. The researcher then asked "Why do you think these two are similar (or different)?" to the participant. Upon the participant's answer, same procedures with the triadic trials were applied as explained above; to summarize, their answers were noted on the repertory grid sheets, the opposite constructs were obtained, and the participants were asked to rate the mouses. Two participants (participants 3 and 4) took part in the pilot study using the dyadic procedure. Interview details can be seen in Table 4.6.

4.8.3 Preliminary Results of the Pilot Study

Two triadic and two dyadic trials were completed for the pilot study to compare time and elicited constructs relationships. To make a judicious comparison, all four participants were selected from fourth grade Industrial Design students. As one of the aims of the pilot study was to estimate experiment duration and round count for estimations, no round or time limit were set for the interviews. So the experiments were continued until the participants failed to elicit new constructs. The duration of all four trials (two dyadic and two triadic) were close. Nine rounds of triads were completed in 2 hours and 8 minutes, whereas 15 rounds of dyads were finalized in 1 hour and 59 minutes. Dyadic trials seemed to be more efficient than triadic trials by providing 50 constructs compared to 27 constructs within a shorter experiment duration. Table 4.6 shows the details of the pilot study experiments.

Table 4.6 Pilot study results

	Procedure	**Age**	**Gender**	**Duration**	**Rounds**	**Elicited Construct**
Participant 1	Triadic	21	Female	55 mins	5	12
Participant 2	Triadic	22	Female	73 mins	4	15
Participant 3	Dyadic	21	Female	65 mins	8	28
Participant 4	Dyadic	22	Female	54 mins	7	22
Participant 5	Dyadic	24	Male	46 mins	5	19

When comparing the dyadic and triadic procedures, the participants found triads more challenging compared to dyads. It was clearly observed that the participants in dyadic trials understood the procedure easier and quicker, therefore they were more productive in eliciting constructs. In parallel to this, it is also emphasized in the literature that the application of dyads are found to be more practical compared to triads in repertory grid interviews, especially if the elements are complex (Caputi &

Reddy, 1999; Fromm, 2004; McEwan & Colwill, 1988). Also, triadic procedures produce cognitively more complex results (Caputi & Reddy, 1999), where contrasting of two elements from the third one is needed. In dyadic procedures, no contrasting is needed.

On the other hand, it was observed that the participants frequently focused on function and size related properties in the beginning of the interview. One participant stressed that this was caused by the influence of the education system as she mostly focused on functionality and tried to find the problems of the computer mouses. This issue started to fade away as the participant got used to the procedure. As an improvement to solve the issue, the aim of the interview could be explained more clearly to the participants before starting the interview.

In general, sessions lasted longer than estimated. Most of the time was spent on the researcher filling the grids on the sheets. Therefore, a number of adjustments had to be made in the organization of the procedural sequences. In order to prevent confusions by switching the rating scales continuously, it was decided to separate the rating phases during the interview. With this, only the elicited constructs would be rated through the sensory scale in every round. After all rounds were completed, all elements would be rated with the seven-point scale through all elicited constructs. Thus, the participant could keep his or her motivation constant and grasp the procedure easily.

The aim of the study is to collect as many constructs as possible within the perceptual awareness of the participants. The dyadic procedures were found to be easier to apply and participate in, therefore more productive in the number of elicited constructs. Yet, there should a limit in terms of time or rounds to create a consistent data collection structure. A time limit would not be proper for such an introspective investigation as participants should not be rushed. Some participants react faster whereas some others may need time to think. Also, the participants should be relaxed and free to talk without pressure. It was decided to limit the rounds to five in an interview session depending on the round and elicitation efficiency. With this, all of the participants would encounter with an equal number of trials. Also, the grid sheet was reduced from two pages to one page. In the interviews with the first four participants, two pages were used, with one page for each measurement. During the interviews, the sheets were switched repeatedly for the participant's evaluation of each scale. Switching the papers continuously was a time consuming action. Furthermore, it was considered that page switching could also distract the participant's attention. To improve the efficiency of the grid sheet usage, both measurements were placed on the same sheet by positioning the elicited constructs section in the middle.

One last dyadic pilot trial was completed with another participant (participant 5) to test the mentioned improvements on the grid sheet design and the procedure. The fifth participant elicited 19 constructs in 46 minutes in five rounds (Table 4.6). The final utilization of the grid sheet was found to be more practical compared to its previous version.

The pilot study was completed with a total of five participants. The data were collected in Turkish. Table 4.7 shows the preliminary results and the detailed presentation of the elicited attitudes. The preliminary results showed that common attitudes were elicited even through a very small number of trials. The attitudes *yeni-eski (new-old), parlak-mat (shiny-matte)* and *büyük-küçük (big-small)* were elicited by all five participants. Common elicited attitudes were merged together within each procedure. A total of 27 attitudes were elicited in two triadic sessions and seven attitudes were found common. In three dyadic procedures, a total of 69 attitudes were elicited and 16 of them were found common for at least two participants. Five attitudes were commonly elicited by all three participants and 11 attitudes were commonly elicited by two different participants. Other commonalities between attitudes can be seen in Table 4.7.

Table 4.7 Preliminary results of the triadic and dyadic procedures

Elicited Attitudes								
Triadic Procedures				Dyadic Procedures				
Bipolar Attitudes		P1	P2	Bipolar Attitudes		P3	P4	P5
yeni	eski	x	x	yeni	eski	x	x	x
parlak	mat	x	x	parlak	mat	x	x	x
büyük	küçük	x	x	küçük	büyük	x	x	x
ağır	hafif	x	x	açık	karanlık	x	x	x
temiz	kirli	x	x	dikkat çekici	durağan	x	x	x
dinamik	durağan	x	x	rahat	rahatsız	x	x	
rahat	rahatsız	x	x	ağır	hafif	x	x	
ince	tok	x		sert	yumuşak	x	x	
sportif	klasik	x		teknolojik	ilkel	x	x	
sade	karmaşık	x		pahalı	ucuz	x	x	
kalitesiz	kaliteli	x		sıradan	farklı	x	x	
açık	koyu	x		kaygan	kaymayan	x	x	
dokulu	dokusuz		x	itici	çekici		x	x
cezbedici	bayağı		x	uyumlu	uyumsuz		x	x
tok	tiz		x	pis	temiz	x		x
şirin	sevimsiz		x	soğuk	sıcak	x		x
tanıdık	yabancı		x	organik	geometrik	x		
dayanıksız	dayanıklı		x	akıcı	hareketsiz	x		
soluk	canlı		x	tok	tiz	x		
kaygan	pürüzlü		x	hareketli	sabit	x		
				çirkin	güzel	x		
				fütüristik	geleneksel	x		
				kalitesiz	kaliteli	x		
				dayanıksız	dayanıklı	x		
				çıkıntılı	düz	x		
				yalın	eklektik	x		
				mekanik	dijital	x		
				prestijli	klasik	x		
				öfkeli	sakin	x		
				nostaljik	modern	x		
				kaba	zarif		x	
				gevşek	dominant		x	
				dokulu	dokusuz		x	
				resmi	gayrıresmi		x	
				sade	karmaşık		x	
				saydam	opak		x	
				tanıdık	yabancı		x	
				evcil	yabani		x	
				masum	uyanık		x	
				ucuz	estetik			x
				rahatsız edici	doğal			x
				terletici	terletmeyen			x
				metalik	plastiki			x
				hızlı	hantal			x
				agresif	pasif			x
				cana yakın	soğukkanlı			x
				maskulen	feminine			x
				parçalı	bütün			x

4.8.4 Data Collection Tool

To conduct the repertory grid interviews, there is a need for a grid format that is utilized for collecting the inquired data. As mentioned before, the final decision on the grid design was made during the pilot study trials. The final design of the grid format was decided upon and the grid sheets were printed out to be filled during the interviews. In this section, the aspects of the data collection tool are described.

The data collection tool for this study is the repertory grid sheet. The data collection tool was initially based on the literature research findings and improved through the pilot study. As there were two different types of products (computer mouses and water bottles) chosen to be investigated throughout the study, the general design of the sheets were secured while only changing the product images. Every repertory grid sheet was prepared blank and filled by the researcher from the beginning of the interviews to the end. The sheet was prepared in Turkish as all of the participants were Turkish. It was considered that application of the test in the native language of the participants would be more practical and useful. The grid format was utilized from Kelly's repertory grids (see Section 3.3). The format of the grid sheet was A3 size, portrait orientation. Each grid sheet consisted of four sections, which were the informative section, elicited constructs section, sensory evaluation section, and element ratings section. The final grid design utilized as the data collection tool can be seen partially in Figure 4.8 and fully in Appendix A and Appendix B.

4.8.4.1 Informative Section

The first section of the repertory grid sheet is the informative section. Informative section consisted of the explanatory title of the experiment concept and general information of the participant such as participant number, age, education experience, gender and date. Informative section can be seen in the exemplary grid sheet (Figure 4.8).

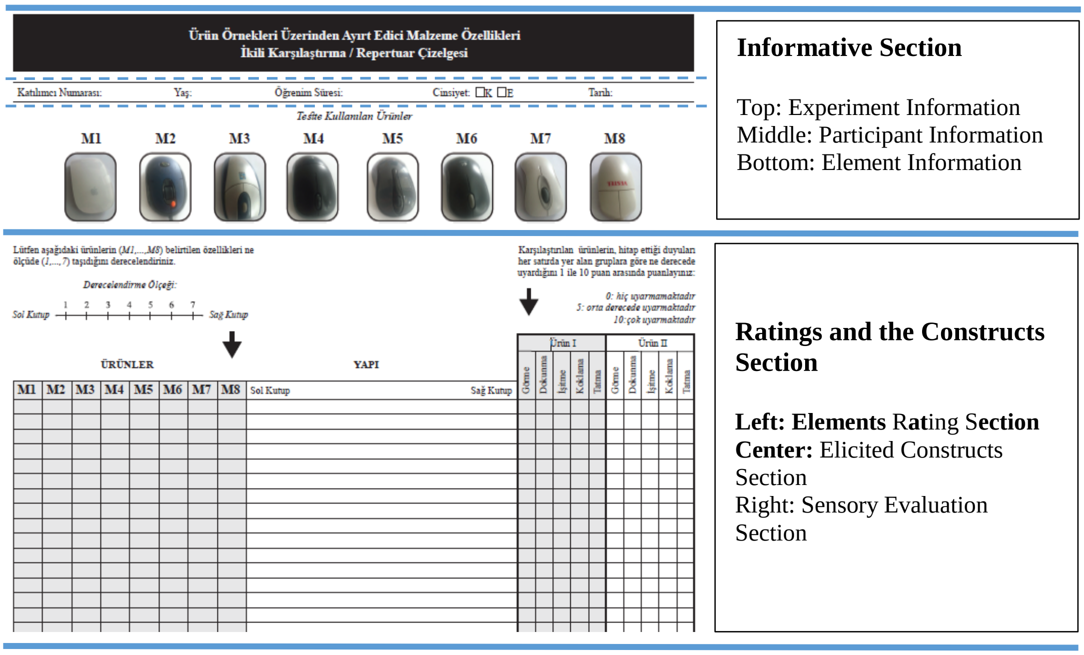

Figure 4.8 Repertory grid sheet utilized for data collection

The explanatory title of the experiment provides information about the procedure (dyadic) and the general information of the experiment. The topic of the experiment was "*Discriminable Material Properties Through Product Samples*" (Ürün Örnekleri Üzerinden Ayırt Edici Malzeme Özellikleri). The sub-topic included the procedure explanation, as "*Dyadic Comparison/Repertory Grid*" (İkili Karşılaştırma/Repertuar Çizelgesi).

The line below the topic contained demographic information of the participants and the date of the test. The name of the participant was not included on the grid sheet in order to preserve privacy rights. Instead, a number for each participant was given and this number was recorded for further organization of the data. The age, education experience and gender of the participant were also recorded on the grid sheet for further organization of the data and some of these data would be used in statistical analyses (such as gender effects on the statistics). The date of the test was also noted on the last section. Recording of this information was made before the interview began.

The element information section includes the representations of the elements, which were expected to be evaluated by each participant throughout the test. In the pilot study, each element was labeled only with "M" and a number (i.e. M1, M2…) on the grid sheet and the elements were lined up depending on their number. This application was experienced as time consuming, as picking an element for dyadic comparison and replacing them with a new pair by simply checking through the label (i.e. M6) was somehow confusing. Because of this, the element information section was updated with the image of each element alongside their representative number for a better identification and control. Figure 4.8 shows the elements located in the informative section.

4.8.4.2 Elicited Constructs Section

The middle part of the grid sheet comprised the elicited constructs section. As can be seen from Figure 4.8, "left pole" (sol kutup) and "right pole" (sağ kutup) were placed on both ends of the section. As mentioned before, a construct (or an attitude) is created by eliciting a pair of opposite poles through the evaluations of the participants. In the construct elicitation process, the first elicited pole (emergent pole) was recorded on the "left pole" (sol kutup) area. It is named the emergent pole as it is expressed as the distinctive attribute of the element comparison. After the left pole was written down, the opposite meaning of the left pole was asked to the participant, and the answer was recorded as the "right pole" (implicit pole).

On the left part of the section, the numbers of the element pairs involved in a comparison were noted manually by the researcher. As each session consisted of five different dyadic comparisons (see Section 4.9), five dyadic pairs were identified for each participant. When a dyadic procedure ended, a straight line was drawn manually to separate procedures. With that, it would be easier for the researcher to discriminate in which dyadic procedure the constructs were elicited. Manual actions taken by the researcher was required as the number of the constructs to be elicited by any of the participant could not be forecasted before the interview. The number of the constructs elicited in any session varied. Therefore, it was important to identify the elements included in a dyadic session to be able to relate them with the elicited constructs to prevent confusions and saving time.

Figure 4.9 shows the (printed and filled) grid sheet of Participant 24 filled during her test. The constructs were elicited in the study with the computer mouses and how they were recorded on the grid sheet can be seen. According to the sheet, the first dyad was M6 and M7, and six constructs were elicited in that round. The constructs elicited in the first round are *büyük-küçük (big-small)*, *rahat-rahatsız (comfortable-uncomfortable)*, *uzun-kısa (long-short)*, *eğimli-düz (curved-flat)*, *yüksek-alçak (high-low)* and *ağır-hafif (heavy-light).*

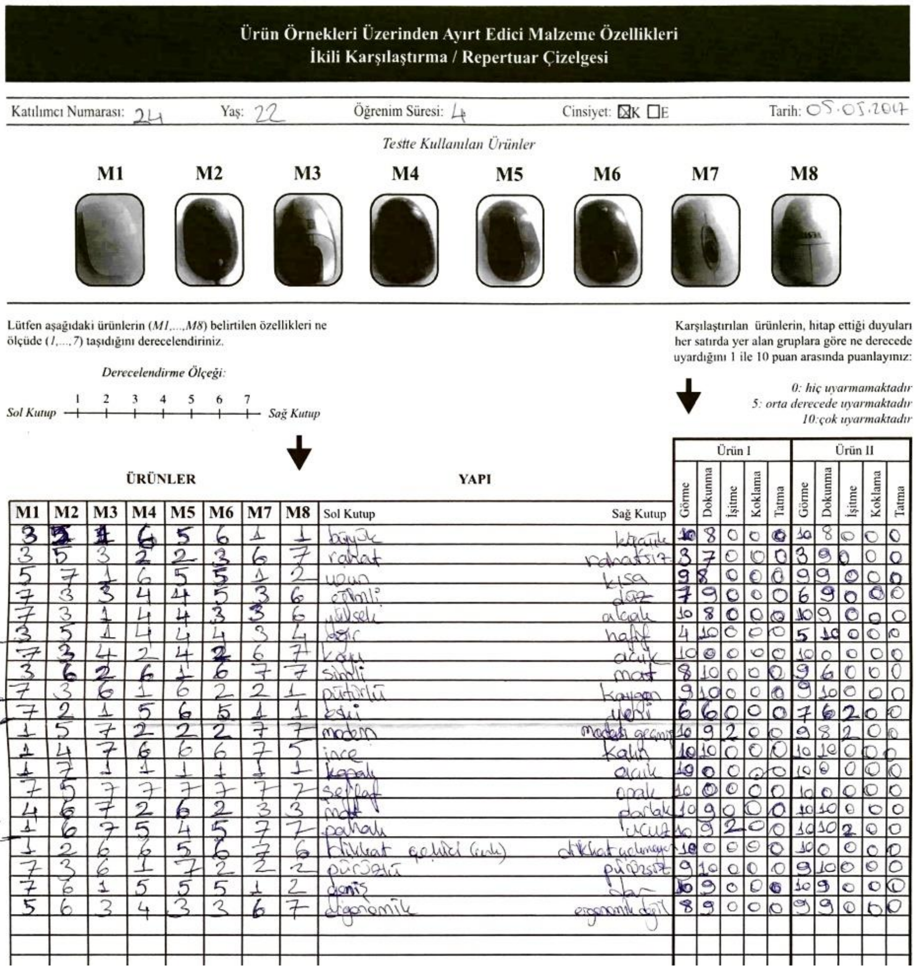

Figure 4.9 Repertory grid sheet of Participant 24 filled during the test

4.8.4.3 Sensory Evaluation Section

The sensory evaluation section contained the measurement scale to investigate sensory relevancies of the constructs. As can be seen in Figure 4.8, this section consisted of empty boxes related to the five basic senses of "vision" (görme), "touch" (dokunma), "audition" (işitme), "olfaction" (koklama) and "gustation" (tatma). Each elicited construct was evaluated through its sensory relevancy for each mentioned sense and was rated by each participant through an eleven-point scale. There was an informative label on the scale that was written "Please rate the compared products through the groups written on the line with the values between 0 to 10, depending on their degree of stimulation of the appealing senses" (Karşılaştırılan ürünlerin, hitap ettiği duyuları her satırda yer alan gruplara göre ne derecede uyardığını 0 ile 10 puan arasında puanlayınız). Each product in comparison creates different sensorial influence in eliciting an attitude. It was expected from the participants to rate both of the compared products depending on their individual sensory relevance on eliciting the attitude. For this reason, there were two sensory rating sections placed on the grid sheet.

4.8.4.4 Elements Rating Section

The last section on the grid sheet was the elements ratings section. Participants were expected to rate every product (element) used in the study through all of the attitudes that they elicited during the interview. A seven-point scale, ranging from 1 to 7, was preferred to measure how each product was evaluated. The one to seven scale is a simple scale that is easy to adapt for computer calculations (Bell, 2003). The value 1 refers to the closeness to the left pole (polar term X) and 7 indicates the closeness to the right pole (polar term Y). A brief explanation of how this scale can be used was provided above the scale, as "Please rate to what extent (from 1 to 7) the products below (M1, M2, … , M8) carry the qualities related to the specified attitudes" (Lütfen aşağıdaki ürünlerin (M1, … , M8) belirtilen özellikleri ne ölçüde (1, … ,7) taşıdığını derecelendiriniz). In addition to this explanation, a graphical drawing of the scale was placed (Figure 4.10).

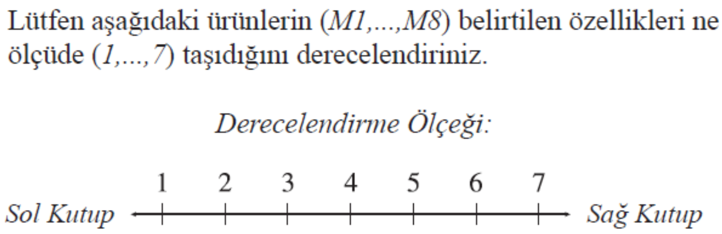

Figure 4.10 Seven-point scale used for rating the elements

The particular product (M1, M2, …, M8) was evaluated through two polar terms, which were opposites in meaning. The degree of intensity was represented by numerical values. As can be seen above, 1 and 7 are the extremities of both poles, where 1 represents the extreme value to the polar term X and 7 indicates the extreme value to the polar term Y. Values 2 and 6 are the moderate values of both poles, where 2 represents quite value to the polar term X and 6 indicates the quite value to the polar term Y. Values 3 and 5 are the indicators of slight values for both polar terms, where 3 points slight value to the polar term X and 5 represents slight value to the polar term Y. Lastly, the value 4 represents the midpoint, which is the neutral point, meaning that the evaluated item is neither. The preferred scale can be represented as follows (Figure 4.11):

(Particular Product)

polar term X	____	____	____	____	____	____	____	polar term Y
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	extremely X	quite X	slightly X	neither X, nor Y	slightly Y	quite Y	extremely Y	

Figure 4.11 Elements evaluation scale

Located on the left side of the grid sheet, there were eight columns containing empty boxes devoted for rating each element. Each element was rated through all the constructs elicited throughout the interview. Participants verbally rated all eight elements and each verbalised rating was filled on the grid sheet by the researcher. The element ratings section can be seen in Figure 4.8.

4.9 Procedure

The dyadic procedure was chosen for the elicitation of the constructs according to the pilot study results. As mentioned before, the dyadic procedure was found more efficient as it is easier to elicit more constructs in a certain time compared to the triadic procedure. The aim of the procedure is to elicit the most number of constructs in a very limited time. RGT interviews are time consuming and the participants are prone to becoming exhausted or geting bored very soon. To keep participants mentally fresh and motivated, the investigation procedure needed to be applied in a fluid fashion and therefore properly designed.

4.9.1 Dyadic Procedure

The dyadic procedure involves the evaluation process of element pairs by simply comparing their similar and contrasted material qualities. Basically, the participants experience two preselected products (elements) while comparing their material qualities simultaneously. Throughout the procedure, a number of different processes are carried out such as construing product pairs, elicitation of constructs, evaluation of the constructs and rating of the products. Broadly, the procedure consists of two main phases, which are the construct organization and rating of the products. The construct organization phase contains two more phases, these are elicitation, and sensory analysis of the constructs. The phases consist of rounds and each round contains sequences that have rules to be strictly followed. The sequence of every step should be defined clearly to minimize possible issues.

4.9.1.1 Sequence of the Experiment

The sequence of the experiment contains general guidelines about the interviews with participants. These guidelines are standardized for every participant. The sequence of the experiment is as follows:

- Product samples were cleaned and organized each time before meeting with the participant.
- Each participant was invited individually into the experiment room. The participant sat on the preserved seat next to the desk.
- An introductory and welcoming conversation was made to make the participant feel relaxed and comfortable.
- The participant information form was filled and the consent form was signed by the participant.
- Experiment instructions and the detailed explanation of the procedure was verbally given by the researcher (Appendix C). The grid sheet was also explained with examples.
- The first pre-randomized product pair was taken and put on the trial area of the table. A brief amount of time was given to the participant to become familiar with the procedure and then the round started.
- Five rounds were completed in each session.
- The products were rated afterwards.

4.9.1.2 Sequence of the Rounds

The experiment consisted of the construct organization and element rating phases. As mentioned before, the construct organization phase contains rounds that are repeated in each session. Each experiment session is comprised of five rounds using different pairs of elements but repeating the same procedure. Each round starts with the elicitation of the constructs and ends after these elicited constructs are evaluated through their sensory relevancies. The detailed steps of each round are as follows:

- As the first round starts, the first pre-randomized product pair was taken and put on the trial area of the table next to the participant. A brief amount of time was given to the participant to accustomise to the procedure.
- Explorations were made by the participant and the constructs were formed.
- The elicited constructs in the round were rated through the sensory scale by the participant.
- This procedure was repeated for four more rounds with the following pre-randomized product pairs.
- After five rounds were completed, all eight products were rated through all of the constructs elicited in all five rounds.

An exemplary section of the dialogue between the researcher and Participant 23 is transcribed below. Table 4.8 shows the exemplary construct elicitation dialogue with Participant 23:

Table 4.8 Exemplary section of the dialogue between the researcher and Participant 23 during the construct elicitation (translated from Turkish to English by the researcher)

Researcher (R): Do you think these computer mouses are similar or different?
Participant (P): Different
R: In what way are these computer mouses different? Why do you think these computer mouses are different?
P: This computer mouse becomes lost in my hand and the other one is **longer** and my hand grips it better.
R: You mentioned that this computer mouse is longer than the other. What do you think is the opposite of long?
P: I assume it is **short**. Also this one feels **uncomfortable** due to its sound.
R: How can you describe the opposite of uncomfortable?
P: I can say **comfortable**.
R: You mentioned that this mouse creates uncomfortable sound. Why do you think that this mouse creates uncomfortable sound?

P: The sound of this mouse is quite **clear**. The other mouse has a **subdued** sound.
R: You stated that this mouse has a clear sound and the other has a subdued sound. Do you think that clear and subdued are opposite?
P: Yes they are.
R: So I am recording these as a construct.
…

The construct elicitation phase continued until the participant stated that she did not perceive any new differences or similarities between selected mouses. Once the participant failed to elicit new constructs, construct elicitation phase ended for the round. The dialogue then continued as in Table 4.9.

Table 4.9 Exemplary section of the dialogue between the researcher and Participant 23 during sensory evaluation of elicited constructs

R: Would you like to mention any more similarities or differencies between these two computer mouses?
P: I think these are all that I can say.
R: Okay, thank you. Now I want you to evaluate the elicited constructs depending on their sensory relevancies. Please rate each mouse in the pair separately and individually. You can rate them between the values of 0 and 10. Considering Mouse 6 (M6), how do you think vision is involved in the forming of the construct *long-short*?
P: I think it is 6.
R: For touch?
P: It is 9.
R: How about audition?
P: I believe audition has not contributed in the elicitation of the construct *long-short.* It is zero.
R: So, for olfaction?
P: It is zero.
R: Lastly, for gustation?

P: It is also zero.
R: Thank you. This time, I want you to rate the same construct depending on its sensory relevancy considering the other mouse (M7). Considering Mouse 7 (M7), how do you think vision is involved in the forming of the construct *long-short*?
…

With the completion of the sensory evaluation of all constructs elicited through the comparison of the related mouse pair, the round ended. The same procedures were applied to the different pre-randomized computer mouse pairs for five dyadic rounds. When five rounds were are completed, the rating of the computer mouses through all elicited constructs started. With the completion of ratings of every computer mouse through all elicited constructs within all five rounds, the experiment ended. Table 4.10 shows the exemplary dialogue section during the mouse rating section of Participant 23.

Table 4.10 Exemplary section of the dialogue between the researcher and Participant 23 during computer mouse rating through elicited constructs.

R: Thank you for your ratings. Now we have completed rating the sensory relevancies of all the constructs you have elicited throughout the experiment. Right now, I would kindly ask you to rate each computer mouse through all elicited constructs. You can examine and experience each mouse before rating. For the first construct *long-short*, 1 resembles the direction to the *long* and 7 indicates the direction to the *short*. How do you rate M1 through the construct *long-short*?
P: I think it is 2.
R: For M2?
P: It is 7.
…
R: We have completed rating of the computer mouses and the experiment is ended. Thank you for your valuable contribution and participation to this experiment.

4.9.1.3 Randomization Procedure

In order to be able to cover all the mouses in a limited time, and also to make sure that all mouses were covered in an (almost) equal amount of trials, it was necessary to determine the mouse pairs to be given to each participant, beforehand. This required a pre-randomization process for determining the product pairs and their order. This random pair generation method intended to select five pairs per session guaranteeing the satisfaction of the following two constraints of the experiment:

- All eight individual products will be included in each session.
- A given pair of products will appear at most once in each session of five pairs.

Since it is clear that a completely random selection of pairs of items might lead to a session that does not satisfy the aforementioned constraints, an alternative method was needed.

The method used, divided the selection of five pairs of items for a given session into two parts; in the first part it selected four pairs of items where each item appeared exactly once. Then, in the second part, it selected the fifth pair such that it was not identical to any of the pairs in that session. Furthermore, the method kept track of the fifth pairs generated across sessions with different participants in order to ensure fairness as well as randomness to a given extent limited by the predefined constraints.

The method employed was not completely random; however, it was fair since using all 28 unique pairs in every set of seven sessions made the frequencies of any two pairs of items approximately equal. Furthermore, the method was not deterministic as it randomly selected pairs from the sets of pairs that satisfied the aforementioned conditions.

The main procedure divided the total number of sessions to groups of seven sessions in which the consumption of all 28 unique pairs was ensured. Since the fifth pair used an independent set of unique pairs, a batch of seven sessions would generate 35 pairs of elements. This approach ensured that each individual element would be compared with all of the seven other individuals in each batch of seven sessions created.

Before each batch-generation loop, possible pairs and possible fifth pairs lists were initialized. For each session to be generated, the algorithm attempted to select four pairs from the first list, then after every selection, checked if any member of the selected pair was present in previous pairs selected for that session. If the pair was ineligible for that session -being an item already used in another pair in that session- it was added to the ineligible list and removed from the possible pairs list temporarily. If the candidate pair was valid and none of its two elements resided in the previously selected pairs, it was added to the session and removed from the possible pairs list permanently.

After the successful selection of the first four pairs for a given session, the algorithm tried to find a suitable fifth pair. A random number was generated to select a pair of items from the list of available fifth pairs. If the selected candidate was unique in the given session, it was added to the session as the last element and the iteration moved to the next session. However, if the exact pair resided in that particular session, the pair was added to the list of ineligible fifth pairs and removed from the possible fifth pairs list temporarily. Then, a new trial for selection of fifth pair was initiated.

After each iteration of session-generation, the elements in the ineligible pairs list were restored back to the possible pairs list accordingly regardless of whether the iteration was successful or not. It is important to note that the ineligibility condition for the fifth pair differed from that of the first four pairs.

The method also had a fail-safe mechanism to evade the infinite loops. In some trials, it could be impossible to form a session under the given constraints from the remainder elements of possible pairs' lists. In those cases, the generation was retried for a predefined number of times. It is also worth noting that for some cases, it was impossible to form a session with the remaining pairs satisfying the constraints of the experiment. For those scenarios, the whole batch was considered to be a failure, then the batch generation was restarted.

In conclusion, the pairs of elements were determined as random dyads to be presented to the participants. The algorithm developed for randomization can be seen in Appendix D, and the generated session list can be seen in Appendix E.

4.9.2 Data Collection

Data collection was made through conducting interviews with the participants. In each interview, eight products were presented as pairs in a previously randomized order. Each participant was expected to experience these pairs through full modal interactions. Participants were free to experience the product pairs in the way they liked. They were asked to make comparisons in between the products with a focus on their material qualities and state whether they were found to be different or alike. The differences or similarities were expected as verbal statements. The first indicated statement was defined as the emergent pole, and written down on the left side of the constructs section by the researcher. After that, the participant was asked to consider the opposite of the emergent statement. The participant's answer was specified as implicit, and was written down on the right side of the elicited constructs section to complete the relevant construct, where a construct consists of two poles, emergent and implicit. Interviewing techniques (laddering and pyramiding) were preferred to achieve in depth information in interviews (See Section 3.3.3). Once there were no further constructs left to be formed, the construct forming round for the relevant pair was ended and grading of the round was started. All eight mouses were graded through elicited constructs by the participant. A seven-point scale (1-7) was used in this phase, where 1 represents affinity to the left pole of the construct and 7 represents the affinity to the right pole. Participants rated the elements vocally, and the researcher wrote them down on the sheet. Each interview consisted of five rounds. Participants experienced two random product pairs in each round, and a total of five different product pairs were covered in an interview session.

A total of 60 participants attended the two experiments. Each experiment was carried out with 30 participants. In the first experiment with computer mouses, a total of 799 bipolar construct sets were elicited, 26 constructs were elicited in average per session and each session lasted 52 minutes in average. In the second experiment with water bottles, 931 constructs were elicited in total, with 31 constructs in average per session. The average duration per session in the second experiment was 88 minutes. Table 4.11 presents the frequency distributions of the experiments. As can be seen from the table, water bottle sessions took significantly longer time and produced more constructs compared to the sessions with computer mouses. Experiencing water bottles took more time as the participants drank water from the bottles. In total, approximately 70 hours were spent to collect 1731 constructs through two experiments.

Table 4.11 Frequency distributions of the experiments

	Experiment 1 (Computer Mouses)	**Experiment 2 (Water Bottles)**
Min. Number of Constructs per Session	15	18
Max. Number of Constructs per Session	42	45
Avg. Number of Constructs per Session	26	31
Total Number of Constructs Elicited	799	931
Minimum Session Duration	34 min 55 sec	46 min 52 sec
Maximum Session Duration	83 min 18 sec	127 min 6 sec
Average Session Duration	52 min 31 sec	88 min 43 sec
Total Session Duration	26 hrs 1 min 38 sec	44 hrs 21 min 17 sec

4.10 Role of the Researcher

Each interview took time and was challenging for the participants as they focused on the details throughout the sessions. The primary role of the researcher was to keep each participant active and motivated during the interview. Negotiation procedures had to be done carefully in order to achieve this. Over-negotiation on a topic could make the participant feel anxious or being judged. The researcher created an environment where the participants would feel comfortable and free to explore and express. It was vital for the research to evoke exploration as there were no expected results. It was possible for the participants to struggle during sessions due to lack of previous experience on the procedure. An informative text about the details of the research and the procedure was read by the researcher in the beginning of each interview. Although the details and examples were given, participants mostly started slow and provided richer data as they got used to the procedure and started feeling more comfortable. Again, the researcher used negotiation techniques to provoke the participants to dig deeper meanings and relations.

During the sessions, participants stated themselves verbally and the researcher filled the grid on the sheet. In the first phase of each session, the researcher noted the emergent and the implicit poles of the construct on the grid based on the participant statements. In addition to that, the researcher took small notes about the process. The interview section of the experiment can also be seen as a participant observation. The researcher can find an opportunity to observe and understand the internal structure of user-product interactions and note taking plays a crucial role in non-verbal expressions. In the ratings section, the researcher also filled the grid after the participant rated the scales verbally. There are two reasons for this. The first reason is to prevent participants to compare their ratings as it is expected that each element should be rated individually. A rating can easily be affected by the previous rating of an element. The second reason is to control the participants' consistency so that their rating value matches the correct pole direction of the constructs they mention. Taking the *dirty-clean* construct as an example, the participant may find a quality as *extremely dirty*. In the 1-7 scale, the value of 1 refers to *extremely dirty,* and the participant may mistakenly state the peak value of the opposite direction, 7, instead of 1. Participants may feel tired especially in the latter part of the sessions and they are prone to making more mistakes when they are not focusing. As they did the ratings verbally, the researcher repeated and double-checked participants' rating while filling the grid. If any mistakes happened, they were immediately corrected.

The researcher has a role in forming the constructs. When an emergent pole was stated by a participant, the researcher asked the antonym of that word. Participants rarely found it difficult to express feelings in words. Also, they felt incapable of stating antonyms from time to time. Here, the researcher encouraged the participants to express their notions in their own words. Once a statement was expressed, it eased the construing of the intended meaning.

A construct was noted only once on the grid sheet. Repetition of a construct was not recorded. Although it was not a goal of this research to interrupt participants during sessions, reminding that a same construct was formed beforehand could limit the participant's exploration process. As Yorke (1978) stated, considering only lexical meanings may create conceptual problems in bipolar rating scales. Two identical constructs may refer to different meanings as they may carry different functions in their meanings (Yorke, 1978). As an example, *dirtiness* could be a characteristic quality defining a bad behavior in a construct, and also a physical quality and can only be related to a dirt on a cloth. To understand whether a construct was a repetition or not, when a possible identical pole was expressed, the participant was asked to verify whether it differed from the related construct. When differed, the construct was recorded by the researcher.

CHAPTER 5

ANALYSIS PROCEDURES, EXPLORATION OF INDIVIDUAL ANTICIPATIONS TOWARDS PERCEIVED MATERIAL QUALITIES AND INVESTIGATING SENSORY RELATIONS

This thesis aims to focus on construed meanings from perceived qualities of materials rather than the materials themselves. The major aim of this introspective study is to explore material qualities that the individuals are aware of during sensory interactions and how the individuals construe these qualities as perceived meanings in their own words. Therefore, the idiosyncratic evaluations of participants are explored through repertory grid interviews. In this chapter, the collected data is analyzed to achieve the objectives that are;

- to identify the material qualities those the participants are perceptually aware of in selected product types,
- to understand how participants construe perceived material qualities as elicited attitudes, and
- to investigate sensory relevancies of elicited attitudes.

Throughout the study, two different product types were investigated separately with 30 participants for each product type. Collected raw data consisted of idiosyncratic definitions of perceived qualities as bipolar adjective pairs and participant ratings through two different scales. The first analysis section of this mixed methods study is qualitative. The raw data need to be organized and prepared for the following quantitative analysis phase. In this chapter, the following steps are taken in order to prepare data for further analyses:

- Thematic analysis of the collected raw data.
- Distribution, central tendency and variability statistics of the reduced data.
- Reliability measurement of the reduced data.
- Sensory relevancy analysis of the elicited attitudes.

In this chapter, the steps of preliminary qualitative and quantitative analyses applied on the data will be explained. Firstly, content analysis was applied on the raw data to find out common elicited attitudes. With content analysis, first data reduction was achieved by merging multiple grid sheets into one for each experiment through commonalities (thirty grid sheets per experiment, a total of 60). Secondly, data was analyzed through basic quantitative statistics. Frequency distributions and central tendencies were calculated. Thirdly, the consistency of the organized data was measured. Alpha coefficient was measured to determine the reliability of the data. Lastly, sensory relevancies of elicited attitudes were identified through participant evaluations. The analysis steps of each experiment are described separately, where details are only given for the first experiment, as the same procedures are followed for the analyses of both experiments.

5.1 Experiment I: Computer Mouses

In the first experiment, eight computer mouses were experienced and evaluated by 30 participants. Data was collected through repertory grid interviews. Collected data carry both qualitative and quantitative parameters, so the data was analyzed both qualitatively and quantitatively. Firstly, qualitative analsyis was applied on the data.

5.1.1 Qualitative Data Analysis

A large amount of data was collected through interviews and a systematic approach was needed to organize the raw data and create interpretable datasets. Constructs elicited in the study were organized and categorized through the content analysis method. Content analysis is used for construing meaningful content of materials that are in any kind of format (i.e. text, video and such) as interpretable units (Given, 2008; Krippendorff, 2004; Neuendorf, 2002). As Krippendorff (2004, p. 18) states, content analysis is a scientific method that provides new insights about a concept and increases the understanding of the researcher about the inquiry.

In this study, participants construed perceived material qualities of selected products and elicited idiosyncratic bipolar attitudes. Collected data consisted of bipolar adjectives, many of them having common meanings. To explore meaningful patterns within the collected data, the procedures of semantic content analysis (thematic analysis) was adopted. Procedures of semantic content analysis includes classification through the meanings of the texts as data (Neuendorf, 2002). In thematic analysis, themes are created to bring adjective sets with common meanings together. This procedure is complex as the latent meanings of the adjective sets should also be investigated to find commonalities in between. Thematic analysis is also a powerful tool to investigate deeper meanings that texts carry, yet Given (2008) underlines that even a single text may make the researcher consider over and over during theme organization as it may belong to more than one theme. Researchers often cooperate with one or more judges to reduce the number of errors that they may experience in dealing with such complexity and to increase trustworthiness of the analysis.

Content analysis is a flexible technique that can be both qualitative and quantitative depending on the aim and the content of the study. Both aspects of content analysis are used in this study. Thematic organization of the elicited attitudes is the qualitative part of the analysis. Attitudes with common meanings were grouped under themes. On the quantitative side, the frequencies of common elicited attitudes were counted and their quantitative statistics were calculated.

5.1.1.1 Content Analysis

In the first step of the classification phase, semantically similar or identical constructs were gathered together under thematic sections while adjusting the poles of the constructs simultaneously. Each construct consisted of two bipolar adjectives, where poles point the direction of opposite meanings. Poles of the common constructs may be indicating different directions depending on their emergent and implicit features. While bringing common constructs together, the poles of the constructs under the same theme should be pointing the same direction. As can be seen in Table 5.1, the poles of *clean-dirty* and *dirty-clean* identical constructs are not pointing the same direction.

Table 5.1 An example of two common constructs with poles pointing opposite directions

M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**Emergent**	**Implicit**
1	6	6	4	4	4	5	2	clean	dirty
7	2	2	4	5	3	2	2	dirty	clean

This happens as some participants elicited *clean* as the emergent pole during a dyadic comparison, and others elicited *dirty* as the emergent pole. At this moment, the pole of the constructs should be matched on the same direction (Fransella, et al., 2004). When reversing the construct poles, the ratings of the elements need to be also adjusted. In reversing of the constructs, the gradings should be reversed as the poles will refer to the opposite direction. On a seven-point scale (ratings ranging from one to seven), the reverse of a rating can be calculated by subtracting the original value from eight. The reversed rating of one is seven and the reversed rating of seven is one. As the rating of four is the midpoint, the reverse of four still stays as four. Data can be construed only after the poles indicate the same direction.

In the previous example, M1 was rated as one in the first row, which means it is very close to the left pole, *clean*. Yet in the second row, M1 was rated as seven, very close to the right pole *clean*. Although their poles point opposite directions, both constructs indicate that M1 is rated as extremely *clean*. The poles and the ratings are reversed for the second construct. The reversed version of the previous example can be seen in Table 5.2.

Table 5.2 Reversed construct example

M1	M2	M3	M4	M5	M6	M7	M8	Emergent	Implicit
1	6	6	4	4	4	5	2	clean	dirty
1	6	6	4	3	5	6	6	clean	dirty

Next step would be to group common bipolar attitudes under themes while adjusting the pole directions simultaneously. As the study was carried out with Turkish participants, the interviews were made in Turkish and participant evaluations were recorded in Turkish. The researcher reviewed the grids in Turkish and then translated the elicited attitudes into English. The translation process required the understanding of not only the dictionary meanings, but also the functional meanings of the bipolar attitudes. Turkish definitions of the elicited attitudes were reviewed through digital resources of Turkish Language Institution (TDK)[38]. For the translation of the adjectives, Oxford English Dictionary[39] was used. Mentioned databases were referred to, to investigate synonyms and antonyms of the elicited bipolar attitudes. In the experiment with computer mouses, all elicited attitudes were translated from Turkish to English by the researcher and the translations were approved with the mutual agreement of the coders. The full list of translations can be seen in Appendix F.

With the guidance of mentioned regulations, all semantically common constructs were grouped under themes, and poles of these constructs were arranged to point the

[38] Türk Dil Kurumu (TDK) is founded in 1932 with the instruction of Atatürk, and scientifically contribute to the Turkish language since then. TDK is a governmentally supported institution, and contains various dictionaries and studies about Turkish language that are open for public access. TDK can be accessed through web (sozluk.gov.tr).

[39] Oxford English Dictionary is the biggest and most comprehensive English dictionary, which contains more than 600.000 words definitions. Published by the Oxford University Press, the English dictionary can be reach through web (www.oed.com).

same direction. The themes are labeled with the general meaning of the grouped constructs in the first level of classification. Table 5.3 shows the first level classification of the theme *Hygiene.*

Table 5.3 Constructs gathered together under the theme Hygiene

clean – dirty	healthy – unhealthy
clean – dirty	healthy – non healthy
clean – dirty	hygienic – non hygienic
clean – dirty	hygienic – non hygienic
clean – filthy	hygienic – dirty
clean – dirty	easy to clean – hard to clean
clean – filthy	easy to clean – hard to clean
clean – dirty	dirt resistant – keeps dirt
clean – dirty	dirt resistant – gets dirty quickly
clean – dirty	

As can be seen from Table 5.3, the theme *Hygiene* consists of 19 constructs. Although these constructs carry similar meanings, some of them refer to meanings that can be distinguished from others. As an example, the constructs *clean-dirty* and *clean-filthy* are very similar, yet relatively dissociate from *healthy-unhealthy*. Hence, a second classification under themes is needed to constitute sub-themes (categories). Categories formed under the theme *Hygiene* is shown in Table 5.4.

The theme *Hygiene* was formed with 19 constructs in the first level classification phase, and divided into four categories as *being clean, ease of cleaning, being healthy* and *resistance to dirt* in the second level classification. All collected data in this study were listed under themes as categories.

Table 5.4 Categories created within the theme Hygiene

HYGIENE	
Being Clean (10)	**Ease of Cleaning (2)**
clean - dirty clean - dirty clean - dirty clean - dirty clean - filthy clean - dirty clean - filthy clean - dirty clean - dirty clean - dirty	easy to clean – hard to clean easy to clean – hard to clean
Being Healthy (5)	**Resistance to Dirt (2)**
healthy - unhealthy healthy - not healthy hygienic - not hygienic hygienic - not hygienic hygienic - dirty	dirt resistant – keeps dirt dirt resistant – gets dirty quickly

In the interviews, each unique construct was recorded only once by the researcher and replication of a construct was not recorded. When a possible replication of a construct was noticed by the researcher during the interview, the researcher asked the participant whether the possible replication carries the same meaning with the previous construct (see Section 4.10). Still, there is a possibility that unnoticed replications of constructs may be recorded by the researcher. To eliminate possible unnoticed replications, the collected data were also reviewed. The whole data were agglomerated and then thematically organized by three different coders. A final review for construct repetitions was made by checking participant numbers of constructs after thematic analysis. If a participant number was seen by more than once under any of the categories, the entire grid sheet of that participant and the sound recording of the related interview was carefully re-examined. Table 5.5 shows an example of repeating constructs.

Table 5.5 A repeated construct example

Participant Number	M1	M2	M3	M4	M5	M6	M7	M8	Emergent	Implicit
P3	7	7	1	7	7	7	1	1	heavy	light
P3	1	1	7	1	1	1	7	7	empty	loaded

As can be seen from the table, Participant 3 (P3) elicited two constructs which are positioned under the same category. When the ratings and the meanings of the constructs are examined, it can be seen that this is a replication of constructs. When a repetition was confirmed by all coders, the repeating pair was removed from the belonging sub theme by the researcher. Twenty-seven constructs were removed from the study as they were confirmed as replications.

In the last phase of content analysis, the main themes were formed. Attitudes with similar meanings were grouped as categories, and main themes were created. The main themes[40] would function as a cross checking mechanism by reconsidering if a theme or category fits under. Five main themes were created upon themes depending on their hierarchical relations. The main themes were named as *physical qualities, evaluation, functionality, perceived value,* and *familiarity*. This classification brought constructs together not only semantically, but also around general functions. A total of 19 themes and 76 categories were formed through thematic analysis.

Consistency is one of the most important aspects of content analysis (Given, 2008). To maintain a reliable dataset, it is often recommended to analyze the dataset with more than one coder. The agreement between different coders would increase the reliability of the data by reducing the possible errors through the individual judgement of the sole coder. Also, consistency tests are applied on the analyzed data to measure if the data is consistent enough for multivariate statistical analyses.

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[40] This hierarchical thematic classification was also practical for classification of the other experiment's data by serving as a preliminary structure.

Grouping in the data analysis phase was carried out with two different coders in terms of intercoder reliability (Krippendorff, 2004; MacPhail, et al., 2015). Intercoder reliability depends on the degree of agreement of independent coders on the same subject. Themes and sub-themes were categorized by the researcher first and concluded with mutual judgement. To increase consistency in the classification of bipolar attitudes, two additional coders have contributed to the thematic analysis. Reliability check procedure (Jankowicz, 2003) was carried out, in which independent coders individually inspected categories, negotiated about generated meanings, individually managed categories again and renegotiated to get a final agreement on the category development. Thematic classification of attitudes was completed with the agreement of three different coders. Constituted main themes, themes and categories are represented in Appendix G. The general aspects of the main themes are listed as follows:

- *Physical qualities* main theme consists of the constructs that picked from measurable physical qualities of materials such as weight, length and roughness.
- *Evaluation* main theme contains the constructs that include subjective interpretations and judgements of the participants such as beauty.
- *Functionality* main theme is complied from the constructs related with performance and usability.
- *Perceived value* main theme is constituted of the constructs that have affect on creating the perception of quality on participants such as quality, value and durability.
- *Familiarity* main theme is formed of the constructs that depend on participant reflections about accustomedness such as feeling familiar or strange.

5.1.1.2 Specification of Elicited Common Bipolar Attitudes

A total of 772 valid constructs were elicited through RGT. Content analysis was applied on the raw data and 717 common constructs were gathered together under

76 groups of common adjective pairs. The remaining 55 constructs were not positioned under any category as they carried no commonality with the other constructs. Theoretically, these construct groups represent participants' ways of perceiving and construing of the selected computer mouses.

It would be necessary to prepare elicitation frequencies of the constructs to identify which construct groups were mentioned the most and the least. The most commonly elicited attitude was *big-small* that was elicited by 29 out of 30 participants, which was 96% of the total population. Next, the attitude *old-new* was mentioned by 28 participants (93% of total) and *smooth-rough* was elicited by 25 participants (83% of total), followed by *heavy-light* which was elicited by 23 participants (77% of total). Further, both *comfortable-uncomfortable* and *shiny-matte* were elicited by 21 participants each (70% of total). Attitudes of *beautiful-ugly* and *soft-hard* were mentioned by 18 participants each (60% of total), followed by the attitudes *curved-flat* and *loud-silent,* which were mentioned by 17 participants each (57% of total). Following, *attractive-unattractive* was elicited by 16 participants (53% of total), and the pairs *simple-complex* and *deep-treble* were elicited by 15 participants each (50%). Next, the attitudes *high quality-poor quality, high-low, slippery-non slippery* and *ergonomic-non ergonomic* were elicited by 14 participants each (47% of total), followed by the attitudes *fluid-stable, dark-light* and *rounded-sharp* which were elicited by 13 participants each (43% of total). After then, the attitudes *non glittery-glittery* and *technological-outdated* were elicited by 12 participants each (40% of total). Further, *durable-flimsy, classical-modern* and *easy-difficult* were elicited by 11 participants each (37% of total). The attitudes *expensive-cheap, whole-fragmented, ambiguous-distinct* and *clean-dirty* were elicited by 10 participants each (33% of total), followed by the attitudes *gracious-coarse, long-short, thick-thin, cold-hot* and *eccentrical-accustomed,* which were elicited by 9 participants each (30% of total). Further, the attitudes *entertaining-serious, sloppy-elaborated, fast-slow, handy impractical* and *extraordinary-common* were elicited by 8 participants each (27% of total), followed by the attitudes *obtuse-pointed, transparent-opaque, dynamic-bulky* and *reassuring-insecure* that were elicited by 7 participants each

(23% of total). The attitudes *functional-functionless, smelt-inodorous, inappropriate-proper, controlled-uncontrolled, long lasting-short lived, good-bad, discordant-coherent, particular-standard, healthy-unhealthy* and *raspy-tuneful* were elicited by 6 participants each (20% of total). Lastly, the attitudes *symmetric-asymmetric, directionless-directional, user friendly-difficult to use, independent-constrained, problematic-unproblematic, unnecessary-necessary, clear-blurry* and *non sticky-sticky* were elicited by 5 participants each (17% of total). Frequencies of the attitudes elicited by five or more participants are graphically represented in Figure 5.1.

After the frequencies of the elicited attitudes were determined, 63 common attitude pairs out of 76 were found as elicited by at least five or more participants. These 63 elicited attitude pairs represented 88% of the all elicited attitudes. Remaining of the list consisted of common adjective pairs elicited by less than five participants. Thirteen common attitude pairs mentioned less than five times covered 5% of the total elicited attitudes and 55 bipolar attitudes were elicited only once covered 7% of the total elicited attitudes. Four common attitudes were mentioned by four participants (13% of total), five common attitudes were elicited by three participants (10% of total) and four common attitudes were elicited by two participants (7% of total) (See Appendix H for the full list of the elicited common attitudes).

After the frequencies were clearly determined, Chi-square test was applied to find out if there were any gender related differences between mentioning frequencies of common elicited bipolar attitudes. Chi-square test was performed to understand whether frequencies of variables in this study were gender dependant, or not. Hypotheses for this study were defined as follows:

H_0: Frequency of mentioning does not depend on gender differences.

H_1: Frequency of mentioning depends on gender differences.

Chi-square test is used to understand if the observed data fits well with the expected data in terms of frequency distribution. The formula to calculate Chi-square value is shown below:

$$X^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

Here in the formula, O_i represents observed value, and E_i represents expected value. To calculate χ^2 value of the data set, frequencies of each common elicited attitude were separated into male and female frequencies as observed value, and their expected values were calculated through the formula below:

$$E = \frac{Row\ total\ X\ Column\ total}{N}$$

E Expected values for each common elicited attitude were calculated through Excel software. The goodness of fit test is accepted valid, if the expected values of variables are at least five or more in the dataset (Kim, 2017; McHugh, 2013). In this context, 63 common elicited bipolar pairs mentioned by at least five or more participants were taken into consideration. The goodness of fit test results (χ^2 :15,108; df: 32, $p < 0.05$) showed that gender differences did not play a significant role in the distribution of frequencies of mentioning, and therefore, null hypothesis was accepted (see Appendix I). The mentioning frequencies of both genders were also found to be balanced, as male participants elicited 335 common bipolar adjective pairs compared to female participants, who elicited 343 common pairs.

According to the goodness of fit results, a further group of statistical analyses were determined to be applied on the 63 common elicited attitudes mentioned by five or more participants to achieve more reliable and valid results, which are described in the following sections.

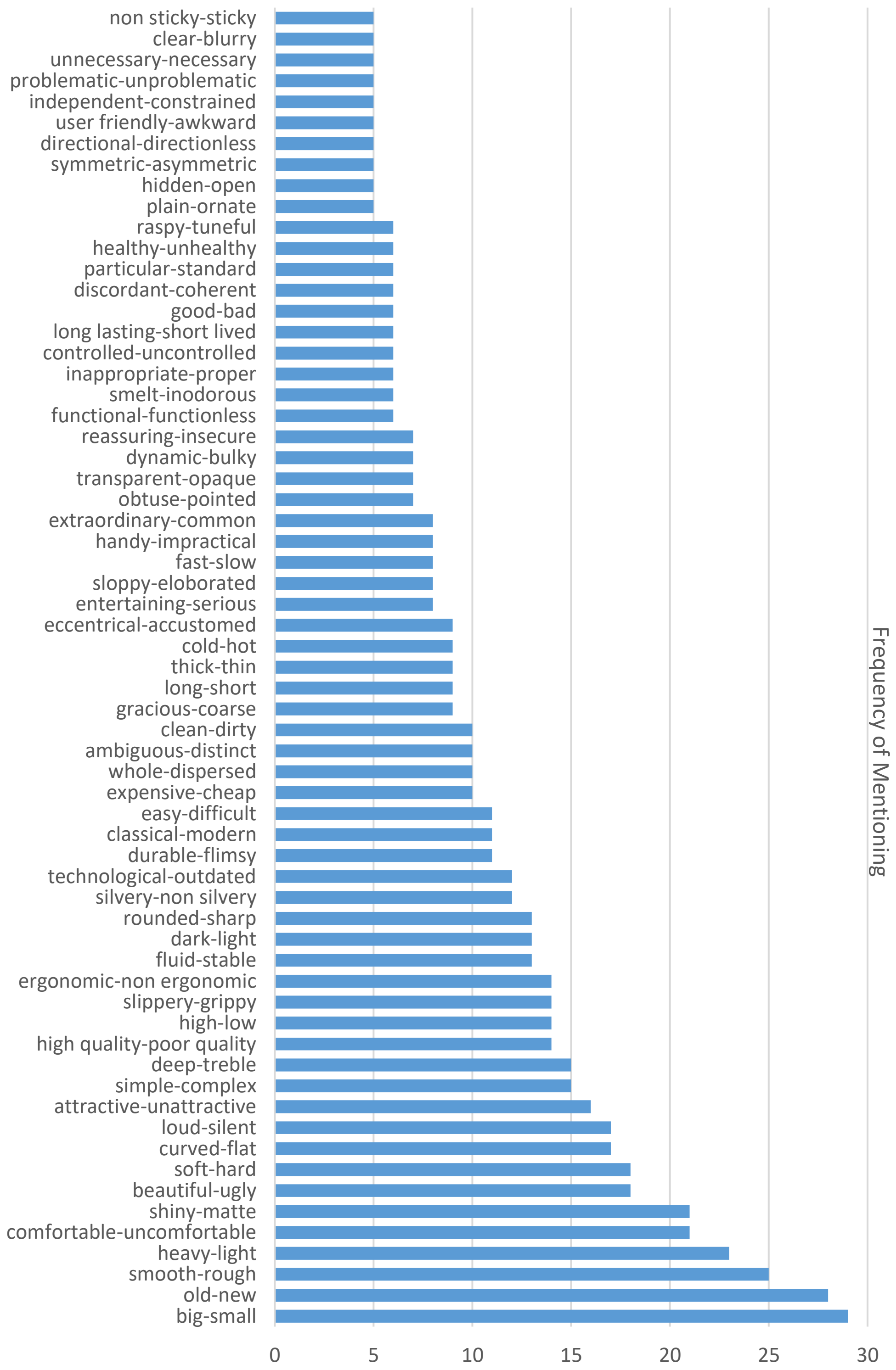

Figure 5.1. Graphical representation of common elicited bipolar attitudes and their freqeuencies in the population.

5.1.2 Normality, Central Tendencies and Variabilities of Collected Data

How the collected data was qualitatively analyzed was described in the previous section. As this mixed research was grounded on both qualitative and quantitative data, the collected data also needed to be analyzed quantitatively. Two different scales, a seven-point scale (rating of product samples) and an eleven-point scale (sensory relevance) were used during the repertory grid interviews. The statistical aspects of quantitative ratings also needed to be investigated.

The first step of a quantitative analysis is to check if the data is normally distributed or not. The type of distribution is important for both basic and multivariate statistical analyses (Tabachnick & Fidell, 2013). To investigate whether the data collected from the ratings of product samples (seven-point scale) was normally distributed, normality test was was applied on the dataset. Normality test was done on the through SPSS software. It is expected that the data would be at least approximately normal distributed as many of the common statistical calculations need at least approximately normal distribution (Siegel, 2016). Figure 5.2 represents the normality test results. As can be seen from the histogram (Figure 5.2) the data was approximately normally distributed.

For the basic quantitative analysis, central tendencies and variabilities should be measured in order to understand distribution statistics. As a measure of central tendency, mean is defined as the arithmetic average of the numbers and standart deviation, as a measure of variability, presents how ratings vary around the mean values (Christopher, 2017). Christopher (2017) states that measuring mean ratings are ideal for scale data, yet as a weakness, mean ratings are influenced by extreme ratings. So both mean statistics and standard deviations are calculated for a clear interpretation.

As previously stated, the repertory grid interviews were carried out with 30 participants and 772 valid bipolar attitudes were collected in the experiment with eight computer mouses. In each interview session, eight computer mouses were rated through bipolar attitudes elicited by each participant. Later, individual grids of each participant were merged as one dataset, and then thematically grouped 76 common attitudes were developed. The means of individual participant ratings of bipolar attitudes were calculated to be used as representing values of the developed common bipolar attitudes. In other words, 30 repertory grids were transformed into one grid. With the results of the goodness of fit test on this transformed dataset, common attitudes mentioned by five and more participants were determined to be taken into consideration for further analyses. Therefore, 63 common bipolar attitudes were analyzed quantitatively.

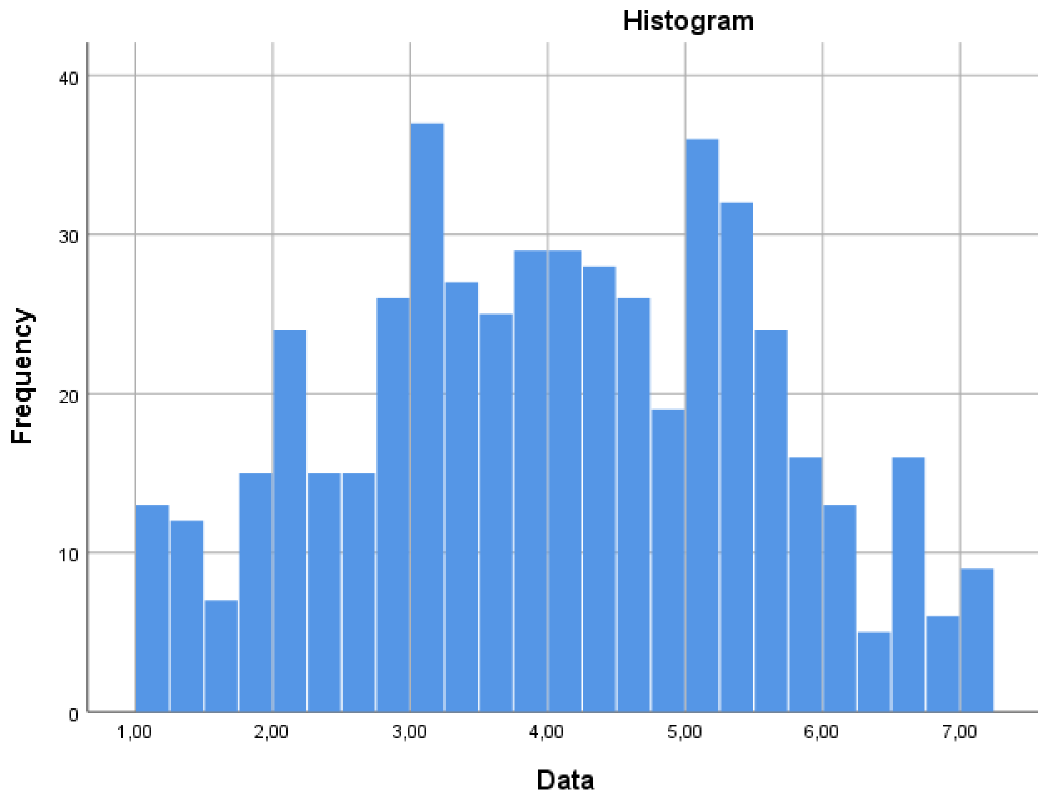

Figure 5.2 Histogram of normality test results

As previously stated, the repertory grid interviews were carried out with 30 participants and 772 valid bipolar attitudes were collected in the experiment with eight computer mouses. In each interview session, eight computer mouses were rated through bipolar attitudes elicited by each participant. Later, individual grids of each participant were merged as one dataset, and then thematically grouped 76 common attitudes were developed. The means of individual participant ratings of bipolar attitudes were calculated to be used as representing values of the developed common bipolar attitudes. In other words, 30 repertory grids were transformed into one grid. With the results of the goodness of fit test on this transformed dataset, common attitudes mentioned by five and more participants were determined to be taken into consideration for further analyses. Therefore, 63 common bipolar attitudes were analyzed quantitatively.

The rating scale of product samples was a 1 to 7 bipolar scale, where 1 indicates one pole and 7 indicates the opposite pole of the elicited attitude. Mean and standart deviation values were calculated on the averages ratings of computer mouses (Table 5.6). In the 1 to 7 point scale, 4 represents the midpoint and 1 is the extreme value to the left pole and 7 indicates the extreme value to the right pole. As can be seen in Table 5.6, most of the mean ratings were relatively close to the midpoint value, and only two attitude were relatively close to the extreme scores. Mean ratings close to the extreme values are regarded as lopsided (Fransella et al., 2004). *Symmetric-asymmetric* (Mean:1.45) is the only attitude that is close to the extreme value of the left pole, which means most of the computer mouses were evaluated as symmetric. Standard deviation reflected how scores are distributed around the mean. The standard deviation values were lowest for the attitudes *durable-flimsy* (0.42), *ambiguous-distinct* (0.50) and *long lasting-short lived* (0.54), and highest for the attitudes *dark-light* (2.15) and *independent-constrained* (1.95). Higher standard deviation value might be indicate that the average ratings spreaded over a wider range than lower standard deviation values, which means averages are located closer to the mean value.

Table 5.6 Mean and standard deviation values of average ratings of computer mouses. M1, M2, M3, M4, M5, M6, M7 and M8 represent eight computer mouses used in the experiment.

Average Ratings of Computer Mouses

	M1	M2	M3	M4	M5	M6	M7	M8	Mean	S. Dev.
dark-light	7,00	1,69	3,85	1,62	1,92	2,54	6,15	6,46	3,90	2,15
independent-constrained	1,20	4,80	3,40	1,40	1,40	1,40	2,40	7,00	2,88	1,95
classical-modern	7,00	3,27	1,45	4,64	4,91	4,55	2,36	1,00	3,65	1,88
long-short	3,00	6,67	1,44	5,11	5,00	5,11	1,44	2,11	3,74	1,86
old-new	6,96	3,75	2,11	5,04	5,36	5,00	2,61	1,32	4,02	1,78
big-small	4,52	6,52	1,21	4,76	4,41	4,72	1,66	2,00	3,72	1,75
directionless-directional	1,40	6,80	6,80	6,60	6,60	6,60	6,60	5,80	5,90	1,73
technological-outdated	1,08	3,75	5,58	3,08	2,83	3,08	5,00	6,92	3,92	1,72
particular-standard	1,00	2,50	6,00	5,33	4,67	5,67	5,33	5,83	4,54	1,70
gracious-coarse	1,22	2,33	6,22	4,00	4,22	3,78	5,22	6,56	4,19	1,70
fast-slow	1,75	2,25	5,75	3,13	2,75	2,88	5,88	5,88	3,78	1,64
shiny-matte	1,38	5,48	3,76	5,10	1,76	4,48	5,62	5,81	4,17	1,63
high quality-poor quality	1,07	5,64	5,21	2,93	2,43	3,14	4,43	5,93	3,85	1,61
clean-dirty	1,00	6,30	5,40	3,80	3,20	3,40	5,30	5,20	4,20	1,59
expensive-cheap	1,10	5,20	6,00	3,90	3,60	4,10	4,80	6,40	4,39	1,55
non glittery-glittery	3,00	1,67	6,17	1,75	5,00	2,00	2,25	2,50	3,04	1,55
thick-thin	6,33	5,11	1,44	3,56	3,44	3,22	1,78	2,89	3,47	1,51
discordant-coherent	6,67	1,83	2,67	5,17	5,33	5,17	5,00	5,67	4,69	1,50
beautiful-ugly	1,78	4,83	5,33	3,22	3,06	3,44	4,33	6,61	4,08	1,42
sloppy-elaborated	6,63	3,38	3,00	5,38	5,00	5,25	4,38	2,00	4,38	1,40
whole-fragmented	1,10	6,20	5,50	4,20	4,40	3,90	4,30	4,50	4,26	1,39
curved-flat	6,18	3,18	3,76	2,76	2,12	2,24	2,76	5,35	3,54	1,39
good-bad	1,50	5,17	4,33	2,33	2,17	2,33	3,83	5,33	3,38	1,38
healthy-unhealthy	1,50	5,33	5,17	2,83	1,83	3,00	3,83	4,67	3,52	1,37
simple-complex	1,40	6,33	4,87	3,47	3,87	3,53	3,80	2,67	3,74	1,36
heavy-light	6,00	5,26	2,09	4,57	4,70	5,04	2,78	2,83	4,16	1,31
problematic-unproblematic	4,40	2,60	3,80	5,40	5,40	4,80	5,60	1,80	4,23	1,31
high-low	7,00	4,43	2,29	3,86	3,86	3,79	2,86	4,43	4,06	1,31
smooth-rough	1,04	5,32	4,28	3,40	2,08	3,68	4,20	4,36	3,55	1,29
extraordinary-common	2,00	3,89	5,11	5,78	5,89	5,89	5,56	4,22	4,79	1,27
non sticky-sticky	1,00	5,60	2,60	4,00	2,40	3,00	3,60	3,40	3,20	1,25
loud-silent	4,88	4,82	2,06	5,29	3,53	4,12	4,00	1,65	3,79	1,24
attractive-unattractive	1,38	4,31	5,25	4,06	3,31	4,25	4,69	5,56	4,10	1,22
hidden-open	1,80	6,20	5,00	3,60	3,00	3,60	4,00	3,80	3,88	1,22
obtuse-pointed	5,29	1,86	4,57	3,00	3,29	2,57	2,57	5,14	3,54	1,21
slippery-non slippery	2,14	5,71	3,86	4,36	2,86	3,93	5,14	5,50	4,19	1,18
functional-functionless	5,50	2,83	4,00	3,67	3,33	3,50	3,33	6,50	4,08	1,18
dynamic-bulky	2,86	2,14	5,29	3,57	2,86	3,43	4,71	5,57	3,80	1,17
transparent-opaque	4,00	4,00	6,71	6,86	6,14	6,57	6,57	6,86	5,96	1,15
eccentrical-accustomed	2,13	4,50	5,75	5,63	5,50	5,63	5,63	5,38	5,02	1,15
handy-impractical	3,75	4,50	4,50	3,13	3,13	2,88	3,38	6,63	3,98	1,15
smelt-inodorous	6,00	2,33	2,83	4,17	3,67	5,33	4,50	3,83	4,08	1,13
rounded-sharp	5,38	2,23	3,62	2,38	2,38	2,00	2,77	4,38	3,14	1,13
user friendly-difficult to use	4,40	3,40	3,40	2,20	2,00	1,80	3,20	5,20	3,20	1,11
reassuring-insecure	1,86	3,14	5,00	3,43	3,29	3,57	5,29	5,00	3,82	1,10
soft-hard	5,39	2,00	5,17	4,67	4,44	4,39	4,61	5,94	4,58	1,09
cold-hot	1,22	5,33	2,89	4,00	3,11	3,22	3,67	3,89	3,42	1,09
plain-ornate	2,20	6,00	3,40	2,80	3,00	2,80	3,40	3,20	3,35	1,07
unnecessary-necessary	4,80	2,20	3,20	4,80	4,60	4,40	4,40	2,20	3,83	1,05
clear-blurry	1,20	2,20	2,60	3,60	3,00	3,20	1,80	4,80	2,80	1,05
raspy-tuneful	5,67	4,67	3,17	5,17	4,83	5,17	5,17	2,50	4,54	1,04
comfortable-uncomfortable	3,52	4,43	4,67	2,90	2,76	2,95	4,33	5,81	3,92	1,00
fluid-stable	3,38	3,85	4,92	4,15	3,23	3,23	5,46	6,00	4,28	1,00
symmetric-asymmetric	1,00	4,00	1,00	1,40	1,00	1,40	1,00	1,00	1,48	0,97
ergonomic-non ergonomic	4,07	4,86	3,64	3,64	3,29	3,50	3,29	5,93	4,03	0,86
entertaining-serious	3,88	2,88	4,13	4,75	4,50	4,50	5,00	6,00	4,45	0,85
deep-treble	5,00	2,60	3,13	4,47	4,53	4,07	2,80	4,20	3,85	0,83
easy-difficult	2,45	3,73	4,00	2,27	2,55	2,27	3,09	4,45	3,10	0,80
inappropriate-proper	5,00	5,67	4,83	5,83	5,67	5,50	4,00	3,50	5,00	0,80
controlled-uncontrolled	4,17	3,33	4,17	3,00	3,00	3,33	3,17	5,33	3,69	0,76
long lasting-short lived	3,00	4,33	4,83	3,67	4,17	4,67	4,33	4,00	4,13	0,54
ambiguous-distinct	3,80	5,10	4,80	5,30	5,40	5,50	5,00	5,00	4,99	0,50
durable-flimsy	2,73	4,09	4,09	3,91	3,45	3,55	3,55	3,91	3,66	0,42

To understand how the ratings were distributed, descriptive statistics were applied to the attitudes of *dark-light*, *independent-constrained* and *classic-modern*, which were those with the highest standard deviation values. As can be seen in Table 5.7, the descriptive statistics of the attitude *dark-light* presented that M5 (SD: 1.07) has relatively higher standard deviation value. It can be inferred from the statistictics that M5 was rated using the left pole (i.e. *dark*). Another computer mouse with a higher standard deviation, M3 (SD: 0.95) had the most scattered ratings, where M3 was rated with more extreme values than other computer mouses. In contrast to that, M1 (SD: 0.00) was the least scattered computer mouse within the attitude *dark-light,* as every participant rated with extreme values to the right pole (i.e. *light*). The ratings of M7 (SD: 0.66) and M8 (SD: 0.63) were also less scattered compared to other computer mouses, where the participants rated them by using the right pole of the scale (i.e. *light*) instead of the left pole (i.e. *dark*).

Table 5.7 Descriptive statistics of the attitude *dark-light*

Descriptive Statistics of the Attitude *dark-light*

Computer Mouses	N	Min.	Max.	Mean	Std. Dev.
M1	13	7,0	7,0	7,00	0,00
M2	13	1,0	4,0	1,69	0,91
M3	13	2,0	6,0	3,85	0,95
M4	13	1,0	4,0	1,62	0,92
M5	13	1,0	4,0	1,92	1,07
M6	13	1,0	4,0	2,54	0,93
M7	13	5,0	7,0	6,15	0,66
M8	13	5,0	7,0	6,46	0,63

The descriptive statistics of the attitude *independent-constrained* can be seen in Table 5.8. As can be seen from the statistics, M2 (SD: 2.04) and M3 (SD: 2.15) were with the highest standard deviation values, because their ratings were scattered highly as participants rated them with the extreme values in both the left pole (i.e. *independent*) and the right pole (i.e. *constrained*). The mean value of M2 is slightly over the midpoint, which means that the participants preferred to rate M2 by using the right pole (i.e. *constrained*) more than the left pole. Conversely, the mean value of M3 is slightly below the midpoint, so it can be understood that the participants preferred to rate by using the left pole (i.e. *independent*) more than the right pole. On the other hand, M8 (SD: 0.00) was with the lowest standard deviation as all the participants rated by using the extreme value of the right pole (i.e. *constrained*). M1 (SD: 0.40) had also one of the lowest standard deviation values, as the ratings were gathered very close to the extreme value of the left pole (i.e. *independent*).

Table 5.8 Descriptive statistics of the attitude *independent-constrained*

Descriptive Statistics of the Attitude *independent-constrained*

Computer Mouses	N	Min.	Max.	Mean	Std. Dev.
M1	5	1,0	2,0	1,20	0,40
M2	5	2,0	7,0	4,80	2,04
M3	5	1,0	6,0	3,40	2,15
M4	5	1,0	3,0	1,40	0,80
M5	5	1,0	3,0	1,40	0,80
M6	5	1,0	3,0	1,40	0,80
M7	5	2,0	4,0	2,40	0,80
M8	5	7,0	7,0	7,00	0,00

The descriptive statistics of the attitude *classic-modern* can be seen in Table 5.9. As can be seen from the descriptive statistics, M6 (SD: 1.72) and M5 (SD: 1.56) had the highest standard deviation values. The ratings of M5 and M6 were scattered highly as the participants rated by using extreme values of both the left pole (i.e. *classic*) and the right pole (i.e. *modern*). As the mean ratings of both M5 and M6 are slightly over the midpoint, it can be understood that participants tended to rate by using the right pole (i.e. *modern*) more than the left pole (i.e. *classic*). M1 (SD: 0.00) and M8 (SD: 0.00) were found to have the least standard deviation values as the ratings were gathered around the extreme values. The participants rated M1 by using the extreme values on the right pole (i.e. *modern*). In contrast to that, the same participants rated M8 by using the extreme values on the left pole (i.e. *classic*).

Table 5.9 Descriptive statistics of the attitude *classic-modern*

Descriptive Statistics of the Attitude *classic-modern*

Computer Mouses	N	Min.	Max.	Mean	Std. Dev.
M1	11	7,0	7,0	7,00	0,00
M2	11	1,0	6,0	3,27	1,54
M3	11	1,0	5,0	1,45	1,16
M4	11	1,0	6,0	4,64	1,55
M5	11	1,0	6,0	4,91	1,56
M6	11	1,0	6,0	4,55	1,72
M7	11	1,0	5,0	2,36	1,23
M8	11	1,0	1,0	1,00	0,00

The exemplary application of descriptive statistics provided feedback about how the ratings were distributed amongst computer mouses in each attitude. To observe how attitudes relate to each other, multivariate statistics needed to be applied to the dataset. Before applying multivariate statistics to the dataset, one last consistency test needed to be conducted on the dataset to measure the reliability of the data.

5.1.3 Reliability Measurement of the Collected Data

In general, reliability carries similar meaning with dependability or consistency. For psychometrics, reliability is defined as the consistency in measurement (Cohen & Swerdlik, 2009). If the collected data is consistent, it is accepted as reliable. There are various statistical methods developed to measure reliability of the data. These reliability measures are internal consistency, test-retest, and coefficients of equivalence (Irwing & Hughes, 2018, p. 18). A test-retest measure would not be proper for the data gathered through repertory grid technique in this study, as the focus of the study is to elicit attitudes depending on perceivers' awareness. The experience from the first test may influence the second test (retest) results for the same participant. Further, the consistency of the data can be estimated not only by applying the same or an alternative test to the same participants, but also by evaluating the test items internally (Cohen & Swerdlik, 2009, p. 145).

Various internal consistency measures can be applied to a data depending on data features. In psychometry, the most commonly used internal consistency measure is Cronbach's Alpha (Irwing & Hughes, 2018). Also, Cronbach's Alpha is preferred to for the reliability analysis of non-dichotomous items, and can be applied to the test which is administered once (Cohen & Swerdlik, 2009, p. 149). Obtained data in this study is non-dichotomous, so Cronbach's Alpha is preferred for measuring the internal reliability.

For Cronbach's Alpha, the internal consistency estimation of the data varies between the values of 0 and 1. The value 0 means there are no similarities between variables and 1 means variables are perfectly identical (Cohen & Swerdlik, 2009). Acceptability of the alpha value is situation-specific. Although the bigger value indicates a higher reliability, the bigger alpha value is not always better, as values above 0.90 could point to redundancy in data (Peterson, 1994; Streiner, 2003). So the alpha value should be neither too low, nor too high. Peterson (1994) investigated 832 studies and found out that 75% of the alphas were above 0.70, where he revealed 0.77 as the typical value. It can be understood that alpha value between 0.70 to 0.90 could be acceptable for the study.

The reliability score of the study was measured through the Cronbach's Alpha formula (Figure 5.3).

$$r_{\alpha} = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum \sigma_i^2}{\sigma^2}\right)$$

Figure 5.3 The Cronbach's Alpha formula

Cronbach's alpha value of the collected data was calculated to verify if the data is internally consistent. The first alpha value was found as 0.75 for 63 items. Tavakol and Dennick (2011) claim that the alpha value can be increased or decreased by removing the items with low correlation values. By this means, the adequate consistency value of the dataset can be achieved. According to the calculation results, the attitudes *old-new* and *classic-modern* were found to impact the consistency of the data significantly if their poles were reversed. For this, the attitude *old-new* was reversed to *new-old* and *classic-modern* was reversed to *modern-classic*, and their ratings were also reversed manually. Once these two attitudes were reversed, the consistency rating of the data increased to 0.87 (Table 5.10). In this context, the measured alpha value for this study is regarded highly reliable, therefore all 63 items were kept for further analysis.

Table 5.10 Reliability test results of the experiment with computer mouses

Reliability Statistics

Cronbach's Alpha	N of Items
0.865	63

5.1.4 Product Involvements in Attitude Elicitation

Attitudes were elicited through dyadic comparisons of computer mouses. In the attitude eliciting phase, two computer mouses were compared to elicit an attitude. Participants compared computer mouse pairs 678 times, (1356 ratings) to elicit 678 attitudes. Throughout the first experiment, it was found that M1 was contributed by 204 times in eliciting attitudes in paired comparisons, having the biggest role. This means that M1 has raised awareness more than any other computer mouses. Next, M7 was contributed by 177 times. Both M8 and M4 were involved 169 times each, followed by M2 which was involved 168 times. Furthermore, M5 was involved 164 times. Moreover, M3 was involved 153 times and lastly, M6 was involved 151 times.

Individual involvement ratings of computer mouses in the attitude elicitation phase could be a meaningful indicator in terms of understanding product-attitude relations. The frequency of involvement of a computer mouse in eliciting an attitude might mean that this computer mouse could be carrying material qualities that provoke participants to elicit that specific attitude. In this context;

- M1 was involved mostly in eliciting the attitudes *beautiful-ugly* (12 appearances with 33% of total), *simple-complex* (11 appearances with 36,7% of total) and *high-low* (9 appearances with 32,1% of total). These results can be interpreted as M1 carries significant material qualities regarded with elicited attitudes, of which users are perceptually aware.
- M2 was involved mostly in eliciting the attitudes *smooth-rough* (10 appearances with 20% of total), *deep-treble* (9 appearances with 30% of total) and *attractive-unattractive* (7 appearances with 21,9% of total).
- M3 was involved mostly in eliciting the attitudes *old-new* (11 appearances with 20% of total), *non glittery-glittery* (10 appearances with 41,7% of total) and *discordant-coherent* (5 appearances with 41,7% of total).
- M4 was involved mostly in eliciting the attitudes *smooth-rough* (11 appearances with 22% of total), *dark-light* (7 appearances with 26,9% of total) and *beautiful-ugly* (7 appearances with 19,4% of total).
- M5 was involved mostly in eliciting the attitudes *shiny-matte* (9 appearances with 21,4% of total), *slippery-non slippery* (7 appearances with 25% of total) and *fast-slow* (6 appearances with 37,5% of total).
- M6 was involved mostly in eliciting the attitudes *curved-flat* (6 appearances with 17,6% of total), *soft-hard* (6 appearances with 16,7% of total) and *entertaining-serious* (4 appearances with 25% of total).

- M7 was involved mostly in eliciting the attitudes *big-small* (15 appearances with 25,9% of total), *dark-light* (7 appearances with 26,9% of total) and *comfortable-uncomfortable* (7 appearances with 16,7% of total).
- M8 was involved mostly in eliciting the attitudes *old-new* (15 appearances with 27,3% of total), *loud-silent* (10 appearances with 29,4% of total) and *gracious-coarse* (7 appearances with 38,9% of total).

As stated above, each computer mouse provoked participants to elicit specific attitudes during dyadic comparison sessions depending on its distinctive perceivable material qualities. The summary of the findings can be seen in Table 5.11.

Table 5.11 Summarized findings of the computer mouses with significant involvements in eliciting particular attitudes

			
M1	**M2**	**M3**	**M4**
beautiful-ugly simple-complex high-low	smooth-rough deep-treble attractive-unattractive	old-new non glittery-glittery discordant-coherent	smooth-rough dark-light beautiful-ugly
			
M5	**M6**	**M7**	**M8**
shiny-matte slippery-non slippery fast-slow	curved-flat soft-hard entertaining-serious	big-small dark-light comfortable-uncomfortable	old-new loud-silent gracious-coarse

5.1.5 Sensory Relevance of Elicited Attitudes

Up to now, the attitudes elicited by the repertory grid technique through interactions with computer mouses were recorded, and analyzed both qualitatively and quantitatively. Elicited attitudes were rated through a seven-point scale by all of the 30 participants.

Investigating sensory aspects of the elicited attitudes is another major aim of this study. Also, sensory information would be used as a supportive data to explore and illustrate the attitude-attitude relationships. The attitudes elicited through repertory grids are bipolar adjectives. As mentioned before, adjective pairs were frequently used in perception and sensory studies (see Section 2.7). According to the literature review, studies mostly conduct measurements through semantic differential scales by using defined dimensions. Although standard factors and dimensions are developed through vocabulary sets, the vocabularies may cover different meanings in different contexts. In applied psychology, it is pointed out that the dimensions of activity, potency and evaluative that are developed through the semantic differential scale (Osgood, et al., 1957) fall short in capturing the meanings as they remain abstract (Suzuki, Gyoba, Kawabata, Yamaguchi, & Komatsu, 2006; Suzuki & Gyoba, 2003). In a study about defining multidimensional olfactory experience, Dalton, Maute, Oshida, Hikichi and Izumi (2008) pointed out that the vocabulary generated for defining olfactory experiences (i.e. soft) refer to other sensory modalities (i.e. tactile and auditory). Sensory investigation of vocabularies could provide insights about the intended meanings of the evaluators.

Schifferstein, Otten, Thoolen and Hekkert (2010) devised an experimental method to measure sensory hierarchy in product experiences. An additive model of sensory integration was used to gather sensory data, in which “the participant’s evaluation of a combination of stimuli (i.e. a product) equals the sum of the (weighted) subjective values of the given stimuli” (Schifferstein, et al., 2010, p. 124). Participants ranked sensory modalities depending on their importance through the pleasantness dimension, consisting of 16 bipolar adjective pairs adapted from the scales developed by Osgood, et al. (1957). In their study, statistically no significant sensory importance value was achieved by Schifferstein et al. (2010) about the sensory importance hierarchy from the participants' ratings on the pleasantness dimension.

Self reports of the users are the simplest method to investigate sensory properties of product experiences (Schifferstein, 2006). Self reports are simply produced by answering questions about the topic. Schifferstein et al. (2010) emphasized that self reports are limited with the awareness of the users. The present study intends to investigate sensory relevance of the attitudes through sensory interaction with product materials within the awareness boundary of the users. As Köster (2003) emphasized, sensory modalities like gustation and olfaction were often neglected in introspective sensory research. This likely happens as information from some sensory modalities are learnt partly unconsciously. Köster (2003) also mentioned about forgetting memories about previous experiences that can influence current evaluations and future expectations. This could be a problem for a basic questionnaire or interview method to investigate sensory relations. Yet, this does not cause limitations on a study where percepts are investigated only of those users who are perceptually aware during usage.

The sensory investigation approach of this thesis is that the present study is inspired from the self reports technique used by Schifferstein (2006) in order to measure multidimensional sensory aspectes of attitudes. Schifferstein (2006) asked users about the importance of each sensory modality on different products, and the users responded through an ordinal scale (where 1 represents "very unimportant" and 5 represents "very important"). In the present study, sensory relevancies of each elicited attitude was evaluated by participants through sample product pairs responsible for elicitation of that attitude in dyadic comparison sessions. In this manner, the sensory relevancies of the products and the attitudes could be understood. As can be seen from the literature review, objective sensory measurement is a highly complex process, where each sensory modality requires specific determining of magnitudes for measuring. Also, measurements are mostly made through basic samples (such as two dimensional material pieces) and often avoided using complex samples (such as products). To measure the sensory relevancies of elicited attitudes through five senses, a simple and practical interval scale was preferred to capture sensory data in a pragmatic way. Dawes (2002) suggested that using eleven-point scale provides more variance compared to five-point scales. As previously mentioned, an eleven-point 0 to 10 scale was used in the study to assess sensory relevance of elicited attitudes for each sensory modality. In the sensory relevancy scale, 0 means “not involved”, 1 means “very low involvement” and 10 means “very high involvement”.

In this study, the attitudes which only the participants were aware of were elicited. Furthermore, grid sheets were utilised to have another scale to measure the sensory relevancies of the elicited attitudes with the adaptation from the modality differential scale (Suzuki, et al, 2006; Suzuki & Gyoba, 2003). Suzuki and Gyoba (2003) calculated sensory relevance coefficients of bipolar adjective pairs through five basic senses by using words, images and their combinations. In the following study, Suzuki et al. (2006) investigated the sensory relevancies of adjective sets through ten sensory modalities to find out sensory components of the dimensions of Osgood, et al. (1957). The sensory relevancy scale was utilized as eleven point sensory relevancy scale, to measure how attitudes and senses are related. The scale consisted of scores of the five basic senses (vision, touch, audition, olfaction and gustation) rated by the perceivers who participated in the study.

Sensory relevancy scores can be analyzed from the perspectives of the computer mouses, the attitudes and the sensory modalities. Sensory relevancies were rated through comparisons of computer mouse pairs. As participants rated each of the computer mouse pair individually, a detailed rating list is achieved. Sixty three attitudes mentioned by five or more participants were taken into consideration for quantitative analysis.

When an attitude is elicited through a dyad of computer mouses, the attitude is then rated by the sensory scale separately for each mouse. There are two reasons for rating the attitudes through the computer mouses separately. As two computer mouses have different material qualities, they may influence the elicited attitude differently. Also, rating an elicited attitude through each computer mouse separately could be used as a cross check and therefore increase consistency in the ratings. An example sensory relevance table from the first experiment can be seen in Table 5.12.

Table 5.12 Exemplary sensory relevance rating of gracious-coarse.

Left Pole	**Right Pole**	**Element (I)**	**Element (II)**	**Vision (I)**	**Touch (I)**	**Audition (I)**	**Olfaction (I)**	**Gustation (I)**	**Vision (II)**	**Touch (II)**	**Audition (II)**	**Olfaction (II)**	**Gustation (II)**
gracious	coarse	M1	M8	7	8	5	0	0	10	8	9	0	0
gracious	coarse	M3	M8	10	10	0	0	0	10	10	0	0	0
sensitive	coarse	M5	M8	7	0	8	0	0	7	0	9	0	0
sweet	coarse	M7	M8	0	0	10	0	0	5	5	10	0	0
gracious	coarse	M4	M8	10	7	0	0	0	10	8	0	0	0
gracious	coarse	M3	M7	9	6	3	2	0	10	9	4	0	0
gracious	coarse	M6	M8	10	7	0	0	0	9	7	0	0	0
gracious	coarse	M1	M3	10	10	5	0	0	10	10	2	0	0
gracious	coarse	M1	M8	10	10	0	0	0	10	10	0	0	0

As can be seen from Table 5.12, elicited poles were written on the left, where compared elements (computer mouses) in a dyadic session was placed in the middle. Sensory ratings were placed on the right. Numbers in parantheses next to modalities (i.e. I and II) represent the elements in dyadic comparison. On the first line, M1 and M8 were compared, and the attitude *gracious-coarse* was elicited. As the attitude *gracious-coarse* is a consequence of the likeness or the differency of computer mouses, each computer mouse may contribute to the forming of the attitude specifically. The roles of the five sensory modalities were rated for each computer mouse by the participants depending on their subjective evaluations. For the first line, vision (7) and touch (8) were considered highly influential in the elicitation of the attitude *gracious-coarse* for M1, where audition (5) was regarded moderately influencing and olfaction (0) and gustation (0) had no influence. Afterwards, vision (10) was found extremely influential in the elicitation of the attitude *gracious-coarse,* where touch (8) and audition (9) were also found highly influential and olfaction (0) and gustation (0) remained ineffective, for M8. A significant difference can be observed on the relevancy of audition in the elicitation of the attitude *gracious-coarse* for both computer mouses, where the auditory qualities of M8 were found more influential compared to M1. If the sensory rating difference is high between compared computer mouses, that could be an indicator of a significant difference between product material qualities. Once preliminary analyses were completed, the data were rearranged into a simple format (see Table 5.13).

Table 5.13 Rearranged sensory relevance table of the theme Grace (*gracious-coarse*)

GRACE
(gracious-coarse)

Element	Vision	Touch	Audition	Olfaction	Gustation
M1	7	8	5	0	0
M1	10	10	5	0	0
M1	10	10	0	0	0
M3	10	10	0	0	0
M3	9	6	3	2	0
M3	10	10	2	0	0
M4	10	7	0	0	0
M5	7	0	8	0	0
M6	10	7	0	0	0
M7	0	0	10	0	0
M7	10	9	4	0	0
M8	10	8	9	0	0
M8	10	10	0	0	0
M8	7	0	9	0	0
M8	5	5	10	0	0
M8	10	8	0	0	0
M8	9	7	0	0	0
M8	10	10	0	0	0
Mean	8,56	6,94	3,61	0,11	0,00

Table 5.13 is the simplified version of the previous table. The attitude *gracious-coarse* is represented by the theme *Grace*. Each element that has a role in the elicitation of the attitude *gracious-coarse* was gathered into a column and their sensory relevance ratings were listed as lines. The mean ratings of each sensory

modality can be viewed in Table 5.13[41]. The theme *Grace* was regarded highly visual (8,56) and tactual (6,94), and slightly auditory (3,61). However, olfaction (0,11) plays a very little role and gustation (0) has no role in the forming of the attitude *gracious-coarse,* according to the participants' evaluation. On the other hand, it can be seen from Table 5.13 that frequencies of computer mouses are different, which means some computer mouses caught the attention of the participants more than the other computer mouses specifically as in the elicitation of the attitude *gracious-coarse* example. By this means, M8 was mentioned seven times and may be regarded as the most influential element in eliciting the attitude *gracious-coarse.* M1 and M3 were equally mentioned three times, whereas M4, M5 and M6 were mentioned only once and M2 was not mentioned. Based on these findings, a preliminary assumption can be made as M8 could be carrying discriminative material qualities that were evaluated as *distinctively gracious* or *distinctively coarse* compared to other mouses, which could be used as a complementary feedback for the forthcoming analyses in the following sections.

The data from the first experiment were reorganized with the procedures mentioned above. With the completion of revealing the roles of each mouse in eliciting attitudes, sensory relevancies of the elicited attitudes can be measured. Sixty three attitudes mentioned by five or more participants and their average sensory relevance ratings are listed in Table 5.14.

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[41] Standard deviations of the ratings were also calculated for each theme. However, the sensory relevance ratings were specific to each computer mouse, so standard deviation values do not provide any meaningful data. Therefore, standard deviation values were not represented.

Table 5.14 List of attitudes mentioned by five or more participants and their sensory relevance ratings.

Category	Attitude Pairs	Freq.	Sensory Relevance				
			Visual	Tactile	Auditory	Olfactory	Gustatory
Size	big-small	29	9,74	8,64	0,55	0,00	0,00
Newness	old-new	28	9,27	6,79	3,70	0,34	0,05
Roughness	smooth-rough	25	8,36	9,54	2,04	0,00	0,20
Weight	heavy-light	23	5,24	8,87	2,50	0,00	0,00
Comfort	comfortable-uncomfortable	21	7,00	9,10	3,98	0,05	0,00
Glossiness	shiny-matte	21	9,71	7,07	0,60	0,00	0,00
Aesthetics	beautiful-ugly	18	9,14	7,72	4,17	0,08	0,11
Softness	soft-hard	18	6,97	9,69	3,39	0,00	0,00
Surface Lines	curved-flat	17	9,41	9,47	0,71	0,00	0,00
Frequency	loud-silent	17	1,76	5,38	9,21	0,00	0,00
Attractiveness	attractive-unattractive	16	9,28	5,94	3,22	0,00	0,09
Loudness	deep-treble	15	2,53	5,43	9,67	0,00	0,00
Simplicity	simple-complex	15	9,80	7,80	2,30	0,00	0,00
Greasiness	slippery-non slippery	14	5,54	9,36	2,07	0,00	0,11
Height	high-low	14	9,57	8,11	0,14	0,00	0,00
Ergonomy	ergonomic-non ergonomic	14	7,07	9,68	0,89	0,00	0,00
Quality	high quality-poor quality	14	8,75	8,46	4,00	0,29	0,00
Fluidity	fluid-stable	13	8,15	8,08	0,77	0,00	0,00
Edge Lines	rounded-sharp	13	8,85	9,04	0,88	0,00	0,00
Hue	dark-light	13	9,85	0,81	0,00	0,00	0,00
Glitteriness	non glittery-glittery	12	9,75	2,63	0,08	0,00	0,00
Technology	technological-outdated	12	9,29	7,04	4,67	0,00	0,00
Modernity	classical-modern	11	9,59	6,55	3,64	0,32	0,00
Difficulty	easy-difficult	11	7,14	9,14	4,50	0,00	0,00
Sturdiness	durable-flimsy	11	8,32	9,45	6,55	0,00	0,00
Ambiguousness	ambiguous-distinct	10	9,90	8,20	2,70	0,00	0,00
Cleanness	clean-dirty	10	9,65	8,05	1,45	0,30	0,00
Wholeness	whole-fragmented	10	9,50	7,50	0,75	0,00	0,00
Value	expensive-cheap	10	9,30	8,65	5,15	0,10	0,15
Accustomedness	eccentrical-accustomed	9	9,17	7,61	3,56	0,72	0,00
Grace	gracious-coarse	9	8,56	6,94	3,61	0,11	0,00
Thickness	thick-thin	9	10,00	9,67	2,67	0,00	0,00
Thermal	cold-hot	9	4,78	9,22	1,22	0,06	0,33
Length	long-short	9	9,00	8,22	0,22	0,00	0,00
Usefulness	handy-impractical	8	7,19	8,81	3,50	0,00	0,00
Discrepancy	extraordinary-common	8	9,38	8,00	3,75	0,00	0,00
Velocity	fast-slow	8	7,56	8,81	2,88	0,00	0,00
Seriousity	entertaining-serious	8	8,50	6,13	4,06	0,00	0,00
Eloboratedness	sloppy-elaborated	8	8,56	8,50	5,44	0,00	0,50
Agility	dynamic-bulky	7	7,86	8,36	2,50	0,00	0,00
Transparency	transparent-opaque	7	9,71	2,21	1,29	0,00	0,00
Safety	reassuring-insecure	7	8,07	6,64	4,21	0,00	0,00
Corner Lines	obtuse-pointed	7	9,86	8,86	0,57	0,00	0,00
Controllability	controlled-uncontrolled	6	3,50	9,42	3,83	0,00	0,00
Specialization	particular-standard	6	9,50	5,83	2,08	0,00	0,00
Healthiness	healthy-unhealthy	6	7,33	9,00	4,42	0,00	0,00
Goodness	good-bad	6	8,17	8,67	5,25	0,67	0,00
Durability	long lasting-short lived	6	8,33	6,42	3,25	0,00	0,00
Smelliness	smelt-inodorous	6	0,33	0,33	0,00	9,83	0,00
Raspiness	raspy-tuneful	6	2,58	6,75	9,25	0,00	0,00
Appropriateness	inappropriate-proper	6	8,92	6,83	4,75	0,00	0,00
Functionality	functional-functionless	6	7,00	8,33	3,42	0,00	0,00
Compatibility	discordant-coherent	6	9,58	5,33	1,92	0,00	0,00
Necessity	unnecessary-necessary	5	8,10	7,70	3,50	0,00	0,00
Ease of Use	user friendly-difficult to use	5	7,10	8,10	4,00	0,00	0,00
Decoratedness	plain-ornate	5	10,00	6,70	4,10	0,70	0,00
Directionality	directionless-directional	5	10,00	8,00	1,70	0,00	0,00
Stickiness	non sticky-sticky	5	6,80	10,00	1,00	0,20	0,00
Problemacy	problematic-unproblematic	5	6,40	7,00	5,00	0,00	0,00
Sound Clarity	clear-blurry	5	0,50	4,90	10,00	0,00	0,00
Symmetry	symmetric-asymmetric	5	10,00	8,30	1,60	0,00	0,00
Restrictiveness	independent-constrained	5	8,50	8,40	1,60	0,00	0,00
Openness	hidden-open	5	9,30	6,10	1,50	0,00	0,00

Mean ratings of the full list of attitudes provide insights about the general sensory relevancies of interactions with computer mouses. Averages of sensory relevance scores for 678 attitudes for all eight computer mouses are 7,91 for vision, 7,50 for touch, 3,11 for audition, 0,22 for olfaction and 0,02 for gustation. Moreover, some attitudes have significantly higher frequency of mentions than others, therefore could be contributing to sensory ratings more than the other attitudes. For this, the weighted[42] arithmetic means of sensory relevance scores are calculated for 678 attitudes for all eight computer mouses. Calculated weighted arithmetic means are 8,01 for vision, 7,65 for touch, 2,97 for audition, 0,15 for olfaction and 0.03 for gustation. It can be understood from the mean ratings that participants describe the interactions with computer mouses as mostly visual and tactile. Audition plays a limited role, whereas olfaction and gustation have very low ratings. Table 5.15 shows the summary of sensory relevance scores for eight computer mouses.

Table 5.15 Averages and weighted means of sensory relevance scores of participants through eight computer mouses

Sensory Modality	Vision	Touch	Audition	Olfaction	Gustation
Average Rating	7,91	7,50	3,11	0,22	0,02
Weighted Mean Rating	8,01	7,65	2,97	0,15	0,03

5.1.5.1 Multisensory Relevancies

The sensory relevance scores also provide insights about how participants evaluate elicited attitudes in terms of their sensory constituents. The attitudes can be investigated through multisensory aspects. Schifferstein et al. (2010) used an additive model to investigate sensory dominance in product experiences through four sensory modalities (vision, touch, audition and olfaction). Basically, the sum of

[42] Weighted arithmetic means are calculated by including frequency of mentions. To calculate weighted mean scores, averages of sensory relevancy ratings were multiplicated with the frequency of mention of each particular attitude, and then divided by the total number of frequency of mentions of all attitudes.

subjective values of each sensory modality was equated to the general response of the multisensory product experience. According to Schifferstein et al. (2010), this additive model is simple to apply and proven as successful. The equation of the additive model used by Schifferstein et al. (2010) was:

$$r_{VTAO} = w_V s_V + w_T s_T + w_A s_A + w_O s_O$$

In the equation, r_{VTAO} means the response to the multisensory experience, w_V is the weighted value and s_V is the subjective value of vision (V for vision, T four touch, A for audition and O for olfaction). This equation was utilized for the present study. To assess the multisensory value of an attitude, a simple equation was formed as:

$$MS_A = V_M + T_M + A_M + O_M + G_M$$

The multisensory value of an attitude is represented as MS_A, and V_M means the sensory relevance score of that attitude rated through the corresponding computer mouse in elicitation (V stands for vision, T stands for touch, A stands for audition, O stands for olfaction and G stands for gustation). Rating the five senses over the 0 to 10 scale, the maximum multisensory score could be 50. Multisensory scores for every attitude mentioned by five or more participants were calculated. The 20 attitudes with the highest multisensory scores above 20,00 can be seen in Table 5.16.

Table 5.16 Attitudes with the highest multisensory scores for computer mouses

Attitudes	Multisensory Score	Attitudes	Multisensory Score
durable-flimsy	24,32	technological-outdated	21,00
expensive-cheap	23,35	ambiguous-distinct	20,80
sloppy-elaborated	23,00	easy-difficult	20,77
good-bad	22,75	healthy-unhealthy	20,75
thick-thin	22,33	inappropriate-proper	20,50
high quality-poor quality	21,50	old-new	20,14
plain-ornate	21,50	smooth-rough	20,14
beautiful-ugly	21,22	comfortable-uncomfortable	20,12
extraordinary-common	21,13	classical-modern	20,09
eccentrical-accustomed	21,06	soft-hard	20,06

As can be seen in Table 5.16., the attitude *durable-flimsy* (V:8,35; T:9,45; A:6,55; O:0,00; G:0,00) was found highest in multisensory values, followed by *expensive-cheap* (V:9,30; T:8,65; A:5,15; O:0,10; G:0,15) and *sloppy-elaborated* (V:8,56; T:8,50; A:5,44; O:0,00; G:0,50). On the other hand, *smelt-inodorous* (V:0,33; T:0,33; A: 0,00; O:9,83; G:0,00) was found as the least multisensory attitude, followed by *dark-light* (V:9,85; T:0,81; A:0,00; O:0,00; G:0,00) and *non glittery-glittery* (V:9,75; T:2,63; A:0,08; O:0,00; G:0,00).

5.1.5.2 Sensory Dominances

After calculating the multisensory scores for each attitude, sensory dominances can be investigated. Having a high mean score in any of the sensory modalities does not mean that it is the dominant sense of the particular attitude. As can be seen from the sensory relevance table (Table 5.14), both unimodal and multimodal dominances were found in many attitude pairs. So it would be better to analyse unimodal and multimodal dominances separately. For unimodal dominance analysis, the percentage of a sensory modality in sum of all sensory scores (multisensory score) for an attitude would be calculated for each attitude. To calculate this, the following equation was formed:

$$x_D = \frac{x}{MS}$$

In the equation, x stands for the sensory modality, x_D stands for the dominance value of that modality x, and MS stands for the multisensory score of the attitude. For instance, the visual dominance in an attitude can be calculated as follows:

$$V_D = \frac{V}{V+T+A+O+G}$$

The dominance value can be between 0 and 1. The dominance of a modality increases as the value gets closer to 1 and decreases in reverse. Sensory dominances for all the attitudes were inspected. To be accepted as the dominant sense modality in one attitude, the difference of the particular sensory score from other sensory modalities were taken into consideration. If the difference is greater, this means the particular sensory modality is more dominant in that attitude. To be regarded as dominant, the sensory relevancy score of a sensory modality can be suggested as above 9,00 as a cut-off value, and there should be a significantly positive difference in scores from any of the other senses.

Vision was regarded as the most dominant sensory modality with the highest sensory dominance value in the attitudes of *dark-light* (0,92), followed by *transparent-opaque* (0,74), *non glittery-glittery* (0,78), *discordant-coherent* (0,57), *shiny-matte* (0,56), *particular-standard* (0,55), *whole-fragmented* (0,54), *hidden-open* (0,55), *attractive-unattractive* (0,50), *simple-complex* (0,49), *classical-modern* (0,48) and *old-new* (0,46). Visually dominant attitudes can be seen in Table 5.17. Contrarily, vision was found significantly less influential in the attitudes where audition and olfaction were dominant, such as *deep-treble* (0,14), *raspy-tuneful* (0,14), *loud-silent* (0,11), *clear-blurry* (0,03) and *smelt-inodorous* (0,03).

Table 5.17 List of attitudes with visual dominance

	Sensory Relevance					**Sensory Dominance**				
Attitudes	**V**	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
dark-light	9,85	0,81	0,00	0,00	0,00	0,92	0,08	0,00	0,00	0,00
non glittery-glittery	9,75	2,63	0,08	0,00	0,00	0,78	0,21	0,01	0,00	0,00
transparent-opaque	9,71	2,21	1,29	0,00	0,00	0,74	0,17	0,10	0,00	0,00
discordant-coherent	9,58	5,33	1,92	0,00	0,00	0,57	0,32	0,11	0,00	0,00
shiny-matte	9,71	7,07	0,60	0,00	0,00	0,56	0,41	0,03	0,00	0,00
particular-standard	9,50	5,83	2,08	0,00	0,00	0,55	0,33	0,12	0,00	0,00
whole-fragmented	9,50	7,50	0,75	0,00	0,00	0,54	0,42	0,04	0,00	0,00
hidden-open	9,30	6,10	1,50	0,00	0,00	0,55	0,36	0,09	0,00	0,00
attractive-unattractive	9,28	5,94	3,22	0,00	0,09	0,50	0,32	0,17	0,00	0,01
simple-complex	9,80	7,80	2,30	0,00	0,00	0,49	0,39	0,12	0,00	0,00
classical-modern	9,59	6,55	3,64	0,32	0,00	0,48	0,33	0,18	0,02	0,00
old-new	9,27	6,79	3,70	0,34	0,05	0,46	0,34	0,18	0,02	0,00

Sensory dominance of touch was found highest in the attitude of *cold-hot* (0,59), followed by the attitudes of *controlled-uncontrolled* (0,56), *non sticky-sticky* (0,56), *ergonomic-non ergonomic* (0,55), *slippery-non slippery* (0,55), *soft-hard* (0,48), *comfortable-uncomfortable* (0,45) and *easy-difficult* (0,44). Attitudes in which touch was found dominant can be seen in Table 5.18. In contrast to this, touch was found least effective in the attitudes of *smelt-inodorous* (0,03), *dark-light* (0,08), *transparent-opaque* (0,17) and *non glittery-glittery* (0,21).

Table 5.18 List of attitudes with tactile dominance

	Sensory Relevance					Sensory Dominance				
Attitudes	**V**	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
cold-hot	4,78	9,22	1,22	0,06	0,33	0,31	0,59	0,08	0,00	0,02
controlled-uncontrolled	3,50	9,42	3,83	0,00	0,00	0,21	0,56	0,23	0,00	0,00
non sticky-sticky	6,80	10,00	1,00	0,20	0,00	0,38	0,56	0,06	0,01	0,00
ergonomic-non ergonomic	7,07	9,68	0,89	0,00	0,00	0,40	0,55	0,05	0,00	0,00
slippery-non slippery	5,54	9,36	2,07	0,00	0,11	0,32	0,55	0,12	0,00	0,01
soft-hard	6,97	9,69	3,39	0,00	0,00	0,35	0,48	0,17	0,00	0,00
comfortable-uncomfortable	7,00	9,10	3,98	0,05	0,00	0,35	0,45	0,20	0,00	0,00
easy-difficult	7,14	9,14	4,50	0,00	0,00	0,34	0,44	0,22	0,00	0,00

Compared to vision and touch, audition was found having relatively less scores from participant responses. Sensory dominance of audition was highest for the attitude *clear-blurry* (0,65), followed by the attitudes *loud-silent* (0,56), *deep-treble* (0,55) and *raspy-tuneful* (0,50). Attitudes in which audition was found dominant can be seen in Table 5.19. Furthermore, audition seemed to have a lower influence mostly on the attitudes related with the form and shape of the product. The attitudes with the lowest auditory dominance scores were *smelt-inodorous* (0,00), *dark-light* (0,00), *glittery-non-glittery* (0,01), *high-low* (0,00) and *long-short* (0,01).

Table 5.19 List of attitudes with auditory dominance

	Sensory Relevance					Sensory Dominance				
Attitudes	**V**	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
clear-blurry	0,50	4,90	10,00	0,00	0,00	0,03	0,32	0,65	0,00	0,00
loud-silent	1,76	5,38	9,21	0,00	0,00	0,11	0,33	0,56	0,00	0,00
deep-treble	2,53	5,43	9,67	0,00	0,00	0,14	0,31	0,55	0,00	0,00
raspy-tuneful	2,58	6,75	9,25	0,00	0,00	0,14	0,36	0,50	0,00	0,00

Olfaction and gustation were found to have significantly low sensory scores for computer mouses. Olfaction had only one dominance in the attitude of *smelt-inodorous* (0,94), yet gustation had no dominance in any of the attitudes.

After investigating the unimodal dominances throughout the attitudes, multimodal dominances were also analyzed. Basically, multimodal dominance is the condition where more than one sensory modalities are regarded as dominant in an attitude. Significantly high dominance scores that are close to each other in values were investigated. Findings can be seen in Table 5.20. For the first experiment, it was found that multimodal dominances with significant values are bimodal. All of the bimodal dominances were visual and tactile.

Table 5.20 List of attitudes with bimodal dominance

	Sensory Relevance					**Sensory Dominance**				
Attitudes	**V**	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
high-low	**9,57**	**8,11**	0,14	0,00	0,00	**0,54**	**0,45**	0,01	0,00	0,00
long-short	**9,00**	**8,22**	0,22	0,00	0,00	**0,52**	**0,47**	0,01	0,00	0,00
big-small	**9,74**	**8,64**	0,55	0,00	0,00	**0,51**	**0,46**	0,03	0,00	0,00
obtuse-pointed	**9,86**	**8,86**	0,57	0,00	0,00	**0,51**	**0,46**	0,03	0,00	0,00
symmetric-asymmetric	**10,00**	**8,30**	1,60	0,00	0,00	**0,50**	**0,42**	0,08	0,00	0,00
directionless-directional	**10,00**	**8,00**	1,70	0,00	0,00	**0,51**	**0,41**	0,09	0,00	0,00
smooth-rough	**8,36**	**9,54**	2,04	0,00	0,20	**0,42**	**0,47**	0,10	0,00	0,01
clean-dirty	**9,65**	**8,05**	1,45	0,30	0,00	**0,50**	**0,41**	0,07	0,02	0,00
ambiguous-distinct	**9,90**	**8,20**	2,70	0,00	0,00	**0,48**	**0,39**	0,13	0,00	0,00
extraordinary-common	**9,38**	**8,00**	3,75	0,00	0,00	**0,44**	**0,38**	0,18	0,00	0,00
independent-constrained	**8,50**	**8,40**	1,60	0,00	0,00	**0,46**	**0,45**	0,09	0,00	0,00
curved-flat	**9,41**	**9,47**	0,71	0,00	0,00	**0,48**	**0,48**	0,04	0,00	0,00
fluid-stable	**8,15**	**8,08**	0,77	0,00	0,00	**0,48**	**0,48**	0,05	0,00	0,00
rounded-sharp	**8,85**	**9,04**	0,88	0,00	0,00	**0,47**	**0,48**	0,05	0,00	0,00
thick-thin	**10,00**	**9,67**	2,67	0,00	0,00	**0,45**	**0,43**	0,12	0,00	0,00

The final dominance analysis was made on the attitudes, in which three sensory modalities were dominant. Vision, touch and audition seemed to be involved in trimodal dominances, yet none of these three modalities were found equally or similary dominant. Attitudes having at least three modalities with sensory relevancy scores of 4 were taken into consideration. Trimodal dominance was found highest in the attitudes *durable-flimsy*, *sloppy-eloborated*, *good-bad*, *expensive-cheap* and *problematic-unproblematic*. Table 5.21 represents the list of attitudes with trimodal dominance.

Table 5.21 List of attitudes with trimodal dominance

	Sensory Relevance					Sensory Dominance				
Attitudes	**V**	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
durable-flimsy	8,32	9,45	6,55	0,00	0,00	0,34	0,39	0,27	0,00	0,00
sloppy-elaborated	8,56	8,50	5,44	0,00	0,50	0,37	0,37	0,24	0,00	0,02
good-bad	8,17	8,67	5,25	0,67	0,00	0,36	0,38	0,23	0,03	0,00
expensive-cheap	9,30	8,65	5,15	0,10	0,15	0,40	0,37	0,22	0,00	0,01
problematic-unproblematic	6,40	7,00	5,00	0,00	0,00	0,35	0,38	0,27	0,00	0,00
inappropriate-proper	8,92	6,83	4,75	0,00	0,00	0,43	0,33	0,23	0,00	0,00
technological-outdated	9,29	7,04	4,67	0,00	0,00	0,44	0,34	0,22	0,00	0,00
easy-difficult	7,14	9,14	4,50	0,00	0,00	0,34	0,44	0,22	0,00	0,00
healthy-unhealthy	7,33	9,00	4,42	0,00	0,00	0,35	0,43	0,21	0,00	0,00
reassuring-insecure	8,07	6,64	4,21	0,00	0,00	0,43	0,35	0,22	0,00	0,00
beautiful-ugly	9,14	7,72	4,17	0,08	0,11	0,43	0,36	0,20	0,00	0,01
plain-ornate	10,0	6,70	4,10	0,70	0,00	0,47	0,31	0,19	0,03	0,00
entertaining-serious	8,50	6,13	4,06	0,00	0,00	0,45	0,33	0,22	0,00	0,00
user friendly-difficult to use	7,10	8,10	4,00	0,00	0,00	0,37	0,42	0,21	0,00	0,00

5.2 Experiment 2: Water Bottles

In the second experiment, eight water bottles were tested and evaluated by 30 participants. As in the first experiment, data collection was made through repertory grid interviews. Collected data contain both qualitative and quantitative aspects, so both qualitative and quantitative analysis methods were applied. In the first phase, qualitative analysis was applied on the data.

5.2.1 Qualitative Data Analysis

For the qualitative analysis of the data collected from the second experiment, the same approach as in the first experiment with computer mouses was adopted (See Section 5.1.1). Content analysis was applied on this large amount of data that was collected through the interviews. Constructs elicited in the study were organized and categorized through thematic analysis method.

5.2.1.1 Content Analysis

Thematic analysis procedures were applied on the collected attitude pairs, and the semantically similar constructs were grouped together as themes. Then, the elicited attitudes were inspected and the pole correction was made to make sure that poles would point the same direction. Later, main themes were created over themes and categories. As this second experiment was also carried out with Turkish participants, the interviews were made in Turkish and participant evaluations were recorded in Turkish. The researcher reviewed the grids in Turkish and then translated the elicited attitudes into English. The same approach as in the first experiment was adopted to spot replicated constructs. During reviewing, the coders checked if any participant mentioned an attitude more than once in his or her interview. If any construct replication was confirmed by an agreement, the repeating pair was removed. Thirty-six constructs were removed from the study as they were confirmed as replications. All valid attitudes were translated into English. Full list of translations can be seen in Appendix J.

A total of 19 themes and 83 categories were formed under five main themes through thematic analysis. Main themes, themes and categories can be seen in Appendix K. The thematic structure of the first experiment was used as a reference during the thematic analysis of the second experiment.

5.2.1.2 Specification of Elicited Common Bipolar Attitudes

A total of 895 valid constructs were obtained through RGT. Content analysis was applied on 895 constructs and 83 groups of common adjective pairs were developed. Twenty-six constructs were mentioned only once and therefore not positioned under any category as they carried no commonality with other constructs. Theoretically, these construct groups represent participants' ways of perceiving and construing the selected water bottles.

Again, it was necessary to prepare elicitation frequencies of the constructs to identify which construct groups were mentioned the most and the least. The most commonly elicited attitude was *durable-flimsy* that was elicited by 27 out of 30 participants, which was 90% of the total population. Next, the attitude *transparent-opaque* was mentioned by 25 participants (83% of total), followed by *smooth-rough, cold-hot* and *deep-treble* that were elicited by 21 out of 30 participants each (70% of total). Further, the attitudes of *heavy-light, hard-soft, healthy-unhealthy, attractive-unattractive* and *elaborated-sloppy* were elicited by 20 participants each (67% of total), followed by *cheap-expensive,* which was mentioned by 19 participants (63% of total). Moreover, *high quality-poor quality* was elicited by 18 participants (60% of total) and followed by *feminine-masculine,* which was elicited by 17 participants (57% of total). Attitudes of *uneven-flat*, *simple-complex* and *clean-dirty* were mentioned by 16 participants each (53% of total), followed by the attitudes *flexible-solid*, *easy-difficult*, *long lasting-short lived* and *childish-mature,* which were mentioned by 15 participants each (50% of total). Following, the attitudes *shiny-matte, comfortable-uncomfortable, natural-artificial, safe-insecure,* and *accustomed-eccentrical* were elicited by 14 participants each (47% of total). The attitude *fresh-stale* was elicited by 13 participants (43% of total), followed by the attitudes *non slippery-slippery, loud-silent, hygienic-non hygienic, excited-calm, dynamic-inactive, portable-stable* and *reliable-unreliable,* which were elicited by 12 participants each (40% of total). Next, the attitudes *wide-narrow, pleasurable-dissatisfactory, beautiful-ugly, ergonomic-non ergonomic, discordant-coherent,* *sportive-formal* and *protective-vulnerable* were elicited by 11 participants each (37%), followed by the pairs *sweet-bitter* and *vivid-pale,* which were elicited by 10 participants each (33%). After these, the attitudes *relieving-irritating* and *user friendly-difficult to use* were elicited by 9 participants each (30% of total). The attitudes *big-small, plain-ornate, controlled-uncontrolled, handy-impractical, unnecessary-necessary* and *distinct-ambiguous* were elicited by 8 participants each (27% of total), followed by the attitudes *thin-thick, tight-loose, steady-unsteady, sincere-insincere, fragmented-whole* and *particular-standard,* which were elicited by 7 participants each (23% of total). The attitudes *conductive-insulative, amusing-boring, coarse-gracious, directionless-directional, easy to clean-hard to clean, functional-functionless* and *outdoor-indoor* were elicited by 6 participants each (20% of total). Lastly, the attitudes *tall-short, rounded-sharp, entertaining-serious, cool-despised, old-new* and *dishonest-honest* were elicited by 5 participants each (17% of total). Frequencies of the attitudes elicited by five or more participants are graphically represented in Figure 5.4.

After the frequencies of elicited attitudes were determined, 69 common attitude pairs out of 83 were found as elicited by at least five or more participants. These 69 elicited attidute pairs represented 91,7% of the all elicited attitudes. The lower part of the list was consisted of common adjective pairs elicited by less than five participants. Forty eight common attitudes (5,3% of total) were mentioned by less than five participants. Four common attitude pairs were elicited by six participants (20% of total), five common attitude pairs were elicited by six participants (20% of total) and three common attitude pairs were elicited by two participants (7% of total). Twenty six bipolar attitudes (3% of total) were elicited only once (See Appendix L for the full list of the elicited common bipolar attitudes).

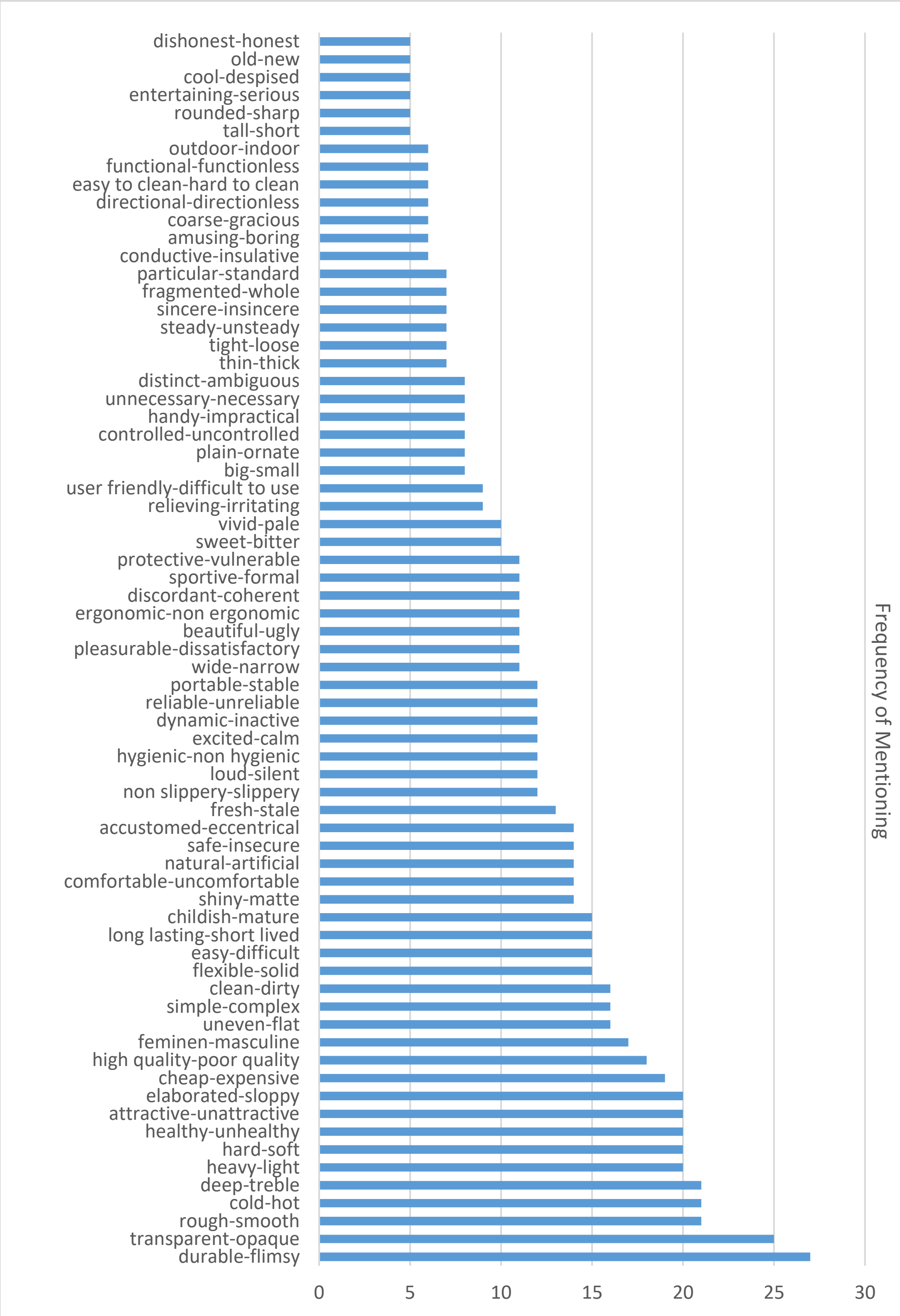

Figure 5.4. The graphical representation of common elicited bipolar attitudes and their freqeuencies in the population.

After the frequencies were determined, Chi-square test was applied to find out if there were any gender related differences between mentioning frequencies of common elicited bipolar attitudes. As previously mentioned, goodness of fit test is accepted valid, if the expected values of variables are at least five or more in the dataset (Kim, 2017; McHugh, 2013). In this context, 69 common elicited bipolar pairs that were mentioned by at least five or more participants were taken into consideration. The goodness of fit test results (χ^2 :33,116; df: 50, $p < 0.05$) showed that gender differences do not play a significant role in the distribution of frequencies of mentioning, and therefore, null hypothesis stating "frequency of mentioning does not depend on gender differences" was accepted (see Appendix I). The mentioning frequencies of both genders are also found balanced, as male participants elicited 412 common bipolar adjective pairs and female participants elicited 408 common bipolar adjective pairs.

According to the goodness of fit results, basic and multivariate statistical analyses were determined to be applied on 69 common elicited attitudes mentioned by five or more participants to achieve more reliable and valid results, which are described in the following sections.

5.2.2 Normality, Central Tendencies and Variabilities of Collected Data

Same procedures as for the first experiment data were followed in measuring the central tendencies and variabilities of the second experiment data. As previously stated, repertory grid interviews were carried out with 30 participants and 895 bipolar attitudes were collected in the experiment with eight water bottles. In each interview session, eight water bottles were rated through bipolar attitudes that were elicited by each participant. The individual grids of each participant were merged as one dataset, and then thematically grouped into 110 common attitudes. As in the first experiment, all 30 grids were transformed into one grid through the mean ratings of the attitude groups. Attitude groups with five or more mentionings were taken into consideration for further analyses. Therefore, 69 common bipolar attitudes were analyzed quantitatively.

To find out how the ratings were distributed, normality test was applied on the dataset. Normality test results can be seen in Figure 5.5. As can be seen from the histogram (Figure 5.5) the data was approximately normally distributed.

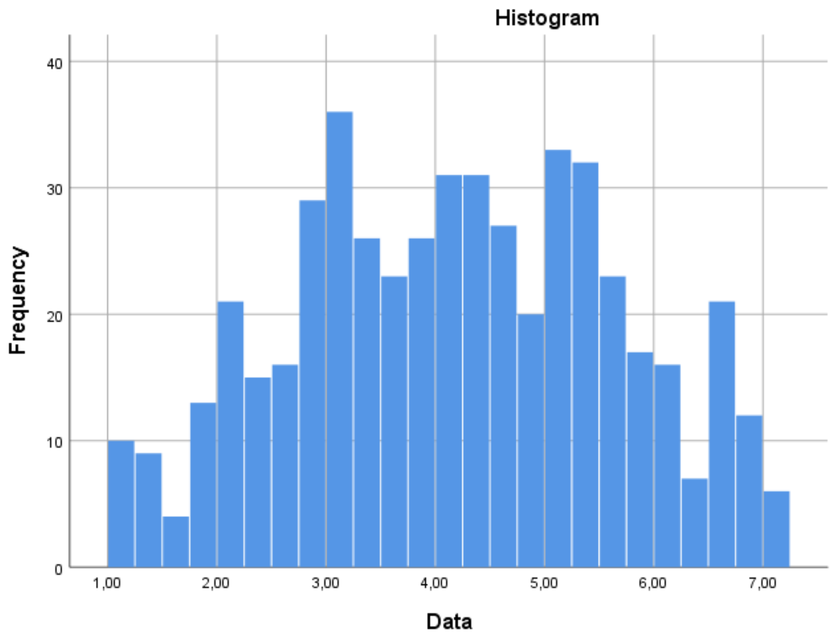

Figure 5.5 Histogram of normality test results

Mean and standart deviation values were calculated on the average ratings of water bottles (Table 5.22). In the 1 to 7 point scale, 4 represents the midpoint, 1 is the extreme value to the left pole and 7 indicates the extreme value to the right pole. According to the table, mean ratings were relatively close to the midpoint value. As the mean ratings close to the extreme values are regarded as lopsided, no lopsidedness was found in the dataset. The standard deviation values were lowest for the attitudes *conductive-insulative* (0.31), *flexible-solid* (0.32) and *comfortable-uncomfortable* (0.48), and highest for the attitudes *transparent-opaque* (2.44) and *entertaining-serious* (1.78). Higher standard deviation value may be an indicator of the scattering of the average ratings over a wider range, compared to lower standard deviation values where the average ratings are closer to the mean value.

Table 5.22 Mean and standard deviation values of average ratings of water bottles. The labels B1 to B8 represent eight water bottles used in the experiment.

Average Ratings of Water Bottles										
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**Mean**	**S. Dev.**
transparent-opaque	6,88	5,12	3,48	1,32	1,60	1,16	6,92	6,92	4,18	2,44
entertaining-serious	2,00	1,80	3,20	3,00	2,60	3,20	6,60	6,60	3,63	1,78
heavy-light	5,60	6,15	5,50	5,65	1,45	1,55	3,65	3,95	4,19	1,75
relieving-irritating	5,44	6,33	5,33	3,78	1,33	1,22	4,00	4,33	3,97	1,74
tall-short	6,00	3,40	5,20	5,00	1,00	4,20	6,60	6,40	4,73	1,74
uneven-flat	5,44	2,31	3,69	2,38	5,00	5,81	6,63	6,50	4,72	1,62
long lasting-short lived	5,00	5,53	4,07	4,53	1,93	2,33	1,47	1,60	3,31	1,54
feminine-masculine	5,35	2,59	5,18	5,00	1,82	1,65	5,41	4,65	3,96	1,54
childish-mature	5,33	1,73	3,87	4,47	3,00	3,47	6,73	5,80	4,30	1,52
healthy-unhealthy	5,10	5,75	4,35	4,35	1,40	1,85	2,50	2,70	3,50	1,49
portable-stable	3,50	4,00	2,75	3,42	4,75	5,83	1,25	1,25	3,34	1,49
fresh-stale	5,69	6,00	4,38	4,00	2,00	1,77	2,92	2,92	3,71	1,49
clean-dirty	5,19	5,75	4,25	3,44	1,44	1,31	3,50	3,63	3,56	1,48
loud-silent	6,17	5,00	5,08	4,17	5,00	3,50	1,83	1,83	4,07	1,48
dynamic-inactive	1,92	3,92	2,58	2,58	5,42	6,08	2,58	2,58	3,46	1,43
durable-flimsy	2,89	3,19	3,19	3,48	5,48	5,78	1,59	1,78	3,42	1,42
outdoor-indoor	2,83	4,67	3,67	3,33	5,00	5,33	1,00	2,00	3,48	1,41
natural-artificial	5,50	6,36	5,00	4,57	2,50	2,50	3,07	3,14	4,08	1,38
cheap-expensive	3,21	1,79	4,37	3,32	4,79	4,26	6,21	5,84	4,22	1,35
steady-unsteady	2,29	6,57	3,29	3,57	2,86	3,71	2,14	2,43	3,36	1,33
hard-soft	5,10	4,35	4,05	3,70	2,75	1,80	1,25	1,65	3,08	1,33
sportive-formal	1,36	4,00	2,36	3,00	5,09	5,73	3,91	3,82	3,66	1,32
sweet-bitter	3,70	4,40	3,30	3,20	1,90	2,10	5,80	4,90	3,66	1,25
deep-treble	2,43	2,57	3,10	5,05	3,95	4,48	5,71	5,71	4,13	1,25
vivid-pale	6,00	2,50	2,80	4,80	2,80	3,30	5,30	3,70	3,90	1,22
excited-calm	3,75	2,92	2,92	3,00	4,25	5,25	6,25	5,50	4,23	1,22
rough-smooth	6,05	2,38	4,19	4,43	3,76	5,86	5,48	5,86	4,75	1,21
plain-ornate	1,75	5,00	4,75	4,00	5,13	4,38	2,75	2,63	3,80	1,18
unnecessary-necessary	5,00	2,88	4,88	3,63	3,38	3,00	5,88	5,88	4,31	1,16
high quality-poor quality	4,00	6,17	3,33	4,50	3,33	3,72	2,33	2,44	3,73	1,15
hygienic-non hygienic	5,50	5,08	4,25	4,17	2,25	2,50	2,92	2,92	3,70	1,14
amusing-boring	4,33	3,33	3,33	3,00	2,50	4,33	6,17	5,17	4,02	1,14
dishonest-honest	5,20	3,80	3,80	3,80	6,60	6,40	4,00	4,00	4,70	1,13
simple-complex	1,81	4,06	4,31	4,25	4,69	3,06	2,06	2,38	3,33	1,07
shiny-matte	5,21	4,57	4,00	3,93	3,93	3,36	2,50	1,71	3,65	1,04
cool-despised	4,20	4,60	2,00	5,00	3,80	4,40	3,20	2,20	3,68	1,04
user friendly-difficult to use	1,44	2,78	3,89	2,56	4,78	4,11	4,11	4,11	3,47	1,03
tight-loose	5,71	4,57	3,86	4,29	2,71	2,86	2,86	2,86	3,71	1,02
fragmented-whole	4,71	5,29	2,43	2,57	2,71	3,29	4,14	4,29	3,68	1,01
coarse-gracious	2,67	5,67	3,17	2,17	4,33	3,83	4,00	3,83	3,71	1,01
accustomed-eccentrical	2,93	3,00	5,07	5,21	4,21	2,64	3,29	3,00	3,67	0,95
beautiful-ugly	4,73	5,73	2,64	3,55	3,91	4,09	3,09	3,27	3,88	0,92
easy-difficult	2,33	3,27	4,00	2,73	4,27	4,67	4,87	4,87	3,88	0,92
directional-directionless	3,17	3,50	2,83	2,67	3,33	4,00	5,17	5,17	3,73	0,91
attractive-unattractive	5,15	3,00	2,60	4,65	3,90	4,80	3,80	2,80	3,84	0,91
ergonomic-non ergonomic	3,18	2,64	2,36	4,09	3,91	5,27	4,27	4,18	3,74	0,89
cold-hot	4,24	4,71	4,48	3,86	3,76	3,24	1,76	3,00	3,63	0,89
non slippery-slippery	4,67	2,75	4,00	3,92	3,08	5,50	4,83	4,67	4,18	0,87
discordant-coherent	4,91	3,45	4,64	4,00	3,91	3,45	5,73	5,73	4,48	0,86
old-new	4,20	2,80	5,60	5,20	5,00	3,80	4,40	5,00	4,50	0,84
rounded-sharp	3,60	2,80	3,40	2,80	3,80	5,00	4,80	4,60	3,85	0,81
particular-standard	3,14	4,14	2,86	4,43	4,43	5,43	3,29	3,43	3,89	0,81
reliable-unreliable	4,33	4,42	3,08	3,92	3,00	4,08	2,33	2,33	3,44	0,80
handy-impractical	3,75	3,88	3,13	2,63	3,50	4,75	2,38	2,38	3,30	0,78
sincere-insincere	4,71	3,86	3,43	4,71	2,71	2,71	4,14	4,57	3,86	0,78
wide-narrow	4,45	5,18	4,73	3,82	3,45	3,73	3,00	3,09	3,93	0,74
safe-insecure	3,50	4,64	2,86	4,00	3,14	3,93	2,43	2,57	3,38	0,72
distinct-ambiguous	3,25	4,75	3,50	2,75	2,63	2,50	3,63	3,63	3,33	0,68
big-small	3,75	4,00	4,38	3,13	2,38	2,88	4,00	4,00	3,56	0,65
protective-vulnerable	3,55	3,82	2,64	3,82	3,18	4,55	2,64	2,73	3,36	0,65
elaborated-sloppy	3,85	4,70	2,35	3,35	3,10	3,85	3,80	3,90	3,61	0,65
pleasurable-dissatisfactory	3,45	4,73	2,64	4,27	3,27	3,18	4,00	3,36	3,61	0,63
functional-functionless	3,83	4,67	3,17	3,00	3,17	4,50	3,00	3,33	3,58	0,63
thin-thick	5,00	4,00	4,71	3,86	5,14	5,29	4,43	3,71	4,52	0,57
controlled-uncontrolled	3,50	4,63	3,75	3,25	4,50	3,25	4,38	4,38	3,95	0,54
easy to clean-hard to clean	3,83	4,17	3,67	2,67	3,50	3,33	4,33	4,33	3,73	0,53
comfortable-uncomfortable	3,93	4,50	3,29	3,79	4,57	4,21	3,21	3,57	3,88	0,48
flexible-solid	3,49	3,95	3,49	3,65	4,51	4,11	3,75	3,99	3,87	0,32
conductive-insulative	4,50	4,00	4,00	4,00	4,17	3,33	3,83	3,83	3,96	0,31

To observe how ratings were distributed, two attitudes with the highest standard deviation values were investigated. The attitude *transparent-opaque* has the highest standard deviation value (SD: 2.24). The descriptive statistics can be viewed in Table 5.23. As can be seen from the descriptive statistics, B3 (SD: 1.24) and B2 (SD: 1.18) have the highest standard deviation scores, which means ratings were scattered. According to the mean ratings, it can be understood that the right pole (i.e. *opaque*) was used more for B2. Water bottles with the lowest standard deviations were B7 (SD: 0,27) and B8 (SD: 0.27), for which the participants preferred to use the extreme value at the right pole (i.e. *opaque*).

Table 5.23 Descriptive statistics of the attitude *transparent-opaque*

Descriptive Statistics of the Attitude *transparent-opaque*

Water Bottles	N	Min.	Max.	Mean	Std. Dev.
B1	25	6,0	7,0	6,88	0,32
B2	25	3,0	7,0	5,12	1,18
B3	25	2,0	7,0	3,48	1,24
B4	25	1,0	4,0	1,32	0,68
B5	25	1,0	3,0	1,60	0,69
B6	25	1,0	2,0	1,16	0,37
B7	25	6,0	7,0	6,92	0,27
B8	25	6,0	7,0	6,92	0,27

The attitude *heavy-light* has one of the highest standard deviation scores (SD: 1.72). The descriptive statistics showed that B1 (SD: 1.62) and B8 (1.75) were most dispersely rated by the participants. It can be understood from the statistics that participants preferred ratings from the right pole more for B1 (i.e. *light*). On the other hand, B2 has the lowest standard deviation score (SD: 0.96), which means ratings were not scattered through the entire scale. As can be seen from Table 5.24, ratings ranged between 4 and 7, and the right pole (i.e. *light*) was preferred more by the participants, as the mean score is 6,15.

Table 5.24 Descriptive statistics of the attitude *heavy-light*

Descriptive Statistics of the Attitude *heavy-light*

Water Bottles	N	Min.	Max.	Mean	Std. Dev.
B1	20	1,0	7,0	5,60	1,62
B2	20	4,0	7,0	6,15	0,96
B3	20	2,0	7,0	5,50	1,28
B4	20	2,0	7,0	5,65	1,39
B5	20	1,0	6,0	1,45	1,12
B6	20	1,0	5,0	1,55	1,20
B7	20	1,0	6,0	3,65	1,56
B8	20	1,0	7,0	3,95	1,75

5.2.3 Reliability Measurement of the Collected Data

Reliability measurement is also needed for this second experiment with water bottles. Same test procedures were applied to the gathered data and the Cronbach's alpha value was measured. As previously mentioned, the alpha value between 0.70 and 0.90 would be acceptable for the consistency of the data. Cronbach's alpha value was calculated as 0.80 for 69 items and therefore the data in the second experiment was also found consistent (Table 5.25).

Table 5.25 Reliability test results of the experiment with water bottles

Reliability Statistics

Cronbach's Alpha	N of Items
0.801	69

5.2.4 Product Involvements in Attitude Elicitation

Attitudes were elicited through dyadic comparisons of water bottles. An attitude is elicited through the comparison of two water bottles and participants compared water bottles 821 times (1642 ratings) to elicit 821 attitudes. Findings of the second experiment show that B7 was involved 218 times in attitude elicitation in paired comparisons, having the biggest role. This means that B7 has raised awareness more than any other water bottle. Next, B5 was involved 215 times, followed by and B4 and B1, that were involved 211 times each. Next, B6 was involved 210 times and B8 was involved 198 times. Further, B2 was involved 195 times and lastly, B3 was involved 184 times.

Individual involvement statistics of water bottles mentioned above could be used as a reference in interpreting product-attitude relationships. A water bottle's frequency of involvement in eliciting an attitude could be an indicator of this water bottle carrying material qualities that provoke participants to elicit that attitude specificaly. In this context;

- B1 was involved mostly in eliciting the attitudes *healthy-unhealthy* (11 appearances with 27,5% of total), *flexible-solid* (8 appearances with 26,7% of total), *sportive-formal* (7 appearances with 31,8% of total) and *user friendly-difficult to use* (6 appearances with 33,3% of total). These results can be interpreted as B1 carries significant material qualities regarded with elicited attitudes, of which users are perceptually aware.
- B2 was involved mostly in eliciting the attitudes *attractive-unattractive* (10 appearances with 25% of total), *relieving-irritating* (5 appearances with 25% of total), and *steady-unsteady* (5 appearances with 35,7% of total).
- B3 was involved mostly in eliciting the attitudes *clean-dirty* (8 appearances with 25% of total), *dynamic-inactive* (6 appearances with 25% of total), and *plain-ornate* (4 appearances with 25% of total).

- B4 was involved mostly in eliciting the attitudes *hard-soft* (11 appearances with 27,5% of total), *uneven-flat* (10 appearances with 31,3% of total), and *rough-smooth* (9 appearances with 21,4% of total).
- B5 was involved mostly in eliciting the attitudes *heavy-light* (9 appearances with 22,5% of total), *deep-treble* (8 appearances with 19% of total), and *wide-narrow* (6 appearances with 27,3% of total).
- B6 was involved mostly in eliciting the attitudes *accustomed-eccentrical* (6 appearances with 21,4% of total), *discordant-coherent* (6 appearances with 27,3% of total), and *pleasurable-dissatisfactory* (5 appearances with 22,7% of total).
- B7 was involved mostly in eliciting the attitudes *cold-hot* (10 appearances with 23,8% of total), *loud-silent* (6 appearances with 25% of total), and *safe-insecure* (6 appearances with 21,4% of total).
- B8 was involved mostly in eliciting the attitudes *comfortable-uncomfortable* (8 appearances with 28,6% of total), *shiny-matte* (7 appearances with 25% of total), and *high quality-poor quality* (8 appearances with 22,2% of total).

Summary of the findings can be seen in Table 5.26.

Table 5.26 Summarized findings of the water bottles with significant involvements in eliciting particular attitudes.

			
B1	**B2**	**B3**	**B4**
healthy-unhealthy flexible-solid sportive-formal	attractive-unattractive relieving-irritating steady-unsteady	clean-dirty dynamic-inactive plain-ornate	hard-soft uneven-flat rough-smooth
			
B5	**B6**	**B7**	**B8**
heavy-light deep-treble wide-narrow	accustomed-eccentrical discordant-coherent pleasurable-dissatisfactory	cold-hot loud-silent safe-insecure	comfortable-uncomfortable shiny-matte high quality-poor quality

5.2.5 Sensory Relevance of Elicited Attitudes

Sensory evaluation of participants were recorded during the experiment. Participants rated the attitudes they elicited depending on their sensory relations with the five senses. The same procedures were applied in gathering sensory information as in the first experiment (See section 5.1.5).

Sensory relevancy ratings of 30 participants were recorded through comparisons of water bottle pairs. Sixty nine common elicited attitudes mentioned by five or more participants were taken into consideration for analysis. Table 5.28 shows the sensory relevance averages of 69 common elicited attitudes.

Mean ratings of the elicited attitudes towards water bottles could be used to develop insights about the general sensory relevancies of interactions. Considering mentioning frequencies with five or above, average ratings of sensory relevance scores for all eight water bottles are 8.34 for vision, 7.35 for touch, 3.62 for audition, 2.22 for olfaction and 2.82 for gustation. Moreover, some attitudes have significantly higher frequency of mentions than others, therefore could be contributing to sensory ratings more than the other attitudes. For this, the weighted arithmetic means of sensory relevance scores are calculated for 821 attitudes for all eight water bottles. Calculated weighted arithmetic means are 8.25 for vision, 7.36 for touch, 3.84 for audition, 2.32 for olfaction and 2.90 for gustation. Results show that the participants describe the interactions with water bottles as mostly visual and tactile. According to the results, audition, olfaction and gustation played limited roles. Table 5.27 shows the summary of sensory relevance scores for eight water bottles.

Table 5.27 Averages and weighted means of sensory relevance scores of participants through eight water bottles.

Sensory Modality	Vision	Touch	Audition	Olfaction	Gustation
Average Rating	8,34	7,35	3,62	2,22	2,82
Weighted Mean Rating	8,25	7,36	3,84	2,32	2,90

Table 5.28 Sensory relevancy scores of 69 common elicited attitudes mentioned by five and more within the second experiment

Category	Attitude Pairs	Freq.	Sensory Relevance				
			Visual	Tactile	Auditory	Olfactory	Gustatory
Sturdiness	durable-flimsy	27	8,59	9,22	6,63	1,85	2,13
Transparency	transparent-opaque	25	9,80	2,88	2,24	1,14	0,88
Pitch	deep-treble	21	4,98	7,93	9,88	1,62	1,83
Roughness	rough-smooth	21	8,19	9,69	3,05	0,31	1,07
Thermal	cold-hot	21	7,60	8,17	4,02	1,79	5,76
Attractiveness	attractive-unattractive	20	9,38	5,25	2,85	1,58	1,95
Elaboratedness	elaborated-sloppy	20	8,78	7,70	3,50	2,80	3,60
Healthiness	healthy-unhealthy	20	8,55	6,95	3,85	6,93	6,88
Softness	hard-soft	20	6,85	8,88	5,83	1,50	2,28
Weight	heavy-light	20	6,83	8,88	6,00	0,53	0,75
Value	cheap-expensive	19	8,82	8,26	5,37	3,74	3,84
Quality	high quality-poor quality	18	9,00	8,03	5,03	6,14	6,50
Gender	feminine-masculine	17	9,68	6,06	2,12	0,56	0,32
Simplicity	simple-complex	16	9,44	7,06	3,44	0,97	0,53
Surface Lines	uneven-flat	16	9,19	9,16	1,00	0,03	0,06
Cleanness	clean-dirty	16	8,91	5,13	1,75	7,19	7,53
Difficulty	easy-difficult	15	6,83	7,47	1,93	1,33	3,33
Durability	long lasting-short lived	15	8,20	8,60	5,10	3,27	3,43
Elasticity	flexible-solid	15	7,43	9,90	5,93	1,73	1,87
Maturity	childish-mature	15	9,53	5,87	2,57	1,23	1,70
Accustomedness	accustomed-eccentrical	14	9,04	7,61	3,32	2,07	1,79
Comfort	comfortable-uncomfortable	14	6,43	7,54	2,89	2,71	3,86
Glossiness	shiny-matte	14	9,64	7,50	3,54	1,18	0,71
Naturality	natural-artificial	14	7,36	6,64	4,25	5,96	6,89
Safety	safe-insecure	14	8,25	8,32	3,96	3,25	3,29
Freshness	fresh-stale	13	3,92	3,69	2,58	8,42	9,46
Activeness	dynamic-inactive	12	9,17	6,92	4,04	2,50	2,75
Enthisuiasm	excited-calm	12	9,13	7,71	3,04	1,13	0,71
Greasiness	non slippery-slippery	12	7,96	9,29	3,88	0,38	0,71
Hygiene	hygienic-non hygienic	12	8,71	5,71	3,00	6,33	7,08
Loudness	loud-silent	12	4,88	7,00	9,88	0,63	1,46
Reliability	reliable-unreliable	12	9,17	7,33	4,96	3,17	3,50
Portability	portable-stable	12	8,96	8,25	4,08	0,63	0,46
Aesthetics	beautiful-ugly	11	9,50	7,36	3,91	3,32	3,64
Compatibility	discordant-coherent	11	8,09	6,23	4,55	1,95	2,55
Ergonomy	ergonomic-non ergonomic	11	7,50	9,23	1,77	1,50	2,23
Pleasantness	pleasurable-dissatisfactory	11	7,82	7,27	5,09	3,27	4,27
Protectiveness	protective-vulnerable	11	8,68	8,91	4,68	0,95	1,73
Sportiveness	sportive-formal	11	9,64	8,14	4,18	1,82	3,68
Width	wide-narrow	11	8,14	6,64	1,64	0,86	3,82
Bitterness	sweet-bitter	10	5,65	4,65	3,15	7,15	9,25
Vividness	vivid-pale	10	9,65	2,95	1,80	0,15	0,15
Ease of Use	user friendly-difficult to use	9	6,67	8,61	4,28	1,72	2,67
Relief	relieving-irritating	9	5,00	4,11	1,06	7,78	8,94
Ambiguousness	distinct-ambiguous	8	8,75	6,31	3,50	1,63	1,25
Controllability	controlled-uncontrolled	8	8,06	7,25	1,44	0,06	2,44
Decoratedness	plain-ornate	8	9,44	9,38	3,94	1,00	1,19
Necessity	unnecessary-necessary	8	8,56	7,25	1,94	1,31	1,88
Size	big-small	8	9,38	5,69	1,13	0,44	0,88
Usefulness	handy-impractical	8	6,69	7,25	1,38	1,56	3,63
Sincerity	sincere-insincere	7	7,79	6,43	5,29	3,57	5,21
Specialization	particular-standard	7	9,00	6,21	2,21	2,93	2,93
Steadiness	steady-unsteady	7	8,64	8,00	3,57	0,71	1,00
Thickness	thin-thick	7	7,64	8,43	4,86	1,93	2,14
Tightness	tight-loose	7	6,00	9,00	4,00	0,29	0,29
Wholeness	fragmented-whole	7	10,00	7,86	4,71	1,07	0,71
Amusingness	amusing-boring	6	9,00	7,25	3,08	0,42	2,17
Area of Usage	outdoor-indoor	6	9,58	8,58	4,08	2,83	4,83
Conductivity	conductive-insulative	6	9,00	7,00	3,92	1,75	4,75
Directionality	directional-directionless	6	9,50	9,00	0,33	0,00	0,00
Ease of Cleaning	easy to clean-hard to clean	6	8,17	7,00	2,25	3,17	0,67
Functionality	functional-functionless	6	9,25	7,67	3,17	1,58	3,33
Grace	coarse-gracious	6	8,83	7,83	5,00	0,83	0,58
Edge Lines	rounded-sharp	5	9,50	8,20	1,00	0,20	0,30
Height	tall-short	5	10,00	7,20	1,80	0,30	0,20
Honesty	dishonest-honest	5	8,00	8,50	3,20	3,90	4,20
Newness	old-new	5	10,00	8,70	4,30	4,00	4,50
Popularity	cool-despised	5	9,40	5,80	3,10	2,50	2,40
Seriousity	entertaining-serious	5	9,80	6,80	5,10	0,00	1,40

5.2.5.1 Multisensory Relevancies

The sensory relevance scores would provide information related with the attitudes' sensory aspects. The attitudes were investigated through their multisensory aspects. As explained before, the sum of subjective values of each sensory modality was equated to the general response of the multisensory product experience (see Section 5.2.5). Through the 11 point sensory rating scale, the multisensory score of an attitude could not exceed 50. Multisensory scores for every attitude mentioned by five or more participants were calculated. The 30 attitudes with the highest multisensory scores above 25,00 can be seen in Table 5.29.

Table 5.29 Attitudes with the highest multisensory scores for water bottles

Attitudes	Multisensory Score	Attitudes	Multisensory Score
high quality-poor quality	34,7	beautiful-ugly	27,7
healthy-unhealthy	33,2	pleasurable-dissatisfactory	27,7
old-new	31,5	sportive-formal	27,5
natural-artificial	31,1	cold-hot	27,3
hygienic-non hygienic	30,8	safe-insecure	27,1
clean-dirty	30,5	relieving-irritating	26,9
cheap-expensive	30,0	flexible-solid	26,9
outdoor-indoor	29,9	conductive-insulative	26,4
sweet-bitter	29,9	elaborated-sloppy	26,4
long lasting-short lived	28,6	deep-treble	26,2
durable-flimsy	28,4	dynamic-inactive	25,4
sincere-insincere	28,3	hard-soft	25,3
reliable-unreliable	28,1	thin-thick	25,0
fresh-stale	28,1	functional-functionless	25,0
dishonest-honest	27,8	protective-vulnerable	25,0

As can be seen in Table 5.29, the attitude *high quality-poor quality* (V:9,00; T:8,03; A:5,03; O:6,14; G:6,50) was found highest in multisensory values, followed by *healthy-unhealthy* (V:8,55; T:6,95; A:3,85; O:6,93; G:6,88) and *old-new* (V:10,00; T:8,70; A:4,30; O:4,00; G:4,50). On the other hand, *vivid-pale* (V:9,65; T:2,95; A: 1,80; O:0,15; G:0,15) was found as the least multisensory attitude, followed by *transparent-opaque* (V:9,80; T:2,88; A:2,24; O:1,14; G:0,88) and *big-small* (V:9,38; T:5,69; A:1,13; O:0,44; G:0,88).

5.2.5.2 Sensory Dominances

The same procedures were applied in calculating the sensory dominances as in the first experiment (See Section 5.1.5.2). As mentioned before, the dominance value reflects the distribution of the sensory ratings and could be between 0 and 1. The dominance of a modality increases as the value gets closer to 1 and decreases in reverse. Sensory dominances were calculated for each elicited attitude. To accept a sensory modality as the dominant sensory modality in one attitude, the difference of the particular sensory score from other sensory modalities were taken into consideration. The greater the difference is, the more dominant the particular sensory modality becomes in that attitude. To be regarded as dominant, the sensory relevancy score of a sensory modality can be suggested as above 9,00 as a cut-off value, and there should be a significantly positive difference in scores from any of the other senses.

Vision was regarded as the most dominant sensory modality with the highest sensory dominance value in the attitudes of *vivid-pale* (0,66), followed by *transparent-opaque* (0,58), *big-small* (0,54) and *feminine-masculine* (0,52), *tall-short* (0,51), *childish-mature* (0,46), *attractive-unattractive* (0,45), *simple-complex* (0,44), *shiny-matte* (0,43), *entertaining-serious* (0,42), *fragmented-whole* (0,41), *cool-despised* (0,41), *particular-standard* (0,39), *dynamic-inactive* (0,36), *beautiful-ugly* (0,34), and *conductive-insulative* (0,34). Visually dominant attitudes can be seen in Table 5.30. On the other hand, vision was found to be significantly less influential in the attitudes where other sensory modalities were dominant, such as *fresh-stale* (0,14), *relieving-irritating* (0,19), *sweet-bitter* (0,19), *deep-treble* (0,19) and *loud-silent* (0,20).

Table 5.30 List of attitudes with visual dominance

Attitudes	Sensory Relevance					Sensory Dominance				
	V	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
vivid-pale	**9,65**	2,95	1,80	0,15	0,15	**0,66**	0,20	0,12	0,01	0,01
transparent-opaque	**9,80**	2,88	2,24	1,14	0,88	**0,58**	0,17	0,13	0,07	0,05
big-small	**9,38**	5,69	1,13	0,44	0,88	**0,54**	0,33	0,06	0,03	0,05
feminine-masculine	**9,68**	6,06	2,12	0,56	0,32	**0,52**	0,32	0,11	0,03	0,02
tall-short	**10,00**	7,20	1,80	0,30	0,20	**0,51**	0,37	0,09	0,02	0,01
childish-mature	**9,53**	5,87	2,57	1,23	1,70	**0,46**	0,28	0,12	0,06	0,08
attractive-unattractive	**9,38**	5,25	2,85	1,58	1,95	**0,45**	0,25	0,14	0,08	0,09
simple-complex	**9,44**	7,06	3,44	0,97	0,53	**0,44**	0,33	0,16	0,05	0,02
shiny-matte	**9,64**	7,50	3,54	1,18	0,71	**0,43**	0,33	0,16	0,05	0,03
entertaining-serious	**9,80**	6,80	5,10	0,00	1,40	**0,42**	0,29	0,22	0,00	0,06
fragmented-whole	**10,00**	7,86	4,71	1,07	0,71	**0,41**	0,32	0,19	0,04	0,03
cool-despised	**9,40**	5,80	3,10	2,50	2,40	**0,41**	0,25	0,13	0,11	0,10
particular-standard	**9,00**	6,21	2,21	2,93	2,93	**0,39**	0,27	0,10	0,13	0,13
dynamic-inactive	**9,17**	6,92	4,04	2,50	2,75	**0,36**	0,27	0,16	0,10	0,11
beautiful-ugly	**9,50**	7,36	3,91	3,32	3,64	**0,34**	0,27	0,14	0,12	0,13
conductive-insulative	**9,00**	7,00	3,92	1,75	4,75	**0,34**	0,26	0,15	0,07	0,18

Sensory dominance of touch was found highest in the attitude of *tight-loose* (0,46), followed by the attitudes of *rough-smooth* (0,43), *non slippery-slippery* (0,42), *ergonomic-non ergonomic* (0,42) and *flexible-solid* (0,37). Attitudes in which touch was found dominant can be seen in Table 5.31. In contrast to this, touch was found to be least effective in the attitudes of *fresh-stale* (0,13), *relieving-irritating* (0,15), *sweet-bitter* (0,16), *clean-dirty* (0,17) and *transparent-opaque* (0,17).

Table 5.31 List of attitudes with tactile dominance

Attitudes	Sensory Relevance					Sensory Dominance				
	V	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
tight-loose	6,00	**9,00**	4,00	0,29	0,29	0,31	**0,46**	0,20	0,01	0,01
rough-smooth	8,19	**9,69**	3,05	0,31	1,07	0,37	**0,43**	0,14	0,01	0,05
non slippery-slippery	7,96	**9,29**	3,88	0,38	0,71	0,36	**0,42**	0,17	0,02	0,03
ergonomic-non ergonomic	7,50	**9,23**	1,77	1,50	2,23	0,34	**0,42**	0,08	0,07	0,10
flexible-solid	7,43	**9,90**	5,93	1,73	1,87	0,28	**0,37**	0,22	0,06	0,07

Compared to vision and touch, auditory dominance was found to be limited in the interactions with water bottles according to the participants' evaluations. Sensory dominance of audition was highest for the attitude *loud-silent* (0,41), followed by the attitude *deep-treble* (0,38). Attitudes in which audition was found dominant can be seen in Table 5.32. Furthermore, audition seemed to have a lower influence mostly on the attitudes related with the shape and size of the product. The attitudes with the lowest auditory dominance scores were *directional-directionless* (0,02), *relieving-irritating* (0,04), *uneven-flat* (0,05), *rounded-sharp* (0,05), *clean-dirty* (0,06) and *big-small* (0,06).

Table 5.32 List of attitudes with auditory dominance

	Sensory Relevance					**Sensory Dominance**				
Attitudes	**V**	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
loud-silent	4,88	7,00	**9,88**	0,63	1,46	0,20	0,29	**0,41**	0,03	0,06
deep-treble	4,98	7,93	**9,88**	1,62	1,83	0,19	0,30	**0,38**	0,06	0,07

Olfactory dominance was not found in any of the attitudes. Although sensory relevancy score of olfaction was rated high in the attitudes of *fresh-stale* (8,42), *relieving-irritating* (7,78), *sweet-bitter* (7,15) and *clean-dirty* (7,19), other sensory modalities have greater scores in these attitudes. On the other hand, olfactory dominance was found to be least in the attitudes *entertaining-serious* (0,00), *directional-directionless* (0,00), *uneven-flat* (0,00) and *controlled-uncontrolled* (0,00).

Gustatory dominance was found to be highest in the attitude of *fresh-stale* (0,34), followed by the attitude *sweet-bitter* (0,31). Attitudes in which gustation was found dominant can be seen in Table 5.33. In contrast to this, gustation was found to be least influential in the attitudes of *directional-directionless* (0,00), *uneven-flat* (0,00), *vivid-pale* (0,01), *tall-short* (0,01) and *tight-loose* (0,01).

Table 5.33 List of attitudes with gustatory dominance

	Sensory Relevance					Sensory Dominance				
Attitudes	**V**	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
fresh-stale	3,92	3,69	2,58	8,42	**9,46**	0,14	0,13	0,09	0,30	**0,34**
sweet-bitter	5,65	4,65	3,15	7,15	**9,25**	0,19	0,16	0,11	0,24	**0,31**

With the completion of examination over unimodal dominances in elicited attitudes, multimodal dominances were also investigated. In the attitudes where two or more sensory modalities were evaluated as highly influential in eliciting that attitude, it can be accepted that there is a multimodal dominance within the attitude. Multimodal dominances were investigated through sensory ratings of the participants. Attitudes with bimodal and trimodal dominances can be seen in Table 5.34.

Table 5.34 The attitudes with multimodal dominances in the second experiment

	Sensory Relevance					Sensory Dominance				
Attitudes	**V**	**T**	**A**	**O**	**G**	**V**	**T**	**A**	**O**	**G**
directional-directionless	**9,50**	**9,00**	0,33	0,00	0,00	**0,50**	**0,48**	0,02	0,00	0,00
rounded-sharp	**9,50**	**8,20**	1,00	0,20	0,30	**0,49**	**0,43**	0,05	0,01	0,02
uneven-flat	**9,19**	**9,16**	1,00	0,03	0,06	**0,47**	**0,47**	0,05	0,00	0,00
excited-calm	**9,13**	**7,71**	3,04	1,13	0,71	**0,42**	**0,36**	0,14	0,05	0,03
controlled-uncontrolled	**8,06**	**7,25**	1,44	0,06	2,44	**0,42**	**0,38**	0,07	0,00	0,13
amusing-boring	**9,00**	**7,25**	3,08	0,42	2,17	**0,41**	**0,33**	0,14	0,02	0,10
plain-ornate	**9,44**	**9,38**	3,94	1,00	1,19	**0,38**	**0,38**	0,16	0,04	0,05
sportive-formal	**9,64**	**8,14**	4,18	1,82	3,68	**0,35**	**0,30**	0,15	0,07	0,13
protective-vulnerable	**8,68**	**8,91**	4,68	0,95	1,73	**0,35**	**0,36**	0,19	0,04	0,07
relieving-irritating	**5,00**	4,11	1,06	**7,78**	**8,94**	**0,19**	0,15	0,04	**0,29**	**0,33**
entertaining-serious	**9,80**	**6,80**	**5,10**	0,00	1,40	**0,42**	**0,29**	**0,22**	0,00	0,06
coarse-gracious	**8,83**	**7,83**	**5,00**	0,83	0,58	**0,38**	**0,34**	**0,22**	0,04	0,03

The multisensory score of an attitude shows the sum of multisensory rating averages of the participants. A multisensory score alone would need a further distributional information to understand how multisensory dominances take role within an attitude. A high multisensory score could be a result of the high ratings of two or three modalities, and the remaining modalities might have very little contribution. It is assumed that the balanced distribution of sensory dominance values in an attitude could be reflecting a full modal multisensory relevancy. In search for a balanced distribution of sensory dominances, the cutoff value was set to 0,10 and the dominance values over the cutoff value would be taken as significant. Table 5.35 shows the attitudes with full modal multisensory relevancy. According to the findings in Table 5.35, the attitudes *high quality-poor quality*, *healthy-unhealthy* and *old-new* were found carrying the highest full modal multisensory aspects.

Table 5.35 Attitudes with full modal relations within second experiment

		Sensory Dominance				
Attitudes	**Multisensory Score**	**V**	**T**	**A**	**O**	**G**
high quality-poor quality	34,7	0,26	0,23	0,14	0,18	0,19
healthy-unhealthy	33,2	0,26	0,21	0,12	0,21	0,21
old-new	31,5	0,32	0,28	0,14	0,13	0,14
natural-artificial	31,1	0,24	0,21	0,14	0,19	0,22
hygienic-non hygienic	30,8	0,28	0,19	0,10	0,21	0,23
cheap-expensive	30,0	0,29	0,28	0,18	0,12	0,13
sweet-bitter	29,9	0,19	0,16	0,11	0,24	0,31
long lasting-short lived	28,6	0,29	0,30	0,18	0,11	0,12
sincere-insincere	28,3	0,28	0,23	0,19	0,13	0,18
reliable-unreliable	28,1	0,33	0,26	0,18	0,11	0,12
dishonest-honest	27,8	0,29	0,31	0,12	0,14	0,15
beautiful-ugly	27,7	0,34	0,27	0,14	0,12	0,13
pleasurable-dissatisfactory	27,7	0,28	0,26	0,18	0,12	0,15
safe-insecure	27,1	0,30	0,31	0,15	0,12	0,12
elaborated-sloppy	26,4	0,33	0,29	0,13	0,11	0,14
dynamic-inactive	25,4	0,36	0,27	0,16	0,10	0,11
comfortable-uncomfortable	23,4	0,27	0,32	0,12	0,12	0,16
particular-standard	23,3	0,39	0,27	0,10	0,13	0,13
cool-despised	23,2	0,41	0,25	0,13	0,11	0,10

5.3 Comparison of Themes for Both Experiments

The data for both experiments were analyzed qualitatively and quantitatively in the previous sections. Before advancing to the inter item correlation statistics, a comparison of gathered themes between two experiments will be useful and may provide insights about the theme-context (product type) relations. The full list of thematic comparison can be seen in Appendix M. Broadly, five categories were developed in describing how themes are related with product types. These categories are:

- Common categories with same attitudes
- Common categories with different attitudes
- Significant product specific categories
- Common categories with inadequate ratings
- Non-significant categories

During the qualitative analysis, some themes were found common for both computer mouses and water bottles. As it was determined previously, five or more ratings were required for an attitude to be regarded as significant throughout the study. If a common theme has at least five ratings in any of the experiments, it is labeled as common themes with same attitudes. Fifty six common themes were found containing the same attitudes for the two products. Roughness (*rough-smooth)* was found to be the most significant (25 for computer mouses and 21 for water bottles) theme in two experiments, followed by weight (*heavy-light*) (23 for computer mouses and 20 for water bottles) and softness (*soft-hard*) (18 for computer mouses and 20 for water bottles). The following themes, sturdiness (*durable-flimsy*) and size (*big-small*) have high frequencies in total, yet their mentioning tendency are not balanced. Size was mentioned more in the first experiment (mentioned by 29 participants) compared to the second experiment, where it was mentioned by 8 participants only. Contrarily, sturdiness was mentioned more in the second experiment (27 participants), compared to the first experiment (11 participants). Table 5.36 represents exemplary common categories with total mentioning frequencies over 30 in the two experiments. It can be inferred from the table that roughness, weight, softness, attractiveness, pitch, comfort, glossiness, quality and simplicity are the common themes that can be accepted as significant for both experiments, where size and newness are more significant for the first experiment, and sturdiness and transparency are more significant for the second experiment.

Table 5.36 Examples of common categories with same attitudes mentioned by over 30 participants in total for two experiments.

Themes	**Frequencies**		
	Experiment 1	**Experiment 2**	**Total**
Roughness	25	21	46
Weight	23	20	43
Softness	18	20	38
Sturdiness	11	27	38
Size	29	8	37
Attractiveness	16	20	36
Pitch	15	21	36
Comfort	21	14	35
Glossiness	21	14	35
Newness	28	5	33
Quality	14	18	32
Transparency	7	25	32
Simplicity	15	16	31

Three themes were also found common to both experiments, yet the attitudes they contained have different poles, so they were separated from the first categorization. In this manner, these three themes were treated as common categories with different attitudes (see Table 5.37). The first theme, agility, consisted of *dynamic-bulky* in the first experiment (mentioned by 7 participants) and the corresponding theme in the second experiment was activeness, which consisted of *dynamic-inactive* (mentioned by 12 participants). The second theme, safety, was common for both experiments, and comprised of *reassuring-insecure* in the first experiment (mentioned by 7 participants) and *safe-insecure* in the second experiment (mentioned by 14 participants). The third theme, surface lines, was also a common theme for both experiments, which contained *curved-flat* in the first experiment (mentioned by 17 participants) and *uneven-flat* in the second experiment (mentioned by 16 participants). These minor differences may cause misconceptions, as the poles define the functional meaning of a theme. Themes with the same names may carry different functional meanings, whereas themes with different names may carry same functional meanings.

Table 5.37 Common categories with different attitudes for two experiments

Experiment 1			Experiment 2		
Freq.	**Attitudes**	**Themes**	**Themes**	**Attitudes**	**Freq.**
7	dynamic-bulky	Agility	Activeness	dynamic-inactive	12
7	reassuring-insecure	Safety	Safety	safe-insecure	14
17	curved-flat	Surface Lines	Surface Lines	uneven-flat	16

Alongside having commonalities on themes in both experiments, some themes were found product specific. If a theme was formed in only one experiment and had at least five mentioning frequency, it was accepted as a significant product specific category. Eleven themes were found specific for computer mouses and 19 themes were found specific for water bottles. For computer mouses, fluidity (*fluid-stable*) has the highest frequency of mentioning with 13 mentions, followed by glitteriness (*non glittery-glittery*) with 12 mentions and length (*long-short*) with 9 mentions. The other computer mouse specific themes are discrepancy, corner lines, goodness, raspiness, smelliness, problemacy, sound clarity, and symmetry. For water bottles, elasticity (*flexible-solid*) was the theme with the highest number of mentions with 15, followed by freshness (*fresh-stale*) and naturality (*natural-artificial*) with 14 mentions each. The remaining themes specific for water bottles are enthusiasm, hygiene, reliability, pleasantness, protectiveness, sportiveness, width, bitterness, relief, tightness, steadiness, amusingness, area of usage, conductivity, honesty and popularity. Themes specific for product types can be seen in Table 5.38.

Besides the significant categories listed above, non significant categories were also identified. If a theme had less than five frequency of mentioning, it was accepted as non significant. Two themes (development level and youthfulness) were found common yet mentioned less than five participants in both experiments. Also, 16 categories were defined as non significant for computer mouses and 19 categories were defined as non significant for water bottles. Non significant categories were not common and had a frequency of mentioning less than five. The full list of thematic comparison can be seen in Appendix M.

Table 5.38 Significant product specific categories for two experiments

Experiment 1		Experiment 2	
Theme	**Frequency**	**Theme**	**Frequency**
Fluidity	13	Elasticity	15
Glitteriness	12	Freshness	14
Length	9	Naturality	14
Discrepancy	8	Enthusiasm	12
Corner Lines	7	Hygiene	12
Goodness	6	Reliability	12
Raspiness	6	Pleasantness	11
Smelliness	6	Protectiveness	11
Problemacy	5	Sportiveness	11
Sound Clarity	5	Width	11
Symmetry	5	Bitterness	10
		Relief	9
		Tightness	7
		Steadiness	7
		Amusingness	6
		Area of Usage	6
		Conductivity	6
		Honesty	5
		Popularity	5

CHAPTER 6

ANALYSIS OF THE RELATIONSHIPS BETWEEN PARTICIPANTS' ATTITUDINAL EVALUATIONS AND COMPUTER MOUSES

This chapter aims to find the answer for the question of "how participants' attitudes are related with the selected products and how they are interrelated with each other". In this chapter, the collected data is analyzed to achieve the objectives that are;

- to explore the latent structure of the individuals' common attitudes and to reveal product-attitude relationships, and
- to investigate the relationships between the selected products and the elicited common attitudes.

Up to this chapter, two experiments with two different product types were carried out with the involvement of a total of 60 participants. Sixty repertory grids were obtained throughout the experiments and they were investigated through content analysis procedure. Sixty-three common attitudes from the first experiment with the computer mouses and 69 common attitudes from the second experiment with water bottles were combined into two single grids for further analyses as described in chapters 6 and 7.

The first aim of these statistical analyses is to apply dimension reduction to the collected data to interpret findings in a clear way. Principal Component Analysis (PCA) was used to explore and define components within the data. With the completion of the dimension reduction process, the relationships between elicited attitudes and products were explored and investigated through statistical analyses containing correlation tests, cluster analyses and one sample *t*-test. SPSS[43] and RStudio[44] (OpenRepGrid[45] package) softwares were used complementarily for these statistical analyses. The objectives and the analysis methods of the research can be seen in Table 6.1.

Table 6.1 The objectives and the analysis methods of the research

Phase	Objective	Method
Exploration	Dimension reduction	Principal Component Analysis
Exploration/ Investigation	Revealing and analysing product-attitude relationships	Correlation Analysis Cluster Analysis One Sample *t*-Test

6.1 Dimension Reduction of the Collected Data

After conducting two separate experiments through eight computer mouses and eight water bottles with 60 participants (30 for each experiment), a very large amount of data (12936 variables for attitude evaluation and 16170 variables for sensory evaluation) was obtained through repertory grid sheets. In the first experiment with computer mouses, 724 bipolar adjectives were reduced into 63 common attitudes, and for the second experiment with water bottles, 895 bipolar adjectives were transformed into 69 common attitudes through content analysis procedures. As a result of first data organization, the data were reduced into 504 pieces of variables

[43] IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. SPSS is the statistical analysis software has a wide usage in behavorial and social science studies (Field, 2018).
[44] RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA URL http://www.rstudio.com/. R is an open source software developed for computing statistics and graphics (Field, Miles, & Field, 2012). There are also packages developed by the researchers to be used in R for specific topics. In this research, OpenRegGrid package utilized for *analyzing* Repertory Grid Data was used.
[45] Heckmann, M. (2016). OpenRepGrid: An R package for the analysis of repertory grids. R package version 0.1.10. Available from: https://cran.r-project.org/package=OpenRepGrid.

(63 x 8 grids) for the experiment with computer mouses and 552 pieces of variables (69 x 8 grids) for the experiment with water bottles. Although a huge amount of reduction was made, the organized data still remained large and complex and therefore were not ready for a clear understanding of the relationships between variables. Instead of dealing with such amount of variables, the data can be reduced into components depending on their similarities. Thus, a great amount of time and effort would be preserved for further statistical analyses. Moreover, reducing a data into groups depending on variable correlations often provide more reliable results than observing variables individually (Tabachnick & Fidell, 2013, p. 613). So an appropriate method for data reduction needed to be chosen and the decision details and results are discussed in the following section.

6.1.1 Exploring Components in Grid Data

Several data reduction methods are available to explore underlying patterns of relationships in the latent structure of a group of variables and these methods are principal components, factor analysis and structural equation modeling (Tabachnick & Fidell, 2013). These data reduction methods contain various procedures that can be used depending on the specific aims of the research. Often factor analysis and principal components analysis are regarded as doing the same things[46], yet they are distinctly separated in some aspects (Osborne, 2014). A schematical representation of structural analyses can be seen in Table 6.2.

[46] Osborne (2014; p. 1) admits that this confusion is mostly caused by the statistical softwares that put principal components analysis as an extraction method under the function of factor analysis.

Table 6.2 Decision tree for structural analysis of the data (Adapted from Tabachnick and Fidell, 2013; p.30)

Major Research Question	**Number (Kind) of Dependant Variables**	**Number (Kind) of Independant Variables**	**Analytic Strategy**	**Goal of Analysis**
Structure	Multiple (continuous observed)	Multiple (latent)	Factor analysis (theoretical)	Create linear combinations of observed variables to represent latent variables.
	Multiple (latent)	Multiple (continuous observed)	Principal components (empirical)	
	Multiple (continuous observed and/or latent)	Multiple (continuous observed and/or latent)	Structural equation modeling	Create linear combinations of observed and latent independent variables to predict linear combinations of observed and latent dependent variables.

Factor analysis is used for reducing a large data into a smaller set to develop meaningful categories (namely factors) by gathering similar variables together for an easier interpretation of the data (Yong & Pearce, 2013). A type of factor analysis, exploratory factor analysis (EFA), is widely used by the researchers to explore the underlying structure by defining factors (Baglin, 2014; Fabrigar, Wegener, MacCallum, & Strahan, 1999). There are certain rules and aspects that resarchers should be aware of if they consider using EFA. Fabrigar et al. (1999) mentioned that the researcher should consider the variables that are included in the analysis, the size and the nature of the sample, the specification of the procedure, the number of the factors to be developed and the rotation method if required. Generally for EFA, a sample size of 150 participants is regarded as small and the proposed ratio for respondant/variable is at least 10:1, of which 30:1 is accepted as stable (Yong & Pearce, 2013).

On the other hand, PCA is another widely used data reduction method alongside EFA. Lever, Krzywinski and Altman (2017, p. 641) explain as “PCA reduces data by geometrically projecting them onto lower dimensions called principal components (PCs), with the goal of finding the best summary of the data using a limited number of PC”. Tabachnick and Fidell (2013, p. 25) emphasized that principal components is an empirical approach compared to factor analysis, which is theoretical and PCA produces components and EFA produces factors. EFA is appropriate for representing variable associations and PCA is more appropriate if the aim is to reduce the data (Baglin, 2014; Fabrigar et al, 1999). Further, the goal of PCA is to extract maximum variances compared to EFA, where the aim is to calculate covariances (Tabachnick & Fidell, 2013, p. 640). Also, Fransella et al. (2004, pp. 86-87) emphasized that PCA is an appropriate solution for reducing repertory grid data into components, and can be used on single grid analysis. The data gathered through 30 repertory grids were refined as one grid for each experiment in the previous section so PCA could be the proper solution for analyzing. In this section, the goal of the analysis is to reduce the data into smaller sets and PCA was found more appropriate and practical compared to EFA for the analysis of the data.

As the aim of dimension reduction is to achieve a simple structure, there can be infinite numbers of combinations to represent variable groups. The data reduction might need a method to make interpretations easier and represent variable relationships clearer. To reveal the most comprehensive and clear form of categorization of the variables, the data is rotated through mathematical and geometric calculations (Fabrigar, et al., 1999). There are various rotation methods available, and they are divided into two groups of orthogonal and oblique rotations; when dimensions of the data are not correlated, orthogonal rotation methods (rotating at 90 degrees) are preferred, and oblique rotations (rotating at degrees other than 90) are preferred if the dimensions are correlated (Fabrigar, et al, 1999; Tabachnick & Fidell, 2013). Statistical softwares calculate these complex rotations in a fast and accurate way.

During the dimension reduction process, it is important to decide on which variables should be retained and which variables should be removed from the analysis. As a result of PCA, variables are grouped under components depending on their loadings. There are different viewpoints available for minimum values of variable loadings in order to be retained in the analysis. The cutoff value for keeping the variables for interpretation depends on the decision of the researcher (Tabachnick & Fidell, 2013).

Mostly, the cutoff value is accepted 0.3 and any item that does not have a value over 0.3 under any of the components or factors should be removed (Kline, 2005; Osborne, 2014; Tabachnick & Fidell, 2013). Comrey and Lee (1992) suggested that values over 0.71 is considered as excellent, 0.63 as very good, 0.55 as good, 0.45 as fair and 0.32 as poor. Depending on these suggestions, PCA was applied on the repertory grid data.

6.1.2 Principal Components Analysis Results

The first objective in the application of PCA was to find out how many components needed to be extracted in order to represent the reduced data in the most appropriate way. To identify how many components should be formed, statistical softwares have a basic procedure to reveal components that have eigenvalues over 1.0 (Kline, 2005). A rotation method is also included in this standard procedure, varimax rotation, which is an orthogonal rotation technique that aims maximizing variances during component analysis (Tabachnick & Fidell, 2013). With the implementation of a rotation method, the item loadings would be clearer and therefore interpretation would be more practical. Sixty-three common attitudes for eight computer mouses were analyzed through this procedure and the results presented that five components were formed with eigenvalues greater than 1.0. Results of this analysis can be seen in Table 6.3.

Table 6.3 Preliminary extraction analysis of components with 63 attitudes

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	29,156	46,280	46,280	29,156	46,280	46,280	18,204	28,896	28,896
2	15,805	25,088	71,368	15,805	25,088	71,368	17,142	27,210	56,106
3	10,395	16,501	87,869	10,395	16,501	87,869	13,574	21,546	77,652
4	3,633	5,767	93,636	3,633	5,767	93,636	9,075	14,405	92,056
5	2,789	4,426	98,062	2,789	4,426	98,062	3,784	6,006	98,062

Extraction Method: Principal Component Analysis.

Preliminary analysis created five components with varimax rotation. The first component covered 46,28% of the total variance, whereas other components covered 25,09%, 16,50%, 5,77% and 4,43% respectively. The fourth and fifth components covered a small portion of total variance and therefore would be investigated if there were enough number of items produced under each of them to be counted as a component. As can be seen from Table 6.3, five components cover 98,06% of the full variance. However, this five components solution produced 10 cross-loaded items under different components. Cross-loading is an issue when an item is significantly loaded in more than one components. If an item has a loading value more than 0.32 in more than one component or factor, it is accepted as cross-loaded (or split loaded) (Brown, 2009; Costello & Osborne, 2005). The interpretation of cross-loaded items is problematic, and if the difference among the item loadings under different components is less than 0.1, the cross-loaded item should be removed from the analysis for better interpretation (Büyüköztürk, 2020). Variables with cross-loadings for the five components solution can be seen in the rotated component matrix table (Appendix N).

The preference of varimax rotation in the first PCA with five components produced 10 cross-loaded items. There are multiple ways to deal with cross-loaded items. The first solution would be to remove cross-loaded items one by one and reapply PCA after each removal (Osborne, 2014). This procedure can be done until cross-loaded items are removed from the data. However for the first PCA attempt with varimax rotation, when the cross-loaded items were removed one at a time and PCA was applied after each removal, other item loadings started to change (which also resulted in a change in component counts) and some items turned to cross-loaded items in the process. Conceivably, this issue could be an indicator that the rotation method could be an improper one for the dataset.

Different rotation types could be applied to decrease the amount of cross-loaded items in the analysis (Schmitt, 2011). To deal with cross-loaded items in an alternative way, other rotation methods with various component counts were tested for interpretable results. Table 6.4 represents summarized information regarding used rotation methods and extracted component counts and their relations with the cross-loaded items. Less amount of cross-loaded items means that the risk of structural change in the components is expected to be minimum during the removal of the problematic items and also it is expected to retain most of the items during the analysis.

Table 6.4 The results of different orthogonal rotation methods applied during PCA

Rotation Method	Varimax	Varimax	Equamax	Equamax	Quartimax	Quartimax
Number of Components	5	4	5	4	5	4
Cross-loaded Items	11	9	10	14	8	7

As can be seen from Table 6.4, three different orthogonal rotation methods were applied to the analysis. Varimax rotation method produced 11 cross-loaded items with five components extraction, and nine cross-loaded items with four components extraction. For equamax rotation, five components solution generated 10 cross-loaded items and four components solution generated 14 cross-loaded items. Lastly, quartimax produced the smallest number of cross-loaded items, which produced eight cross-loaded items with five components solution and seven cross-loaded items with four components solution.

Still, the dataset was only analyzed through orthogonal rotations. A decision had to be made in order to choose either orthogonal or oblique rotation methods for PCA, and this depended on the correlations between components. Component transformation matrix can be used as an indicator of whether the components are correlated or not. If the components are not correlated, which means each component is separated and has no relation with any other components, orthogonal rotations are appropriate (Brown, 2009; Costello & Osborne, 2005, Fabrigar et al, 1999). On the other hand, if the components are correlated, oblique rotation methods would be appropriate. Depending on the results from Table 6.4, quartimax rotation with four components solution was found to provide better structural results and the component transformation matrix of this procedure was investigated. Component transformation matrix of four components PCA with quartimax rotation can be seen in Table 6.5.

Table 6.5 Component transformation matrix of four components PCA with quartimax rotation

Component Transformation Matrix

Component	1	2	3	4
1	,955	,295	,002	,039
2	-,193	,621	**,760**	-,001
3	,222	**-,727**	,650	,006
4	-,039	-,007	-,003	,999

Extraction Method: Principal Component Analysis.
Rotation Method: Quartimax with Kaiser Normalization.

As can be seen from Table 6.5., the values in the component correlation matrix showed Component 2 and Component 3 to be significantly correlated. Schmitt (2011) emphasized that most components and factors are correlated in behavioral studies and oblique rotation methods are therefore more appropriate. So rather than using orthogonal rotations, oblique rotation methods would be more proper than orthogonal rotations in analyzing the data. A similar approach was taken to test oblique rotation methods as trying various orthogonal rotations for the best result. Direct oblimin and promax rotations were applied to the PCA in SPSS, yet still the results were not simple and clear, and generated components that still provided many cross-loaded items. A contemporary cluster-based oblique rotation method was developed for the data with complex structures (Yamamoto & Jennrich, 2013). In their own words, Yamamoto and Jennrich (2013, p. 488) explain this newly developed rotation method as follows:

> “Although many rotation methods can also recover a perfect simple structure, they perform poorly when a perfect simple structure is not possible. In this case, the new method tends to perform better because it clusters the loadings without requiring

> the clusters to be perfect. Artificial and real data analyses demonstrate that the proposed method can give a simple structure, which the other methods cannot produce, and provides a more interpretable result than those of widely known rotation techniques."

Yamamoto and Jennrich (2013) underline that all rotation techniques aim to reach the perfect simple structure which is not possible to reach often. Instead, they offer developing a slightly more complex structure than the perfect simple structure. To understand whether cluster rotation would be appropriate for the research data or not, another trial with cluster rotation was applied. This cluster rotation was not available in SPSS, so PCA was applied through R statistics software with OpenRepGrid package developed by Heckmann (2016). PCA was run with five components solution and cluster rotation. R statistics software calculated variance results that can be seen in Table 6.6.

Table 6.6 Variance results of five components extraction

Total Variance Explained

	RC1	RC3	RC2	RC4	RC5
Sum of Squared Loadings	20.77	17.94	14.01	04.18	03.35
Proportion Variance	0.33	0.28	0.22	0.07	0.05
Cumulative Variance	0.33	0.61	0.84	0.90	0.96

As can be seen from Table 6.6., five components with eigenvalues over 1.0 covered 96% of total variance. However, Component 4 and Component 5 covered a small portion of the total variance and therefore had to be checked if variables with significant loadings were available under them. Component 4 seemed to be containing only one variable (*clear-blurry*) with a significant loading (0.95) and thus needed not to be retained as a component. So another PCA was run with four components extraction with the cluster rotation. Results can be seen in Table 6.7.

Table 6.7 Variance results of four components extraction

Total Variance Explained

	RC1	RC3	RC2	RC4
Sum of Squared Loadings	20.68	18.79	14.20	4.05
Proportion Variance	0.33	0.30	0.23	0.06
Cumulative Variance	0.33	0.63	0.85	0.92

Four components were extracted with the final PCA run through R statistics software. As can be seen from the results in Table 6.7, four components covered 92% of the total variance. This four components extraction produced four cross-loaded items, which was the lowest amongst all rotation and extraction types applied to the data. Cutoff value was set to 0.5, which means loadings above 0.5 are accepted significant. Detailed PCA results with item loadings can be seen in Appendix N. These four cross-loaded items were *inappropriate-appropriate, long lasting-short lived, independent-constrained,* and *expensive-cheap.* These cross-loaded items were removed one by one and PCA was run each time after an item was removed. After four cross-loaded items were removed, the structure of the data changed again and two other items became cross-loaded, which were *beautiful-ugly* and *easy-difficult.* In the final run, these two cross-loaded items were removed one at a time and PCA was run. Results of the final PCA produced no cross-loaded items, which can be seen in Table 6.8. It can be seen from Table 6.8. that the fourth component consisted of two items. Although the usual acceptance of a component is that it consists of at least three items with the significant loadings, there could be exceptions in some cases to retain components with two items (Raubenheimer, 2004). So component four was retained in the study for further analyses.

For the dimension reduction of this highly complex data, various combinations of analysis methods were tested and four components were developed in the final. To maintain clear and interpretative results, six cross-loaded items were removed from the data, as they were involved in more than one component. These six cross-loaded items and their correlations with other variables would be investigated separately after the inter item correlations of each component results of PCA was completed.

These four components would be used for simplified and interpretative representations of correlations between items. Labeling of these components with labels, which carry the the group identity meanings of items loaded on each of the component would be beneficial in order to interpret them practically. The labels assigned for components are explained below.

Component 1 is consisted of the items with high loadings such as *plain-ornate, hidden-open, discordant-coherent, simple-complex, deep-treble, healthy-unhealthy* and *clean-dirty.* These items are mostly evaluative in nature, and the component was labeled as **evaluation**. The evaluation component covers the biggest part (33% of proportional variance) of the total variance.

Component 2 contains the items with high loadings such as *user friendly-difficult to use, curved-flat, extraordinary-common, controlled-uncontrolled,* and *functional-functionless.* These items were regarded as related with function and ergonomics, and the component is labeled as **usability**. The component covers the third most (23% of proportional variance) portion of the total variance.

Component 3 contains the items with high loadings such as *thick-thin, big-small, heavy-light, gracious-coarse, fast-slow* and *dynamic-bulky.* These items are related to size and appearance of the computer mouses and therefore the component is labeled as **capacity**. This component covers the second most (30% of proportional variance) part of the total variance.

Component 4 consists of only two items, *clear-blurry* and *non glittery-glittery.* The label of the component was assigned as **clarity**. The clarity component covers the smallest part (6% of proportional variance) of the total variance.

Table 6.8 Four components PCA results with cluster rotation.

Loadings:		RC1	RC3	RC2	RC4
Component 1	plain - ornate	1.06			
	hidden - open	1.00			
	discordant - coherent	-0.97			
	simple - complex	0.92			
	symmetric - asymmetric	0.92			
	deep - treble	-0.86			
	smelt - inodorous	-0.86			
	healthy - unhealthy	0.86			
	clean - dirty	0.85			
	non sticky - sticky	0.84			
	smooth - rough	0.83			
	whole - fragmented	0.83			
	unnecessary - necessary	-0.82			
	good - bad	0.82			
	soft - hard	-0.81			
	cold - hot	0.80			
	high quality - poor quality	0.78			
	slippery - non slippery	0.72			
	durable - flimsy	0.71			
	sloppy - elaborated	-0.64			
	shiny - matte	0.53			
Component 3	thick - thin		-1.02		
	big - small		-0.99		
	heavy - light		-0.99		
	gracious - coarse		0.97		
	fast - slow		0.97		
	dynamic - bulky		0.96		
	reassuring - insecure		0.94		
	transparent - opaque		0.93		
	particular - standard		0.91		
	long - short		-0.81		
	high - low		-0.80		
	loud - silent		-0.79		
	technological - outdated		0.76		
	entertaining - serious		0.73		
	eccentrical - accustomed		0.73		
	classical - modern		-0.72		
	old - new		-0.72		
	fluid - stable		0.71		
	attractive - unattractive		0.69		
	raspy - tuneful		-0.60		
Component 2	user friendly - difficult to use			0.98	
	curved - flat			0.97	
	extraordinary - common			-0.88	
	controlled - uncontrolled			0.88	
	rounded - sharp			0.87	
	functional - functionless			0.84	
	ergonomic - non ergonomic			0.82	
	handy - impractical			0.81	
	problematic - unproblematic			-0.78	
	ambiguous - distinct			-0.72	
	comfortable - uncomfortable			0.71	
	dark - light			0.71	
	obtuse - pointed			0.71	
	directional - directionless			-0.64	
Component 4	clear - blurry				0.76
	non glittery - glittery				-0.71

Number of components extracted: 4
Type of rotation: cluster

Four components were created and labeled. As cross-loaded items were removed and the data was reduced into components, an internal consistency test was applied within components to investigate if the data was reliable for further analyses. Cronbach's Alpha test was run with the variables within each component. Component 4 contains two items and it would be unnecessary to conduct an internal consistency test with them. Consistency test results can be seen in Table 6.9.

Table 6.9 Internal consistency test results of four components

Reliability Statistics

	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Component 1	,866	,844	21
Component 2	,886	,871	14
Component 3	,883	,868	20
Component 4	N/A	N/A	2

As can be seen from Table 6.9., the alpha values of Component 1 (0.87), Component 2 (0.89) and Component 3 (0.89) indicate that all three components are highly reliable in terms of internal consistencies. Note that five items and their ratings were reversed during alpha calculations due to the recommendation of the SPSS. In Component 1, *discordant-coherent* was reversed as *coherent-discordant*, in Component 2, *extraordinary-common* and *directionless-directional* were reversed as *common-extraordinary* and *directional-directionless*, and in Component 3, *thick-thin*, *big-small* and *long-short* were reversed as *thin-thick*, *small-big* and *short-long*. These changes would only change the positivity and negativity of correlations between variables and therefore would not interfere with further analyses.

6.1.3 Component Relationships

Understanding component relationships requires the measuring of correlation coefficients. Pearson correlation coefficient (*r*) measasures the lineer correlations between variables (Tabachnick & Fidell, 2013, p. 83). Pearson *r* was calculated among four components. The value of *r* is represented between the numbers of -1,00 and 1,00. If the *r* value is 1,00, this is an indicator of a perfect positive correlation and if the value is -1,00, this indicates there is a perfect correlation in negative way. 0 means there are no lineer correlations between variables. Also, if the Sig. (2-tailed) value is greater than 0.05, the increase or decrease in the first variable is not related with the change in the other variable.

Table 6.10 Relationships between four components of the experiment with computer mouses

Correlations

		Component1	Component2	Component3	Component4
Component1	Pearson Correlation	1	,023	,766*	-,090
	Sig. (2-tailed)		,957	,027	,831
	N	8	8	8	8
Component2	Pearson Correlation	,023	1	,322	,301
	Sig. (2-tailed)	,957		,437	,469
	N	8	8	8	8
Component3	Pearson Correlation	,766*	,322	1	,274
	Sig. (2-tailed)	,027	,437		,512
	N	8	8	8	8
Component4	Pearson Correlation	-,090	,301	,274	1
	Sig. (2-tailed)	,831	,469	,512	
	N	8	8	8	8

*. Correlation is significant at the 0.05 level (2-tailed).

According to Table 6.10, the Pearson correlation value between Component 1 and Component 2 is very close to zero (*r*=0,023), which means there are nearly no correlations between them. Also Component 1 and Component 4 were found as not correlated (*r*=0,09). Findings showed that Component 4 is moderately correlated with Component 2 (*r*=301) and slightly correlated with Component 3 (*r*=0,274). Further, Component 2 was found moderately correlated with Component 3 (*r*=0,322). The only strong correlation was found between Component 1 and Component 3 (*r*=0,766) and this correlation is positive. Also as these results prove that components are correlated in various degrees, the choice of cluster rotation method during PCA was approved, as oblique rotation types are appropriate when the components are correlated.

6.2 Exploration of the Relationships Between Computer Mouses and Elicited Common Attitudes

A three step approach was adopted in order to identify the relationships between computer mouses and the elicited common attitudes. In the first section, the relationships between common attitudes were investigated through bivariate correlation statistics. Pearson product moment correlation coefficient statistics were used to reveal attitude-attitude relationships. In the second section, clustering was adopted to analyse relationships between computer mouses. Hierarchical cluster analysis was adopted to observe similarities between computer mouses. In the third section, computer mouse-attitude relationships were investigated through *t*-test results. One sample *t*-test was applied to the dataset. Steps taken during the application of mentioned statistical methods are described in the following sections.

6.2.1 Relationships Between Common Attitudes Using Bivariate Statistics

In this section, the relationships between common attitudes are investigated. The relationship between two different variables is defined as correlation. There are various types of correlations available and Pearson's product moment correlation coefficient is one of the most widely used correlation statistics (Goodwin & Leech, 2010). As Goodwin and Leech (2010, p. 252) state, Pearson correlation coefficient is used to identify the aspects of the linear relationships between two variables. The aspects of this relationship are the size and the direction. The coefficient value ranges between +1 and -1. If the coefficient value is positive, then there is a positive correlation between two variables, where +1 describes perfect positive correlation. Contrarily, the negative correlation value means the correlation is negative, where -1 indicates perfect negative correlation. If the correlation value is 0, this indicates that there is no correlation between two variables.

6.2.1.1 Correlations Between Items Within Component 1 (Evaluation)

Component 1 consists of 21 common attitudes and correlations between them were calculated through Pearson's product moment correlation coefficient. Correlation results can be seen in Table 6.11. Negative values in the correlation matrix show that the correlated poles are opposite. In other words, if there is a negative correlation available between two attitudes, the left pole of the first attitude is correlated with the right pole of the other attitude. The interpretation of the correlation matrix in Table 6.11 is listed below;

- The attitude *plain-ornate* is highly correlated with the attitudes *symmetric-asymmetric* (*r*= 0,91), *hidden-open* (*r*= 0,89) and *simple-complex* (*r*= 0,86). Among eight computer mouses, the construing of *plain* shows a tendency to be also perceived as *symmetric*, *hidden* and *simple*. On the flipside, in eight computer mouses, the construing of *ornate* shows a tendency to be perceived as *asymmetric, open* and *complex*. In addition, the construing of *plain* is also associated with the perception of *coherent* (*r*= 0,84), *hard* (*r*= -0,84) and *healthy* (*r*= 0,83), and so on.
- The attitude *hidden-open* is highly correlated with the attitudes *coherent-discordant* (*r*= 0,95), *simple-complex* (*r*= 0,92), and *whole-fragmented* (*r*= 0,92). Among eight computer mouses, the construing of *hidden* shows a tendency to be also perceived as *coherent*, *simple* and *whole*. On the flipside, in eight computer mouses, the construing of *open* shows a tendency to be perceived as *discordant, complex* and *fragmented.* In addition, the construing of *hidden* is also associated with the perception of *clean* (*r*= 0,91), *smooth* (*r*= -0,91), *plain* (*r*= 0,89) and *treble* (*r*= -0,87), and so on.
- The attitude *coherent-discordant* is highly correlated with the attitudes *hidden-open* (*r*= 0,95), *simple-complex* (*r*= 0,95) and *whole-fragmented* (*r*= 0,85). Among eight computer mouses, the construing of *coherent* shows a tendency to be also perceived as *hidden*, *simple* and *whole.* On the flipside, in eight computer mouses, the construing of *discordant* shows a tendency to

be perceived as *open*, *complex,* and *fragmented.* In addition, the construing of *coherent* is also associated with the perception of *inodorous* (*r*= -0,85), *plain* (*r*= 0,84) and *treble* (*r*= -0,82), and so on.

- The attitude *simple-complex* is highly correlated with the attitudes *coherent-discordant* (*r*= 0,95), *hidden-open* (*r*= 0,92) and *whole-fragmented* (*r*= 0,90). Among eight computer mouses, the construing of *simple* shows a tendency to be also perceived as *coherent*, *hidden* and *whole*. On the flipside, in eight computer mouses, the construing of *complex* shows a tendency to be perceived as *discordant*, *open,* and *fragmented.* In addition, the construing of *simple* is also associated with the perception of *plain* (*r*= 0,86), *inodorous* (*r*= -0,85) and *treble* (*r*= -0,81), and so on.
- The attitude *symmetric-asymmetric* is highly correlated with the attitude *soft-hard* (*r*= -0,92) and *plain-ornate* (*r*= 0,91). Among eight computer mouses, the construing of *symmetric* shows a tendency to be also perceived as *hard* and *plain*. On the flipside, in eight computer mouses, the construing of *asymmetric* shows a tendency to be perceived as *soft,* and *ornate.* In addition, the construing of *symmetric* is also associated with the perception of *simple* (*r*= 0,72) and *coherent* (*r*= 0,70), and so on.
- The attitude *deep-treble* is highly correlated with the attitude *hidden-open* (*r*= -0,87), *clean-dirty* (*r*= -0,86) and *smooth-rough* (*r*= -0,83). Among eight computer mouses, the construing of *deep* shows a tendency to be also perceived as *open*, *dirty* and *rough*. On the flipside, in eight computer mouses, the construing of *treble* shows a tendency to be perceived as *hidden, clean* and *smooth.* In addition, the construing of *deep* is also associated with the perception of *discordant* (*r*= -0,82), *complex* (*r*= -0,81) and *unhealthy* (*r*= -0,81), and so on.

Table 6.11 Correlation matrix of 21 items within Component 1

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
1. plain-ornate	**1,00**	**0,89**	0,84	**0,86**	**0,91**	-0,77	-0,77	0,71	0,76	0,83	0,73	0,76	-0,70	0,70	-0,84	0,80	0,66	0,67	0,61	-0,52	0,48
2. hidden-open	0,89	**1,00**	**0,95**	**0,92**	0,71	-0,87	-0,85	0,90	0,91	0,82	0,91	**0,92**	-0,72	0,79	-0,65	0,80	0,83	0,75	0,85	-0,69	0,64
3. coherent-discordant	0,84	**0,95**	**1,00**	**0,95**	0,70	-0,82	-0,85	0,78	0,77	0,66	0,74	**0,85**	-0,61	0,63	-0,68	0,63	0,66	0,50	0,75	-0,54	0,37
4. simple-complex	0,86	**0,92**	**0,95**	**1,00**	0,72	-0,81	-0,85	0,68	0,78	0,75	0,74	**0,90**	-0,50	0,56	-0,79	0,75	0,61	0,54	0,75	-0,47	0,40
5. symmetric-asymmetric	**0,91**	0,71	0,70	0,72	**1,00**	-0,53	-0,54	0,46	0,47	0,77	0,53	0,52	-0,52	0,42	**-0,92**	0,70	0,38	0,50	0,41	-0,21	0,35
6. deep-treble	-0,77	**-0,87**	**-0,82**	-0,81	-0,53	**1,00**	0,64	-0,81	**-0,86**	-0,67	**-0,83**	-0,75	0,53	-0,72	0,56	-0,62	-0,74	-0,69	-0,61	0,56	-0,60
7. smelt-inodorous	-0,77	**-0,85**	**-0,85**	**-0,85**	-0,54	0,64	**1,00**	-0,74	-0,82	-0,65	-0,69	**-0,92**	0,70	-0,73	0,49	-0,71	-0,74	-0,55	-0,84	0,73	-0,37
8. healthy-unhealthy	0,71	0,90	0,78	0,68	0,46	-0,81	-0,74	**1,00**	**0,93**	0,66	**0,93**	0,80	-0,86	**0,94**	-0,29	0,66	**0,96**	0,80	0,83	-0,88	0,72
9. clean-dirty	0,76	**0,91**	0,77	0,78	0,47	-0,86	-0,82	**0,93**	**1,00**	0,80	**0,95**	**0,91**	-0,74	0,90	-0,41	0,82	**0,95**	0,88	0,88	-0,85	0,78
10. non sticky-sticky	0,83	0,82	0,66	0,75	0,77	-0,67	-0,65	0,66	0,80	**1,00**	**0,84**	0,78	-0,54	0,63	-0,72	**0,98**	0,67	**0,87**	0,76	-0,49	0,80
11. smooth-rough	0,73	0,91	0,74	0,74	0,53	-0,83	-0,69	**0,93**	**0,95**	0,84	**1,00**	0,85	-0,73	0,86	-0,43	0,84	**0,92**	**0,92**	0,87	-0,78	0,88
12. whole-fragmented	0,76	**0,92**	0,85	0,90	0,52	-0,75	**-0,92**	0,80	0,91	0,78	0,85	**1,00**	-0,64	0,74	-0,53	0,83	0,81	0,71	**0,93**	-0,74	0,60
13. unnecessary-necessary	-0,70	-0,72	-0,61	-0,50	-0,52	0,53	0,70	-0,86	-0,74	-0,54	-0,73	-0,64	**1,00**	**-0,93**	0,25	-0,58	**-0,88**	-0,69	-0,65	**0,89**	-0,53
14. good-bad	0,70	0,79	0,63	0,56	0,42	-0,72	-0,73	**0,94**	0,90	0,63	0,86	0,74	**-0,93**	**1,00**	-0,22	0,67	**0,98**	0,84	0,74	**-0,94**	0,70
15. soft-hard	-0,84	-0,65	-0,68	-0,79	**-0,92**	0,56	0,49	-0,29	-0,41	-0,72	-0,43	-0,53	0,25	-0,22	**1,00**	-0,65	-0,21	-0,36	-0,32	0,02	-0,23
16. cold-hot	0,80	0,80	0,63	0,75	0,70	-0,62	-0,71	0,66	0,82	**0,98**	**0,84**	0,83	-0,58	0,67	-0,65	**1,00**	0,71	**0,88**	0,80	-0,57	0,79
17. high quality-poor quality	0,66	0,83	0,66	0,61	0,38	-0,74	-0,74	**0,96**	**0,95**	0,67	**0,92**	0,81	-0,88	**0,98**	-0,21	0,71	**1,00**	0,87	0,83	**-0,95**	0,77
18. slippery-non slippery	0,67	0,75	0,50	0,54	0,50	-0,69	-0,55	0,80	**0,88**	0,87	**0,92**	0,71	-0,69	0,84	-0,36	**0,88**	0,87	**1,00**	0,75	-0,73	**0,95**
19. durable-flimsy	0,61	0,85	0,75	0,75	0,41	-0,61	-0,84	0,83	**0,88**	0,76	**0,87**	**0,93**	-0,65	0,74	-0,32	0,80	0,83	0,75	**1,00**	-0,78	0,71
20. sloppy-elaborated	-0,52	-0,69	-0,54	-0,47	-0,21	0,56	0,73	-0,88	-0,85	-0,49	-0,78	-0,74	**0,89**	**-0,94**	0,02	-0,57	**-0,95**	-0,73	-0,78	**1,00**	-0,61
21. shiny-matte	0,48	0,64	0,37	0,40	0,35	-0,60	-0,37	0,72	0,78	**0,80**	**0,88**	0,60	-0,53	0,70	-0,23	0,79	0,77	**0,95**	0,71	-0,61	**1,00**

- The attitude *smelt-inodorous* is highly correlated with the attitude *non sticky-sticky* (*r*= -0,92), *hidden-open* (*r*= -0,85), *coherent-discordant* (*r*= -0,85) and *simple-complex* (*r*= -0,85). Among eight computer mouses, the construing of *smelt* shows a tendency to be also perceived as *sticky*, *open* and *discordant*. On the flipside, in eight computer mouses, the construing of *inodorous* shows a tendency to be perceived as *non sticky*, *hidden* and *coherent.* In addition, the construing of *smelt* is also associated with the perception of *flimsy* (*r*= -0,84) and *dirty* (*r*= -0,82), and so on.
- The attitude *healthy-unhealthy* is highly correlated with the attitude *high quality-poor quality* (*r*= 0,96), *good-bad* (*r*= 0,94), *smooth-rough* (*r*= 0,93) and *clean-dirty* (*r*= 0,93). Among eight computer mouses, the construing of *healthy* shows a tendency to be also perceived as *high quality*, *good*, *smooth* and *clean*. On the flipside, in eight computer mouses, the construing of *unhealthy* shows a tendency to be perceived as *poor quality, bad, rough* and *dirty*. In addition, the construing of *healthy* is also associated with the perception of *hidden* (*r*= 0,90), *elaborated* (*r*= -0,88), *necessary* (*r*= -0,86) and *durable* (*r*= 0,83), and so on.
- The attitude *clean-dirty* is highly correlated with the attitude *high quality-poor quality* (*r*= 0,95), *smooth-rough* (*r*= 0,95) and *healthy-unhealthy* (*r*= 0,93). Among eight computer mouses, the construing of *healthy* shows a tendency to be also perceived as *high quality*, *good*, *smooth* and *clean*. On the flipside, in eight computer mouses, the construing of *unhealthy* shows a tendency to be perceived as *poor quality, bad*, *rough* and *dirty*. In addition, the construing of *clean* is also associated with the perception of *hidden* (*r*= 0,91), *whole* (*r*= -0,91), *good* (*r*= 0,90) *durable* (*r*= 0,88) and *slippery* (*r*= 0,88), and so on.
- The attitude *non sticky-sticky* is highly correlated with the attitude *cold-hot* (*r*= 0,98), *slippery-non slippery* (*r*= 0,87) and *smooth-rough* (*r*= 0,84). Among eight computer mouses, the construing of *non sticky* shows a tendency to be also perceived as *cold*, *slippery* and *smooth*. On the flipside,

in eight computer mouses, the construing of *sticky* shows a tendency to be perceived as *hot, non slippery,* and *rough.* In addition, the construing of *non sticky* is also associated with the perception of *plain* (*r*= 0,83), *hidden* (*r*= 0,82) and *shiny* (*r*= 0,80), and so on.

- The attitude *smooth-rough* is highly correlated with the attitude *clean-dirty* (*r*= 0,95), *healthy-unhealthy* (*r*= 0,93), *high quality-poor quality* (*r*= 0,92), *slippery-non slippery* (*r*= 0,92) and *hidden-open* (*r*= 0,91). Among eight computer mouses, the construing of *smooth* shows a tendency to be also perceived as *clean, healthy, high quality, slippery* and *hidden*. On the flipside, in eight computer mouses, the construing of *rough* shows a tendency to be perceived as *unhealthy, poor quality, non slippery* and *open.* In addition, the construing of *smooth* is also associated with the perception of *shiny* (*r*= 0,88), *durable* (*r*= 0,87), *good* (*r*= 0,86), *cold* (*r*= 0,84) and *treble* (*r*= -0,83), and so on.
- The attitude *whole-fragmented* is highly correlated with the attitude *durable-flimsy* (*r*= 0,93), *hidden-open* (*r*= 0,92), *smelt-inodorous* (*r*= -0,92), *clean-dirty* (*r*= 0,91), and *simple-complex* (*r*= 0,90). Among eight computer mouses, the construing of *whole* shows a tendency to be also perceived as *durable*, *hidden*, *inodorous*, *clean* and *simple*. On the flipside, in eight computer mouses, the construing of *fragmented* shows a tendency to be perceived as *flimsy, open, smelt, dirty* and *complex.* In addition, the construing of *whole* is also associated with the perception of *smooth* (*r*= 0,85), *coherent* (*r*= 0,85), *cold* (*r*= 0,83), *cold* (*r*= 0,84), *high quality* (*r*= 0,81) and *healthy* (*r*= 0,80), and so on.
- The attitude *unnecessary-necessary* is highly correlated with the attitude *good-bad* (*r*= -0,93) and *sloppy-elaborated* (*r*= 0,89). Among eight computer mouses, the construing of *unnecessary* shows a tendency to be also perceived as *bad* and *sloppy.* On the flipside, in eight computer mouses, the construing of *necessary* shows a tendency to be perceived as *good* and

elaborated. In addition, the construing of *unnecessary* is also associated with the perception of *poor quality* (*r*= -0,88) and *unhealthy* (*r*= -0,86), and so on.

- The attitude *good-bad* is highly correlated with the attitude *high quality-poor quality* (*r*= 0,98), *healthy-unhealthy* (*r*= 0,94), *sloppy-elaborated* (*r*= -0,94) and *unnecessary-necessary* (*r*= -0,93). Among eight computer mouses, the construing of *good* shows a tendency to be also perceived as *high quality, healthy, elaborated* and *necessary.* On the flipside, in eight computer mouses, the construing of *bad* shows a tendency to be perceived as *poor quality, unhealthy, sloppy* and *unnecessary.* In addition, the construing of *good* is also associated with the perception of *clean* (*r*= 0,90), *smooth* (*r*= 0,86) and *slippery* (*r*= 0,84), and so on.
- The attitude *soft-hard* is highly correlated with the attitude *symmetric-asymmetric* (*r*= -0,92) and *plain-ornate* (*r*= -0,84). Among eight computer mouses, the construing of *soft* shows a tendency to be also perceived as *asymmetric* and *ornate.* On the flipside, in eight computer mouses, the construing of *hard* shows a tendency to be perceived as *symmetric* and *plain.*
- The attitude *cold-hot* is highly correlated with the attitude *non sticky-sticky* (*r*= 0,98) *slippery-non slippery* (*r*= 0,88) and *smooth-rough* (*r*= 0,84). Among eight computer mouses, the construing of *cold* shows a tendency to be also perceived as *non sticky, slippery* and *smooth.* On the flipside, in eight computer mouses, the construing of *hot* shows a tendency to be perceived as *sticky* , *non slippery* and *rough.* In addition, the construing of *cold* is also associated with the perception of *whole* (*r*= 0,83), *clean* (*r*= 0,82), *hidden* (*r*= 0,80) and *durable* (*r*= 0,80), and so on.
- The attitude *high quality-poor quality* is highly correlated with the attitude *good-bad* (*r*= 0,98), *healthy-unhealthy* (*r*= 0,96), *clean-dirty* (*r*= 0,95), *sloppy-elaborated* (*r*= -0,95) and *smooth-rough* (*r*= 0,92). Among eight computer mouses, the construing of *high quality* shows a tendency to be also perceived as *good, healthy, clean, elaborated* and *smooth.* On the flipside, in eight computer mouses, the construing of *poor quality* shows a tendency to

be perceived as *bad, unhealthy, dirty, sloppy* and *rough.* In addition, the construing of *high quality* is also associated with the perception of *necessary* (*r*= -0,88), *slippery* (*r*= 0,87) *durable* (*r*= 0,83) and *hidden* (*r*= 0,83), and so on.

- The attitude *slippery-non slippery* is highly correlated with the attitude *shiny-matte* (*r*= 0,95), *whole-fragmented* (*r*= 0,92), *clean-dirty* (*r*= 0,88) and *cold-hot* (*r*= 0,88). Among eight computer mouses, the construing of *slippery* shows a tendency to be also perceived as *shiny, whole, clean* and *cold.* On the flipside, in eight computer mouses, the construing of *non slippery* shows a tendency to be perceived as *matte, fragmented, dirty* and *hot.* In addition, the construing of *slippery* is also associated with the perception of *non sticky* (*r*= 0,87)*, high quality* (*r*= 0,87), *good* (*r*= 0,84) and *healthy* (*r*= 0,80), and so on.
- The attitude *durable-flimsy* is highly correlated with the attitude *whole-fragmented* (*r*= 0,93), *clean-dirty* (*r*= 0,88) and *smooth-rough* (*r*= 0,87). Among eight computer mouses, the construing of *durable* shows a tendency to be also perceived as *whole, clean* and *smooth.* On the flipside, in eight computer mouses, the construing of *flimsy* shows a tendency to be perceived as *fragmented, dirty* and *rough.* In addition, the construing of *durable* is also associated with the perception of *hidden* (*r*= 0,85), *inodorous* (*r*= -0,84), *high quality* (*r*= 0,83), *healthy* (*r*= 0,83) and *cold* (*r*= 0,80), and so on.
- The attitude *sloppy-elaborated* is highly correlated with the attitude *high quality-poor quality* (*r*= -0,95), *good-bad* (*r*= -0,94), *unnecessary-necessary* (*r*= 0,89) and *healthy-unhealthy* (*r*= -0,88). Among eight computer mouses, the construing of *sloppy* shows a tendency to be also perceived as *poor quality* and *unhealthy.* On the flipside, in eight computer mouses, the construing of *elaborated* shows a tendency to be perceived as *high quality, good, necessary* and *healthy.* In addition, the construing of *sloppy* is also associated with the perception of *dirty* (*r*= -0,85), and so on.

- The attitude *shiny-matte* is highly correlated with the attitude *slippery-non slippery* (*r*= 0,95) and *smooth-rough* (*r*= 0,88). Among eight computer mouses, the construing of *shiny* shows a tendency to be also perceived as *slippery* and *smooth.* On the flipside, in eight computer mouses, the construing of *matte* shows a tendency to be perceived as *non slippery* and *rough.* In addition, the construing of *shiny* is also associated with the perception of *non sticky* (*r*= 0,80), *cold* (*r*= 0,79) and *clean* (*r*= 0,78), and so on.

Although the correlations in Table 6.11 were interpreted, the table itself is still complex and contains a large amount of data. Quadratic mean (also known as root mean square) calculations simplifies the correlation matrix. Quadratic mean calculation is used to find out the average relation of an attitude with all other attitudes (Fransella, et al., 2004; Akbay, 2013). Quadratic means were calculated through the item correlation ratings within Component 1 (Table 6.12). According to the quadratic mean results, the attitude *clean-dirty* was found having the greatest average relation with all other attitudes, followed by *hidden-open, smooth-rough, high quality-poor quality*, *healthy-unhealthy* and *whole-fragmented.*

Table 6.12 Quadratic mean *(*RMS) scores for 21 items within Component 1

Attitude	**Root Mean Squares**
plain - ornate	0,75
hidden - open	**0,82**
discordant - coherent	0,73
simple - complex	0,73
symmetric - asymmetric	0,59
deep - treble	0,71
smelt - inodorous	0,72
healthy - unhealthy	**0,78**
clean - dirty	**0,82**
non sticky - sticky	0,74
smooth - rough	**0,81**
whole - fragmented	**0,78**
unnecessary - necessary	0,68
good - bad	0,75
soft - hard	0,53
cold - hot	0,75
high quality - poor quality	**0,78**
slippery - non slippery	0,74
durable - flimsy	0,75
sloppy - elaborated	0,69
shiny-matte	0,64
Average	0,73
Standard deviation	0,07

6.2.1.2 Correlations Between Items Within Component 2 (Usability)

Component 2 consists of 14 common attitudes and correlations between them were calculated through Pearson’s product moment correlation coefficient. Correlation results can be seen in Table 6.13. Negative values in the correlation matrix show that the correlated poles are opposite. In other words, if there is a negative correlation available between two attitudes, the left pole of the first attitude is correlated with the right pole of the other attitude. The interpretation of the correlation matrix in Table 6.13 is listed below;

- The attitude *user friendly-difficult to use* is highly correlated with the attitudes *curved-flat* (*r*= 0,90), *controlled-uncontrolled* (*r*= 0,87) and *handy-impractical* (*r*= 0,84). Among eight computer mouses, the construing of *user friendly* shows a tendency to be also perceived as *curved* and *controlled*. On the flipside, in eight computer mouses, the construing of *difficult to use* shows a tendency to be perceived as *flat, uncontrolled* and *impractical*. In addition, the construing of *user friendly* is also associated with the perception of *rounded* (*r*= 0,83), *comfortable* (*r*= 0,82) and *functional* (*r*= 0,80), and so on.
- The attitude *curved-flat* is highly correlated with the attitudes *rounded-sharp* (*r*= 0,95), *user friendly-difficult to use* (*r*= 0,92), and *common-extraordinary* (*r*= 0,92). Among eight computer mouses, the construing of *curved* shows a tendency to be also perceived as *rounded*, *user friendly* and *common*. On the flipside, in eight computer mouses, the construing of *flat* shows a tendency to be perceived as *sharp, difficult to use* and *extraordinary.* In addition, the construing of *curved* is also associated with the perception of *functional* (*r*= 0,87), *distinct* (*r*= -0,85), *obtuse* (*r*= 0,83) and *controlled* (*r*= 0,81), and so on.
- The attitude *common-extraordinary* is highly correlated with the attitudes *curved-flat* (*r*= 0,88) and *ambiguous-distinct* (*r*= -0,88). Among eight computer mouses, the construing of *common* shows a tendency to be also

perceived as *curved* and *distinct.* On the flipside, in eight computer mouses, the construing of *extraordinary* shows a tendency to be perceived as *flat* and *ambiguous.* In addition, the construing of *common* is also associated with the perception of *directionless* (*r*= -0,84) and *rounded* (*r*= 0,79), and so on.

- The attitude *controlled-uncontrolled* is highly correlated with the attitudes *functional-functionless* (*r*= 0,90), *handy-impractical* (*r*= 0,88) and *user friendly-difficult to use* (*r*= 0,87). Among eight computer mouses, the construing of *controlled* shows a tendency to be also perceived as *functional*, *handy* and *user friendly*. On the flipside, in eight computer mouses, the construing of *uncontrolled* shows a tendency to be perceived as *functionless, impractical,* and *difficult to use.* In addition, the construing of *controlled* is also associated with the perception of *curved* (*r*= 0,81) and *obtuse* (*r*= 0,81), and so on.
- The attitude *rounded-sharp* is highly correlated with the attitudes *curved-flat* (*r*= 0,96), *obtuse-pointed* (*r*= 0,91), *ambiguous-distinct* (*r*= -0,88) and *functional-functionless* (*r*= 0,86). Among eight computer mouses, the construing of *rounded* shows a tendency to be also perceived as *curved*, *obtuse, distinct* and *functional*. On the flipside, in eight computer mouses, the construing of *sharp* shows a tendency to be perceived as *flat*, *pointed*, *ambiguous* and *functionless.* In addition, the construing of *rounded* is also associated with the perception of *user friendly* (*r*= 0,83), *dark* (*r*= 0,83) and *directionless* (*r*= -0,81), and so on.
- The attitude *functional-functionless* is highly correlated with the attitudes *controlled-uncontrolled* (*r*= 0,90), *obtuse-pointed* (*r*= 0,88) and *curved-flat* (*r*= 0,87). Among eight computer mouses, the construing of *functional* shows a tendency to be also perceived as *controlled*, *obtuse* and *curved*. On the flipside, in eight computer mouses, the construing of *functionless* shows a tendency to be perceived as *uncontrolled, pointed,* and *flat.* In addition, the construing of *functional* is also associated with the perception of *rounded* (*r*= 0,86), *user friendly* (*r*= 0,80) and *dark* (*r*= 0,73), and so on.

Table 6.13 Correlation matrix of 14 items within

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1. user friendly-difficult to use	**1,00**	**0,90**	0,74	**0,87**	0,83	**0,80**	0,77	**0,84**	-0,72	-0,66	**0,82**	0,78	0,68	-0,50
2. curved-flat	**0,90**	**1,00**	**0,88**	**0,81**	**0,96**	**0,87**	0,60	0,62	-0,54	**-0,85**	0,52	0,76	0,83	-0,79
3. common-extraordinary	0,74	**0,88**	**1,00**	0,52	0,79	0,56	0,50	0,39	-0,48	**-0,88**	0,31	0,56	0,53	**-0,84**
4. controlled-uncontrolled	**0,87**	0,81	0,52	**1,00**	0,77	**0,90**	0,76	**0,88**	-0,76	-0,45	0,77	0,67	**0,81**	-0,36
5. rounded-sharp	0,83	**0,96**	0,79	0,77	**1,00**	**0,86**	0,41	0,51	-0,36	**-0,88**	0,44	**0,83**	**0,91**	**-0,81**
6. functional-functionless	0,80	**0,87**	0,56	**0,90**	**0,86**	**1,00**	0,64	0,69	-0,51	-0,54	0,51	0,73	**0,88**	-0,59
7. ergonomic-non ergonomic	0,77	0,60	0,50	0,76	0,41	0,64	**1,00**	**0,91**	**-0,93**	-0,16	0,75	0,31	0,35	-0,14
8. handy-impractical	**0,84**	0,62	0,39	**0,88**	0,51	0,69	**0,91**	**1,00**	**-0,91**	-0,20	**0,91**	0,44	0,52	-0,04
9. problematic-unproblematic	-0,72	-0,54	-0,48	-0,76	-0,36	-0,51	**-0,93**	**-0,91**	**1,00**	0,16	-0,80	-0,21	-0,32	0,03
10. ambiguous-distinct	-0,66	-0,85	**-0,88**	-0,45	**-0,88**	-0,54	-0,16	-0,20	0,16	**1,00**	-0,22	-0,71	-0,67	**0,89**
11. comfortable-uncomfortable	0,82	0,52	0,31	0,77	0,44	0,51	0,75	**0,91**	-0,80	-0,22	**1,00**	0,54	0,37	0,06
12. dark-light	0,78	0,76	0,56	0,67	**0,83**	0,73	0,31	0,44	-0,21	-0,71	0,54	**1,00**	0,67	-0,63
13. obtuse-pointed	0,68	0,83	0,53	0,81	**0,91**	**0,88**	0,35	0,52	-0,32	-0,67	0,37	0,67	**1,00**	-0,63
14. directionless-directional	-0,50	-0,79	-0,84	-0,36	-0,81	-0,59	-0,14	-0,04	0,03	**0,89**	0,06	-0,63	-0,63	**1,00**

- The attitude *ergonomic-non ergonomic* is highly correlated with the attitudes *problematic-unproblematic* (*r*= -0,93) and *handy-impractical* (*r*= 0,91). Among eight computer mouses, the construing of *ergonomic* shows a tendency to be also perceived as *unproblematic* and *handy*. On the flipside, in eight computer mouses, the construing of *non ergonomic* shows a tendency to be perceived as *problematic* and *impractical.* In addition, the construing of *ergonomic* is also associated with the perception of *user friendly* (*r*= 0,77), *controlled* (*r*= 0,76) and *comfortable* (*r*= 0,75), and so on.
- The attitude *handy-impractical* is highly correlated with the attitudes *comfortable-uncomfortable* (*r*= 0,91), *ergonomic-non ergonomic* (*r*= 0,91) and *problematic-unproblematic* (*r*= -0,91). Among eight computer mouses, the construing of *handy* shows a tendency to be also perceived as *comfortable*, *ergonomic* and *unproblematic*. On the flipside, in eight computer mouses, the construing of *impractical* shows a tendency to be perceived as *uncomfortable, non ergonomic* and *problematic*. In addition, the construing of *handy* is also associated with the perception of *controlled* (*r*= 0,88) and *user friendly* (*r*= 0,84), and so on.
- The attitude *problematic-unproblematic* is highly correlated with the attitudes *ergonomic-non ergonomic* (*r*= -0,93) and *handy-impractical* (*r*= -0,91). Among eight computer mouses, the construing of *problematic* shows a tendency to be also perceived as *non ergonomic* and *impractical*. On the flipside, in eight computer mouses, the construing of *unproblematic* shows a tendency to be perceived as *ergonomic* and *handy*. In addition, the construing of *problematic* is also associated with the perception of *uncomfortable* (*r*= -0,80), *uncontrolled* (*r*= -0,76) and *difficult to use* (*r*= -0,72), and so on.
- The attitude *ambiguous-distinct* is highly correlated with the attitudes *directionless-directional* (*r*= 0,89), *rounded-sharp* (*r*= -0,88) and *common-extraordinary* (*r*= -0,88). Among eight computer mouses, the construing of *ambiguous* shows a tendency to be also perceived as *directionless, sharp* and *extraordinary*. On the flipside, in eight computer mouses, the construing of

distinct shows a tendency to be perceived as *directional*, *rounded,* and *common.* In addition, the construing of *ambiguous* is also associated with the perception of *flat* (*r*= 0,86) and *light* (*r*= -0,71), and so on.

- The attitude *comfortable-uncomfortable* is highly correlated with the attitudes *handy-impractical* (*r*= 0,91), *user friendly-difficult to use* (*r*= 0,82) and *problematic-unproblematic* (*r*= -0,80). Among eight computer mouses, the construing of *comfortable* shows a tendency to be also perceived as *handy*, *user friendly* and *unproblematic*. On the flipside, in eight computer mouses, the construing of *uncomfortable* shows a tendency to be perceived as *impractical, difficult to use* and *problematic.* In addition, the construing of *comfortable* is also associated with the perception of *controlled* (*r*= 0,77) and *ergonomic* (*r*= 0,75), and so on.
- The attitude *dark-light* is highly correlated with the attitudes *rounded-sharp* (*r*= 0,83). Among eight computer mouses, the construing of *dark* shows a tendency to be also perceived as *rounded*. On the flipside, in eight computer mouses, the construing of *light* shows a tendency to be perceived as *sharp.* In addition, the construing of *dark* is also associated with the perception of *user friendly* (*r*= 0,78), *curved* (*r*= 0,76) and *functional* (*r*= 0,73), and so on.
- The attitude *obtuse-pointed* is highly correlated with the attitudes *rounded-sharp* (*r*= 0,91), *functional-functionless* (*r*= 0,88) and *curved-flat* (*r*= 0,83). Among eight computer mouses, the construing of *obtuse* shows a tendency to be also perceived as *rounded*, *functional* and *curved.* On the flipside, in eight computer mouses, the construing of *pointed* shows a tendency to be perceived as *sharp, functionless,* and *flat.* In addition, the construing of *obtuse* is also associated with the perception of *controlled* (*r*= 0,81), and so on.
- The attitude *directionless-directional* is highly correlated with the attitudes *ambiguous-distinct* (*r*= 0,89), *common-extraordinary* (*r*= -0,84) and *rounded-sharp* (*r*= -0,81). Among eight computer mouses, the construing of *directionless* shows a tendency to be also perceived as *ambiguous* and *sharp*.

On the flipside, in eight computer mouses, the construing of *directional* shows a tendency to be perceived as *distinct* and *rounded.* In addition, the construing of *directionless* is also associated with the perception of *flat* (*r*= -0,79), and so on.

Root mean squares were calculated through the correlation ratings of 14 items within Component 2 (Table 6.14). According to the quadratic mean results, the attitude *curved-flat* was found having the greatest average relation with all other attitudes, followed by *user friendly-difficult to use, rounded-sharp, controlled-uncontrolled* and *functional-functionless.*

Table 6.14 Quadratic mean *(*RMS) scores for 14 items within Component 2

Attitude	**Root Mean Squares**
user friendly-difficult to use	**0,77**
curved-flat	**0,78**
common-extraordinary	0,64
controlled-uncontrolled	**0,74**
rounded-sharp	**0,75**
functional-functionless	**0,71**
ergonomic-non ergonomic	0,61
handy-impractical	0,66
problematic-unproblematic	0,59
ambiguous-distinct	0,63
comfortable-uncomfortable	0,59
dark-light	0,63
obtuse-pointed	0,66
directionless-directional	0,58
Average	0,67
Standard deviation	0,07

6.2.1.3 Correlations Between Items Within Component 3 (Capacity)

Component 3 consists of 20 common attitudes and correlations between them were calculated through Pearson’s product moment correlation coefficient. Correlation results can be seen in Table 6.13. Negative values in the correlation matrix show that the correlated poles are opposite. In other words, if there is a negative correlation available between two attitudes, the left pole of the first attitude is correlated with the right pole of the other attitude. The interpretation of the correlation matrix in Table 6.15 is listed below;

- The attitude *thin-thick* is highly correlated with the attitudes *gracious-coarse* (*r*= 0,92), *reassuring-insecure* (*r*= 0,92), *high-low* (*r*= -0,92) and *particular-standard* (*r*= 0,91). Among eight computer mouses, the construing of *thin* shows a tendency to be also perceived as *gracious, reassuring, low* and *particular*. On the flipside, in eight computer mouses, the construing of *thick* shows a tendency to be perceived as *coarse, insecure, high* and *standard*. In addition, the construing of *thin* is also associated with the perception of *light* (*r*= -0,89), *eccentrical* (*r*= 0,86) and *fast* (*r*= 0,85), and so on.
- The attitude *small-big* is highly correlated with the attitudes *short-long* (*r*= 0,94), *dynamic-bulky* (*r*= 0,94), *fast-slow* (*r*= 0,92) and *heavy-light* (*r*= -0,90). Among eight computer mouses, the construing of *small* shows a tendency to be also perceived as *short, dynamic, fast* and *light*. On the flipside, in eight computer mouses, the construing of *big* shows a tendency to be perceived as *long, bulky, slow* and *heavy*. In addition, the construing of *small* is also associated with the perception of *thick* (*r*= -0,89), *outdated* (*r*= -0,89), *gracious* (*r*= 0,77) and *silent* (*r*= -0,75), and so on.
- The attitude *heavy-light* is highly correlated with the attitudes *fast-slow* (*r*= -0,98), *reassuring-insecure* (*r*= -0,95), *dynamic-bulky* (*r*= -0,91), *gracious-coarse* (*r*= -0,91) and *small-big* (*r*= -0,90). Among eight computer mouses, the construing of *heavy* shows a tendency to be also perceived as *slow, insecure, bulky, coarse* and *big*. On the flipside, in eight computer mouses, the construing of *light* shows a tendency to be perceived as *fast, reassuring, dynamic*, *gracious* and *small*. In addition, the construing of *heavy* is also associated with the perception of *thick* (*r*= -0,89), *outdated* (*r*= -0,89), *old* (*r*= -0,89) and *classical* (*r*= -0,89), and so on.
- The attitude *gracious-coarse* is highly correlated with the attitudes *reassuring-insecure* (*r*= 0,95), *heavy-light* (*r*= -0,91), *thin-thick* (*r*= 0,92), *particular-standard* (*r*= 0,92) and *fast-slow* (*r*= 0,91). Among eight

computer mouses, the construing of *gracious* shows a tendency to be also perceived as *reassuring, light, thin, particular* and *fast*. On the flipside, in eight computer mouses, the construing of *coarse* shows a tendency to be perceived as *insecure, heavy, thick, standard* and *slow*. In addition, the construing of *gracious* is also associated with the perception of *transparent* (*r*= 0,88), *attractive* (*r*= 0,88), *dynamic* (*r*= 0,88) and *technological* (*r*= 0,87), and so on.

- The attitude *fast-slow* is highly correlated with the attitudes *heavy-light* (*r*= -0,98), *reassuring-insecure* (*r*= 0,96), *dynamic-bulky* (*r*= 0,95), *small-big* (*r*= 0,92), *gracious-coarse* (*r*= 0,91), *fluid-stable* (*r*= 0,91) and *technological-outdated* (*r*= 0,90). Among eight computer mouses, the construing of *fast* shows a tendency to be also perceived as *light, reassuring, dynamic, small, gracious, fluid* and *technological*. On the flipside, in eight computer mouses, the construing of *slow* shows a tendency to be perceived as *heavy, insecure, bulky, big, coarse, stable* and *outdated*. In addition, the construing of *fast* is also associated with the perception of *new* (*r*= 0,89), *modern* (*r*= 0,88), *dynamic* (*r*= 0,88) and *thin* (*r*= 0,85), and so on.
- The attitude *dynamic-bulky* is highly correlated with the attitudes *fast-slow* (*r*= 0,95), *small-big* (*r*= 0,94), *heavy-light* (*r*= -0,91) and *gracious-coarse* (*r*= 0,88). Among eight computer mouses, the construing of *dynamic* shows a tendency to be also perceived as *fast, small, light* and *gracious*. On the flipside, in eight computer mouses, the construing of *bulky* shows a tendency to be perceived as *slow, big, heavy* and *coarse.* In addition, the construing of *dynamic* is also associated with the perception of *fluid* (*r*= 0,86), *reassuring* (*r*= 0,86), *short* (*r*= 0,84) and *technological* (*r*= 0,83), and so on.
- The attitude *reassuring-insecure* is highly correlated with the attitudes *fast-slow* (*r*= 0,96), *heavy-light* (*r*= -0,95), *gracious-coarse* (*r*= 0,95), *thin-thick* (*r*= 0,92), *new-old* (*r*= 0,92), *technological-outdated* (*r*= 0,92) and *modern-classical* (*r*= 0,92). Among eight computer mouses, the construing of *reassuring* shows a tendency to be also perceived as *fast, light, gracious, thin,*

new, technological and *modern*. On the flipside, in eight computer mouses, the construing of *insecure* shows a tendency to be perceived as *slow, heavy, coarse, thick, old, outdated* and *classic*. In addition, the construing of *reassuring* is also associated with the perception of *attractive* (*r*= 0,89), *dynamic* (*r*= 0,86) and *fluid* (*r*= 0,84), and so on.

- The attitude *transparent-opaque* is highly correlated with the attitudes *particular-standard* (*r*= 0,96) and *gracious-coarse* (*r*= 0,88). Among eight computer mouses, the construing of *transparent* shows a tendency to be also perceived as *particular* and *gracious*. On the flipside, in eight computer mouses, the construing of *opaque* shows a tendency to be perceived as *standard* and *coarse*. In addition, the construing of *transparent* is also associated with the perception of *thin* (*r*= 0,86), *eccentrical* (*r*= 0,84) and *entertaining* (*r*= 0,77), and so on.
- The attitude *particular-standard* is highly correlated with the attitudes *transparent-opaque* (*r*= 0,96), *eccentrical-accustomed* (*r*= 0,93), *gracious-coarse* (*r*= 0,92) and *thin-thick* (*r*= 0,91). Among eight computer mouses, the construing of *particular* shows a tendency to be also perceived as *transparent, eccentrical, gracious* and *thin*. On the flipside, in eight computer mouses, the construing of *standard* shows a tendency to be perceived as *opaque, accustomed, coarse* and *thick*. In addition, the construing of *particular* is also associated with the perception of *low* (*r*= -0,83), *reassuring* (*r*= 0,81) and *attractive* (*r*= 0,80), and so on.
- The attitude *short-long* is highly correlated with the attitudes *small-big* (*r*= 0,94) and *dynamic-bulky* (*r*= 0,84). Among eight computer mouses, the construing of *short* shows a tendency to be also perceived as *small* and *dynamic.* On the flipside, in eight computer mouses, the construing of *long* shows a tendency to be perceived as *big* and *bulky.* In addition, the construing of *short* is also associated with the perception of *fast* (*r*= 0,79), *light* (*r*= -0,74) and *fluid* (*r*= 0,71), and so on.

Table 6.15 Correlation matrix of 20 items within

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1.thin-thick	**1,00**	0,77	-0,89	**0,92**	0,85	0,77	**0,92**	**0,86**	**0,91**	0,53	**-0,92**	-0,62	0,73	0,53	**0,86**	0,75	0,72	0,60	0,79	-0,50
2.small-big	0,77	**1,00**	**-0,90**	0,77	**0,92**	**0,94**	0,81	0,62	0,59	**0,94**	-0,49	-0,75	0,70	0,63	0,37	0,65	0,68	0,77	0,51	-0,58
3.heavy-light	-0,89	**-0,90**	**1,00**	**-0,91**	**-0,98**	**-0,91**	**-0,95**	-0,69	-0,74	-0,74	0,74	0,77	-0,89	-0,54	-0,63	-0,89	-0,89	-0,85	-0,80	0,72
4.gracious-coarse	**0,92**	0,77	**-0,91**	**1,00**	**0,91**	0,88	**0,95**	0,88	0,92	0,54	-0,78	-0,68	0,87	0,71	0,82	0,84	0,84	0,79	0,88	-0,66
5.fast-slow	0,85	**0,92**	**-0,98**	**0,91**	**1,00**	**0,95**	**0,96**	0,68	0,71	0,79	-0,65	-0,75	**0,90**	0,64	0,58	0,88	0,89	**0,91**	0,78	-0,69
6.dynamic-bulky	0,77	**0,94**	**-0,91**	0,88	**0,95**	**1,00**	0,86	0,72	0,71	0,84	-0,50	-0,79	0,83	0,73	0,47	0,76	0,79	0,86	0,68	-0,72
7.reassuring-insecure	**0,92**	0,81	**-0,95**	**0,95**	**0,96**	0,86	**1,00**	0,73	0,81	0,61	-0,80	-0,70	**0,92**	0,58	0,74	**0,92**	**0,92**	0,84	0,89	-0,65
8.transparent-opaque	0,86	0,62	-0,69	**0,88**	0,68	0,72	0,73	**1,00**	**0,96**	0,38	-0,71	-0,50	0,57	0,77	0,84	0,52	0,50	0,48	0,66	-0,41
9.particular-standard	**0,91**	0,59	-0,74	**0,92**	0,71	0,71	0,81	**0,96**	**1,00**	0,31	-0,83	-0,57	0,68	0,65	**0,93**	0,66	0,63	0,50	0,80	-0,51
10.short-long	0,53	**0,94**	-0,74	0,54	0,79	**0,84**	0,61	0,38	0,31	**1,00**	-0,22	-0,62	0,52	0,53	0,05	0,46	0,51	0,71	0,25	-0,43
11.high-low	**-0,92**	-0,49	0,74	-0,78	-0,65	-0,50	-0,80	-0,71	**-0,83**	-0,22	**1,00**	0,41	-0,61	-0,21	**-0,91**	-0,69	-0,64	-0,40	-0,78	0,36
12.loud-silent	-0,62	-0,75	0,77	-0,68	-0,75	-0,79	-0,70	-0,50	-0,57	-0,62	0,41	**1,00**	**-0,80**	-0,53	-0,40	-0,75	-0,75	-0,63	-0,62	**0,91**
13.technological-outdated	0,73	0,70	-0,89	0,87	**0,90**	0,83	**0,92**	0,57	0,68	0,52	-0,61	-0,80	**1,00**	0,54	0,61	**0,98**	**0,99**	0,89	**0,92**	-0,86
14.entertaining-serious	0,53	0,63	-0,54	**0,71**	0,64	**0,73**	0,58	**0,77**	0,65	0,53	-0,21	-0,53	0,54	**1,00**	0,43	0,40	0,43	0,62	0,41	-0,43
15.eccentrical-accustomed	**0,86**	0,37	-0,63	0,82	0,58	0,47	0,74	0,84	**0,93**	0,05	**-0,91**	-0,40	0,61	0,43	**1,00**	0,64	0,59	0,37	0,82	-0,39
16.modern-classical	0,75	0,65	**-0,89**	0,84	**0,88**	0,76	**0,92**	0,52	0,66	0,46	-0,69	-0,75	**0,98**	0,40	0,64	**1,00**	**1,00**	0,85	**0,94**	-0,83
17.new-old	0,72	0,68	**-0,89**	0,84	**0,89**	0,79	**0,92**	0,50	0,63	0,51	-0,64	-0,75	**0,99**	0,43	0,59	**1,00**	**1,00**	**0,89**	**0,92**	-0,82
18.fluid-stable	0,60	0,77	**-0,85**	0,79	**0,91**	**0,86**	0,84	0,48	0,50	0,71	-0,40	-0,63	**0,89**	0,62	0,37	**0,85**	**0,89**	**1,00**	0,72	-0,70
19.attractive-unattractive	0,79	0,51	-0,80	**0,88**	0,78	0,68	**0,89**	0,66	0,80	0,25	-0,78	-0,62	**0,92**	0,41	0,82	**0,94**	**0,92**	0,72	**1,00**	-0,73
20.raspy-tuneful	-0,50	-0,58	0,72	-0,66	-0,69	-0,72	-0,65	-0,41	-0,51	-0,43	0,36	**0,91**	**-0,86**	-0,43	-0,39	**-0,83**	**-0,82**	-0,70	-0,73	**1,00**

- The attitude *high-low* is highly correlated with the attitudes *thin-thick* (*r*= -0,92) and *eccentrical-accustomed* (*r*= -0,91). Among eight computer mouses, the construing of *high* shows a tendency to be also perceived as *thick* and *accustomed.* On the flipside, in eight computer mouses, the construing of *low* shows a tendency to be perceived as *thin* and *eccentrical.* In addition, the construing of *high* is also associated with the perception of *standard* (*r*= -0,83) and *insecure* (*r*= -0,80), and so on.
- The attitude *loud-silent* is highly correlated with the attitudes *raspy-tuneful* (*r*= 0,91) and *technological-outdated* (*r*= -0,80). Among eight computer mouses, the construing of *loud* shows a tendency to be also perceived as *raspy* and *outdated.* On the flipside, in eight computer mouses, the construing of *silent* shows a tendency to be perceived as *tuneful* and *technological.* In addition, the construing of *loud* is also associated with the perception of *bulky* (*r*= -0,79), *heavy* (*r*= 0,77) and *slow* (*r*= -0,75), and so on.
- The attitude *technological-outdated* is highly correlated with the attitudes *new-old* (*r*= 0,99), *modern-classical* (*r*= 0,98), *attractive-unattractive* (*r*= 0,92), *reassuring-insecure* (*r*= 0,92) and *fast-slow* (*r*= 0,90). Among eight computer mouses, the construing of *technological* shows a tendency to be also perceived as *new, modern, attractive, reassuring* and *fast.* On the flipside, in eight computer mouses, the construing of *old* shows a tendency to be perceived as *classical, unattractive*, *insecure*, and *slow.* In addition, the construing of *technological* is also associated with the perception of *fluid* (*r*= 0,89), *light* (*r*= -0,89), *gracious* (*r*= 0,87), *tuneful* (*r*= -0,86), *dynamic* (*r*= 0,83) and *silent* (*r*= -0,80), and so on.
- The attitude *entertaining-serious* is highly correlated with the attitudes *transparent-opaque* (*r*= 0,77) and *dynamic-bulky* (*r*= 0,73). Among eight computer mouses, the construing of *entertaining* shows

a tendency to be also perceived as *transparent* and *dynamic.* On the flipside, in eight computer mouses, the construing of *serious* shows a tendency to be perceived as *opaque* and *bulky.* In addition, the construing of *entertaining* is also associated with the perception of *gracious* (*r*= 0,71), and so on.

- The attitude *eccentrical-accustomed* is highly correlated with the attitudes *particular-standard* (*r*= 0,93), *high-low* (*r*= -0,91) and *thin-thick* (*r*= 0,86). Among eight computer mouses, the construing of *eccentrical* shows a tendency to be also perceived as *particular, low* and *thin.* On the flipside, in eight computer mouses, the construing of *accustomed* shows a tendency to be perceived as *standard, high* and *thick.* In addition, the construing of *eccentrical* is also associated with the perception of *transparent* (*r*= 0,84), *gracious* (*r*= 0,82) and *attractive* (*r*= 0,82), and so on.
- The attitude *modern-classical* is highly correlated with the attitudes *new-old* (*r*= 0,996), *technological-outdated* (*r*= 0,98), *attractive-unattractive* (*r*= 0,94) and *reassuring-insecure* (*r*= 0,92). Among eight computer mouses, the construing of *modern* shows a tendency to be also perceived as *new, technological, attractive* and *reassuring.* On the flipside, in eight computer mouses, the construing of *classical* shows a tendency to be perceived as *old, outdated, unattractive* and *insecure.* In addition, the construing of *modern* is also associated with the perception of *light* (*r*= -0,89), *fast* (*r*= 0,88), *fluid* (*r*= 0,85) and *gracious* (*r*= 0,84), and so on.
- The attitude *new-old* is highly correlated with the attitudes *modern-classical* (*r*= 0,996), *technological-outdated* (*r*= 0,99), *attractive-unattractive* (*r*= 0,92) and *reassuring-insecure* (*r*= 0,92). Among eight computer mouses, the construing of *new* shows a tendency to be also perceived as *modern, technological, attractive* and *reassuring.* On the flipside, in eight computer mouses, the construing of *old*

shows a tendency to be perceived as *classical, outdated, unattractive* and *insecure.* In addition, the construing of *new* is also associated with the perception of *fast* (*r*= 0,89), *light* (*r*= -0,89), *fluid* (*r*= 0,89) and *gracious* (*r*= 0,84), and so on.

- The attitude *fluid-stable* is highly correlated with the attitudes *fast-slow* (*r*= 0,91), *technological-outdated* (*r*= 0,89), *new-old* (*r*= 0,89) and *dynamic-bulky* (*r*= 0,86). Among eight computer mouses, the construing of *fluid* shows a tendency to be also perceived as *fast, technological, new* and *dynamic.* On the flipside, in eight computer mouses, the construing of *stable* shows a tendency to be perceived as *slow, outdated, old* and *bulky.* In addition, the construing of *fluid* is also associated with the perception of *modern* (*r*= 0,85), *light* (*r*= -0,85) and *reassuring* (*r*= 0,84), and so on.
- The attitude *attractive-unattractive* is highly correlated with the attitudes *modern-classical* (*r*= 0,94), *new-old* (*r*= 0,92), *technological-outdated* (*r*= 0,92) and *reassuring-insecure* (*r*= 0,89). Among eight computer mouses, the construing of *attractive* shows a tendency to be also perceived as *modern, new, technological* and *reassuring.* On the flipside, in eight computer mouses, the construing of *unattractive* shows a tendency to be perceived as *classical, old, outdated* and *insecure.* In addition, the construing of *attractive* is also associated with the perception of *gracious* (*r*= 0,88), *eccentrical* (*r*= 0,82) and *particular* (*r*= 0,80), and so on.
- The attitude *raspy-tuneful* is highly correlated with the attitudes *loud-silent* (*r*= 0,91), *technological-outdated* (*r*= -0,86) and *modern-classical* (*r*= -0,83). Among eight computer mouses, the construing of *raspy* shows a tendency to be also perceived as *loud, outdated* and *classical.* On the flipside, in eight computer mouses, the construing of *tuneful* shows a tendency to be perceived as *silent, technological* and *modern.* In addition, the construing of *raspy* is also associated

with the perception of *old* (*r*= -0,82), *unattractive* (*r*= -0,73) and *bulky* (*r*= -0,72), and so on.

Root mean squares were calculated through the correlation ratings of 20 items within Component 3 (Table 6.16). According to the quadratic mean results, the attitude *gracious-coarse* was found having the greatest average relation with all other attitudes, followed by *reassuring-insecure, fast-slow, heavy-light, technological-outdated* and *modern-classical.*

Table 6.16 Quadratic mean *(*RMS) scores for 20 items within Component 3

Attitude	Root Mean Squares
thin-thick	0,77
small-big	0,72
heavy-light	**0,82**
gracious-coarse	**0,83**
fast-slow	**0,82**
dynamic-bulky	0,78
reassuring-insecure	**0,83**
transparent-opaque	0,68
particular-standard	0,73
short-long	0,57
high-low	0,65
loud-silent	0,67
technological-outdated	**0,79**
entertaining-serious	0,56
eccentrical-accustomed	0,64
modern-classical	**0,78**
new-old	0,77
fluid-stable	0,72
attractive-unattractive	0,75
raspy-tuneful	0,65
Average	0,73
Standard deviation	0,08

6.2.1.4 Correlations Between Items Within Component 4 (Clarity)

Component 4 consists of 2 common attitudes and correlations between them were calculated through Pearson's product moment correlation coefficient. Correlation results can be seen in Table 6.17. Negative values in the correlation matrix show that the correlated poles are opposite. In other words, if there is a negative correlation available between two attitudes, the left pole of the first attitude is correlated with the right pole of the other attitude. The interpretation of the correlation matrix in Table 6.17 is listed below;

- The attitude *clear-blurry* is highly correlated with the attitude *non-glittery-glittery* (*r*= -0,84). Among eight computer mouses, the construing of *clear* shows a tendency to be also perceived as *glittery*. On the flipside, in eight computer mouses, the construing of *blurry* shows a tendency to be perceived as *non glittery*.

Table 6.17 Correlation matrix of 2 items within Component 4

	1	**2**
1.clear-blurry	1,00	-0,84
2.non glittery-glittery	-0,84	1

6.2.2 Relationships Between Computer Mouses Using Hierarchical Cluster Analysis

After the investigation of relationships between attitudes was completed, the similarities between computer mouses were examined. Cluster analysis is a widely used method to investigate similarities within observed elements (Hennig, Meila, Murtagh and Rocci, 2016; Zhang, Murtagh, Van Poucke, Lin and Lan, 2017). In cluster analysis, groups are found in the data through clustering. As Hennig, et al. (2016) state, similar objects are grouped together as a cluster and dissimilarities are represented with different clusters. Similarities and dissimilarities are calculated through various methods, and the most widely used method is Euclidean distance (Hennig, et al., 2016).

Hierarchical cluster analysis is used to reveal sequence of partititons and is mostly visualized as trees (dendrograms) through reflecting similarity levels (Hennig et al., 2016). The sequencing of partitions could be divisive or agglomerative. Divisive method starts with a single cluster where all objects are included and clusters are splitted in each step (Hennig, et al., 2016). On the other hand, agglomerative hierarchical clustering is the “bottom up” approach, where the similarities are investigated from the leaves to the roots in the cluster tree (Zhang, et al., 2017). Each object is accepted as an individual cluster in the beginning of the analysis and similar objects are gathered as a new cluster step by step. According to Hennig, et al. (2016), agglomerative hierarchical methods are not as difficult as divisive methods and have a wider usage than counterparts.

Several methods could be adopted to investigate similarity levels between clusters in hierarchical cluster analysis. If the aim is to look for maximum homogeneity, then minimum variance is accepted as the main criteria (Hennig, et al., 2016). Variance is also used in other data analysis procedures such as principal components analysis. In hierarchical cluster analysis, Ward’s method adopts minimum variance strategy and is accepted as the most suitable method for more balanced hierarchies, offering the most practical results (Hennig, et al., 2016).

The representation of hierarchical cluster analysis is mostly done through dendrograms. In dendrograms, the relationships between clusters are shown as leaves and the distances among clusters present similarity levels. Similarities are calculated through Euclidean distance, and similarities are greater as the distance becomes closer to 0 (Lovric, 2010). If the distance value is 0 between two merged clusters, then both clusters are perfectly identical. With hierarchical cluster analysis, similar computer mouses would be found and their similarities would be presented as dendrograms.

The following section describes how dendrograms of computer mouses were prepared within each component. R Studio software was used for applying hieararchical cluster analysis and preparing dendrograms. Further, semantic differential charts of similar computer mouse pairs were drawn for a better understanding of how participants construed computer mouses depending on their material qualities. A statistical calculation and graph creation software, XLSTAT for Excel[47], was used for preparing semantic differential charts.

6.2.2.1 Hierarchical Cluster Analysis Results of Computer Mouses within Component 1

Hierarchical cluster analysis of the computer mouses was performed using R statistics software through the participant ratings of the 21 attitudes within Component 1. Ward's minimum variance method was selected to search for maximum homogeneity between clusters. Analysis results can be seen as dendrogram in Figure 6.1.

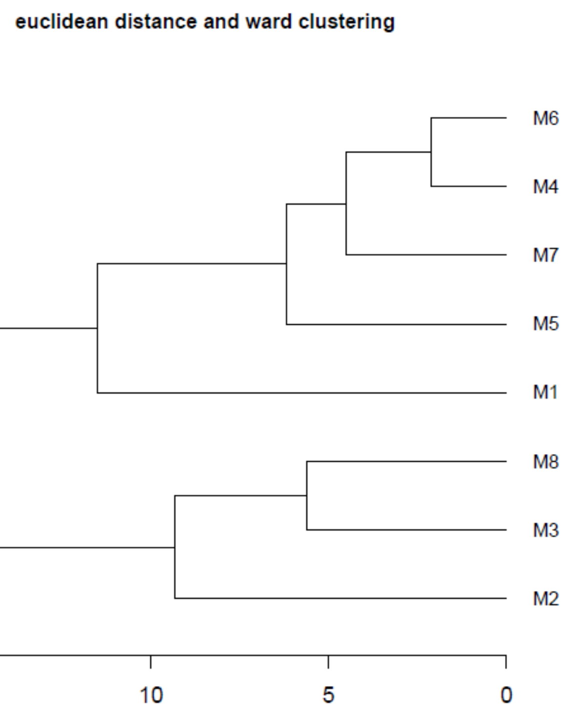

Figure 6.1 Dendrogram representation of hierarchical relationships between computer mouses in Component 1

[47] Developed by Addinsoft, XLSTAT is an add on software for Excel, which offers practical results for data statistics and representations. XLSTAT can be downloaded from https://www.xlstat.com/

In the dendrogram, horizontal lines represent the height, which is the measure of closeness between clusters, and vertical lines indicate where the clusters are merged. According to the analysis results, M6 and M4 were found to be the most similar computer mouses. Another similarity was found between M3 and M8, yet this similarity is lesser than the first mentioned cluster. As can be seen from the dendrogram, M1 was regarded as the most dissimilar computer mouse within eight computer mouses. Figure 6.2 shows the clusters of similarly perceived computer mouses.

Figure 6.2 Clusters of computer mouses perceived similar within Component 1

Figure 6.3 contains the semantic differential graph of M4 and M6, which is based on participant ratings on eight computer mouses through 21 attitudes within Component 1. Dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Both computer mouses seem to have very close ratings on all of the attitudes and ratings are not scattered extremely. Most distinguishably, both of the computer mouses were perceived extremely *symmetric*. Further, both mouses were rated nearly identical as quite *coherent* and quite *elaborated* on the left pole, and quite *healthy*, quite *high quality*, quite *good* and quite *plain* on the right pole. The chart shows that M4 and M6 were perceived very similarly in most of the attitudes. Two computer mouses slightly differ in *coldness, cleanness, stickiness, shininess* and *smelliness,* where M6 was perceived slightly more *cold*, *clean*, *shiny*, yet less *sticky* and *smelt* than M4. Also both mouses were perceived neither *deep* nor *treble,* neither *durable* nor *flimsy* and neither *whole* nor *fragmented* as they were rated close to the midpoint value.

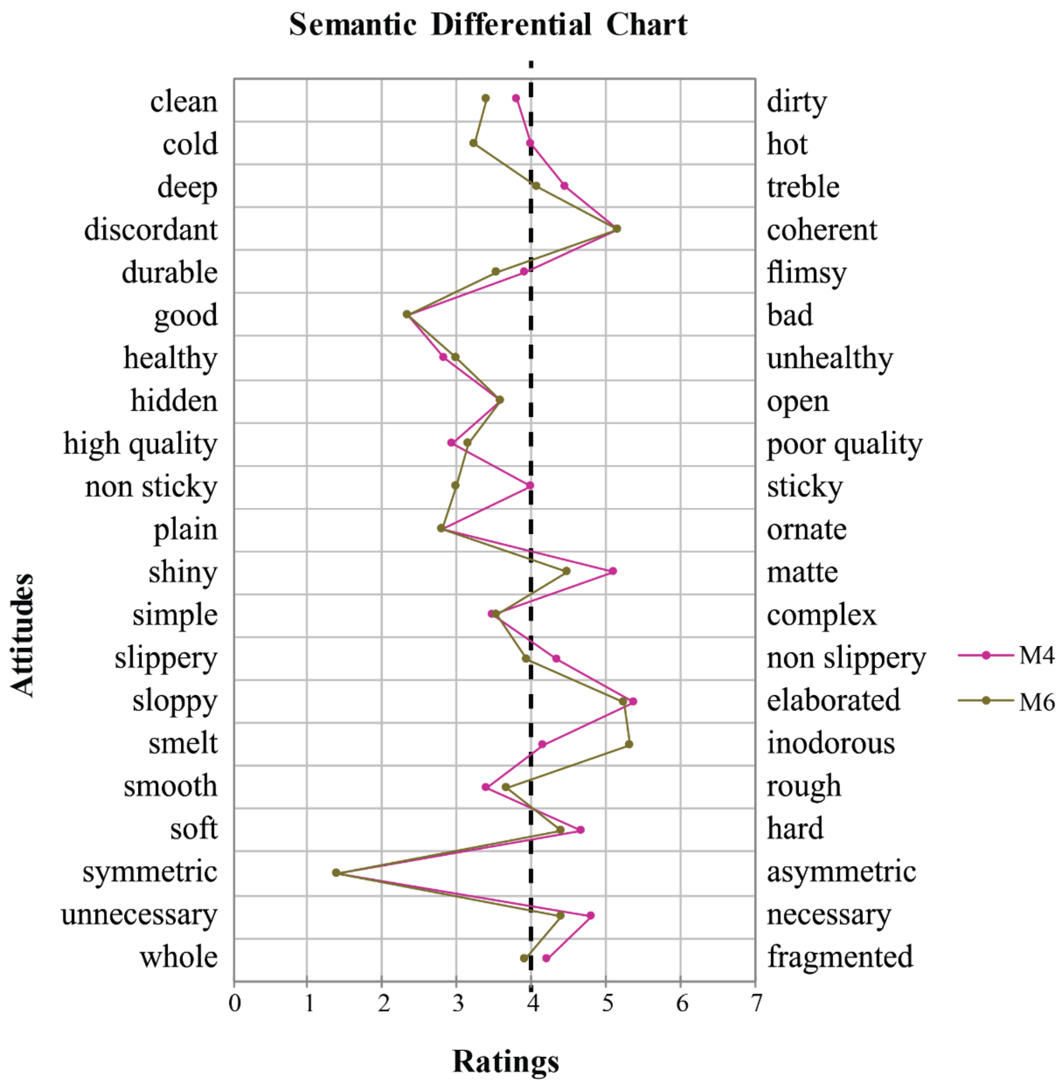

Figure 6.3 Semantic differential chart of M4 and M6 within Component 1

Figure 6.4 contains the semantic differential graph of M3 and M8, which is based on participant ratings on eight computer mouses through 21 attitudes within Component 1. Dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Although M3 and M8 were found similar in hierarchical cluster analysis, the similarity is limited because the distance among mouse pairs is not close. Because of that, most of the attitudinal ratings are seen scattered on the semantic differential chart. Both computer mouses seem to be perceived nearly identical as extremely *symmetric*, quite *dirty*, neither *durable* nor *flimsy*, and neither *smooth* nor *rough*. Further, both computer mouses were perceived quite *poor quality*, quite *hard* and quite *sloppy*. The most considerable differences on attitude ratings among the two mouses are *non slippery-slippery*, *shiny-matte*, *discordant-coherent* and *simple-complex*. M8 was perceived as quite *coherent*.

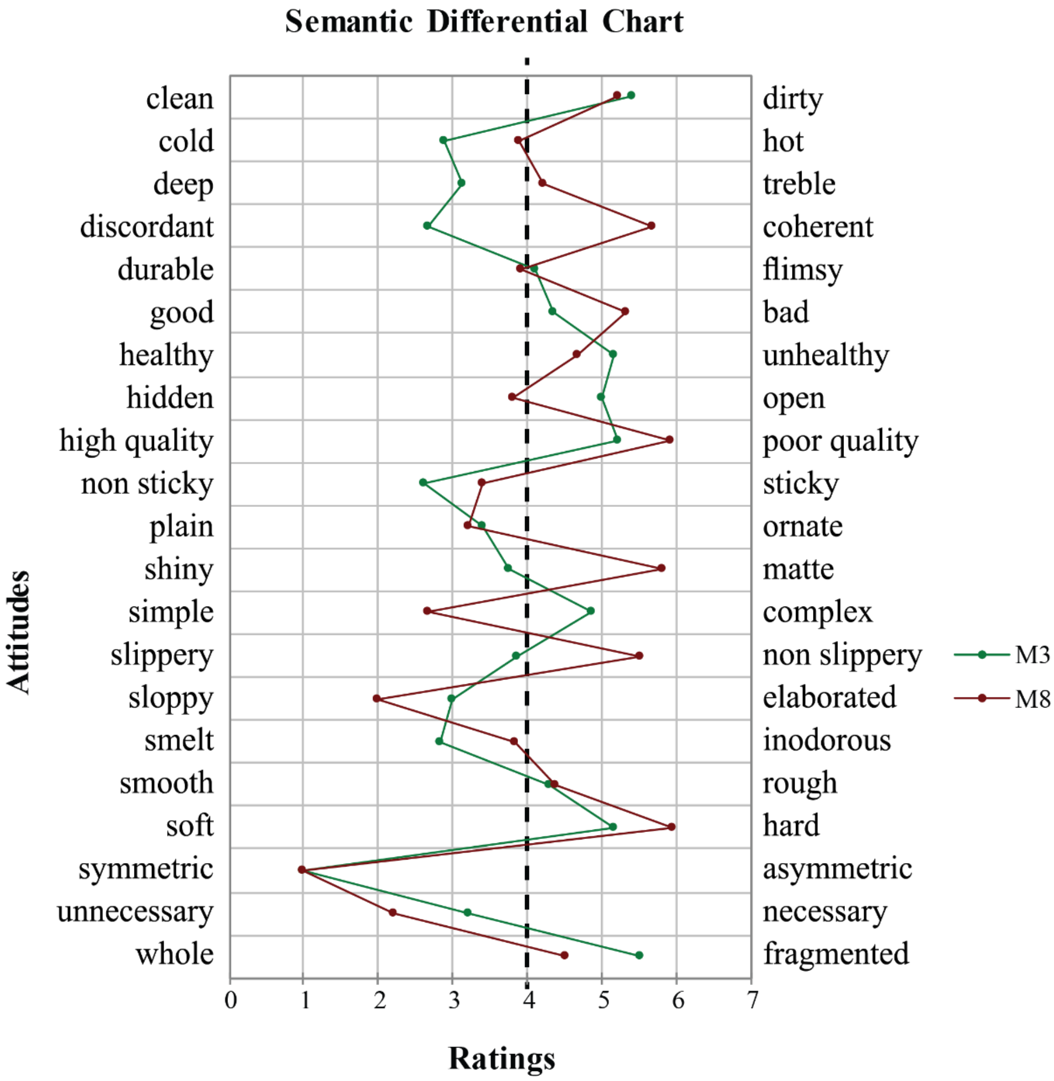

Figure 6.4 Semantic differential chart of M3 and M8 within Component 1

6.2.2.2 Hierarchical Cluster Analysis Results of Computer Mouses within Component 2

Hierarchical cluster analysis of the computer mouses was performed using R statistics software through the participant ratings of the 14 attitudes within Component 2. Ward's minimum variance method was selected to search for maximum homogeneity between clusters. Analysis results can be seen as dendrogram in Figure 6.5.

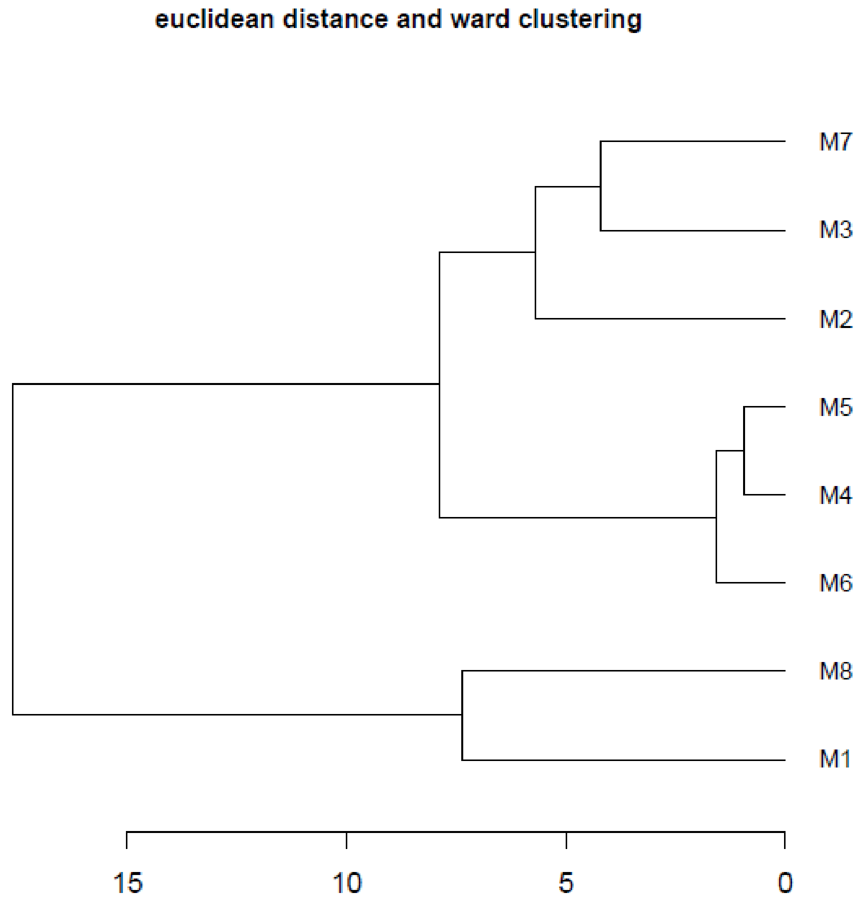

Figure 6.5 Dendrogram representation of hierarchical relationships between computer mouses in Component 2

In the dendrogram, horizontal lines represent the height, which is the measure of closeness between clusters, and vertical lines indicate where the clusters are merged. According to the analysis results, M5 and M4 were found as the most similar computer mouse pair, followed by M7 and M3. Also another similarity was found between M1 and M8, yet this similarity is limited as the horizontal branch lengths are longer compared to other pairs. As can be seen from the dendrogram, the cluster of M1 and M8 was regarded as the most dissimilar among eight computer mouses. Figure 6.6 shows the clusters of similarly perceived computer mouses.

Figure 6.6 Clusters of computer mouses perceived similar within Component 2

Figure 6.7 contains the semantic differential graph of M3 and M7, based on participant ratings on eight computer mouses through 14 attitudes within Component 2. Dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Both computer mouses seem to be perceived nearly identical as extremely *directional*, quite *common*, slightly *distinct*, neither *comfortable* nor *uncomfortable* and neither *ergonomic* nor *non ergonomic*. The most considerable differences on attitude ratings among two mouses are *controlled-uncontrolled*, *curved-flat*, *handy-impractical*, *dark-light*, *obtuse-pointed* and *problematic-unproblematic*. M7 was perceived more *controlled, curved, light, obtuse* and *unproblematic* compared to M3.

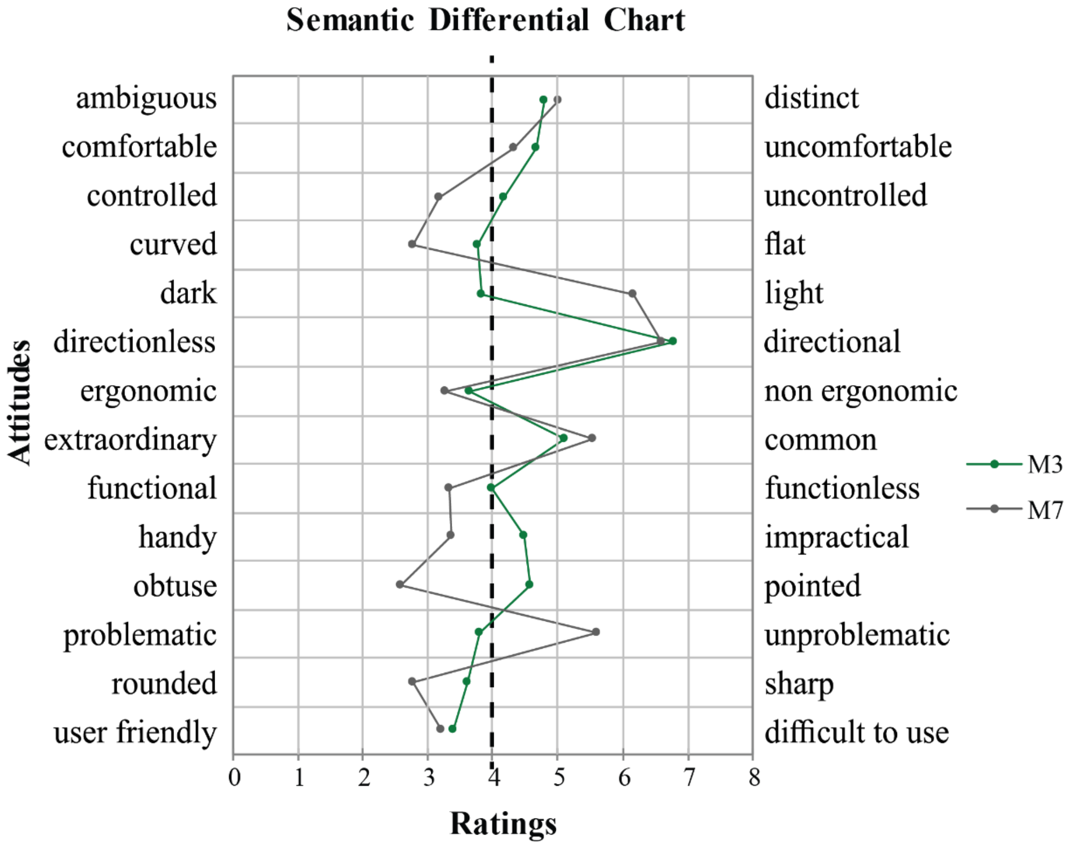

Figure 6.7 Semantic differential chart of M3 and M7 within Component 2

Figure 6.8 contains the semantic differential graph of M4 and M5, based on participant ratings on eight computer mouses through 14 attitudes within Component 2. Dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Both computer mouses seem to have very close ratings on all of the attitudes, therefore were perceived nearly identical. Most distinguishably among all attitudes, both of the computer mouses were perceived extremely *directional* and extremely *dark*. Moreover, M4 and M5 were perceived quite *distinct*, quite *comfortable*, quite *controlled*, quite *common*, and quite *curved*, slightly *handy* and slightly *obtuse*, neither *ergonomic* nor *non ergonomic* and neither *functional* nor *functionless*.

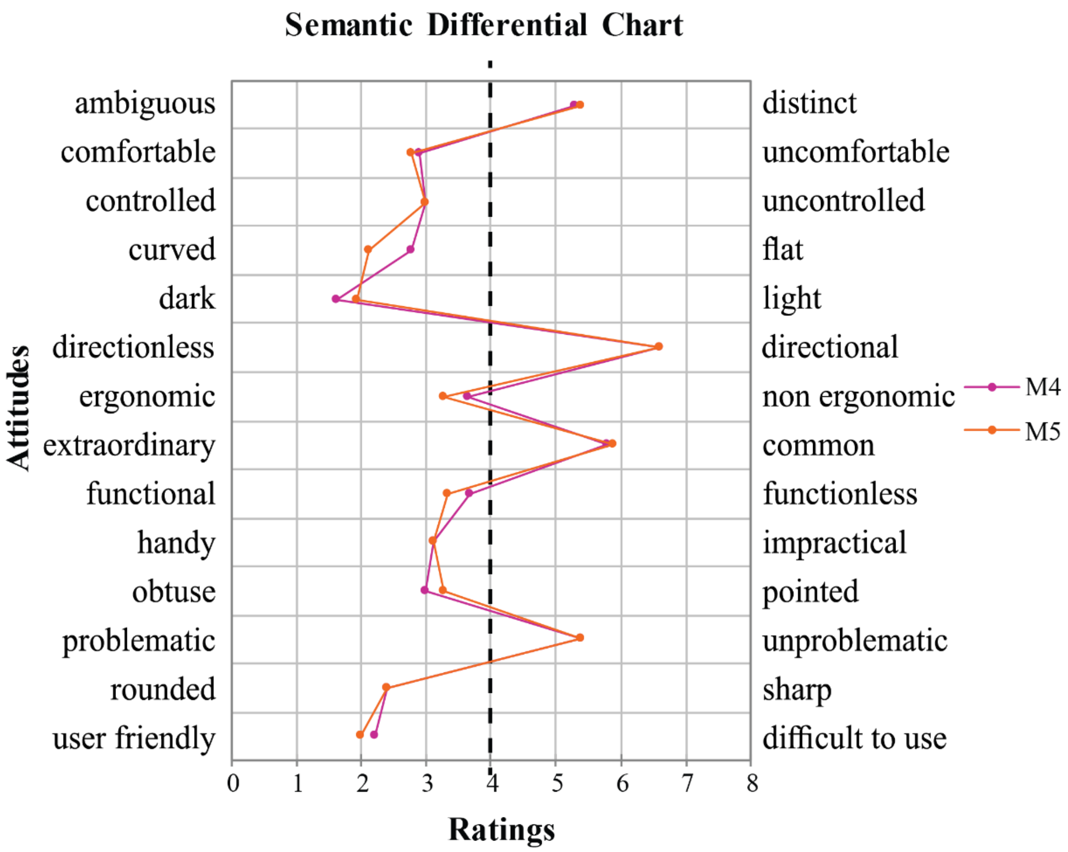

Figure 6.8 Semantic differential chart of M4 and M5 within Component 2

Figure 6.9 contains the semantic differential graph of M1 and M8, based on participant ratings on eight computer mouses through 14 attitudes within Component 2. Dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Although M1 and M8 were found similar in hierarchical cluster analysis, the similarity is limited because the distance among mouse pairs is not close. Because of that, most of the attitudinal ratings are seen scattered on the semantic differential chart. Besides, both computer mouses seem to be perceived very similarly as extremely *light* (opposite of *dark*) and quite *pointed*. Further, additional similarities are available for both mouses, as both were perceived as *flat* and *functionless*. The most considerable differences on attitude ratings among two mouses are *directionless-directional*, *ergonomic-non ergonomic*, *extraordinary-common*, *handy-impractical* and *problematic-unproblematic*. M1 was perceived more *directionless*, *extraordinary* and *handy* and less *problematic* than M8.

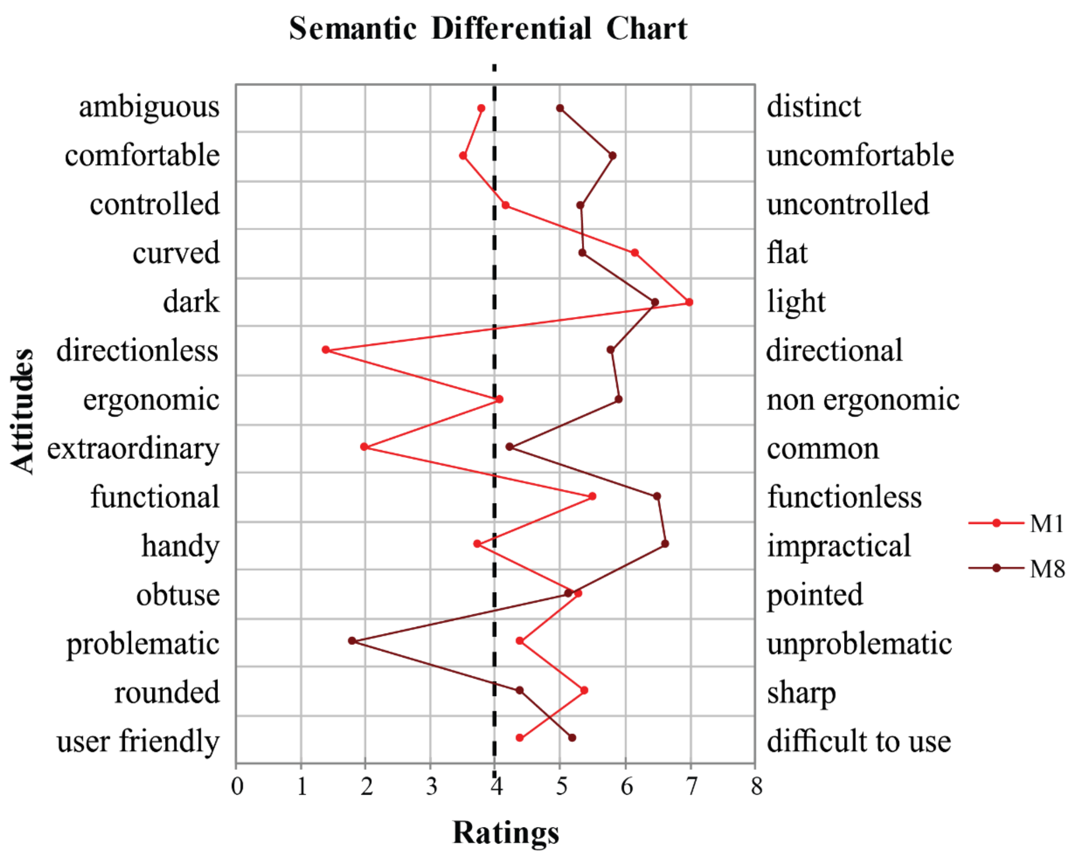

Figure 6.9 Semantic differential chart of M1 and M8 within Component 2

6.2.2.3 Hierarchical Cluster Analysis Results of Computer Mouses within Component 3

Hierarchical cluster analysis of the computer mouses was performed using R statistics software through the participant ratings of the 20 attitudes within Component 3. Ward's minimum variance method was selected to search for maximum homogeneity between clusters. Analysis results can be seen as dendrogram in Figure 6.10.

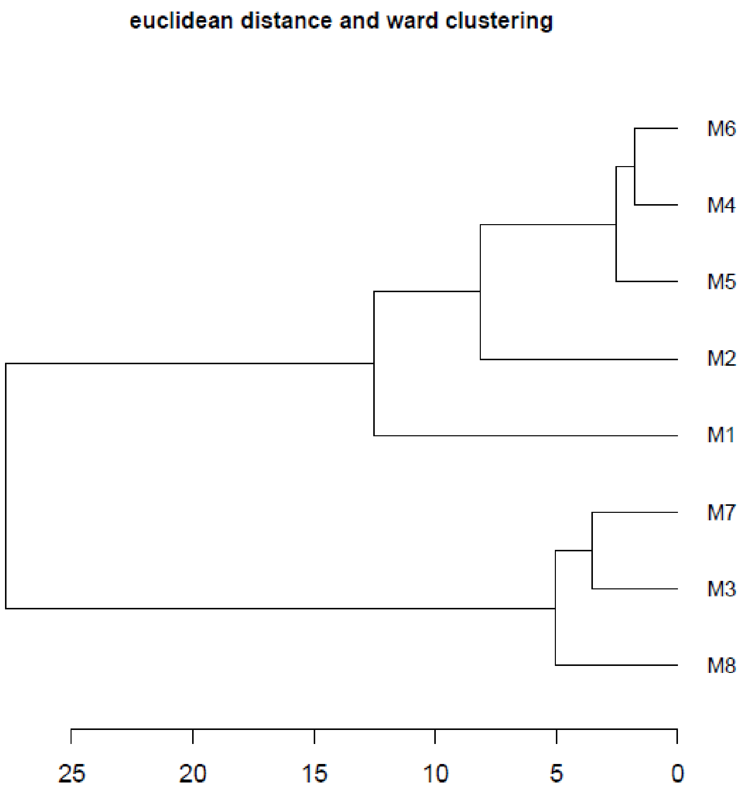

Figure 6.10 Dendrogram representation of hierarchical relationships between computer mouses in Component 3

In the dendrogram, horizontal lines represent the height, which is the measure of closeness between clusters and vertical lines indicate where the clusters are merged. According to the analysis results, M6 and M4 were found to be the most similar computer mouses. Another similarity was found between M7 and M3, yet this similarity is lesser than the first mentioned cluster. As can be seen from the dendrogram, M1 was regarded as the most dissimilar computer mouse within eight computer mouses. Figure 6.11 shows the clusters of similarly perceived computer mouses.

Figure 6.11 Clusters of computer mouses perceived similar within Component 3

Figure 6.12 contains the semantic differential graph of M3 and M7, based on participant ratings on eight computer mouses through 20 attitudes within Component 3. Dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Both computer mouses seem to have very close ratings on all of the attitudes other than the attitudes *loud-silent* and *raspy-tuneful*, therefore were perceived as very similar. Most distinguishably among all attitudes, both of the computer mouses were perceived extremely *big*, extremely *long*, extremely *thick* and extremely *opaque*. Further, both computer mouses were perceived quite *classical*, quite *accustomed*, quite *slow* and quite *coarse*, quite *heavy*, quite *high*, quite *old*, quite *stable*, quite *standard*, quite *insecure*, quite *outdated*, slightly *bulky* and slightly *unattractive*. M3 was perceived considerably *louder*, yet less *tuneful* than M7.

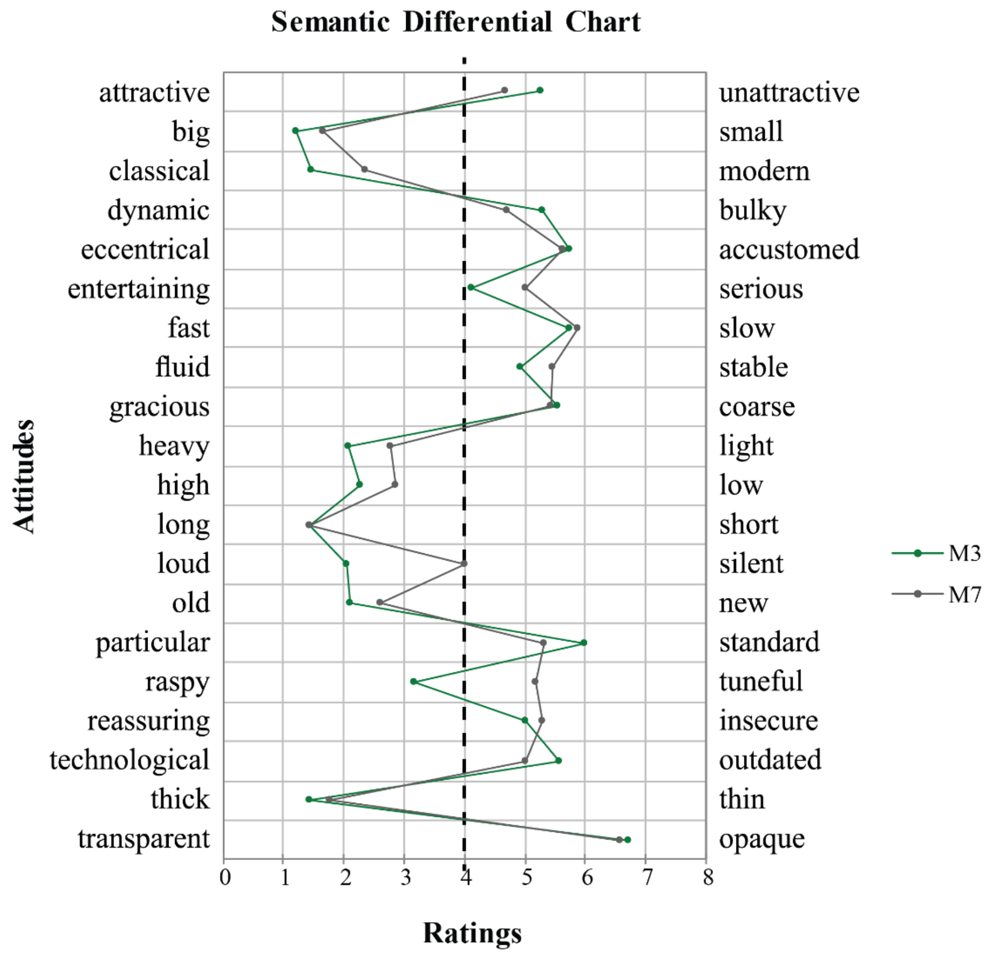

Figure 6.12 Semantic differential chart of M3 and M7 within Component 3

Figure 6.13 contains the semantic differential graph of M4 and M6, based on participant ratings on eight computer mouses through 20 attitudes within Component 3. Dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Both computer mouses seem to have very close ratings on all of the attitudes other than the attitude *loud-silent*, therefore were perceived as very similar. Most distinguishably among all attitudes, both of the computer mouses were perceived as extremely *opaque*. Further, both computer mouses were perceived as quite *accustomed*, quite *fast*, quite *short*, quite *new*, quite *tuneful*, quite *standard* and quite *technological*, and so on. M4 was perceived more *silent* and *stable* than M6. Also both mouses were perceived as neither *attractive* nor *unattractive*, and neither *high* nor *low*.

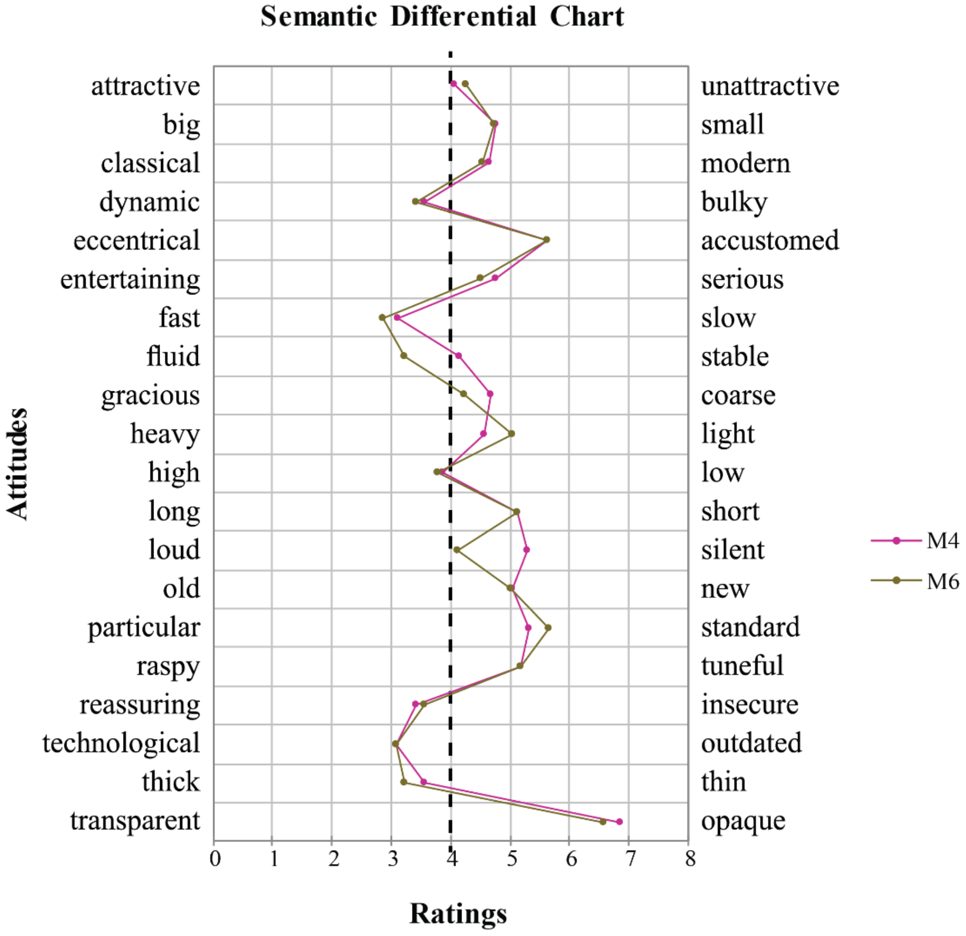

Figure 6.13 Semantic differential chart of M4 and M6 within Component 3

6.2.2.4 Hierarchical Cluster Analysis Results of Computer Mouses within Component 4

Hierarchical cluster analysis of the computer mouses was performed through R statistics software through the participant ratings of the 2 attitudes within Component 4. Ward's minimum variance method was selected to search for maximum homogeneity between clusters. Analysis results can be seen as dendrogram in Figure 6.14.

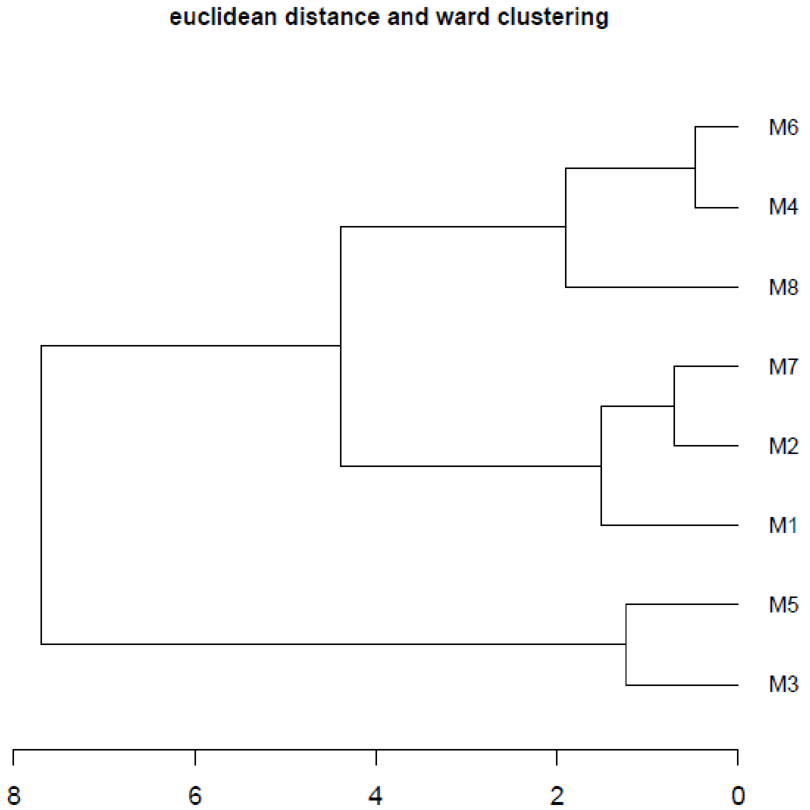

Figure 6.14 Dendrogram representation of hierarchical relationships between computer mouses in Component 4

In the dendrogram, horizontal lines represent the height, which is the measure of closeness between clusters, and vertical lines indicate where the clusters are merged. According to the analysis results, M6 and M4 were found to be the most similar computer mouse pair, followed by M7 and M2. Also another similarity was found between M3 and M5, yet this similarity is lesser compared to the other pairs. As can be seen from the dendrogram, M8 was regarded as the most dissimilar among eight computer mouses. Figure 6.15 shows the clusters of similarly perceived computer mouses.

Figure 6.15 Clusters of computer mouses perceived similar within Component 4

Figure 6.16 contains the semantic differential graph of all eight computer mouses, based on participant ratings through 2 attitudes within Component 4. As Component 4 consists of only two attitudes, semantic differential chart was given as a whole. Dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. According to the hieararchical cluster analysis results, M4 and M6, M2 and M7 and M3 and M5 were found similar in varying distances. M4 and M6 were perceived very similar as extremely *non glittery* and slightly *clear*. M2 and M7 were perceived quite similar as both of them were perceived as quite *clear* and quite *non glittery*. With the least similarity level compared to other pairs, M3 and M5 were both perceived as quite *clear*, yet M3 was found extremely *glittery*, whereas M5 was perceived quite *glittery*.

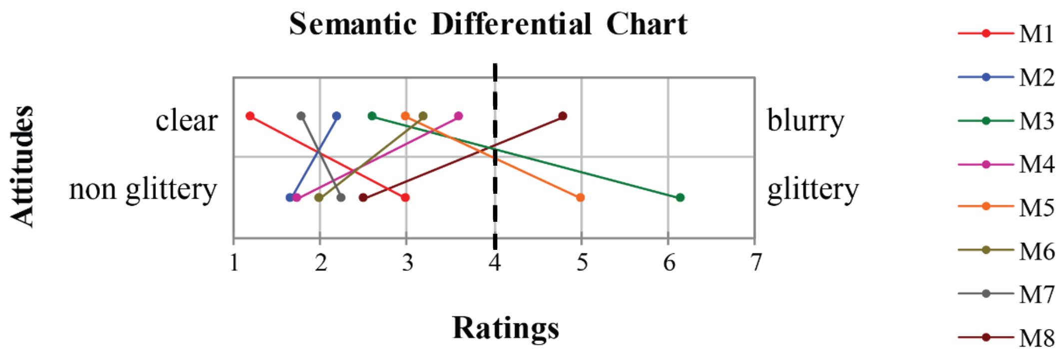

Figure 6.16 Semantic differential chart of eight computer mouses within Component 4

6.2.3 Relationships Between Computer Mouses and Attitudes Through Mean Differences

In the final step of relationship analysis, computer mouse-attitude relationships were investigated through mean differences. *t*-tests are used to investigate mean differences in a dataset. *t*-test is a parametric test applied on normally distributed data. As Gerald (2018) explains, *t*-test is used for comparing two means and applied on small populations ($n \leq 30$). One sample *t*-test is used to compare the object's mean value with a predefined value (here the overall mean rating of the computer mouse). So each average rating of an attitude for a computer mouse would be compared with the overall mean rating of that computer mouse. This test was applied within each component separately and independent from each other. After each comparison, significant differencies were revealed. The treshold for significant values was defined as 0.05. SPSS was used to calculate one sample *t*-test results.

6.2.3.1 One Sample *t*-Test Results of Element-Attitude Relationships Within Component 1

One sample *t*-test was applied to the dataset to find out the most significant attitudes specific to each computer mouse and to highlight the significantly perceived pole of those attitudes. For this, each attitude-based mean score of a computer mouse was compared with the overall attitude-based mean score of that computer mouse.

As all computer mouses have different overall mean scores, calculations were made individually for each computer mouse through 21 attitudes within Component 1 and those overall mean scores were taken as test values. When the mean score of an attitude is significantly different from the test value, that attitude would be regarded as important and the significant pole of that attitude would be highlighted depending on that difference. Akbay (2013) also stated that if the mean value of an attitude is significantly above the test value, this means the right pole is dominant, and if the value is below the test value, the left pole is dominant. Detailed *t*-test scores of each computer mouse can be seen in Appendix O. For a simple and clear interpretation, only the significant results (Sig. 2-tailed, $p<0.05$) were represented in this section. Significant *t*-test results can be seen in Table 6.18. The interpretation of Table 6.18 is listed below.

M1 was perceived by the participants most considerably as *coherent* (6,67) and *clean* (1,00) as their ratings were furthest (above and below) from the overall mean score (2,69). Being *non sticky* (1,00), *symmetric* (1,00), *smooth* (1,04), *high quality (1,07)*, *whole* (1,10), *cold* (1,22), *shiny* (1,38), *simple* (1,40), *healthy* (1,50) and *good* (1,50) were the most important percepts following being *clean*, whereas being *elaborated* (6,63), *inodorous* (6,00), *hard* (5,39), *deep* (5,00) and *necessary* (4,80) were the most considerable following being *coherent* in the construing of M1.

M2 was perceived by the participants most considerably as *complex* (6,33) and *discordant* (1,83) as their ratings were furthest from the overall mean score (4,62). Being *soft* (2,00), *unnecessary* (2,20), *smelt* (2,33) and *deep* (2,60) were the most important percepts following being *discordant*, whereas being *dirty* (6,30), *open* (6,20), *fragmented* (6,20), *ornate* (6,00), *non slippery* (5,71), *poor quality* (5,64) and *matte* (5,48) were the most considerable after being *complex* in the construing of M2.

M3 was perceived by the participants most considerably as *fragmented* (5,50) and *symmetric* (1,00) as their ratings were furthest from the overall mean score (3,87).

Bening dirty (5,40), *poor quality* (5,21), *hard* (5,17) and *complex* (4,87) are the most considerable percepts after *being fragmented* in construing of M3.

M4 was perceived by the participants most considerably as *elaborated* (6,67) and *symmetric* (1,40) as their ratings were furthest (above and below) from the overall mean score (3,85). *Being good* (2,33) and *high quality* (2,92) are the most important percepts following *being symmetric*, whereas *being matte* (5,10) and *hard* (4,67) are the most considerable after *elaboratedness* in construing of M4.

M5 was perceived by the participants most considerably as *coherent* (5,33) and *symmetric* (1,00) as their ratings were furthest (above and below) from the overall mean score (3,24). *Being shiny* (1,76), *healthy* (1,83), *smooth* (2,08), *good* (2,17) and *high quality* (2,42) are the most important percepts following *being symmetric*, whereas *being elaborated* (5,00), *treble* (4,53), *hard* (4,44) and *fragmented* (4,40) are the most considerable after *being coherent* in construing of M5.

M6 was perceived by the participants most considerably as *elaborated* (5,25) and *symmetric* (1,40) as their ratings were furthest from the overall mean score (3,69). *Being good* (2,33), *healthy* (3,00) and *high quality* (3,14) are the most important percepts following *being symmetric*, whereas *being coherent* (5,17) and *matte* (4,48) are the most considerable after *elaboratedness* in construing of M6.

M7 was perceived by the participants most considerably as *matte* (5,62) and *symmetric* (1,00) as their ratings were furthest from the overall mean score (4,06). *Being treble* (2,80) is the most important percept in following *being symmetric*, whereas *being dirty* (5,30) and *non slippery* (5,14) are the most considerable after *mattiness* in construing of M7.

M8 was perceived by the participants most considerably as *hard* (5,94) and *symmetric* (1,00) as their ratings were furthest from the overall mean score (4,14). *Being sloppy* (2,00), *unnecessary* (2,20) and *simple* (2,67) are the most important percepts following *being symmetric*, whereas *being poor quality* (5,93), *matte* (5,81) and *non slippery* (5,50) are the most considerable after *hardness* in construing of M8.

Table 6.18 Significant one sample *t*-test results among eight computer mouses within Component 1

Computer Mouse 1 (M1) Test Value:2.69

Attitudes	t	df	Sig. (2- tailed)	Mean
discordant-coherent	11,930	5	0,000	6,6667
simple-complex	-3,848	14	0,002	1,4000
symmetric-asymmetric	a	4	0,000	1,0000
deep-treble	4,322	14	0,001	5,0000
smelt-inodorous	3,310	5	0,021	6,0000
healthy-unhealthy	-3,484	5	0,018	1,5000
clean-dirty	a	9	0,000	1,0000
non sticky-sticky	a	4	0,000	1,0000
smooth-rough	-41,250	24	0,000	1,0400
whole-fragmented	-15,900	9	0,000	1,1000
unnecessary-necessary	2,871	4	0,045	4,8000
good-bad	-5,322	5	0,003	1,5000
soft-hard	5,143	17	0,000	5,3889
cold-hot	-9,986	8	0,000	1,2222
high quality-poor quality	-22,660	13	0,000	1,0714
sloppy-elaborated	21,505	7	0,000	6,6250
shiny-matte	-6,938	20	0,000	1,3810

Computer Mouse 2 (M2) Test Value:4.62

Attitudes	t	df	Sig. (2- tailed)	Mean
plain-ornate	3,086	4	0,037	6,0000
hidden-open	3,225	4	0,032	6,2000
discordant-coherent	-6,943	5	0,001	1,8333
simple-complex	8,127	14	0,000	6,3333
deep-treble	-3,509	14	0,003	2,6000
smelt-inodorous	-3,720	5	0,014	2,3333
clean-dirty	7,871	9	0,000	6,3000
whole-fragmented	5,437	9	0,000	6,2000
unnecessary-necessary	-6,468	4	0,003	2,2000
soft-hard	-7,860	17	0,000	2,0000
high quality-poor quality	2,864	13	0,013	5,6429
slippery-non slippery	2,849	13	0,014	5,7143
shiny-matte	2,207	20	0,039	5,4762

Computer Mouse 3 (M3) Test Value:3.87

Attitudes	t	df	Sig. (2- tailed)	Mean
simple-complex	2,487	14	0,026	4,8667
symmetric-asymmetric	a	4	0,000	1,0000
clean-dirty	2,825	9	0,020	5,4000
whole-fragmented	5,304	9	0,000	5,5000
soft-hard	3,656	17	0,002	5,1667
high quality-poor quality	3,835	13	0,002	5,2143

Computer Mouse 4 (M4) Test Value:3.85

Attitudes	t	df	Sig. (2- tailed)	Mean
symmetric-asymmetric	-6,125	4	0,004	1,4000
good-bad	-4,550	5	0,006	2,3333
soft-hard	2,381	17	0,029	4,6667
high quality-poor quality	-4,723	13	0,000	2,9286
sloppy-elaborated	5,797	7	0,001	5,3750
shiny-matte	4,389	20	0,000	5,0952

a. *t* cannot be computed because the standard deviation is 0.

Table 6.18 (cont'd).

Computer Mouse 5 (M5) Test Value:3.24

Attitudes	t	df	Sig. (2- tailed)	Mean
discordant-coherent	3,753	5	0,013	5,3333
symmetric-asymmetric	a	4	0,000	1,0000
deep-treble	2,901	14	0,012	4,5333
healthy-unhealthy	-4,577	5	0,006	1,8333
smooth-rough	-4,746	24	0,000	2,0800
whole-fragmented	2,900	9	0,018	4,4000
good-bad	-2,674	5	0,044	2,1667
soft-hard	2,909	17	0,010	4,4444
high quality-poor quality	-4,698	13	0,000	2,4286
sloppy-elaborated	5,377	7	0,001	5,0000
shiny-matte	-10,840	20	0,000	1,7619

Computer Mouse 6 (M6) Test Value:3.69

Attitudes	t	df	Sig. (2- tailed)	Mean
discordant-coherent	3,094	5	0,027	5,1667
symmetric-asymmetric	-5,725	4	0,005	1,4000
healthy-unhealthy	-2,672	5	0,044	3,0000
good-bad	-4,070	5	0,010	2,3333
high quality-poor quality	-2,368	13	0,034	3,1429
sloppy-elaborated	4,978	7	0,002	5,2500
shiny-matte	2,714	20	0,013	4,4762

Computer Mouse 7 (M7) Test Value:4.06

Attitudes	t	df	Sig. (2- tailed)	Mean
symmetric-asymmetric	a	4	0,000	1,0000
deep-treble	-2,873	14	0,012	2,8000
clean-dirty	2,932	9	0,017	5,3000
slippery-non slippery	3,135	13	0,008	5,1429
shiny-matte	5,938	20	0,000	5,6190

Computer Mouse 8 (M8) Test Value:4.14

Attitudes	t	df	Sig. (2- tailed)	Mean
simple-complex	-2,980	14	0,010	2,6667
symmetric-asymmetric	a	4	0,000	1,0000
unnecessary-necessary	-3,327	4	0,029	2,2000
soft-hard	8,773	17	0,000	5,9444
high quality-poor quality	4,486	13	0,001	5,9286
slippery-non slippery	2,919	13	0,012	5,5000
sloppy-elaborated	-3,414	7	0,011	2,0000
shiny-matte	6,122	20	0,000	5,8095

a. *t* cannot be computed because the standard deviation is 0.

The interpretation results and the significantly perceived qualities of computer mouses within Component 1 are summarized and can be seen in Table 6.19. The table illustrates the qualities that are statistically significant for each computer mouse. There are no positivity or negativity for the attitudes as the attitudes were listed depending on their poles (left or right). Also the order of the attitudes were sorted based on their statistical significance values.

Table 6.19 Summarized table of construed computer mouses within Component 1

								
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Attitudes (Left Pole)	clean non sticky smooth high quality whole shiny cold symmetric simple good healthy	soft discordant unnecessary deep smelt	symmetric	high quality symmetric good	symmetric shiny smooth high quality healthy good	symmetric good high quality healthy	symmetric deep	symmetric simple sloppy unnecessary
Attitudes (Right Pole)	elaborated coherent hard treble inodorous necessary	complex dirty fragmented poor quality non slippery open ornate matte	fragmented hard poor quality dirty complex	matte elaborated hard	elaborated hard treble coherent fragmented	elaborated matte coherent	matte non slippery dirty	hard matte poor quality non slippery

6.2.3.2 One Sample *t*-Test Results of Element-Attitude Relationships Within Component 2

As all computer mouses have different overall mean scores, calculations were made individually for each computer mouse through 14 attitudes within Component 2 and those overall mean scores were taken as test values. If the mean score of an attitude is significantly different from the test value, that attitude would be regarded as important and the significant pole of that attitude would be highlighted depending on that difference. Also if the mean value of an attitude is significantly above the test value, this means the right pole is dominant and if the value is below the test value, the left pole is dominant. Detailed *t*-test scores of each computer mouse can be seen in Appendix P. For a simple and clear interpretation, only the significant results (Sig. 2-tailed, $p < 0.05$) are represented in this section. Significant *t*-test results can be seen in Table 6.20. The interpretation of Table 6.20 is listed below.

M1 was perceived by the participants most considerably as *light* (opposite of *dark*) (7,00) and *directionless* (1,40) as their ratings were furthest (above and below) from the overall mean score (4,35). *Being extraordinary* (2,13) is the most important percept following *lightness* (opposite of *dark*), whereas *being flat* (6,18) and *sharp* (5,38) are the most considerable after *being directionless* in construing of M1.

M2 was perceived by the participants most considerably as *directional* (6,80) and *dark* (1,69) as their ratings were furthest from the overall mean score (3,62). *Being obtuse* (1,86) and *rounded* (2,23) are the most important percepts following *darkness* in construing of M2.

M3 was perceived by the participants most considerably as *directional* (6,80) as its rating was furthest from the overall mean score (4,33). *Being common* (5,75) is the most important percept in following *being directional* in construing of M3.

M4 was perceived by the participants most considerably as *directional* (6,60) and *dark* (1,62) as their ratings were furthest (above and below) from the overall mean score (3,67). *Being user friendly* (2,20), *rounded* (2,38), *curved* (2,76) and *comfortable* (2,90) are the most important percepts following *being directionless*, whereas *being common* (5,63), *unproblematic* (5,40) and *distinct* (5,40) are the most considerable after *being directional* construing of M4.

M5 was perceived by the participants most considerably as *directional* (6,60) and *dark* (1,92) as their ratings were furthest (above and below) from the overall mean score (3,61). *Being user friendly* (2,00), *curved* (2,12), *rounded* (2,38) and *comfortable* (2,76) are the most important percepts following *darkness*, whereas *being common* (5,50), *distinct* (5,40) and *unproblematic* (5,40) are the most considerable after *being directional* in construing of M5.

M6 was perceived by the participants most considerably as *directional* (6,60) and *user friendly* (1,80) as their ratings were furthest (above and below) from the overall mean score (3,61). *Being rounded* (2,00), *curved* (2,24), *dark* (2,54) and *comfortable* (2,95) are the most important percepts following *being user friendly*, whereas *being common* (5,63) and *distinct* (5,50) are the most considerable after *being directional* in construing of M6.

M7 was perceived by the participants most considerably as *directional* (6,60) and *obtuse* (2,57) as their ratings were furthest from the overall mean score (4,12). *Being curved* (2,76) and *rounded* (2,77) are the most important percepts following *being obtuse*, whereas *being light* (opposite of *dark)* (6,15) and *common* (5,63) are the most considerable after *being directional* in construing of M7.

M8 was perceived by the participants most considerably as *impractical* (6,63) and *problematic* (1,80) as their ratings were furthest from the overall mean score (5,25). *Being functionless* (6,50), *light* (opposite of *dark*) (6,46) and *sharp* (4,38) are the most considerable after *being impractical* in construing of M8.

Table 6.20 Significant one sample *t*-test results among eight computer mouses within Component 2

Computer Mouse 1 (M1)				Test Value:4.35
Attitudes	t	df	Sig. (2- tailed)	Mean
curved-flat	5,645	16	0,000	6,1765
dark-light	a	12	0,000	7,0000
directionless-directional	-7,375	4	0,002	1,4000
extraordinary-common	-2,997	7	0,020	2,1250
rounded-sharp	2,182	12	0,050	5,3846

Computer Mouse 2 (M2)				Test Value:3.62
Attitudes	t	df	Sig. (2- tailed)	Mean
dark-light	-7,337	12	0,000	1,6923
directionless-directional	15,900	4	0,000	6,8000
obtuse-pointed	-5,184	6	0,002	1,8571
rounded-sharp	-6,020	12	0,000	2,2308

Computer Mouse 3 (M3)				Test Value:4.33
Attitudes	t	df	Sig. (2- tailed)	Mean
directionless-directional	12,350	4	0,000	6,8000
extraordinary-common	2,406	7	0,047	5,7500

Computer Mouse 4 (M4)				Test Value:3.67
Attitudes	t	df	Sig. (2- tailed)	Mean
ambiguous-distinct	2,648	9	0,027	5,3000
comfortable-uncomfortable	-2,974	20	0,008	2,9048
curved-flat	-2,330	16	0,033	2,7647
dark-light	-7,711	12	0,000	1,6154
directionless-directional	11,962	4	0,000	6,6000
extraordinary-common	6,036	7	0,001	5,6250
problematic-unproblematic	3,393	4	0,027	5,4000
rounded-sharp	-6,035	12	0,000	2,3846
user friendly-difficult to use	-3,929	4	0,017	2,2000

Computer Mouse 5 (M5)				Test Value:3.61
Attitudes	t	df	Sig. (2- tailed)	Mean
ambiguous-distinct	3,187	9	0,011	5,4000
comfortable-uncomfortable	-2,989	20	0,007	2,7619
curved-flat	-6,199	16	0,000	2,1176
dark-light	-5,454	12	0,000	1,9231
directionless-directional	12,207	4	0,000	6,6000
extraordinary-common	5,774	7	0,001	5,5000
problematic-unproblematic	4,475	4	0,011	5,4000
rounded-sharp	-5,080	12	0,000	2,3846
user friendly-difficult to use	-3,600	4	0,023	2,0000

Table 6.20 (cont'd).

Computer Mouse 6 (M6) Test Value:3.58

Attitudes	t	df	Sig. (2- tailed)	Mean
ambiguous-distinct	3,015	9	0,015	5,5000
comfortable-uncomfortable	-2,390	20	0,027	2,9524
curved-flat	-4,430	16	0,000	2,2353
dark-light	-3,882	12	0,002	2,5385
directionless-directional	12,329	4	0,000	6,6000
extraordinary-common	6,314	7	0,000	5,6250
problematic-unproblematic	3,261	4	0,031	4,8000
rounded-sharp	-8,056	12	0,000	2,0000
user friendly-difficult to use	-3,633	4	0,022	1,8000

Computer Mouse 7 (M7) Test Value:4.12

Attitudes	t	df	Sig. (2- tailed)	Mean
curved-flat	-3,330	16	0,004	2,7647
dark-light	10,647	12	0,000	6,1538
directionless-directional	10,125	4	0,001	6,6000
extraordinary-common	2,526	7	0,039	5,6250
obtuse-pointed	-3,220	6	0,018	2,5714
rounded-sharp	-3,171	12	0,008	2,7692

Computer Mouse 8 (M8) Test Value:5.25

Attitudes	t	df	Sig. (2- tailed)	Mean
dark-light	6,616	12	0,000	6,4615
functional-functionless	5,590	5	0,003	6,5000
handy-impractical	7,514	7	0,000	6,6250
problematic-unproblematic	-9,221	4	0,001	1,8000
rounded-sharp	-2,784	12	0,017	4,3846

a. *t* cannot be computed because the standard deviation is 0.

The interpretation results and the significantly perceived qualities of computer mouses within Component 2 are summarized and can be seen in Table 6.21. The table illustrates the qualities that are statistically significant for each computer mouse. There are no positivity or negativity for the attitudes as the attitudes were listed depending on their poles (left or right). Also the order of the attitudes were sorted based on their statistical significance values.

Table 6.21 Summarized table of construed computer mouses within Component 2

	M1	M2	M3	M4	M5	M6	M7	M8
Attitudes (Left	directionless extraordinary	dark rounded obtuse		dark rounded comfortable user friendly curved	curved dark rounded comfortable user friendly	curved rounded dark user friendly comfortable	curved rounded obtuse	problematic
Attitudes (Right Pole)	light* flat sharp	directional	directional common	directional common distinct unproblematic	directional common distinct unproblematic	directional common distinct unproblematic	light* directional common	impractical light* functionless sharp

*opposite of dark

6.2.3.3 One Sample *t*-Test Results of Element-Attitude Relationships Within Component 3

As all computer mouses have different overall mean scores, calculations were made individually for each computer mouse through 20 attitudes within Component 3 and those overall mean scores were taken as test values. If the mean score of an attitude is significantly different from the test value, that attitude would be regarded as important and the significant pole of that attitude would be highlighted based on that difference. Also if the mean value of an attitude is significantly above the test value, this means the right pole is dominant and if the value is below the test value, the left pole is dominant. Detailed *t*-test scores of each computer mouse can be seen in Appendix Q. For a simple and clear interpretation, only the significant results (Sig. 2-tailed, $p < 0.05$) are represented in this section. Significant *t*-test results can be seen in Table 6.22. The interpretation of Table 6.22 is listed below.

M1 was perceived by the participants most considerably as *modern* (7,00) and *particular* (1,00) as their ratings were furthest (above and below) from the overall mean score (3,83). *Being technological* (1,08), *gracious* (1,22), *attractive* (1,38), *fast* (1,75), *reassuring* (1,86) and *eccentrical* (2,00) are the most important percepts following *being modern*, whereas *being low* (7,00), *new* (6,96), *thin* (6,33), *light* (opposite of *heavy*) (6,00) and *small* (4,50) are the most considerable after *being particular* in construing of M1.

M2 was perceived by the participants most considerably as *short* (6,67) and *bulky* (2,14) as their ratings were furthest from the overall mean score (4,04). *Being fast* (2,25) and *gracious* (2,33) are the most important percepts following *bulkiness,* whereas *being small* (6,52) and *light* (opposite of *heavy*) (5,26) are the most considerable after *being short* in construing of M2.

M3 was perceived by the participants most considerably as *opaque* (6,71) and *big* (1.21) as their ratings were furthest from the overall mean score (3,86). *Being thick* (1,44), *long* (1,44), *classical* (1,45), *loud* (2,06), *heavy* (2,09), *old* (2,11) and *high* (2,29) are the most important percepts following *being opaque*, whereas *being coarse* (6,22), *standard* (6,00), *slow* (5,75), *outdated* (5,58), *unattractive* (5,25), *accustomed* (5,11) and *stable* (4,92) are the most considerable after *being opaque* in construing of M3.

M4 was perceived by the participants most considerably as *opaque* (6,86) and *technological* (3,08) as their ratings were furthest (above and below) from the overall mean score (4,53). *Being fast* (3,13) and *dynamic* (3,57) are the most important percepts following *being technological*, whereas *being accustomed* (5,78), *silent* (5,29) and *new* (5,04) are the most considerable after *being directionless* in construing of M4.

M5 was perceived by the participants most considerably as *opaque* (6,14) and *fast* (2,75) as their ratings were furthest (above and below) from the overall mean score (4,14). *Being outdated* (2,83) and *bulky* (2,86) are the most important percepts following *fastness*, whereas *being accustomed* (5,89) and *new* (5,36) are the most considerable after *being opaque* in construing of M5.

M6 was perceived by the participants most considerably as *opaque* (6,57) and *fast* (2,88) as their ratings were furthest (above and below) from the overall mean score (4,39). *Being technological* (3,08), *thick* (3,22), *fluid* (3,23) and *dynamic* (3,43) are the most important percepts following *fastness*, whereas *being accustomed* (5,89), *standard* (5,67), *light* (opposite of *heavy*) (5,04) and *new* (5,00) are the most considerable after *being opaque* in construing of M6.

M7 was perceived by the participants most considerably as *opaque* (6,57) and *long* (1,44) as their ratings were furthest from the overall mean score (4,18). *Being big* (1,66), *thick* (1,78), *classical* (2,36), *old* (2,61), *heavy* (2,78) and *high* (2,86) are the most important percepts following *longness*, whereas *being slow* (5,88), *accustomed* (5,56) and *stable* (5,46) are the most considerable after *being opaque* in construing of M7.

M8 was perceived by the participants most considerably as *outdated* (6,92) and *classical* (1,00) as their ratings were furthest from the overall mean score (4,28). *Being old* (1,32), *loud* (1,65), *big* (2,00), *long* (2,11), *heavy* (2,83) and *thick* (2,89) are the most important percepts following *being classical*, whereas *being opaque* (6,86), *coarse* (6,56), *stable* (6,00), *serious* (6,00), *slow* (5,88), *standard* (5,83) and *unattractive* (5,56) are the most considerable after *being outdated* in construing of M8.

Table 6.22 Significant one sample *t*-test results among eight computer mouses within Component 3

Computer Mouse 1 (M1) Test Value:3.83

Attitudes	t	df	Sig. (2- tailed)	Mean
thick-thin	5,310	8	0,001	6,3333
big-small	2,632	27	0,014	4,5000
heavy-light	6,199	22	0,000	6,0000
gracious-coarse	-11,735	8	0,000	1,2222
fast-slow	-6,637	7	0,000	1,7500
reassuring-insecure	-4,883	6	0,003	1,8571
particular-standard	a	5	0,000	1,0000
high-low	a	13	0,000	7,0000
technological-outdated	-32,960	11	0,000	1,0833
eccentrical-accustomed	-2,835	8	0,022	2,0000
classical-modern	a	10	0,000	7,0000
old-new	87,760	27	0,000	6,9643
attractive-unattractive	-6,547	15	0,000	1,3750

Computer Mouse 2 (M2) Test Value:4.04

Attitudes	t	df	Sig. (2- tailed)	Mean
big-small	19,399	28	0,000	6,5172
heavy-light	3,793	22	0,001	5,2609
gracious-coarse	-3,620	8	0,007	2,3333
fast-slow	-4,891	7	0,002	2,2500
dynamic-bulky	-5,579	6	0,001	2,1429
long-short	15,760	8	0,000	6,6667

Computer Mouse 3 (M3) Test Value:3.86

Attitudes	t	df	Sig. (2- tailed)	Mean
thick-thin	-13,750	8	0,000	1,4444
big-small	-29,081	28	0,000	1,2069
heavy-light	-5,540	22	0,000	2,0870
gracious-coarse	6,484	8	0,000	6,2222
fast-slow	3,381	7	0,012	5,7500
transparent-opaque	15,476	6	0,000	6,7143
particular-standard	3,384	5	0,020	6,0000
long-short	-9,975	8	0,000	1,4444
high-low	-3,954	13	0,002	2,2857
loud-silent	-5,176	16	0,000	2,0588
technological-outdated	5,509	11	0,000	5,5833
eccentrical-accustomed	2,323	8	0,049	5,1111
classical-modern	-6,574	10	0,000	1,4545
old-new	-8,184	27	0,000	2,1071
fluid-stable	2,185	12	0,049	4,9231
attractive-unattractive	4,307	15	0,001	5,2500

Table 6.22 (cont'd).

Computer Mouse 4 (M4) Test Value:4.53

Attitudes	t	df	Sig. (2- tailed)	Mean
fast-slow	-4,010	7	0,005	3,1250
dynamic-bulky	-2,599	6	0,041	3,5714
transparent-opaque	16,290	6	0,000	6,8571
loud-silent	2,716	16	0,015	5,2941
technological-outdated	-5,030	11	0,000	3,0833
eccentrical-accustomed	3,115	8	0,014	5,7778
old-new	2,352	27	0,026	5,0357

Computer Mouse 5 (M5) Test Value:4.14

Attitudes	t	df	Sig. (2- tailed)	Mean
fast-slow	-4,435	7	0,003	2,7500
dynamic-bulky	-2,794	6	0,031	2,8571
transparent-opaque	3,367	6	0,015	6,1429
technological-outdated	-4,061	11	0,002	2,8333
eccentrical-accustomed	4,134	8	0,003	5,8889
old-new	5,545	27	0,000	5,3571

Computer Mouse 6 (M6) Test Value:4.39

Attitudes	t	df	Sig. (2- tailed)	Mean
thick-thin	-2,915	8	0,019	3,2222
heavy-light	2,192	22	0,039	5,0435
fast-slow	-3,438	7	0,011	2,8750
dynamic-bulky	-2,607	6	0,040	3,4286
transparent-opaque	7,335	6	0,000	6,5714
particular-standard	2,582	5	0,049	5,6667
technological-outdated	-4,544	11	0,001	3,0833
eccentrical-accustomed	3,543	8	0,008	5,8889
old-new	2,795	27	0,009	5,0000
fluid-stable	-2,937	12	0,012	3,2308

Computer Mouse 7 (M7) Test Value:4.18

Attitudes	t	df	Sig. (2- tailed)	Mean
thick-thin	-16,343	8	0,000	1,7778
big-small	-11,900	28	0,000	1,6552
heavy-light	-3,707	22	0,001	2,7826
fast-slow	7,481	7	0,000	5,8750
transparent-opaque	8,042	6	0,000	6,5714
long-short	-15,571	8	0,000	1,4444
high-low	-3,274	13	0,006	2,8571
eccentrical-accustomed	2,898	8	0,020	5,5556
classical-modern	-4,683	10	0,001	2,3636
old-new	-6,330	27	0,000	2,6071
fluid-stable	3,067	12	0,010	5,4615

Table 6.22 (cont'd).

Computer Mouse 8 (M8)				Test Value:4.28
Attitudes	t	df	Sig. (2- tailed)	Mean
thick-thin	-2,467	8	0,039	2,8889
big-small	-10,540	28	0,000	2,0000
heavy-light	-3,249	22	0,004	2,8261
gracious-coarse	9,397	8	0,000	6,5556
fast-slow	3,095	7	0,017	5,8750
transparent-opaque	18,040	6	0,000	6,8571
particular-standard	2,585	5	0,049	5,8333
long-short	-7,012	8	0,000	2,1111
loud-silent	-7,249	16	0,000	1,6471
technological-outdated	31,640	11	0,000	6,9167
entertaining-serious	2,744	7	0,029	6,0000
classical-modern	a	10	0,000	1,0000
old-new	-13,538	27	0,000	1,3214
fluid-stable	3,684	12	0,003	6,0000
attractive-unattractive	2,657	15	0,018	5,5625

a. *t* cannot be computed because the standard deviation is 0.

The interpretation results and the significantly perceived qualities of computer mouses within Component 3 are summarized and can be seen in Table 6.23. The table illustrates the qualities that are statistically significant for each computer mouse. There are no positivity or negativity for the attitudes as the attitudes were listed depending on their poles (left or right). Also the order of the attitudes were sorted based on their statistical significance values.

Table 6.23 Summarized table of construed computer mouses within Component 3

								
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Attitudes (Left Pole)	particular technological gracious attractive fast reassuring eccentrical	dynamic fast gracious	big thick long classical loud heavy old high	technological fast dynamic	technological fast dynamic	technological fast fluid thick dynamic	big thick long old classical heavy high	classical old big loud long heavy thick
Attitudes (Right Pole)	small light* thin new low modern	short small light*	opaque coarse standard slow outdated unattractive accustomed stable	opaque accustomed silent new	new accustomed opaque	opaque accustomed new light* standard	slow opaque stable accustomed	outdated opaque coarse stable slow unattractive serious standard

*opposite of heavy

6.2.3.4 One Sample *t*-Test Results of Element-Attitude Relationships Within Component 4

As all computer mouses have different overall mean scores, calculations were made individually for each computer mouse through 2 attitudes within Component 4 and those overall mean scores were taken as test values. If the mean score of an attitude is significantly different from the test value, that attitude would be regarded as important and the significant pole of that attitude would be highlighted depending on that difference. Also if the mean value of an attitude is significantly above the test value, this means the right pole is dominant and if the value is below the test value, the left pole is dominant. Detailed *t*-test scores of each computer mouse can be seen in Appendix R. For a simple and clear interpretation, only the significant results (Sig. 2-tailed, $p < 0.05$) are represented in this section. Significant *t*-test results can be seen in Table 6.22. The interpretation of Table 6.22 is listed below.

M1 was perceived by the participants most considerably as *clear* (1,20) and its rating was furthest from the overall mean score (2.10).

M3 was perceived by the participants most considerably as *glittery* (6,17) and its rating was furthest from the overall mean score (4.38).

M4 was perceived by the participants most considerably as *non glittery* (1,75) and its rating was furthest from the overall mean score (2,68).

Table 6.24 Significant one sample *t*-test results among eight computer mouses within Component 4

Computer Mouse 1 (M1)				Test Value:2.10
Attitudes	t	df	Sig. (2- tailed)	Mean
clear-blurry	-4,500	4	0,011	1,2000

Computer Mouse 3 (M3)				Test Value:4.38
Attitudes	t	df	Sig. (2- tailed)	Mean
non glittery-glittery	3,648	11	0,004	6,1667

Computer Mouse 4 (M4)				Test Value:2.68
Attitudes	t	df	Sig. (2- tailed)	Mean
non glittery-glittery	-2,830	11	0,016	1,7500

The interpretation results and the significantly perceived qualities of computer mouses within Component 2 are summarized and can be seen in Table 6.25. The table illustrates the qualities that are statistically significant for each computer mouse. There are no positivity or negativity for the attitudes as the attitudes were listed depending on their poles (left or right). Also the order of the attitudes were sorted based on their statistical significance values.

Table 6.25 Summarized table of construed computer mouses within Component 4

								
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Attitudes (Left	clear			non glittery				
Attitudes (Right			glittery					

CHAPTER 7

ANALYSIS OF RELATIONSHIPS BETWEEN PARTICIPANTS' ATTITUDINAL EVALUATIONS AND WATER BOTTLES

In this chapter, the same analysis procedures used in the previous chapter were followed to analyze the results of the experiment with water bottles.

7.1 Dimension Reduction of the Data

As mentioned before, a large amount of data was gathered through two experiments with different product categories. For the second experiment with water bottles, 895 bipolar adjectives were transformed into 69 common attitudes through content analysis procedures. As a result of the first data organization, the data were reduced into 552 pieces of variables (69 x 8 grids) for the experiment with water bottles. The dataset still contained large amount of data and required an additional dimension reduction application for a clear interpretation of the findings.

7.1.1 Exploring Components in Grid Data

Principal components analysis (PCA) was considered as the appropriate solution for dimension reduction of the dataset of the second experiment (see Section 6.1). The application of PCA on the data of the first experiment produced four components through 63 attitudes. Cluster rotation method was preferred because of producing fewest complex variables among other rotation methods. Still, six attitudes were found cross-loaded and removed from the component analysis. Proper procedures would be applied to the dataset to adjust the number of the components to be extracted and to specify the items to be retained in the analysis for the second experiment also.

7.1.2 Principal Components Analysis Results

The first objective in the application of PCA was to find out how many components had to be extracted. PCA with varimax rotation was applied to reveal the components with eigenvalues over 1 for the initial component number estimation. Sixty-nine common attitudes for eight water bottles were analyzed through this procedure and the results presented that six components were formed with eigenvalues greater than 1.0. Results of this analysis can be seen in Table 7.1.

Table 7.1 Preliminary extraction analysis of components with 69 attitudes

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	24,986	36,212	36,212	24,986	36,212	36,212	22,646	32,820	32,820
2	20,017	29,009	65,222	20,017	29,009	65,222	20,736	30,052	62,872
3	8,980	13,015	78,237	8,980	13,015	78,237	8,765	12,703	75,575
4	7,644	11,078	89,315	7,644	11,078	89,315	8,470	12,276	87,851
5	3,991	5,785	95,099	3,991	5,785	95,099	4,840	7,015	94,866
6	2,635	3,819	98,918	2,635	3,819	98,918	2,796	4,053	98,918
7	0,746	1,082	100,000						

Extraction Method: Principal Component Analysis.

Preliminary analysis created six eligible components with varimax rotation. The seventh component had an eigenvalue below 1, therefore it was not eligible. The first component covered 36,21% of the total variance, whereas the other components covered 29,01%, 13,01%, 11,08%, 5,78% and 3,82% respectively. The fifth and sixth components covered a small portion of total variance and therefore would be investigated if there were enough an number of items produced under each of them to be counted as a component. As can be seen from Table 7.1, the six components cover 98,92% of the full variance. However, this six components solution produced

8 cross-loaded items under different components. The interpretation of cross-loaded items is problematic, and if the difference among the item loadings under different components is lesser than 0.1, the cross-loaded item should be removed from the analysis for better interpretation. Further, the sixth component consisted of only one item and the fifth component contained only two items and therefore the number of component extraction needed to be reduced. Variables with cross loadings for the six components solution can be seen in Appendix S.

In order to reduce the number of cross-loaded items, various orthogonal rotation types were applied in PCA. Varimax, equamax and promax rotations were applied on the data separately through five and four components extraction. Table 7.2 shows the summarized results of the combination of various rotation and extraction analyses.

Table 7.2 Results of different orthogonal rotation methods applied during PCA

Rotation Method	Varimax	Varimax	Equamax	Equamax	Quartimax	Quartimax
Number of Components	5	4	5	4	5	4
Cross-loaded Items	9	7	17	13	6	11

As can be seen from the results in Table 7.2, the least amount of cross-loaded items were produced through quartimax rotation with five components extraction. The optimum solution in orthogonal rotation types produced six cross-loaded items. Orthogonal rotation types are used in situations where the components or factors are not correlated with each other. To understand whether the components are correlated or not, component transformation matrix should be inspected. Component transformation matrix for the PCA with quartimax with five components exraction can be seen in Table 7.3.

Table 7.3 Component transformation matrix of five components PCA with quartimax rotation

Component Transformation Matrix

Component	1	2	3	4	5
1	0,838	**-0,532**	0,064	-0,049	0,084
2	**0,522**	0,845	0,085	-0,021	0,074
3	-0,133	-0,036	0,917	-0,308	0,212
4	0,026	-0,019	0,341	0,934	-0,104
5	0,081	0,013	0,177	-0,174	-0,965

Extraction Method: Principal Component Analysis.
Rotation Method: Quartimax with Kaiser Normalization.

According to the component transformation matrix (Table 7.3), Component 1 and Component 2 are significatly correlated. As mentioned in the previous chapter, if components are correlated, oblique rotation types are used in PCA. The cluster rotation method provided the best result in the first experiment analysis. Cluster rotation is preferable when the data structure is highly complex and components are correlated. Another trial of PCA with five and four components extraction was run with cluster rotation method in R statistics. Results of the procedure can be seen in Table 7.4.

Table 7.4 Variance results of five components extraction

Total Variance Explained

	RC1	RC2	RC3	RC4	RC5
Sum of Squared Loadings	22.75	21.56	8.79	8.74	5.79
Proportion Variance	0.33	0.31	0.13	0.13	0.08
Cumulative Variance	0.33	0.64	0.77	0.90	0.98

According to Table 7.4, five components with eigenvalues over 1.0 covered 98% of total variance. Component 5 covered a small portion of the total variance containing two variables with significant loadings within. Also, this five components solution produced five cross-loaded items. These cross-loaded items are *simple-complex, flexible-solid, reliable-unreliable, relieving-irritating* and *plain-ornate.* Cross-loaded items were removed and PCA was run again. However, significant structural changes occurred and new cross-loaded items were generated. Last attempt would be to change the number of the extracted components while keeping other properties the same. This time, PCA was run with four components extraction with the cluster rotation. Results can be seen in Table 7.5.

Table 7.5 Variance results of four components extraction

Total Variance Explained

	RC1	RC2	RC4	RC3
Sum of Squared Loadings	21.71	19.06	9.60	9.18
Proportion Variance	0.32	0.28	0.14	0.14
Cumulative Variance	0.32	0.61	0.75	0.89

Four components were extracted with the final PCA run through R statistics software. As can be seen from the results in Table 7.5, four components covered 89% of the total variance. This four components extraction produced only two cross-loaded items, which was the lowest amongst all rotation and extraction types applied to the data. Cutoff value was set to 0.5, which means loadings above 0.5 are accepted as significant. Detailed PCA results with item loadings can be seen in Appendix T. These two cross-loaded items were *safe-insecure* and *clean-dirty*. These cross-loaded items were removed one by one and PCA was run each time after an item was removed. Results of the final PCA produced no cross-loaded items, which can be seen in Table 7.6.

For the dimension reduction of this highly complex data, various combinations of analysis methods were tested and four components were developed finally. To maintain clear and interpretative results, two cross-loaded items were removed from the data, as they were involved in more than one component. These two cross-loaded items and their correlations with other variables would be investigated separately after the inter-item correlations of each component results of PCA was completed. These four components would be used for simplified and interpretative representations of correlations between items. Labeling of these components with labels, which carry the the group identity meanings of items loaded on each of the component would be beneficial in order to interpret them practically. The labels assigned for components were explained below.

Component 1 is consisted of the items with high loadings such as *hard-soft, long lasting-short lived, easy-difficult, tight-loose, hygienic-non hygienic, excited-calm* and *natural-artificial.* These items are mostly evaluative and the component was labeled as **evaluation**. The evaluation component covers the biggest part (32% of proportional variance) of the total variance.

Component 2 contains the items with high loadings such as *portable-stable, dynamic-inactive, outdoor-indoor, protective-vulnerable, dishonest-honest* and *durable-flimsy.* These items reflect meanings related to reliability conditions mostly and therefore the component is labeled as **assurance**. This component covers the second most (28% of proportional variance) part of the total variance.

Component 3 is labeled through the items with high loadings such as *elaborated-sloppy, old-new* and *accustomed-eccentrical.* These items were regarded as carrying habitual meanings and therefore the component is named as **familiarity**. The component covers 14% of the total variance.

Component 4 is consisted of items with high loadings such as *attractive-unattractive*, *vivid-pale*, *coarse-gracious* and *plain-ornate.* These attitudes are considered as related to style and classiness and the label of this component was assigned as **elegancy**. The elegancy component covers the 14% of the total variance.

Table 7.6 Four components PCA results with cluster rotation.

Loadings:		RC1	RC2	RC3	RC4
Component 1	hard - soft	0.99			
	long lasting - short lived	0.97			
	easy - difficult	-0.96			
	tight - loose	0.94			
	hygienic - non hygienic	0.92			
	excited - calm	-0.91			
	natural - artificial	0.89			
	rounded - sharp	-0.88			
	healthy - unhealthy	0.88			
	shiny - matte	0.86			
	directional - directionless	-0.85			
	fresh - stale	0.85			
	user friendly - difficult to use	-0.84			
	loud - silent	0.83			
	cold - hot	0.82			
	cheap - expensive	-0.81			
	wide - narrow	0.81			
	heavy - light	0.80			
	sportive - formal	-0.77			
	uneven - flat	-0.75			
	deep - treble	-0.74			
	entertaining - serious	-0.74			
	ergonomic - non ergonomic	-0.71			
	reliable - unreliable	0.70			
	conductive - insulative	0.67			
	high quality - poor quality	0.66			
	flexible - solid	-0.64			
	amusing - boring	-0.54			
Component 2	durable - flimsy		-0.98		
	portable - stable		-0.97		
	sweet - bitter		0.91		
	big - small		0.90		
	particular - standard		-0.88		
	dishonest - honest		-0.88		
	dynamic - inactive		-0.83		
	protective - vulnerable		-0.83		
	outdoor - indoor		-0.80		
	transparent - opaque		0.80		
	handy - impractical		-0.79		
	relieving - irritating		0.78		
	unnecessary - necessary		0.78		
	discordant - coherent		0.77		
	feminine - masculine		0.75		
	distinct - ambiguous		0.75		
	comfortable - uncomfortable		-0.70		
	thin - thick		-0.70		
	easy to clean - hard to clean		0.69		
	cool - despised		-0.64		
	sincere - insincere		0.64		
	tall - short		0.63		
Component 3	elaborated - sloppy			0.97	
	old - new			-0.95	
	accustomed - eccentrical			-0.90	
	fragmented - whole			0.89	
	functional - functionless			0.79	
	beautiful - ugly			0.77	
	pleasurable - dissatisfactory			0.55	
Component 4	attractive - unattractive				0.88
	vivid - pale				0.88
	rough - smooth				0.86
	non slippery - slippery				0.78
	controlled - uncontrolled				-0.77
	coarse - gracious				-0.77
	plain - ornate				-0.75
	simple - complex				-0.67
	steady - unsteady				-0.62
	childish - mature				0.60

Number of components extracted: 4
Type of rotation: cluster

After the data was reduced into four components and the components were labeled, a final internal consistency test was applied within components to investigate whether the data was reliable for further analyses. Cronbach's Alpha test was run with the variables within each component and test results can be seen in Table 7.7.

Table 7.7 Internal consistency test results of four components

Reliability Statistics

	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Component 1	,871	,822	28
Component 2	,883	,796	22
Component 3	,927	,932	7
Component 4	,836	,786	10

As can be seen from Table 7.7, the alpha values of Component 1 (0.87), Component 2 (0.88), Component 3 (0.93) and Component 4 (0.84) indicate that all four components are highly reliable in terms of internal consistencies. It should be noted that some items and their ratings were reversed during alpha calculations due to the recommendation of the SPSS. In Component 1, *expensive-cheap, flat-uneven, calm-exciting, difficult to use-user friendly* and *serious-entertaining* were reversed as *cheap-expensive, uneven-flat, exciting-calm, user friendly-difficult to use* and *entertaining-serious*. In Component 2, *honest-dishonest* was reversed as *dishonest-honest.* In Component 3, *new-old* and *eccentrical-accustomed* were reversed as *old-new* and *accustomed-eccentrical*. In Component 4, *ornate-plain* and *unsteady-steady* were reversed as *plain-ornate* and *steady-unsteady*. These changes would only change the positivity and negativity of the correlations between variables and therefore would not interfere with further analyses.

7.1.3 Component Relationships

Pearson corelation coefficient (*r*) was calculated among four components to understand component relationships. The value of *r* would represent the lineer correlation type if available. As mentioned before, *r* values of -1,00 and 1,00 indicate perfect relationships in negative and positive manners and the value 0 means there are no correlations in between. Also, if the Sig. (2-tailed) value is greater than 0.05, the increase or decrease in the first variable is not related with the change in the other variable. Table 7.8 shows the result of the calculations.

Table 7.8 Relationships between four components of the experiment with water bottles

Correlations

		Component1	Component2	Component3	Component4
Component 1	Pearson Correlation	1	,107	,393	-,426
	Sig. (2-tailed)		,801	,335	,292
	N	8	8	8	8
Component 2	Pearson Correlation	,107	1	,162	,534
	Sig. (2-tailed)	,801		,701	,173
	N	8	8	8	8
Component 3	Pearson Correlation	,393	,162	1	,018
	Sig. (2-tailed)	,335	,701		,966
	N	8	8	8	8
Component 4	Pearson Correlation	-,426	,534	,018	1
	Sig. (2-tailed)	,292	,173	,966	
	N	8	8	8	8

According to Table 7.8, the Pearson correlation value between Component 3 and Component 4 is very close to zero (*r*=0,018), which means there are nearly no correlations between them. Component 2 has weak correlations with Component 1 (*r*= 0,107) and Component 3 (*r*=0,162). Also, there is a weak correlation between Component 1 and Component 3 (*r=0*,393). Further, Component 4 was found having a negative moderate correlation with Component 1 (*r=-0*,426) and positive moderate correlation with Component 2 (*r*=0,534). According to the results, all four components were found to have correlations with each other in some degree and therefore the choice of an oblique rotation was approved.

7.2 Exploration of the Relationships Between Water Bottles and Elicited Common Attitudes

A three step approach was adopted in order to identify the relationships between water bottles and the elicited common attitudes. In the first step, the relationships between common attitudes were investigated through bivariate correlation statistics. Pearson product moment correlation coefficient statistics were used to reveal attitude-attitude relationships. In the second step, clustering was adopted to analyse relationships between water bottles. Hierarchical cluster analysis was adopted to observe similarities between water bottles. In the third step, water bottle-attitude relationships were investigated through *t*-test results. One sample *t* test was applied to the dataset. Steps taken during the application of mentioned statistical methods are described in the following section.

7.2.1 Relationships Between Common Attitudes Using Bivariate Statistics

In this section, the relationships between common attitudes are investigated. Pearson's product moment correlation coefficient is used to identify the aspects of the linear relationships between two variables. The aspects of this relationship are the size and the direction. The coefficient value ranges between +1 and -1. If the coefficient value is positive, then there is a positive correlation between two variables, where +1 describes perfect positive correlation. Contrarily, the negative correlation value means the correlation is negative, where -1 indicates perfect negative correlation. If the correlation value is 0, this indicates that there is no correlation between two variables.

7.2.1.1 Correlations Between Items Within Component 1 (Evaluation)

Component 1 consists of 28 common attitudes and correlations between them were calculated through Pearson’s product moment correlation coefficient. Correlation results can be seen in Table 7.9. In the correlation matrix, negative values show that the correlated poles are opposite. In other words, if there is a negative correlation available between two attitudes, the left pole of the first attitude is correlated with the right pole of the other attitude. The interpretation of the correlation matrix in Table 7.9 is listed below;

- The attitude *hard-soft* is highly correlated with the attitudes *long lasting-short lived* (*r*= 0,93), *tight-loose* (*r*= 0,91), *easy-difficult* (*r*= -0,90), *shiny-matte* (*r*= 0,90) and *loud-silent* (*r*= 0,90). Among eight water bottles, the construing of *hard* shows a tendency to be also perceived as *long lasting, tight, difficult, shiny* and *loud.* On the flipside, in eight water bottles, the construing of *soft* shows a tendency to be perceived as *short lived, loose, easy, matte* and *silent*. In addition, the construing of *hard* is also associated with the perception of *hygienic* (*r*= 0,89), *calm* (*r*= 0,88), *cold* (*r*= 0,88), *natural* (*r*= 0,87), *fresh* (*r*= 0,85), *expensive* (*r*= 0,81) and *serious* (*r*= 0,80), and so on.
- The attitude *long lasting-short lived* is highly correlated with the attitudes *natural-artificial* (*r*= 0,94), *hard-soft* (*r*= 0,93), *hygienic-non hygienic* (*r*= 0,93), *healthy-unhealthy* (*r*= 0,93) and *expensive-cheap* (*r*= 0,92). Among eight water bottles, the construing of *long lasting* shows a tendency to be also perceived as *natural*, *hard*, *hygienic*, *healthy* and *expensive*. On the flipside, in eight water bottles, the construing of *short lived* shows a tendency to be perceived as *artificial*, *soft*, *non hygienic*, *unhealthy* and *cheap*. In addition, the construing of long lasting is also associated with the perception of *tight* (*r*= 0,90), *wide* (*r*= 0,90), *difficult* (*r*= -0,89), *fresh* (*r*= 0,89), *calm* (*r*= 0,87), *sharp* (*r*= -0,85) and *high quality* (*r*= 0,84), and so on.

- The attitude *easy-difficult* is highly correlated with the attitudes *tight-loose* (*r*= -0,93), *difficult to use-user friendly* (*r*= -0,91), *hard-soft* (*r*= -0,90), *long lasting-short lived* (*r*= -0,89) and *hygienic-non hygienic* (*r*= -0,85). Among eight water bottles, the construing of *easy* shows a tendency to be also perceived as *loose*, *user friendly, soft*, *short lived* and *non hygienic*. On the flipside, in eight water bottles, the construing of *difficult* shows a tendency to be perceived as *tight*, *difficult to use, hard*, *long lasting* and *hygienic*. In addition, the construing of *easy* is also associated with the perception of *matte* (*r*= -0,83), *rounded* (*r*= 0,79), *cheap* (*r*= -0,79), *unhealthy* (*r*= -0,78), *artificial* (*r*= -0,77) and *stale* (*r*= -0,77) and so on.
- The attitude *tight-loose* is highly correlated with the attitudes *hygienic-non hygienic* (*r*= 0,96), *difficult to use-user friendly* (*r*= 0,96), *easy-difficult* (*r*= -0,93), *hard-soft* (*r*= 0,91), *long lasting-short lived* (*r*= 0,90) and *fresh-stale* (*r*= 0,90). Among eight water bottles, the construing of *tight* shows a tendency to be also perceived as *hygienic, difficult to use, difficult, hard, long lasting* and *fresh*. On the flipside, in eight water bottles, the construing of *loose* shows a tendency to be perceived as *non hygienic, user friendly, easy, soft*, *short lived* and *stale*. In addition, the construing of *tight* is also associated with the perception of *healthy* (*r*= 0,89), *natural* (*r*= 0,87), *shiny* (*r*= 0,79) and *heavy* (*r*= 0,79), and so on.
- The attitude *hygienic-non hygienic* is highly correlated with the attitudes *fresh-stale* (*r*= 0,98), *healthy-unhealthy* (*r*= 0,97), *tight-loose* (*r*= 0,96), *natural-artificial* (*r*= 0,96) and *long lasting-short lived* (*r*= 0,93). Among eight water bottles, the construing of *hygienic* shows a tendency to be also perceived as *fresh, healthy, tight, natural* and *long lasting*. On the flipside, in eight water bottles, the construing of *non hygienic* shows a tendency to be perceived as *stale, unhealthy, loose, artificial* and *short lived.* In addition, the construing of *hygienic* is also associated with the perception of *difficult to use* (*r*= 0,90), *heavy* (*r*= 0,90), *hard* (*r*= 0,89), *difficult* (*r*= -0,85), *wide* (*r*= 0,80) and *formal* (*r*= -0,79), and so on.

Table 7.9 Correlation matrix of 28 items within Component 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1.hard-soft	**1.00**	**0.93**	**-0.90**	**0.91**	0.89	0.88	0.87	-0.83	0.83	**0.90**	-0.81	0.85	0.77	**0.90**	**0.88**	0.81	0.85	0.70	-0.69	0.67	**-0.86**	0.80	-0.76	0.69	**0.72**	0.68	-0.48	-0.58
2.long lasting-short lived	**0.93**	**1.00**	-0.89	**0.90**	**0.93**	0.87	**0.94**	-0.85	**0.93**	0.82	-0.73	0.89	0.82	0.75	0.82	**0.92**	**0.90**	0.80	-0.59	0.79	-0.76	0.75	-0.68	**0.80**	0.49	**0.84**	-0.53	-0.49
3.easy-difficult	**-0.90**	-0.89	**1.00**	**-0.93**	-0.85	-0.76	-0.77	0.79	-0.78	-0.83	0.74	-0.77	**-0.91**	-0.76	-0.68	-0.79	-0.63	-0.68	0.67	-0.63	0.62	-0.72	0.48	-0.74	-0.69	-0.67	0.49	0.47
4.tight-loose	**0.91**	**0.90**	**-0,93**	**1.00**	**0.96**	0.67	0.87	-0.68	0.89	0.79	-0.58	**0.90**	**0.96**	0.71	0.65	0.75	0.72	0.79	-0.78	0.49	-0.71	0.61	-0.60	0.71	0,67	0.61	-0.65	-0.24
5.hygienic-non hygienic	0.89	**0.93**	-0.85	**0.96**	**1.00**	0.70	**0.96**	-0.71	**0.97**	0.71	-0.52	**0.98**	**0.90**	0.63	0.66	0.74	0.80	**0.90**	-0.79	0.56	-0.70	0.53	-0.73	0.62	0.61	0.64	-0.71	-0.19
6.calm-excited	0.88	0.87	-0.76	0.67	0.70	**1.00**	0.77	**-0.94**	0.73	0.77	**-0.90**	0.68	0.52	0.80	**0.93**	0.81	0.83	0.64	-0.47	**0.90**	-0.71	0.79	-0.72	0.62	0.49	0.73	-0.32	**-0.81**
7.natural-artificial	0.87	**0.94**	-0.77	0.87	**0.96**	0.77	**1.00**	-0.79	**0.99**	0.67	-0.52	**0.98**	0.78	0.61	0.72	0.79	0.87	**0.92**	-0.68	0.69	-0.72	0.54	**-0.82**	0.59	0.53	0.73	-0.61	-0.29
8.rounded-sharp	-0.83	-0.85	0.79	-0.68	-0.71	**-0.94**	-0.79	**1.00**	-0.76	-0.69	0.79	-0.73	-0.56	-0.68	-0.80	-0.77	-0.71	-0.72	0.49	**-0.92**	0.58	-0.67	0.71	-0.52	-0.59	-0.74	0.30	0.72
9.healthy-unhealthy	0.83	**0.93**	-0.78	0.89	**0.97**	0.73	**0.99**	-0.76	**1.00**	0.62	-0.48	**0.98**	0.82	0.53	0.66	0.76	0.82	**0.95**	-0.72	0.66	-0.63	0.47	-0.75	0.58	0.50	0.69	-0.69	-0.21
10.shiny-matte	**0.90**	0.82	-0.83	0.79	0.71	0.77	0.67	-0.69	0.62	**1.00**	-0.83	0.65	0.66	**0.96**	0.78	0.82	0.79	0.41	-0.43	0.59	**-0.89**	**0.93**	-0.55	0.81	0.60	0.70	-0.26	-0.62
11.directional-directionless	-0.81	-0.73	0.74	-0.58	-0.52	**-0.90**	-0.52	0.79	-0.48	-0.83	**1.00**	-0.43	-0.45	-0.87	-0.82	-0.70	-0.67	-0.37	0.38	-0.76	0.66	**-0.86**	0.49	-0.64	-0.45	-0.58	0.24	**0.85**
12.fresh-stale	0.85	0.89	-0.77	**0.90**	**0.98**	0.68	**0.98**	-0.73	**0.98**	0.65	-0.43	**1.00**	0.82	0.57	0.64	0.72	0.80	**0.91**	-0.74	0.57	-0.69	0.47	**-0.80**	0.54	0.61	0.65	-0.64	-0.17
13.difficult to use-user friendly	0.77	0.82	**-0.91**	**0.96**	**0.90**	0.52	0.78	-0.56	0.82	0.66	-0.45	0.82	**1.00**	0.54	0.48	0.69	0.55	0.74	-0.73	0.40	-0.51	0.48	-0.38	0.70	0.56	0.56	-0.65	-0.09
14.loud-silent	**0.90**	0.75	-0.76	0.71	0.63	0.80	0.61	-0.68	0.53	**0.96**	**-0.87**	0.57	0.54	**1.00**	0.86	0.74	0.77	0.34	-0.43	0.55	**-0.91**	**0.93**	-0.61	0.70	0.64	0.60	-0.17	-0.72
15.cold-hot	0.88	0.82	-0.68	0.65	0.66	**0.93**	0.72	-0.80	0.66	0.78	-0.82	0.64	0.48	0.86	**1.00**	0.83	**0.88**	0.50	-0.37	0.75	-0.84	0.85	-0.70	0.67	0.46	0.73	-0.16	-0.79
16.expensive-cheap	0.81	**0.92**	-0.79	0.75	0.74	0.81	0.79	-0.77	0.76	0.82	-0.70	0.72	0.69	0.74	0.83	**1.00**	**0.86**	0.55	-0.25	0.80	-0.75	**0.86**	-0.48	**0.92**	0.31	**0.97**	-0.19	-0.60
17.wide-narrow	0.85	**0.90**	-0.63	0.72	0.80	0.83	0.87	-0.71	0.82	0.79	-0.67	0.80	0.55	0.77	**0.88**	0.86	**1.00**	0.64	-0.41	0.72	**-0.89**	0.77	-0.77	0.72	0.34	0.79	-0.38	-0.51
18.heavy-light	0.70	0.80	-0.68	0.79	**0.90**	0.64	**0.92**	-0.72	**0.95**	0.41	-0.37	**0.91**	0.74	0.34	0.50	0.55	0.64	**1.00**	**-0.80**	0.60	-0.41	0.23	-0.73	0.34	0.49	0.49	-0.78	-0.09
19.sportive-formal	-0.69	-0.59	0.67	-0.78	-0.79	-0.47	-0.68	0.49	-0.72	-0.43	0.38	-0.74	-0.73	-0.43	-0.37	-0.25	-0.41	-0.80	**1.00**	-0.22	0.40	-0.16	0.64	-0.16	**-0.72**	-0.08	**0.86**	-0.02
20.flat-uneven	0.67	0.79	-0.63	0.49	0.56	**0.90**	0.69	**-0.92**	0.66	0.59	-0.76	0.57	0.40	0.55	0.75	0.80	0.72	0.60	-0.22	**1.00**	-0.47	0.66	-0.55	0.57	0.24	0.82	-0.21	-0.75
21.deep-treble	-0.86	-0.76	0.62	-0.71	-0.70	-0.71	-0.72	0.58	-0.63	-0.89	0.66	-0.69	-0.51	**-0.91**	-0.84	-0.75	**-0.89**	-0.41	0.40	-0.47	**1.00**	-0.84	0.72	-0.68	-0.54	-0.64	0.21	0.52
22.serious-entertaining	0.80	0.75	-0.72	0.61	0.53	0.79	0.54	-0.67	0.47	**0.93**	**-0.86**	0.47	0.48	**0.93**	0.85	0.86	0.77	0.23	-0.16	0.66	-0.84	**1.00**	-0.42	**0.85**	0.39	0.78	0.00	-0.79
23.ergonomic-non ergonomic	-0.76	-0.68	0.48	-0.60	-0.73	-0.72	-0.82	0.71	-0.75	-0.55	0.49	**-0.80**	-0.38	-0.61	-0.70	-0.48	-0.77	-0.73	0.64	-0.55	0.72	-0.42	**1.00**	-0.19	-0.65	-0.41	0.45	0.37
24.reliable-unreliable	0.69	0.80	-0.74	0.71	0.62	0.62	0.59	-0.52	0.58	**0.81**	-0.64	0.54	0.70	0.70	0.67	**0.92**	0.72	0.34	-0.16	0.57	-0.68	**0.85**	-0.19	**1.00**	0.16	**0.85**	-0.17	-0.47
25.conductive-insulative	**0.72**	0.49	-0.69	0.67	0.61	0.49	0.53	-0.59	0.50	0.60	-0.45	0.61	0.56	0.64	0.46	0.31	0.34	0.49	**-0.72**	0.24	-0.54	0.39	-0.65	0.16	**1.00**	0.19	-0.30	-0.31
26.high quality-poor quality	0.68	0.84	-0.67	0.61	0.64	0.73	0.73	-0.74	0.69	0.70	-0.58	0.65	0.56	0.60	0.73	**0.97**	0.79	0.49	-0.08	**0.82**	-0.64	0.78	-0.41	**0.85**	0.19	**1.00**	-0.06	-0.57
27.flexible-solid	-0.48	-0.53	0.49	-0.65	-0.71	-0.32	-0.61	0.30	-0.69	-0.26	0.24	-0.64	-0.65	-0.17	-0.16	-0.19	-0.38	-0.78	**0.86**	-0.21	0.21	0.00	0.45	-0.17	-0.30	-0.06	**1.00**	-0.24
28.amusing-boring	-0,58	-0,49	0,47	-0,24	-0,19	**-0,81**	-0,29	0,72	-0,21	-0,62	**0,85**	-0,17	-0,09	-0,72	-0,79	-0,60	-0,51	-0,09	-0,02	-0,75	0,52	-0,79	0,37	-0,47	-0,31	-0,57	-0,24	**1,00**

- The attitude *natural-artificial* is highly correlated with the attitudes *healthy-unhealthy* (*r*= 0,99), *fresh-stale* (*r*= 0,98), *hygienic-non hygienic* (*r*= 0,96), *long lasting-short lived* (*r*= 0,94) and *heavy-light* (*r*= 0,92). Among eight water bottles, the construing of *natural* shows a tendency to be also perceived as *healthy, fresh, hygienic, long lasting* and *heavy*. On the flipside, in eight water bottles, the construing of *artificial* shows a tendency to be perceived as *unhealthy, stale, non hygienic, short lived* and *light*. In addition, the construing of *natural* is also associated with the perception of *hard* (*r*= 0,87), *tight* (*r*= 0,87), *wide* (*r*= 0,87), *non ergonomic* (*r*= -0,82) and *sharp* (*r*= -0,79), and so on.
- The attitude *rounded-sharp* is highly correlated with the attitudes *calm-excited* (*r*= -0,94), *flat-uneven* (*r*= -0,92), *long lasting-short lived* (*r*= -0,85) and *hard-soft* (*r*= -0,83). Among eight water bottles, the construing of *rounded* shows a tendency to be also perceived as *excited, uneven, short lived* and *soft*. On the flipside, in eight water bottles, the construing of *sharp* shows a tendency to be perceived as *calm, flat, long lasting* and *hard*. In addition, the construing of *rounded* is also associated with the perception of *hot* (*r*= -0,80), *easy* (*r*= 0,79), *artificial* (*r*= -0,79), *directional* (*r*= 0,79) and *cheap* (*r*= -0,77), and so on.
- The attitude *healthy-unhealthy* is highly correlated with the attitudes *natural-artificial* (*r*= 0,99), *fresh-stale* (*r*= 0,98), *hygienic-non hygienic* (*r*= 0,97), *heavy-light* (*r*= 0,95) and *long lasting-short lived* (*r*= 0,93). Among eight water bottles, the construing of *healthy* shows a tendency to be also perceived as *natural, fresh, hygienic, heavy* and *long lasting*. On the flipside, in eight water bottles, the construing of *unhealthy* shows a tendency to be perceived as *artificial, stale, non hygienic, light* and *short lived*. In addition, the construing of *healthy* is also associated with the perception of *tight* (*r*= 0,89), *hard* (*r*= 0,83), *difficult to use* (*r*= 0,82), *wide* (*r*= 0,82), *sharp* (*r*= -0,76) and *expensive* (*r*= 0,76), and so on.

- The attitude *shiny-matte* is highly correlated with the attitudes *loud-silent* (*r*= 0,96), *serious-entertaining* (*r*= 0,93), *hard-soft* (*r*= 0,90) and *deep-treble* (*r*= -0,89). Among eight water bottles, the construing of *shiny* shows a tendency to be also perceived as *loud, serious, hard* and *treble*. On the flipside, in eight water bottles, the construing of *matte* shows a tendency to be perceived as *silent, entertaining, soft* and *deep*. In addition, the construing of *shiny* is also associated with the perception of *difficult* (*r*= -0,83), *directionless* (*r*= -0,83), *long lasting* (*r*= 0,82), *expensive* (*r*= 0,82) and *reliable* (*r*= 0,81), and so on.
- The attitude *directional-directionless* is highly correlated with the attitudes *calm-excited* (*r*= -0,90), *loud-silent* (*r*= -0,87), *serious-entertaining* (*r*= -0,86) and *shiny-matte* (*r*= -0,83). Among eight water bottles, the construing of *directional* shows a tendency to be also perceived as *excited, silent, entertaining* and *matte*. On the flipside, in eight water bottles, the construing of *directionless* shows a tendency to be perceived as *calm, loud, serious* and *shiny*. In addition, the construing of directional is also associated with the perception of *hot* (*r*= -0,82), *soft* (*r*= -0,81), *amusing* (*r*= 0,80), *rounded* (*r*= 0,79) and *uneven* (*r*= -0,76), and so on.
- The attitude *fresh-stale* is highly correlated with the attitudes *hygienic-non hygienic* (*r*= 0,98), *natural-artificial* (*r*= 0,98), *healthy-unhealthy* (*r*= 0,98), *heavy-light* (*r*= 0,91) and *tight-loose* (*r*= 0,90). Among eight water bottles, the construing of *fresh* shows a tendency to be also perceived as *hygienic, natural, healthy, heavy* and *tight*. On the flipside, in eight water bottles, the construing of *stale* shows a tendency to be perceived as *non hygienic, artificial, unhealthy, light* and *loose*. In addition, the construing of *fresh* is also associated with the perception of *long lasting* (*r*= 0,89), *hard* (*r*= 0,85), *difficult to use* (*r*= 0,82) and *wide* (*r*= 0,80), and so on.
- The attitude *difficult to use-user friendly* is highly correlated with the attitudes *tight-loose* (*r*= 0,96), *easy-difficult* (*r*= -0,91), *hygienic-non hygienic* (*r*= 0,90) and *long lasting-short lived* (*r*= 0,82). Among eight water bottles, the construing of *difficult to use* shows a tendency to be also

perceived as *tight, difficult, hygienic* and *long lasting*. On the flipside, in eight water bottles, the construing of *user friendly* shows a tendency to be perceived as *loose, easy, non hygienic* and *short lived.* In addition, the construing of difficult to use is also associated with the perception of *healthy* (*r*= 0,82), *fresh* (*r*= 0,82), *natural* (*r*= 0,78), *hard* (*r*= 0,77) and *heavy* (*r*= 0,74), and so on.

- The attitude *loud-silent* is highly correlated with the attitudes *shiny-matte* (*r*= 0,96), *serious-entertaining* (*r*= 0,93), *deep-treble* (*r*= -0,91) and *hard-soft* (*r*= 0,90). Among eight water bottles, the construing of *loud* shows a tendency to be also perceived as *shiny, serious, treble* and *hard*. On the flipside, in eight water bottles, the construing of *silent* shows a tendency to be perceived as *matte, entertaining, deep* and *soft*. In addition, the construing of *loud* is also associated with the perception of *directionless* (*r*= -0,87), *cold* (*r*= 0,86), *calm* (*r*= 0,80) and *wide* (*r*= 0,77), and so on.
- The attitude *cold-hot* is highly correlated with the attitudes *calm-excited* (*r*= 0,93), *hard-soft* (*r*= 0,88), *wide-narrow* (*r*= 0,88), *loud-silent* (*r*= 0,86) and *serious-entertaining* (*r*= 0,85). Among eight water bottles, the construing of *cold* shows a tendency to be also perceived as *calm, hard, wide, loud* and *serious*. On the flipside, in eight water bottles, the construing of *hot* shows a tendency to be perceived as *excited, soft, narrow, silent* and *entertaining*. In addition, the construing of *cold* is also associated with the perception *treble* (*r*= -0,84), *expensive* (*r*= 0,83), *long lasting* (*r*= 0,82), *directionless* (*r*= -0,82) and *sharp* (*r*= -0,80), and so on.
- The attitude *expensive-cheap* is highly correlated with the attitudes *high quality-poor quality* (*r*= 0,97), *long lasting-short lived* (*r*= 0,92), *reliable-unreliable* (*r*= 0,92), *wide-narrow* (*r*= 0,86) and *serious-entertaining* (*r*= 0,86). Among eight water bottles, the construing of *expensive* shows a tendency to be also perceived as *high quality, long lasting, reliable, wide,* and *serious*. On the flipside, in eight water bottles, the construing of *cheap* shows a tendency to be perceived as *poor quality, short lived, unreliable,*

narrow and *entertaining*. In addition, the construing of *expensive* is also associated with the perception of *serious* (*r*= 0,86), *cold* (*r*= 0,83), *shiny* (*r*= 0,82), *hard* (*r*= 0,81) and *calm* (*r*= 0,81), and so on.

- The attitude *wide-narrow* is highly correlated with the attitudes *long lasting-short lived* (*r*= 0,90), *deep-treble* (*r*= -0,89), *cold-hot* (*r*= 0,88) and *natural-artificial* (*r*= 0,87). Among eight water bottles, the construing of *wide* shows a tendency to be also perceived as *long lasting, treble, cold* and *natural*. On the flipside, in eight water bottles, the construing of *narrow* shows a tendency to be perceived as *short lived, deep, hot* and *artificial*. In addition, the construing of *wide* is also associated with the perception of *expensive* (*r*= 0,86), *hard* (*r*= 0,85), *calm* (*r*= 0,83), *healthy* (*r*= 0,82), *hygienic* (*r*= 0,80) and *fresh* (*r*= 0,80), and so on.
- The attitude *heavy-light* is highly correlated with the attitudes *healthy-unhealthy* (*r*= 0,95), *natural-artificial* (*r*= 0,92), *fresh-stale* (*r*= 0,91) and *hygienic-non hygienic* (*r*= 0,90). Among eight water bottles, the construing of *heavy* shows a tendency to be also perceived as *healthy, natural, fresh,* and *hygienic.* On the flipside, in eight water bottles, the construing of *light* shows a tendency to be perceived as *unhealthy, artificial, stale* and *non hygienic*. In addition, the construing of *heavy* is also associated with the perception of *long lasting* (*r*= 0,80), *formal* (*r*= -0,80), *tight* (*r*= 0,79) and *solid* (*r*= -0,78), and so on.
- The attitude *sportive-formal* is highly correlated with the attitudes *flexible-solid* (*r*= 0,86) and *heavy-light* (*r*= -0,80). Among eight water bottles, the construing of sportive shows a tendency to be also perceived as *flexible* and *light*. On the flipside, in eight water bottles, the construing of *formal* shows a tendency to be perceived as *solid* and *heavy*. In addition, the construing of *sportive* is also associated with the perception of *non hygienic* (*r*= -0,79), *loose* (*r*= -0,78), *stale* (*r*= -0,74), *user friendly* (*r*= -0,73), *unhealthy* (*r*= -0,72) and *insulative* (*r*= -0,72), and so on.

- The attitude *flat-uneven* is highly correlated with the attitudes *rounded-sharp* (*r*= -0,92), *calm-excited* (*r*= 0,90) and *high quality-poor quality* (*r*= 0,82). Among eight water bottles, the construing of *flat* shows a tendency to be also perceived as *sharp, calm* and *high quality*. On the flipside, in eight water bottles, the construing of *uneven* shows a tendency to be perceived as *rounded, excited* and *poor quality*. In addition, the construing of *flat* is also associated with the perception of *expensive* (*r*= 0,80), *long lasting* (*r*= 0,79), *directionless* (*r*= -0,76) and *cold* (*r*= 0,75), and so on.
- The attitude *deep-treble* is highly correlated with the attitudes *loud-silent* (*r*= -0,91), *shiny-matte* (*r*= -0,89), *wide-narrow* (*r*= -0,89) and *hard-soft* (*r*= -0,86). Among eight water bottles, the construing of *deep* shows a tendency to be also perceived as *silent, matte, narrow* and *soft*. On the flipside, in eight water bottles, the construing of *treble* shows a tendency to be perceived as *loud, shiny, wide* and *hard*. In addition, the construing of *deep* is also associated with the perception of *hot* (*r*= -0,84), *entertaining* (*r*= -0,84), *short lived* (*r*= -0,76) and *cheap* (*r*= -0,75), and so on.
- The attitude *serious-entertaining* is highly correlated with the attitudes *shiny-matte* (*r*= 0,93), *loud-silent* (*r*= 0,93), *directional-directionless* (*r*= -0,86), *expensive-cheap* (*r*= 0,86) and *cold-hot* (*r*= 0,85). Among eight water bottles, the construing of *serious* shows a tendency to be also perceived as *shiny, loud, directionless, expensive, cold*. On the flipside, in eight water bottles, the construing of *entertaining* shows a tendency to be perceived as *matte, silent, directional, cheap* and *hot*. In addition, the construing of *serious* is also associated with the perception of *reliable* (*r*= 0,85), *treble* (*r*= -0,84), *hard* (*r*= 0,80) and *calm* (*r*= 0,79), and so on.
- The attitude *ergonomic-non ergonomic* is highly correlated with the attitudes *natural-artificial* (*r*= -0,82), *fresh-stale* (*r*= -0,80), *wide-narrow* (*r*= -0,77) and *hard-soft* (*r*= -0,76). Among eight water bottles, the construing of *ergonomic* shows a tendency to be also perceived as *artificial, stale, narrow,* and *soft.* On the flipside, in eight water bottles, the construing of *non*

ergonomic shows a tendency to be perceived as *natural, fresh, wide* and *hard*. In addition, the construing of *ergonomic* is also associated with the perception of *unhealthy* (*r*= -0,75), *non hygienic* (*r*= -0,73) and *light* (*r*= -0,73), and so on.

- The attitude *reliable-unreliable* is highly correlated with the attitudes *expensive-cheap* (*r*= 0,92), *serious-entertaining* (*r*= 0,85) and *high quality-poor quality* (*r*= 0,85). Among eight water bottles, the construing of *reliable* shows a tendency to be also perceived as *expensive, serious* and *high quality*. On the flipside, in eight water bottles, the construing of *unreliable* shows a tendency to be perceived as *cheap, entertaining* and *poor quality*. In addition, the construing of *reliable* is also associated with the perception of *shiny* (*r*= 0,81), *long lasting* (*r*= 0,80), *difficult* (*r*= -0,74), *wide* (*r*= 0,72) and *tight* (*r*= 0,71), and so on.
- The attitude *conductive-insulative* is highly correlated with the attitudes *hard-soft* (*r*= 0,72), and *sportive-formal* (*r*= -0,72). Among eight water bottles, the construing of *conductive* shows a tendency to be also perceived as *hard* and *formal*. On the flipside, in eight water bottles, the construing of *insulative* shows a tendency to be perceived as *soft* and *sportive*.
- The attitude *high quality-poor quality* is highly correlated with the attitudes *expensive-cheap* (*r*= 0,97), *reliable-unreliable* (*r*= 0,85) and *long lasting-short lived* (*r*= 0,84). Among eight water bottles, the construing of *high quality* shows a tendency to be also perceived as *expensive, reliable* and *long lasting*. On the flipside, in eight water bottles, the construing of *poor quality* shows a tendency to be perceived as *cheap, unreliable* and *short lived*. In addition, the construing of *high quality* is also associated with the perception of *flat* (*r*= 0,82), *wide* (*r*= 0,79), *serious* (*r*= 0,78) and *sharp* (*r*= -0,74), and so on.

- The attitude *flexible-solid* is highly correlated with the attitude *sportive-formal* (*r*= 0,86). Among eight water bottles, the construing of *flexible* shows a tendency to be also perceived as *sportive*. On the flipside, in eight water bottles, the construing of *solid* shows a tendency to be perceived as *formal*. In addition, the construing of *flexible* is also associated with the perception of *light* (*r*= -0,78) and *non hygienic* (*r*= -0,71), and so on.
- The attitude *amusing-boring* is highly correlated with the attitudes *directional-directionless* (*r*= 0,85), *calm-excited* (*r*= -0,81) and *cold-hot* (*r*= -0,79). Among eight water bottles, the construing of *amusing* shows a tendency to be also perceived as *directional, excited* and *hot*. On the flipside, in eight water bottles, the construing of *boring* shows a tendency to be perceived as *directionless, calm* and *cold*. In addition, the construing of *amusing* is also associated with the perception of *entertaining* (*r*= -0,79), *uneven* (*r*= -0,75), *rounded* (*r*= 0,72) and *silent* (*r*= -0,72), and so on.

Quadratic mean (root mean square) calculations were made to simplify the correlation matrix in Table 7.9 as the table was still complex even after the interpretation of the data. Quadratic mean calculations through the item correlation ratings within Component 1 can be seen in Table 7.10. According to the quadratic mean results, the attitude *long lasting-short lived* was found having the greatest average relation with all other attitudes, followed by *hard-soft, hygienic-non hygienic, natural-artificial, calm-excited* and *tight-loose.*

Table 7.10 Quadratic mean *(*RMS) scores for 28 items within Component 1

Attitudes	**Root Mean Square**
hard-soft	**0,80**
long lasting-short lived	**0,80**
easy-difficult	0,74
tight-loose	**0,75**
hygienic-non hygienic	**0,76**
calm-excited	**0,75**
natural-artificial	**0,76**
rounded-sharp	0,72
healthy-unhealthy	0,74
shiny-matte	0,72
directional-directionless	0,66
fresh-stale	0,73
difficult to use-user friendly	0,66
loud-silent	0,70
cold-hot	0,72
expensive-cheap	0,74
wide-narrow	0,73
heavy-light	0,65
sportive-formal	0,56
flat-uneven	0,64
deep-treble	0,68
serious-entertaining	0,68
ergonomic-non ergonomic	0,62
reliable-unreliable	0,63
conductive-insulative	0,52
high quality-poor quality	0,66
flexible-solid	0,46
amusing-boring	0,52
Average	0,68
Standard deviation	0,08

7.2.1.2 Correlations Between Items Within Component 2 (Assurance)

Component 2 consists of 22 common attitudes and correlations between them were calculated through Pearson’s product moment correlation coefficient. Correlation results can be seen in Table 7.11. The interpretation of the correlation matrix in Table 7.11 is listed below;

- The attitude *flimsy-durable* is highly correlated with the attitudes *stable-portable* (*r*= 0.94), *sweet-bitter* (*r*= 0.94) and *indoor-outdoor* (*r*= 0.90). Among eight water bottles, the construing of *flimsy* shows a tendency to be also perceived as *stable*, *sweet* and *indoor*. On the flipside, in eight water bottles, the construing of *durable* shows a tendency to be perceived as *portable*, *bitter* and *outdoor*. In addition, the construing of *flimsy* is also associated with the perception of *inactive* (r= 0.87), *transparent* (r= 0.85), *feminine* (r= 0.82) and *big* (r= 0.81), and so on.

- The attitude *stable-portable* is highly correlated with the attitudes *flimsy-durable* (r= 0.94), *indoor-outdoor* (r= 0.93), *discordant-coherent* (r= 0.90) and *handy-impractical* (r= -0.89). Among eight water bottles, the construing of *stable* shows a tendency to be also perceived as *flimsy*, *indoor*, *discordant* and *impractical*. On the flipside, in eight water bottles, the construing of *portable* shows a tendency to be perceived as *durable*, *outdoor*, *coherent* and *handy*. In addition, the construing of *stable* is also associated with the perception of *unnecessary* (r= 0.89), *sweet* (r= 0.86), *vulnerable* (r= -0.82), *feminine* (r= 0.80) and *uncomfortable* (r= -0.80), and so on.
- The attitude *sweet-bitter* is highly correlated with the attitudes *flimsy-durable* (r= 0.94), *stable-portable* (r= 0.86) and *transparent-opaque* (r= 0.85). Among eight water bottles, the construing of *sweet* shows a tendency to be also perceived as *flimsy*, *stable* and *transparent*. On the flipside, in eight water bottles, the construing of *bitter* shows a tendency to be perceived as *durable*, *portable* and *opaque*. In addition, the construing of *sweet* is also associated with the perception of *indoor* (r= 0.84), *big* (r= 0.75), *honest* (r= 0.73) and *easy to clean* (r= 0.73), and so on.
- The attitude *big-small* is highly correlated with the attitudes *relieving-irritating* (r= 0.85), *flimsy-durable* (r= 0.81) and *honest-dishonest* (r= 0.80). Among eight water bottles, the construing of *big* shows a tendency to be also perceived as *relieving*, *flimsy* and *honest*. On the flipside, in eight water bottles, the construing of *small* shows a tendency to be perceived as *irritating*, *durable* and *dishonest*. In addition, the construing

of *big* is also associated with the perception of *standard* (*r*= -0.78), *sweet* (*r*= 0.75), *distinct* (*r*= 0.75) and *inactive* (*r*= 0.72), and so on.

- The attitude *particular-standard* is highly correlated with the attitudes *inactive-dynamic* (*r*= -0.84), *protective-vulnerable* (*r*= 0.82) and *unnecessary-necessary* (*r*= -0.80). Among eight water bottles, the construing of *particular* shows a tendency to be also perceived as *dynamic, protective* and *necessary*. On the flipside, in eight water bottles, the construing of *standard* shows a tendency to be perceived as *inactive*, *vulnerable* and *unnecessary*. In addition, the construing of *particular* is also associated with the perception of *masculine* (*r*= -0.80), *durable* (*r*= -0.78), *portable* (*r*= -0.78) and *small* (*r*= -0.78), and so on.
- The attitude *honest-dishonest* is highly correlated with the attitudes *thin-thick* (*r*= -0.82), *flimsy-durable* (*r*= 0.81), *big-small* (*r*= 0.80) and *relieving-irritating* (*r*= 0.79). Among eight water bottles, the construing of *honest* shows a tendency to be also perceived as *thick*, *flimsy*, *big* and *relieving*. On the flipside, in eight water bottles, the construing of *dishonest* shows a tendency to be perceived as *thin*, *durable*, *small* and *irritating*. In addition, the construing of *honest* is also associated with the perception of *inactive* (*r*= 0.76), *stable* (*r*= 0.73) and *sweet* (*r*= 0.73), and so on.
- The attitude *inactive-dynamic* is highly correlated with the attitudes *feminine-masculine* (*r*= 0.96), *sincere-insincere* (*r*= 0.88) and *flimsy-durable* (*r*= 0.87). Among eight water bottles, the construing of *inactive* shows a tendency to be also perceived as *feminine, sincere* and *flimsy*. On the flipside, in eight water bottles, the construing of *dynamic* shows a tendency to be perceived as *masculine*, *insincere* and *durable*. In addition, the construing of *inactive* is also associated with the perception of *standard* (*r*= -0.84), *stable* (*r*= 0.79) and *indoor* (*r*= 0.79), and so on.

Table 7.11 Correlation matrix of 22 items within Component 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1.flimsy-durable	**1,00**	**0,94**	**0,94**	0,81	-0,78	0,81	0,87	-0,65	**0,90**	0,85	-0,75	0,72	0,80	0,81	0,82	0,62	-0,71	-0,67	0,61	-0,44	0,79	0,79
2.stable-portable	**0,94**	**1,00**	0,86	0,70	-0,78	0,73	0,79	-0,82	**0,93**	0,74	-0,89	0,50	0,89	**0,90**	0,80	0,43	-0,80	-0,62	0,56	-0,63	0,66	0,72
3.sweet-bitter	**0,94**	0,86	**1,00**	0,75	-0,61	0,73	0,66	-0,54	0,84	**0,85**	-0,63	0,62	0,69	0,72	0,61	0,70	-0,58	-0,63	0,73	-0,34	0,65	0,70
4.big-small	0,81	0,70	0,75	**1,00**	-0,78	0,80	0,72	-0,52	0,57	0,72	-0,38	**0,85**	0,61	0,55	0,66	0,75	-0,65	-0,46	0,62	-0,55	0,50	0,70
5.particular-standard	-0,78	-0,78	-0,61	-0,78	**1,00**	-0,58	**-0,84**	**0,82**	-0,70	-0,73	0,58	-0,70	**-0,80**	-0,75	**-0,80**	-0,46	0,67	0,25	-0,54	0,66	-0,52	-0,57
6.honest-dishonest	**0,81**	0,73	0,73	0,80	-0,58	**1,00**	0,76	-0,44	0,58	0,46	-0,65	0,79	0,43	0,40	0,69	0,67	-0,60	**-0,82**	0,27	-0,28	0,68	0,59
7.inactive-dynamic	**0,87**	0,79	0,66	0,72	**-0,84**	0,76	**1,00**	-0,55	0,79	0,66	-0,69	0,75	0,72	0,69	**0,96**	0,37	-0,70	-0,53	0,25	-0,32	**0,88**	0,76
8.protective-vulnerable	-0,65	**-0,82**	-0,54	-0,52	**0,82**	-0,44	-0,55	**1,00**	-0,67	-0,53	0,77	-0,31	-0,79	-0,79	-0,58	-0,29	0,65	0,27	-0,53	**0,83**	-0,24	-0,33
9.indoor-outdoor	**0,90**	**0,93**	0,84	0,57	-0,70	0,58	0,79	-0,67	**1,00**	0,75	-0,81	0,38	**0,91**	**0,93**	0,84	0,25	-0,80	-0,46	0,48	-0,44	0,72	**0,82**
10.transparent-opaque	**0,85**	0,74	**0,85**	0,72	-0,73	0,46	0,66	-0,53	0,75	**1,00**	-0,40	0,65	0,75	0,76	0,57	0,64	-0,43	-0,34	**0,85**	-0,40	0,61	0,65
11.handy-impractical	-0,75	**-0,89**	-0,63	-0,38	0,58	-0,65	-0,69	0,77	-0,81	-0,40	**1,00**	-0,27	-0,71	-0,74	-0,71	-0,18	0,68	0,67	-0,21	0,47	-0,60	-0,48
12.relieving-irritating	0,72	0,50	0,62	**0,85**	-0,70	0,79	0,75	-0,31	0,38	0,65	-0,27	**1,00**	0,32	0,28	0,59	**0,82**	-0,31	-0,53	0,44	-0,17	0,64	0,47
13.unnecessary-necessary	0,80	**0,89**	0,69	0,61	-0,80	0,43	0,72	-0,79	**0,91**	0,75	-0,71	0,32	**1,00**	**0,99**	0,79	0,17	-0,83	-0,26	0,56	-0,72	0,54	0,78
14.discordant-coherent	0,81	**0,90**	0,72	0,55	-0,75	0,40	0,69	-0,79	**0,93**	0,76	-0,74	0,28	0,99	**1,00**	0,75	0,17	-0,78	-0,30	0,58	-0,68	0,55	0,74
15.feminine-masculine	0,82	0,80	0,61	0,66	-0,80	0,69	**0,96**	-0,58	**0,84**	0,57	-0,71	0,59	0,79	0,75	**1,00**	0,19	**-0,84**	-0,41	0,16	-0,38	0,79	**0,82**
16.distinct-ambiguous	0,62	0,43	0,70	0,75	-0,46	0,67	0,37	-0,29	0,25	0,64	-0,18	**0,82**	0,17	0,17	0,19	**1,00**	-0,08	-0,54	0,71	-0,19	0,33	0,22
17.comfortable-	-0,71	**-0,80**	-0,58	-0,65	0,67	-0,60	-0,70	0,65	**-0,80**	-0,43	0,68	-0,31	**-0,83**	-0,78	**-0,84**	-0,08	**1,00**	0,29	-0,23	0,64	-0,45	-0,83
18.thin-thick	-0,67	-0,62	-0,63	-0,46	0,25	**-0,82**	-0,53	0,27	-0,46	-0,34	0,67	-0,53	-0,26	-0,30	-0,41	-0,54	0,29	**1,00**	-0,20	0,10	-0,68	-0,38
19.easy to clean-hard to	0,61	0,56	0,73	0,62	-0,54	0,27	0,25	-0,53	0,48	**0,85**	-0,21	0,44	0,56	0,58	0,16	0,71	-0,23	-0,20	**1,00**	-0,53	0,16	0,33
20.cool-despised	-0,44	-0,63	-0,34	-0,55	0,66	-0,28	-0,32	**0,83**	-0,44	-0,40	0,47	-0,17	-0,72	-0,68	-0,38	-0,19	0,64	0,10	-0,53	**1,00**	0,02	-0,36
21.sincere-insincere	**0,79**	0,66	0,65	0,50	-0,52	0,68	**0,88**	-0,24	0,72	0,61	-0,60	0,64	0,54	0,55	**0,79**	0,33	-0,45	-0,68	0,16	0,02	**1,00**	0,71
22.tall-short	0,79	0,72	0,70	0,70	-0,57	0,59	0,76	-0,33	**0,82**	0,65	-0,48	0,47	0,78	0,74	**0,82**	0,22	**-0,83**	-0,38	0,33	-0,36	0,71	**1,00**

- The attitude *protective-vulnerable* is highly correlated with the attitudes *cool-despised* (*r*= 0.83), *stable-portable* (*r*= -0.82) and *particular-standard* (*r*= 0.82). Among eight water bottles, the construing of *protective* shows a tendency to be also perceived as *cool*, *portable* and *particular*. On the flipside, in eight water bottles, the construing of *vulnerable* shows a tendency to be perceived as *despised*, *stable* and *standard*. In addition, the construing of *protective* is also associated with the perception of *necessary* (*r*= -0.79), *coherent* (*r*= -0.79) and *handy* (*r*= 0.77), and so on.
- The attitude *indoor-outdoor* is highly correlated with the attitudes *stable-portable* (*r*= 0.93), *discordant-coherent* (*r*= 0.93), *unnecessary-necessary* (*r*= 0.91) and *flimsy-durable* (*r*= 0.90). Among eight water bottles, the construing of *indoor* shows a tendency to be also perceived as *stable*, *discordant*, *unnecessary* and *flimsy*. On the flipside, in eight water bottles, the construing of *outdoor* shows a tendency to be perceived as *portable*, *coherent*, *necessary* and *durable*. In addition, the construing of *indoor* is also associated with the perception of *sweet* (*r*= 0.84), *feminine* (*r*= 0.84), *tall* (*r*= 0.82) and *impractical* (*r*= -0.81), and so on.

- The attitude *transparent-opaque* is highly correlated with the attitudes *flimsy-durable* (*r*= 0.85), *sweet-bitter* (*r*= 0.85), and *easy to clean-hard to clean* (*r*= 0.85). Among eight water bottles, the construing of *transparent* shows a tendency to be also perceived as *flimsy*, *sweet* and *easy to clean*. On the flipside, in eight water bottles, the construing of *opaque* shows a tendency to be perceived as *durable*, *bitter* and *hard to clean*. In addition, the construing of *transparent* is also associated with the perception of *discordant* (*r*= 0.76), *indoor* (*r*= 0.75), *unnecessary* (*r*= 0.75) and *stable* (*r*= 0.74), and so on.

- The attitude *handy-impractical* is highly correlated with the attitudes *stable-portable* (*r*= -0.89) and *indoor-outdoor* (*r*= -0.81). Among eight water bottles, the construing of *handy* shows a tendency to be also perceived as *portable* and *outdoor*. On the flipside, in eight water bottles, the construing of *impractical* shows a tendency to be perceived as *stable* and *indoor*. In addition, the construing of *handy* is also associated with the perception of *protective* (*r*= 0.77), *durable* (*r*= -0.75) and *coherent* (*r*= -0.74), and so on.
- The attitude *relieving-irritating* is highly correlated with the attitudes *big-small* (*r*= 0.85) and *distinct-ambiguous* (*r*= 0.82). Among eight water bottles, the construing of *relieving* shows a tendency to be also perceived as *big* and *distinct*. On the flipside, in eight water bottles, the construing of *irritating* shows a tendency to be perceived as *small* and *ambiguous*. In addition, the construing of *relieving* is also associated with the perception of *honest* (*r*= 0.79), *inactive* (*r*= 0.75), *flimsy* (*r*= 0.72) and *standard* (*r*= -0.70), and so on.
- The attitude *unnecessary-necessary* is highly correlated with the attitudes *discordant-coherent* (*r*= 0.99), *indoor-outdoor* (*r*= 0.91) and *stable-portable* (*r*= 0.89). Among eight water bottles, the construing of *unnecessary* shows a tendency to be also perceived as *discordant*, *indoor* and *stable*. On the flipside, in eight water bottles, the construing of *necessary* shows a tendency to be perceived as *coherent*, *outdoor* and *portable*. In addition, the construing of *unnecessary* is also associated with the perception of *uncomfortable* (*r*= -0.83), *flimsy* (*r*= 0.80), *standard* (*r*= -0.80) and *vulnerable* (*r*= -0.79), and so on.
- The attitude *discordant-coherent* is highly correlated with the attitudes *unnecessary-necessary* (*r*= 0.99), *indoor-outdoor* (*r*= 0.93) and stable-portable (*r*= 0.90). Among eight water bottles, the construing of *discordant* shows a tendency to be also perceived as *unnecessary*, *indoor* and *stable*. On the flipside, in eight water bottles, the construing of

coherent shows a tendency to be perceived as *necessary*, *outdoor* and *portable*. In addition, the construing of *discordant* is also associated with the perception of *flimsy* (*r*= 0.81), *vulnerable* (*r*= -0.79), *uncomfortable* (*r*= -0.78) and *transparent* (*r*= 0.76), and so on.

- The attitude *feminine-masculine* is highly correlated with the attitudes *inactive-dynamic* (*r*= 0.96), *indoor-outdoor* (*r*= 0.84), *comfortable-uncomfortable* (*r*= -0.84) and *flimsy-durable* (*r*= 0.82). Among eight water bottles, the construing of *feminine* shows a tendency to be also perceived as *inactive*, *indoor*, *uncomfortable* and *flimsy*. On the flipside, in eight water bottles, the construing of *masculine* shows a tendency to be perceived as *dynamic, outdoor, comfortable* and *durable*. In addition, the construing of *feminine* is also associated with the perception of *tall* (*r*= 0.82), *stable* (*r*= 0.80), *standard* (*r*= -0.80) and *sincere* (*r*= 0.79), and so on.
- The attitude *distinct-ambiguous* is highly correlated with the attitudes *relieving-irritating* (*r*= 0.82) and *big-small* (*r*= 0.75). Among eight water bottles, the construing of *distinct* shows a tendency to be also perceived as *relieving* and *big*. On the flipside, in eight water bottles, the construing of ambiguous shows a tendency to be perceived as *irritating* and *small*. In addition, the construing of *distinct* is also associated with the perception of *easy to clean* (*r*= 0.71) and *sweet* (*r*= 0.70), and so on.
- The attitude *comfortable-uncomfortable* is highly correlated with the attitudes *feminine-masculine* (*r*= -0.84), *unnecessary-necessary* (*r*= -0.83) and *tall-short* (*r*= -0.83). Among eight water bottles, the construing of *comfortable* shows a tendency to be also perceived as *masculine*, *necessary* and **short**. On the flipside, in eight water bottles, the construing of *uncomfortable* shows a tendency to be perceived as *feminine*, *unnecessary* and *tall*. In addition, the construing of *comfortable* is also associated with the perception of *portable* (*r*= -0.80), *outdoor* (*r*= -0.80) and *coherent* (*r*= -0.78), and so on.

- The attitude *thin-thick* is highly correlated with the attitude *honest-dishonest* (*r*= -0.82). Among eight water bottles, the construing of *thin* shows a tendency to be also perceived as *dishonest*. On the flipside, in eight water bottles, the construing of *thick* shows a tendency to be perceived as *honest*.
- The attitude *easy to clean-hard to clean* is highly correlated with the attitude *transparent-opaque* (*r*= 0.85). Among eight water bottles, the construing of *easy to clean* shows a tendency to be also perceived as *transparent*. On the flipside, in eight water bottles, the construing of *hard to clean* shows a tendency to be perceived as *opaque*. In addition, the construing of *easy to clean* is also associated with the perception of *sweet* (*r*= 0.73) and *distinct* (*r*= 0.71), and so on.
- The attitude *cool-despised* is highly correlated with the attitudes *protective-vulnerable* (*r*= 0.83) and *unnecessary-necessary* (*r*= -0.72). Among eight water bottles, the construing of *cool* shows a tendency to be also perceived as *protective* and *necessary*. On the flipside, in eight water bottles, the construing of *despised* shows a tendency to be perceived as *vulnerable* and *unnecessary*.
- The attitude *sincere-insincere* is highly correlated with the attitude *inactive-dynamic* (*r*= 0.88). Among eight water bottles, the construing of *sincere* shows a tendency to be also perceived as *inactive*. On the flipside, in eight water bottles, the construing of *insincere* shows a tendency to be perceived as *dynamic*. In addition, the construing of *sincere* is also associated with the perception of *flimsy* (*r*= 0.79), *feminine* (*r*= 0.79), *indoor* (*r*= 0.72) and *tall* (*r*= 0.71), and so on.
- The attitude *tall-short* is highly correlated with the attitudes *comfortable-uncomfortable* (*r*= -0.83), *indoor-outdoor* (*r*= 0.82), *feminine-masculine* (*r*= 0.82). Among eight water bottles, the construing of *tall* shows a tendency to be also perceived as *uncomfortable*, *indoor* and *feminine*. On the flipside, in eight water bottles, the construing of *short* shows a

tendency to be perceived as *comfortable*, *outdoor* and *masculine*. In addition, the construing of *tall* is also associated with the perception of *flimsy* (r= 0.79), *unnecessary* (r= 0.78), *inactive* (r= 0.76) and *discordant* (r= 0.74), and so on.

Quadratic mean calculations through the item correlation ratings within Component 2 can be seen in Table 7.12. According to the quadratic mean results, the attitude *flimsy-durable* was found having the greatest average relation with all other attitudes, followed by *stable-portable, indoor-outdoor, inactive-dynamic, sweet-bitter* and *unnecessary-necessary.*

Table 7.12 Quadratic mean *(*RMS) scores for 22 items within Component 2

Attitudes	**Root Mean Score**
flimsy-durable	**0,77**
stable-portable	**0,76**
sweet-bitter	**0,70**
big-small	0,66
particular-standard	0,68
honest-dishonest	0,63
inactive-dynamic	**0,70**
protective-vulnerable	0,60
indoor-outdoor	**0,72**
transparent-opaque	0,65
handy-impractical	0,62
relieving-irritating	0,56
unnecessary-necessary	**0,70**
discordant-coherent	0,69
feminine-masculine	0,69
distinct-ambiguous	0,48
comfortable-uncomfortable	0,64
thin-thick	0,49
easy to clean-hard to clean	0,50
cool-despised	0,48
sincere-insincere	0,60
tall-short	0,63
Average	0,63
Standard deviation	0,09

7.2.1.3 Correlations Between Items Within Component 3 (Familiarity)

Component 3 consists of 7 common attitudes and correlations between them were calculated through Pearson's product moment correlation coefficient. Correlation results can be seen in Table 7.13. The interpretation of the correlation matrix in Table 7.13 is listed below;

- The attitude *elaborated-sloppy* is highly correlated with the attitudes *new-old* (r= 0.87) and *fragmented-whole* (r= 0.87). Among eight water bottles, the construing of *elaborated* shows a tendency to be also perceived as *new* and *fragmented*. On the flipside, in eight water bottles, the construing of *sloppy* shows a tendency to be perceived as *old* and *whole*. In addition, the construing of *elaborated* is also associated with the perception of *eccentrical* (r= 0.78), *beautiful* (r= 0.75) and *pleasurable* (r= 0.71), and so on.
- The attitude *new-old* is highly correlated with the attitudes *elaborated-sloppy* (r= 0.87), *functional-functionless* (r= 0.87) and *beautiful-ugly* (r= 0.86). Among eight water bottles, the construing of *new* shows a tendency to be also perceived as *elaborated*, *functional* and *beautiful*. On the flipside, in eight water bottles, the construing of *old* shows a tendency to be perceived as *sloppy*, *functionless* and *ugly*. In addition, the construing of *new* is also associated with the perception of *fragmented* (r= 0.76) and *eccentrical* (r= 0.73), and so on.
- The attitude *eccentrical-accustomed* is highly correlated with the attitudes *elaborated-sloppy* (r= 0.78), *fragmented-whole* (r= 0.78), and *new-old* (r= 0.73). Among eight water bottles, the construing of eccentrical shows a tendency to be also perceived as *elaborated*, *fragmented* and *new*. On the flipside, in eight water bottles, the construing of *accustomed* shows a tendency to be perceived as *sloppy*, *whole* and *old*.
- The attitude *fragmented-whole* is highly correlated with the attitudes *elaborated-sloppy* (r= 0.87), *eccentrical-accustomed* (r= 0.78) and *new-old* (r= 0.76). Among eight water bottles, the construing of *fragmented* shows a

tendency to be also perceived as *elaborated*, *eccentrical* and *new*. On the flipside, in eight water bottles, the construing of *whole* shows a tendency to be perceived as *sloppy*, *accustomed* and *old*.

- The attitude *functional-functionless* is highly correlated with the attitudes *new-old* (r= 0.87) and *beautiful-ugly* (r= 0.80). Among eight water bottles, the construing of *functional* shows a tendency to be also perceived as *new* and *beautiful*. On the flipside, in eight water bottles, the construing of *functionless* shows a tendency to be perceived as *old* and *ugly*.
- The attitude *beautiful-ugly* is highly correlated with the attitudes *new-old* (r= 0.86), *functional-functionless* (r= 0.80) and *elaborated-sloppy* (r= 0.75). Among eight water bottles, the construing of *beautiful* shows a tendency to be also perceived as *new*, *functional* and *elaborated*. On the flipside, in eight water bottles, the construing of *ugly* shows a tendency to be perceived as *old*, *functionless* and *sloppy*.
- The attitude *pleasurable-dissatisfactory* is highly correlated with the attitude *elaborated-sloppy* (r= 0.71). Among eight water bottles, the construing of *pleasurable* shows a tendency to be also perceived as *elaborated*. On the flipside, in eight water bottles, the construing of *dissatisfactory* shows a tendency to be perceived as *sloppy*.

Table 7.13 Correlation matrix of 7 items within Component 3

	1	**2**	**3**	**4**	**5**	**6**	**7**
elaborated-sloppy	**1,00**	**0,87**	0,78	**0,87**	0,66	0,75	0,71
new-old	**0,87**	**1,00**	0,73	0,76	**0,87**	**0,86**	0,59
eccentrical-accustomed	**0,78**	0,73	**1,00**	**0,78**	0,66	0,51	0,14
fragmented-whole	**0,87**	0,76	0,78	**1,00**	0,55	0,66	0,52
functional-functionless	0,66	**0,87**	0,66	0,55	**1,00**	0,80	0,24
beautiful-ugly	0,75	**0,86**	0,51	0,66	**0,80**	**1,00**	0,57
pleasurable-dissatisfactory	**0,71**	0,59	0,14	0,52	0,24	0,57	**1,00**

Quadratic mean calculations through the item correlation ratings within Component 3 can be seen in Table 7.14. According to the quadratic mean results, the attitude *new-old* was found having the greatest average relation with all other attitudes, followed by *elaborated-sloppy.*

Table 7.14 Quadratic mean *(*RMS) scores for 7 items within Component 3

Attitudes	**Root Mean Score**
elaborated-sloppy	**0,78**
new-old	**0,79**
eccentrical-accustomed	0,64
fragmented-whole	0,70
functional-functionless	0,66
beautiful-ugly	0,70
pleasurable-dissatisfactory	0,50
Average	0,68
Standard deviation	0,09

7.2.1.4 Correlations Between Items Within Component 4 (Elegancy)

Component 4 consists of 10 common attitudes and correlations between them were calculated through Pearson's product moment correlation coefficient. Correlation results can be seen in Table 7.15Table 7.13. The interpretation of the correlation matrix in Table 7.15 is listed below;

- The attitude *attractive-unattractive* has only slight and moderate correlations (r is below 0.70) with the other attitudes in the same component[48] and none of these correlations were accepted as significant (r is above 0.70).
- The attitude *vivid-pale* is highly correlated with the attitude *ornate-plain* (*r*= 0.86). Among eight water bottles, the construing of *vivid* shows a tendency to be also perceived as *ornate*. On the flipside, in eight water bottles, the

[48] Although the attitude *attractive-unattractive* has no significant correlations within Component 3, it is correlated with the attitude *cool-despised* (*r*= 0.70), which is located in Component 2. This is an expected result when the components are correlated.

construing of *pale* shows a tendency to be perceived as *plain*. In addition, the construing of *vivid* is also associated with the perception of *childish* (r= 0.77) and *complex* (r= 0.71), and so on.

- The attitude *rough-smooth* is highly correlated with the attitudes *non slippery-slippery* (r= 0.93). Among eight water bottles, the construing of *rough* shows a tendency to be also perceived as *non slippery*. On the flipside, in eight water bottles, the construing of *smooth* shows a tendency to be perceived as *slippery*. In addition, the construing of *rough* is also associated with the perception of *complex* (r= 0.79), *unsteady* (r= 0.78), *childish* (r= 0.78) and *ornate* (r= 0.77), and so on.
- The attitude *non slippery-slippery* is highly correlated with the attitude *rough-smooth* (r= 0.93). Among eight water bottles, the construing of *non slippery* shows a tendency to be also perceived as *rough*. On the flipside, in eight water bottles, the construing of *slippery* shows a tendency to be perceived as *smooth*. In addition, the construing of *non slippery* is also associated with the perception of *complex* (r= 0.72), and so on.

Table 7.15 Correlation matrix of 10 items within Component 4

	1	2	3	4	5	6	7	8	9	10
attractive-unattractive	**1,00**	0,62	0,45	0,40	-0,65	-0,49	0,33	0,28	0,26	0,15
vivid-pale	0,62	**1,00**	0,64	0,50	-0,37	-0,62	**0,86**	0,71	0,59	**0,77**
rough-smooth	0,45	0,64	**1,00**	**0,93**	-0,46	-0,55	0,77	**0,79**	0,78	0,78
non slippery-slippery	0,40	0,50	**0,93**	**1,00**	-0,54	-0,44	0,60	0,72	0,58	0,65
controlled-uncontrolled	-0,65	-0,37	-0,46	-0,54	**1,00**	**0,78**	-0,15	-0,07	-0,19	-0,10
coarse-gracious	-0,49	-0,62	-0,55	-0,44	**0,78**	**1,00**	-0,43	-0,16	-0,60	-0,50
ornate-plain	0,33	**0,86**	0,77	0,60	-0,15	-0,43	**1,00**	**0,91**	0,63	**0,84**
complex-simple	0,28	0,71	**0,79**	0,72	-0,07	-0,16	**0,91**	**1,00**	0,51	0,75
unsteady-steady	0,26	0,59	**0,78**	0,58	-0,19	-0,60	0,63	0,51	**1,00**	**0,82**
childish-mature	0,15	0,77	0,78	0,65	-0,10	-0,50	**0,84**	0,75	**0,82**	**1,00**

- The attitude *controlled-uncontrolled* is highly correlated with the attitude *coarse-gracious* (r= 0.78). Among eight water bottles, the construing of *controlled* shows a tendency to be also perceived as *coarse*. On the flipside, in eight water bottles, the construing of *uncontrolled* shows a tendency to be perceived as *gracious*.

- The attitude *coarse-gracious* is highly correlated with the attitude *controlled-uncontrolled* (r= 0.78). Among eight water bottles, the construing of *coarse* shows a tendency to be also perceived as *controlled*. On the flipside, in eight water bottles, the construing of *gracious* shows a tendency to be perceived as *uncontrolled*.
- The attitude *ornate-plain* is highly correlated with the attitudes *complex-simple* (r= 0.91), *vivid-pale* (r= 0.86) and *childish-mature* (r= 0.84). Among eight water bottles, the construing of *ornate* shows a tendency to be also perceived as *complex, vivid* and *childish*. On the flipside, in eight water bottles, the construing of *plain* shows a tendency to be perceived as *simple, pale* and *mature*. In addition, the construing of *ornate* is also associated with the perception of *rough* (r= 0.77), and so on.
- The attitude *complex-simple* is highly correlated with the attitude *ornate-plain* (r= 0.91). Among eight water bottles, the construing of *complex* shows a tendency to be also perceived as *ornate*. On the flipside, in eight water bottles, the construing of *simple* shows a tendency to be perceived as *plain*. In addition, the construing of *complex* is also associated with the perception of *rough* (r= 0.79), *childish* (r= 0.75), *non slippery* (r= 0.72) and *vivid* (r= 0.71), and so on.
- The attitude *unsteady-steady* is highly correlated with the attitudes *childish-mature* (r= 0.82) and *rough-smooth* (r= 0.78). Among eight water bottles, the construing of *unsteady* shows a tendency to be also perceived as *childish* and *rough.* On the flipside, in eight water bottles, the construing of *steady* shows a tendency to be perceived as *mature* and *smooth*.
- The attitude *childish-mature* is highly correlated with the attitudes *ornate-plain* (r= 0.84) and *unsteady-steady* (r= 0.82). Among eight water bottles, the construing of *childish* shows a tendency to be also perceived as *ornate* and *unsteady*. On the flipside, in eight water bottles, the construing of *mature*

shows a tendency to be perceived as *plain* and *steady*. In addition, the construing of *childish* is also associated with the perception of *rough* (*r*= 0.78), *vivid* (*r*= 0.77) and *complex* (*r*= 0.75), and so on.

Quadratic mean calculations through the item correlation ratings within Component 4 can be seen in Table 7.16. According to the quadratic mean results, the attitude *rough-smooth* was found having the greatest average relation with all other attitudes.

Table 7.16 Quadratic mean *(*RMS) scores for 7 items within Component 4

Average	Root Mean Square
attractive-unattractive	0,43
vivid-pale	0,64
rough-smooth	**0,70**
non slippery-slippery	0,62
controlled-uncontrolled	0,44
coarse-gracious	0,53
ornate-plain	0,66
complex-simple	0,62
unsteady-steady	0,58
childish-mature	0,66
Average	0,59
Standard deviation	0,09

7.2.2 Relationships Between Water Bottles Using Hierarchical Cluster Analysis

Following the investigation of relationships between attitudes, the similarities between water bottles were examined. As previously discussed in the first experiment, hierarchical cluster analysis was adopted to find out similarities between elements (see Section 6.2.2). Again, Ward's method (minimum variance) and Euclidean distances were used to create dendrograms of similarities for each component separately. In the next step, dendrograms of water bottles were prepared within each component. R Studio software was used for applying hierarchical cluster analysis and preparing dendrograms. Further, semantic differential charts of similar water bottle pairs were drawn for a better understanding of how participants construed water bottles depending on their material qualities. Also, a statistical calculation and graph creation software, XLSTAT for Excel[49], was used for preparing semantic differential charts.

7.2.2.1 Hierarchical Cluster Analysis Results of Water Bottles Within Component 1

Hierarchical cluster analysis of the water bottles was performed using R statistics software based on the participant ratings of the 28 attitudes within Component 1. Ward's minimum variance method was selected to search for maximum homogeneity between clusters. Analysis results can be seen as dendrogram in Figure 7.1.

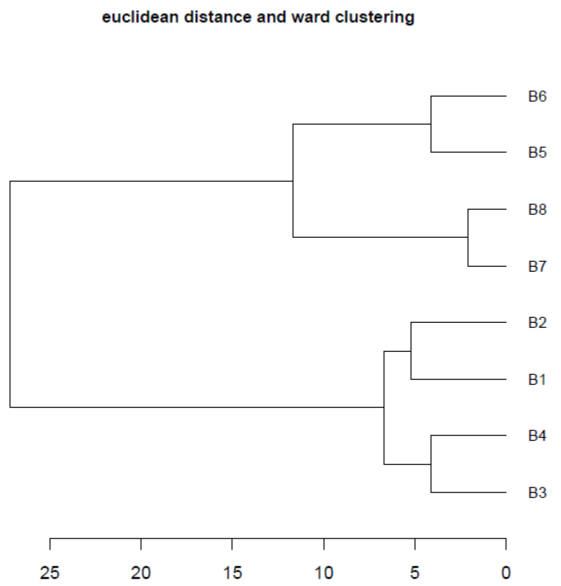

Figure 7.1 Hierarchical cluster analysis results of water bottles within Component 1

[49] Developed by Addinsoft, XLSTAT is an add on software for Excel, which offers practical results for data statistics and representations. XLSTAT can be downloaded from https://www.xlstat.com/

In the dendrogram, horizontal lines represent the height, which is the measure of closeness between clusters and vertical lines indicate where the clusters are merged. According to the analysis results, B8 and B7 were found as the most similar water bottle pair, followed by B6 and B5. Also the similarity level between B4 and B3 were found nearly equal with the similarity level between B6 and B5. Moreover, another similarity was found between B1 and B2, yet this similarity is lesser compared to the other pairs. Figure 7.2 shows the clusters of similarly perceived water bottles.

Figure 7.2 Clusters of water bottles perceived similar within Component 1

Figure 7.3 contains the semantic differential graph of B5 and B6, based on participant ratings on eight water bottles through 28 attitudes within Component 1. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Both water bottles seem to have similar ratings on all of the attitudes and ratings are slightly scattered. Most distinguishably, both of the water bottles were perceived extremely *heavy*, *healthy* and *fresh*. Further, both bottles were rated nearly identical as quite *natural* and quite *tight.* The chart shows that B5 and B6 were perceived similarly in most of the attitudes. Yet, the two water bottles slightly differ in *hardness, sharpness, egonomicness, coldness* and *conductiveness*. Moreover, both bottles were perceived differently through the attitudes *amusing-boring*, *ergonomic-non ergonomic*, *loud-silent* and *rounded-sharp*. B5 was perceived quite *reliable, quite silent* and quite *amusing*, whereas B6 was perceived slightly *loud*, slightly *boring*, quite *non ergonomic* and quite *calm*.

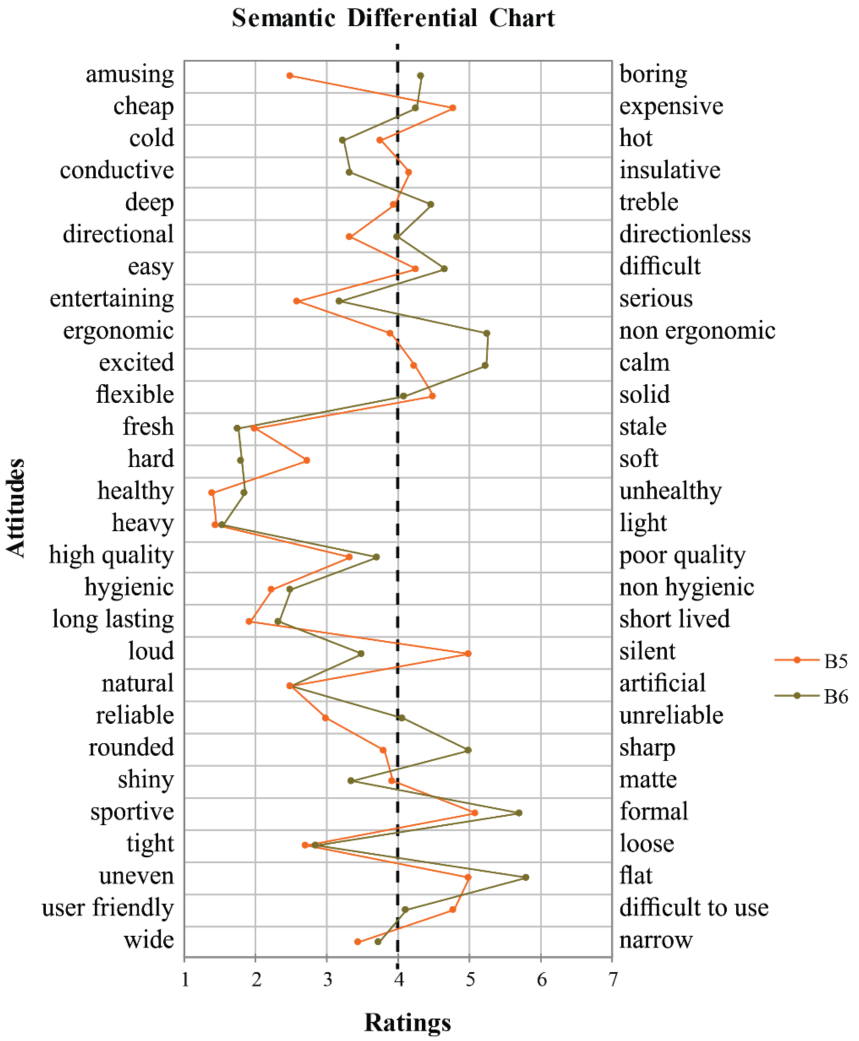

Figure 7.3 Semantic differential chart of B5 and B6 within Component 1

Figure 7.4 contains the semantic differential graph of B1 and B2, based on participant ratings on eight water bottles through 28 attitudes within Component 1. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Although B1 and B2 were found similar in hierarchical cluster analysis, the similarity is limited because the distance among bottle pairs is not close. Because of that, most of the attitudinal ratings are seen scattered on the semantic differential chart. Besides, both water bottles seem to be perceived very similarly as extremely *entertaining*, quite *stale*, quite *deep* and slightly *unreliable*. The chart shows that B1 and B2 were perceived similarly in most of the attitudes. Yet, the two water bottles significantly differ in some attitudes. B1 was perceived extremely *sportive*, extremely *user friendly*, quite *flat* and quite *loose*, whereas B2 was perceived extremely *cheap*, extremely *poor quality*, extremely *light* and quite *uneven.* Moreover, B1 was perceived neither *high quality* nor *poor quality*, and B2 was perceived neither *sportive* nor *formal*.

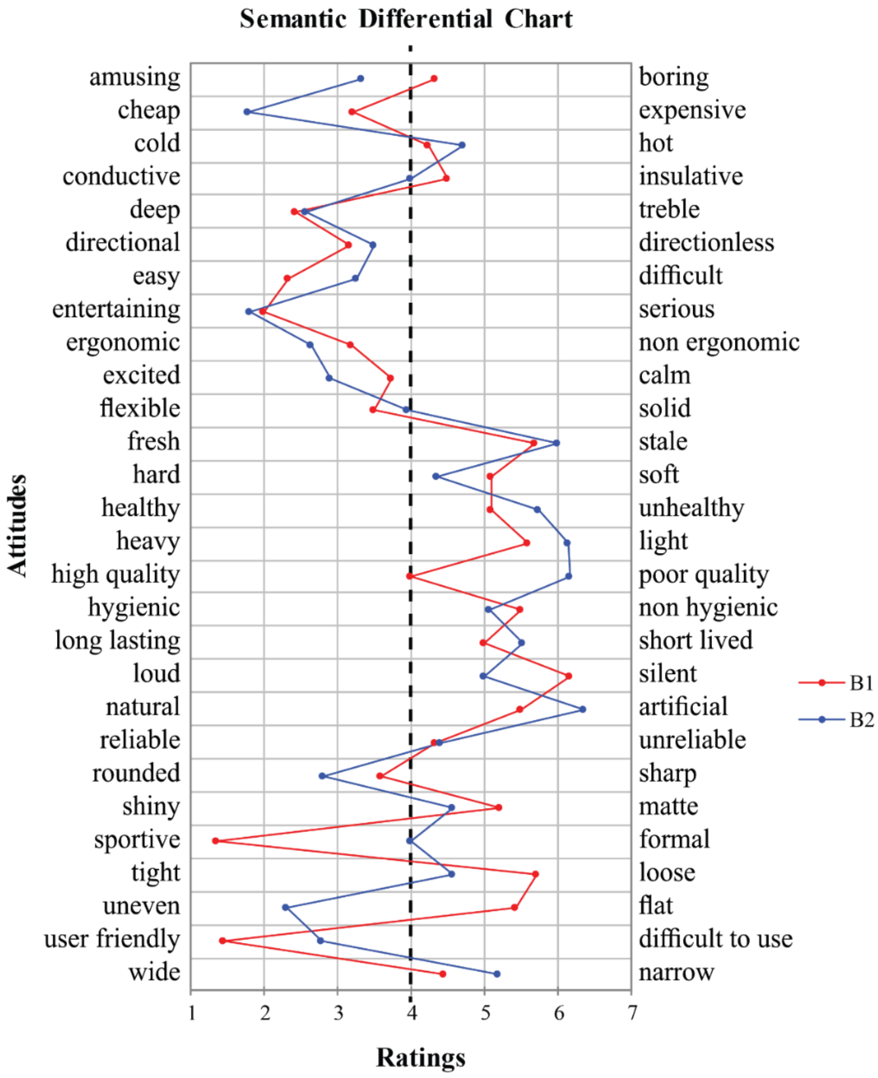

Figure 7.4 Semantic differential chart of B1 and B2 within Component 1

Figure 7.5 contains the semantic differential graph of B7 and B8, based on participant ratings on eight water bottles through 28 attitudes within Component 1. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale.

Both water bottles seem to have very close ratings on most of the attitudes and some ratings are nearly identical. Most distinguishably, both of the water bottles were perceived nearly identical as extremely *serious,* extremely *flat,* quite *treble,* quite *tight,* quite *reliable*, quite *natural*, quite *wide*, quite *fresh*, quite *directionless,* slightly *difficult,* neither *conductive* nor *insulative* and neither *sportive* nor *formal*. Yet, two water bottles slightly differ in some attitudes. B8 was perceived *shinier* than B7 and B7 was found more *boring*, *expensive*, *cold*, *calm* and *hard* compared to B8.

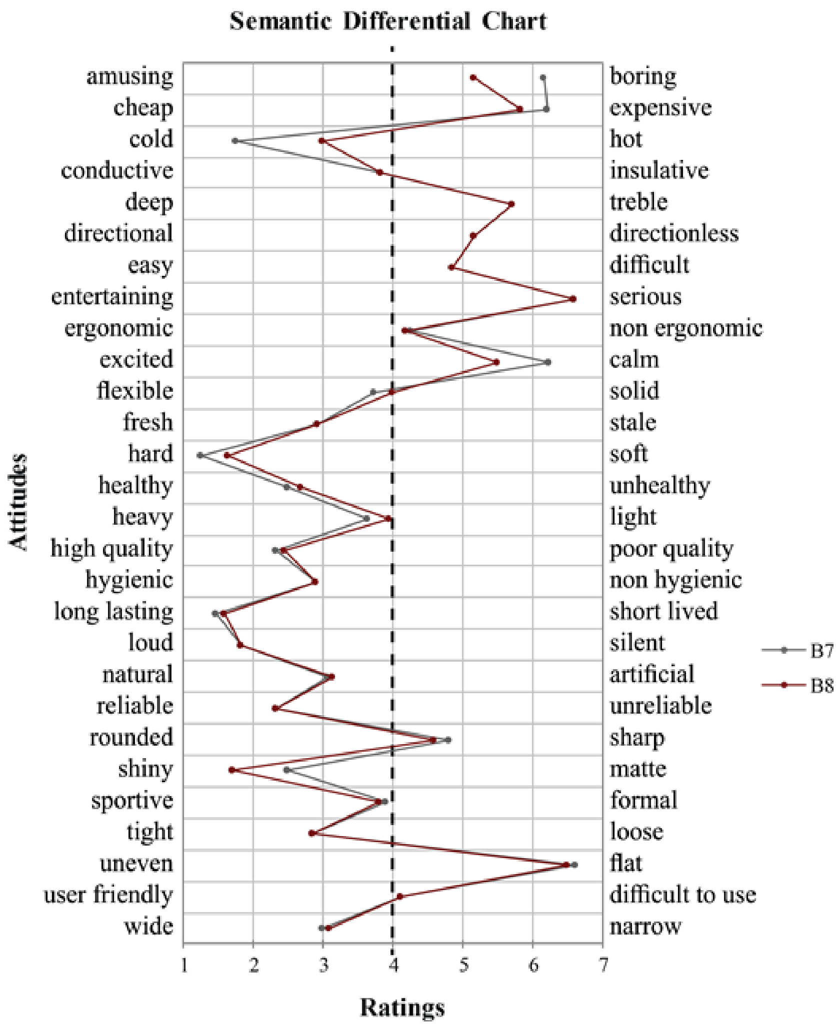

Figure 7.5 Semantic differential chart of B7 and B8 within Component 1

Figure 7.6 contains the semantic differential graph of B3 and B4, based on participant ratings on eight water bottles through 28 attitudes within Component 1.

The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Although B3 and B4 were found similar in hierarchical cluster analysis, the similarity is limited because the distance among bottle pairs is not close. Because of that, some of the attitudinal ratings are seen scattered on the semantic differential chart. Most distinguishably, both of the water bottles were perceived nearly identical as quite *light* (opposite of *heavy*), quite *excited*, slightly *unhealthy*, neither *shiny* nor *matte* and neither *conductive* nor *insulative.* Yet, the two water bottles slightly differ in some attitudes. B3 was perceived slightly *expensive*, quite *deep*, quite *ergonomic*, slightly *high quality*, quite *silent*, quite *reliable*, slightly *hot* and slightly *narrow*. On the other hand, B4 was perceived quite *uneven*, quite *user friendly*, quite *treble*, quite *easy*, slightly *cheap* and slightly *poor quality.*

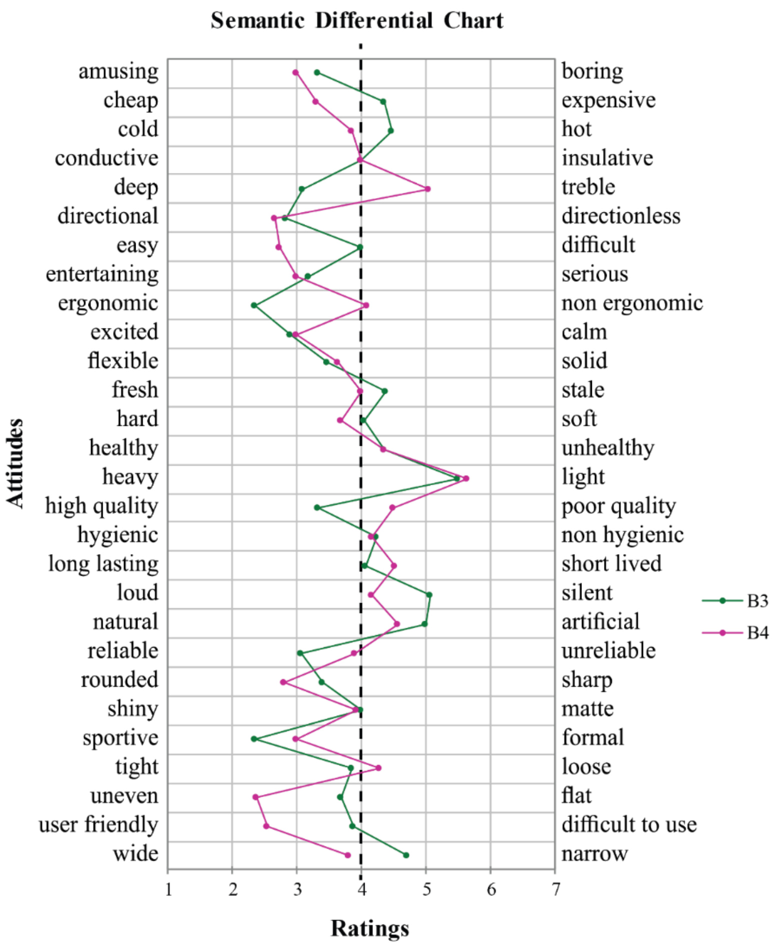

Figure 7.6 Semantic differential chart of B3 and B4 within Component 1

7.2.2.2 Hierarchical Cluster Analysis Results of Water Bottles Within Component 2

Hierarchical cluster analysis of the water bottles was performed using R statistics software based on the participant ratings of the 22 attitudes within Component 2. Ward's minimum variance method was selected to search for maximum homogeneity between clusters. Analysis results can be seen as dendrogram in Figure 7.7.

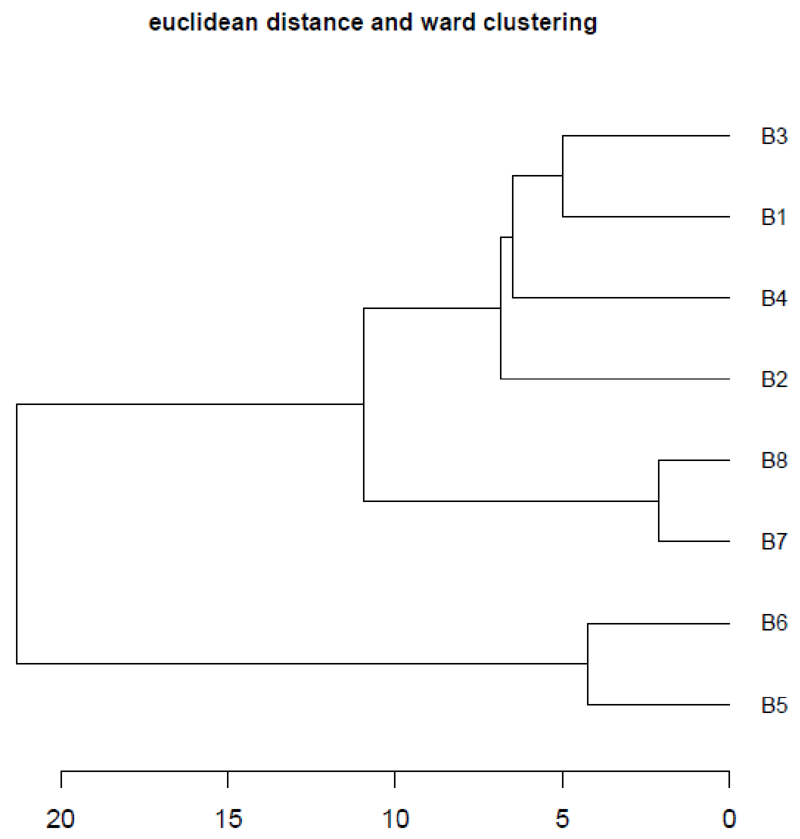

Figure 7.7 Hierarchical cluster analysis results of water bottles within Component 2

In the dendrogram, horizontal lines represent the height, which is the measure of closeness between clusters and vertical lines indicate where the clusters are merged. According to the analysis results, B8 and B7 were found as the most similar water bottle pair, followed by B6 and B5. Also another similarity was found between B1 and B3, yet this similarity is lesser compared to the other pairs. Figure 7.8 shows the clusters of similarly perceived water bottles.

Figure 7.8 Clusters of water bottles perceived similar within Component 2

Figure 7.9 contains the semantic differential graph of B1 and B3, based on participant ratings on eight water bottles through 22 attitudes within Component 2. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Although B1 and B3 were found similar in hierarchical cluster analysis, the similarity is limited because the distance among bottle pairs is not close. Because of that, some of the attitudinal ratings are seen scattered on the semantic differential chart. Most distinguishably, both of the water bottles were perceived nearly identical as quite *masculine,* quite *irritating,* quite *excited* and neither *easy to clean* nor *hard to clean.* Yet, the two water bottles were perceived differently in some attitudes. B1 was perceived extremely *opaque*, extremely *dynamic,* quite *honest* and slightly *insincere,* whereas B3 was perceived quite *cool,* quite *protective,* quite *portable,* slightly *transparent* and slightly *sincere.*

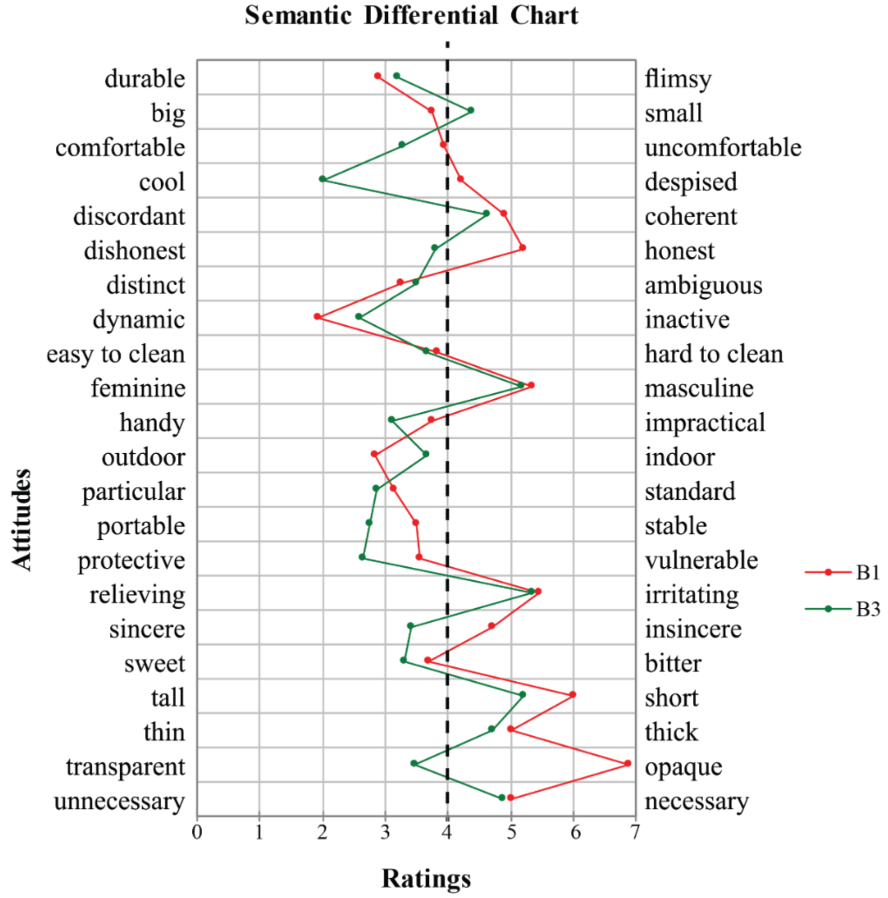

Figure 7.9 Semantic differential chart of B1 and B3 within Component 2

Figure 7.10 contains the semantic differential graph of B7 and B8, based on participant ratings on eight water bottles through 22 attitudes within Component 2. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. As can be seen from the chart, both water bottles were perceived very similarly on most of the attitudes. Most distinguishably, both of the water bottles were perceived nearly identical as extremely *opaque,* extremely *portable,* quite *coherent,* quite *necessary,* quite *handy,* quite *dynamic,* quite *protective,* slightly *distinct,* slightly *hard to clean,* slightly *particular* and neither *dishonest* nor *honest.* Yet, the two water bottles were perceived slightly different in some attitudes. B7 was perceived more *masculine*, more *outdoor*, more *bitter* and less *cool* than B8.

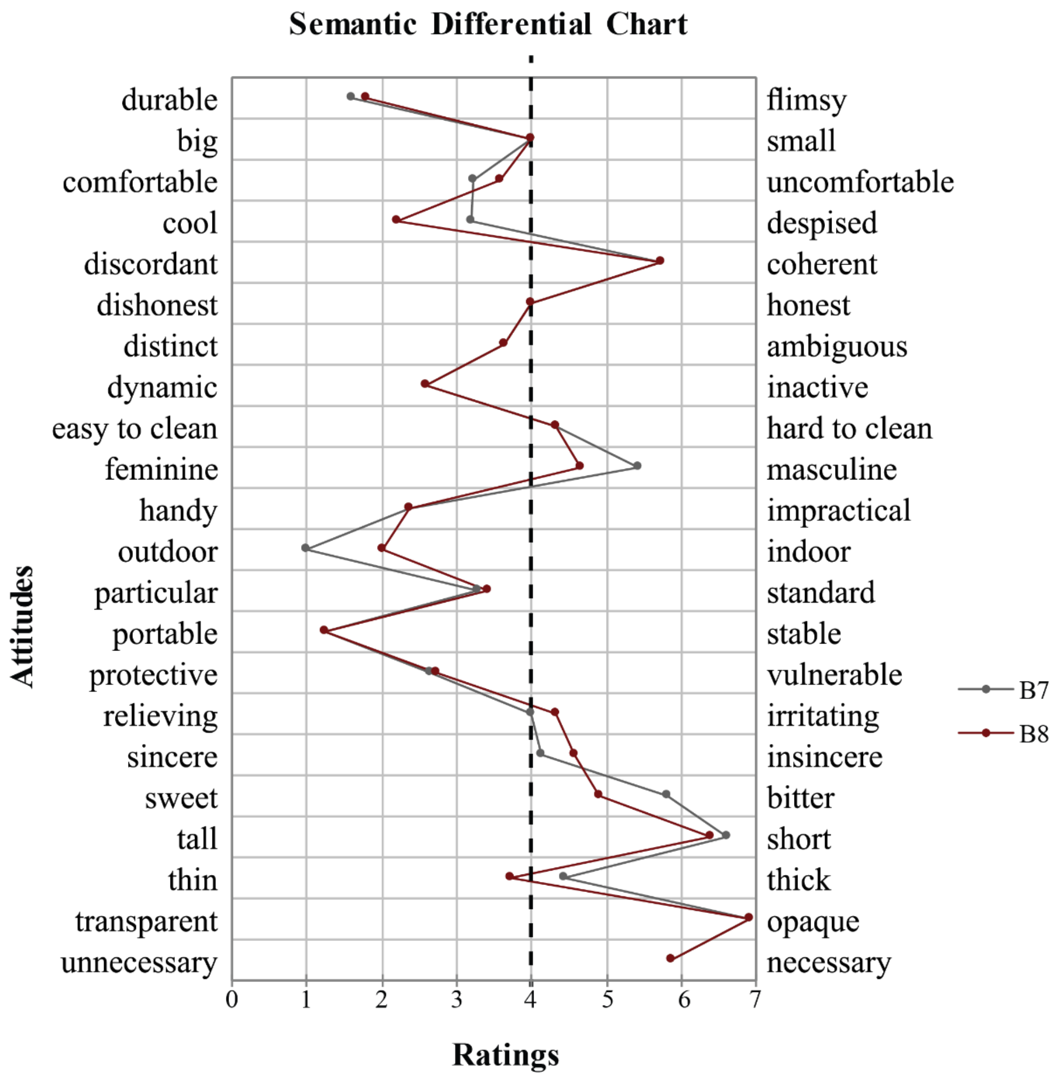

Figure 7.10 Semantic differential chart of B7 and B8 within Component 2

Figure 7.11 contains the semantic differential graph of B5 and B6, based on participant ratings on eight water bottles through 22 attitudes within Component 2. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. As can be seen from the chart, both water bottles were perceived very similarly on most of the attitudes. Most distinguishably, both of the water bottles were perceived nearly identical as extremely *honest*, extremely *relieving*, extremely *feminine*, extremely *sweet*, quite *thick*, quite *distinct* and slightly *easy to clean*. Moreover, both water bottles were perceived similarly as extremely *transparent*, quite *flimsy*, quite *big* and slightly *uncomfortable*. Yet, the two water bottles were perceived slightly different in some attitudes. B5 was perceived more *handy*, *taller*, more *protective*, yet less *stable* and less *standard* than B6.

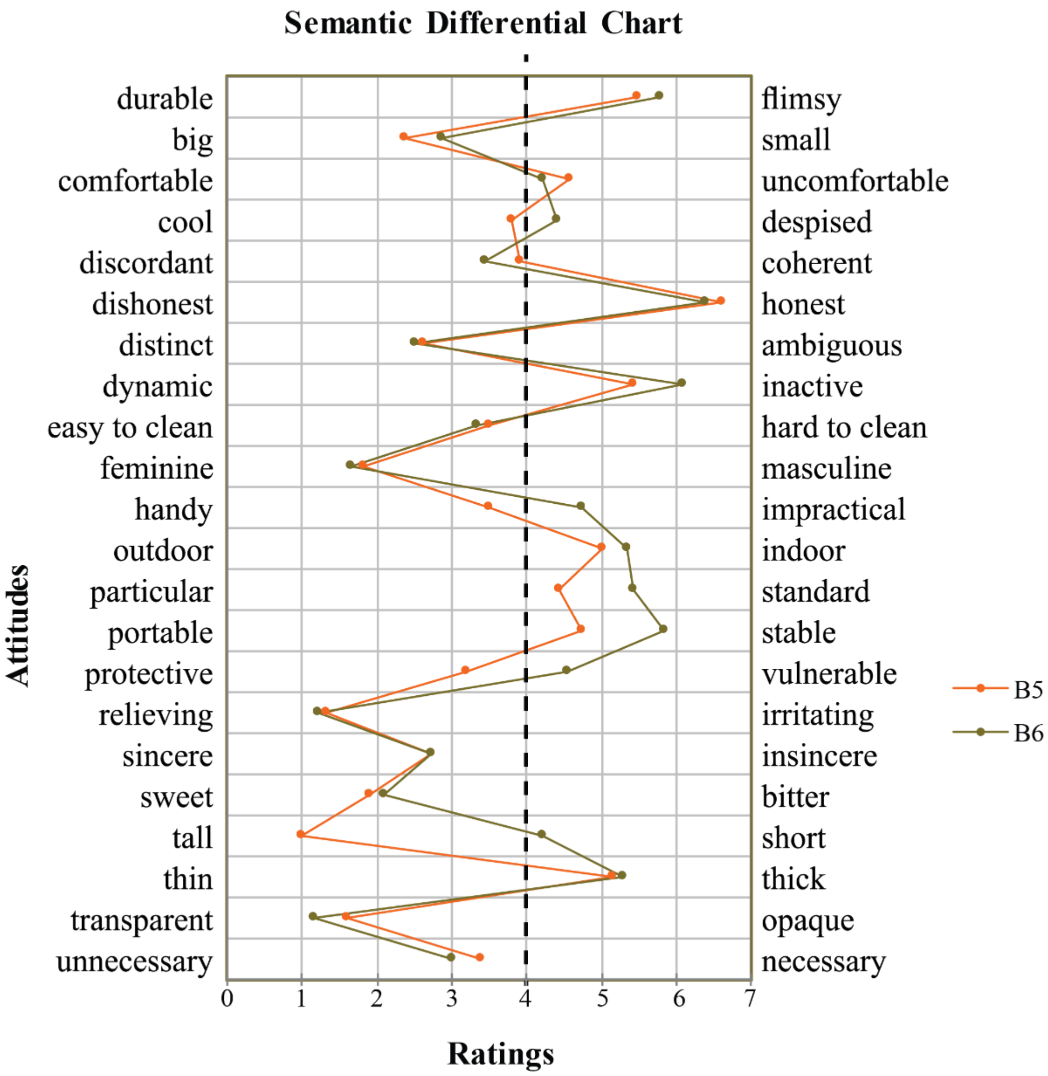

Figure 7.11 Semantic differential chart of B5 and B6 within Component 2

7.2.2.3 Hierarchical Cluster Analysis Results of Water Bottles Within Component 3

Hierarchical cluster analysis of the water bottles was performed using R statistics software based on the participant ratings of the 7 attitudes within Component 3. Ward's minimum variance method was selected to search for maximum homogeneity between clusters. Analysis results can be seen as dendrogram in Figure 7.12.

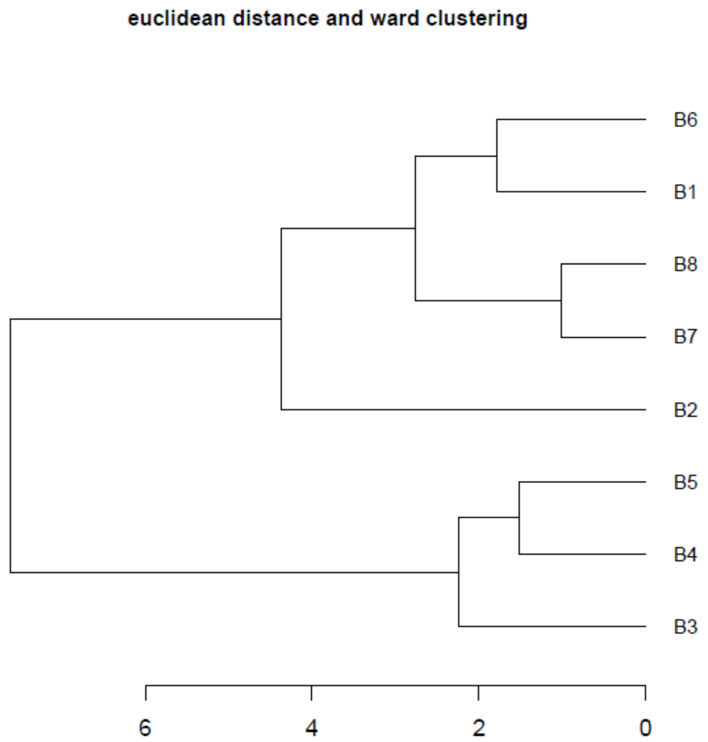

Figure 7.12 Hierarchical cluster analysis results of water bottles within Component 3

In the dendrogram, horizontal lines represent the height, which is the measure of closeness between clusters and vertical lines indicate where the clusters are merged. According to the analysis results, B8 and B7 were found as the most similar water bottle pair, followed by B5 and B4. Also another similarity was found between B6 and B1, yet this similarity is lesser compared to the other pairs. Figure 7.13 shows the clusters of similarly perceived water bottles.

Figure 7.13 Clusters of water bottles perceived similar within Component 3

Figure 7.14 contains the semantic differential graph of B4 and B5, based on participant ratings on eight water bottles through 7 attitudes within Component 3. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. As can be seen from the chart, both water bottles were perceived very similarly on most of the attitudes. Most distinguishably, both of the water bottles were perceived nearly identical as quite *fragmented*, quite *new* and quite *functional*. Moreover, both water bottles were perceived similarly as slightly *elaborated*. Yet, the two water bottles were perceived slightly differently in some attitudes. B4 was perceived quite *eccentrical*, slightly *dissatisfactory* and slightly *beautiful*, whereas B5 was perceived slightly *pleasurable*, neither *beautiful* nor *ugly* and neither *accustomed* nor *eccentrical*.

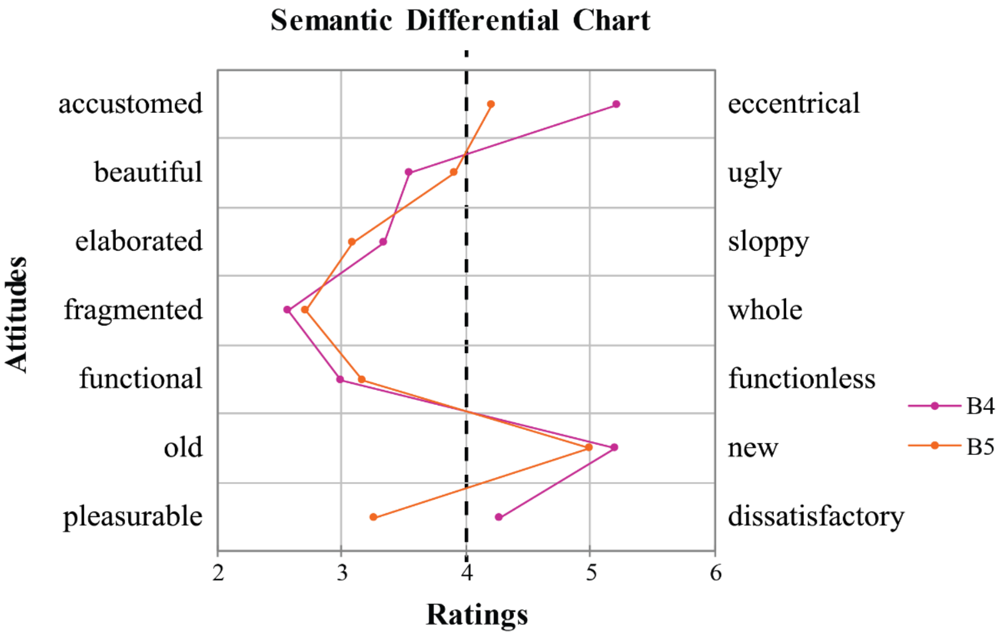

Figure 7.14 Semantic differential chart of B4 and B5 within Component 3

Figure 7.15 contains the semantic differential graph of B1 and B6, based on participant ratings on eight water bottles through 7 attitudes within Component 3. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Although B1 and B6 were found similar in hierarchical cluster analysis, the similarity is limited because the distance among bottle pairs is not close. Because of that, some of the attitudinal ratings are seen scattered on the semantic differential chart. As can be seen from the chart, both water bottles were perceived very similarly on most of the attitudes. Both of the water bottles were perceived nearly identical as neither *elaborated* nor *sloppy*. Moreover, both water bottles were perceived similarly as quite *accustomed*, slightly *pleasurable* and neither *old* nor *new*. Yet, the two water bottles were perceived differently in some attitudes. B1 was perceived slightly *whole* and slightly *ugly*, whereas B6 was perceived slightly *fragmented* and slightly *functionless*.

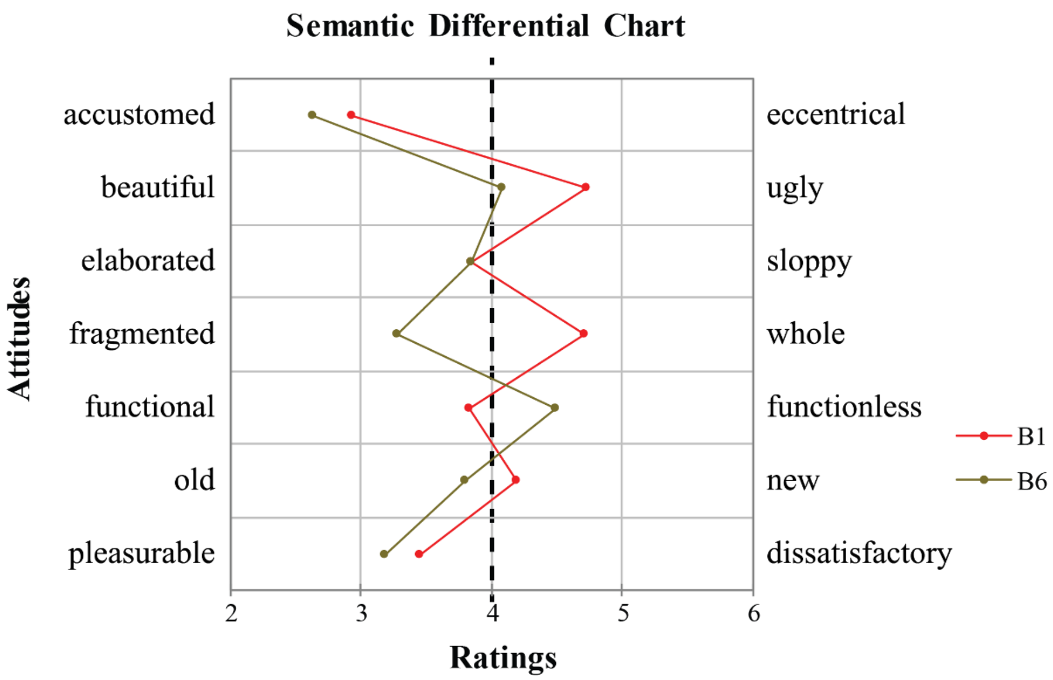

Figure 7.15 Semantic differential chart of B1 and B6 within Component 3

Figure 7.16 contains the semantic differential graph of B7 and B8, based on participant ratings on eight water bottles through 7 attitudes within Component 3. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. As can be seen from the chart, both water bottles were perceived very similarly on most of the attitudes. Both of the water bottles were perceived nearly identical as slightly *beautiful*, neither *elaborated* nor *sloppy* and neither *fragmented* nor *whole.* Moreover, both water bottles were perceived similarly as slightly *accustomed* and slightly *functional*. Yet, the two water bottles perceived slightly different in some attitudes. B8 was perceived more *pleasurable* and *newer* than B7.

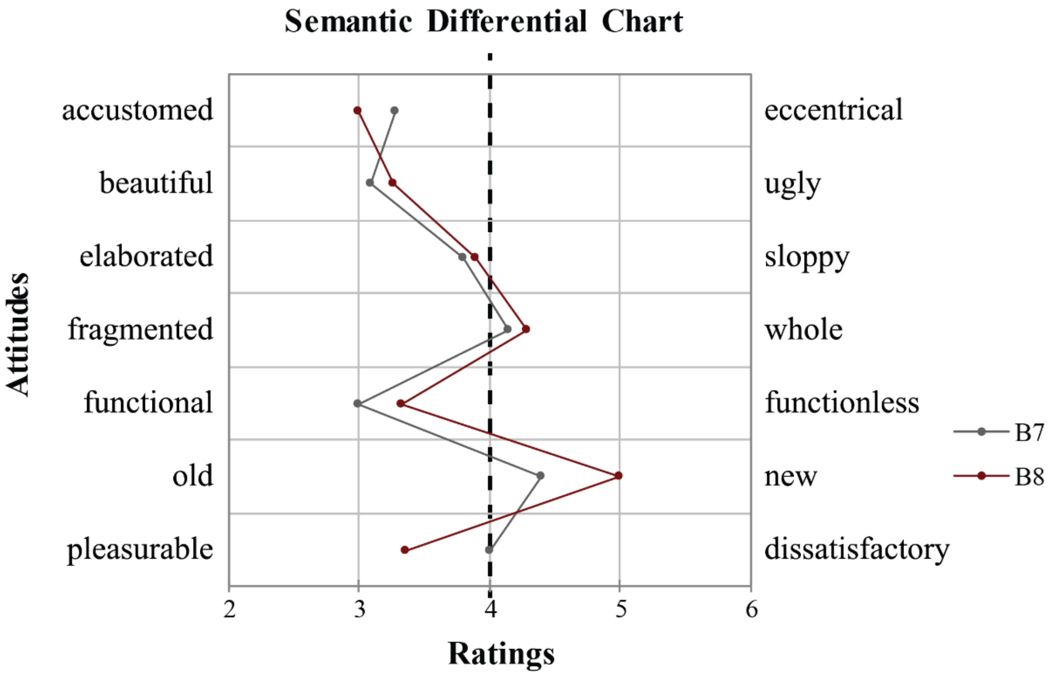

Figure 7.16 Semantic differential chart of B7 and B8 within Component 3

7.2.2.4 Hierarchical Cluster Analysis Results of Water Bottles Within Component 4

Hierarchical cluster analysis of the water bottles was performed using R statistics software based on the participant ratings of the 7 attitudes within Component 3. Ward’s minimum variance method was selected to search for maximum homogeneity between clusters. Analysis results can be seen as dendrogram in Figure 7.17.

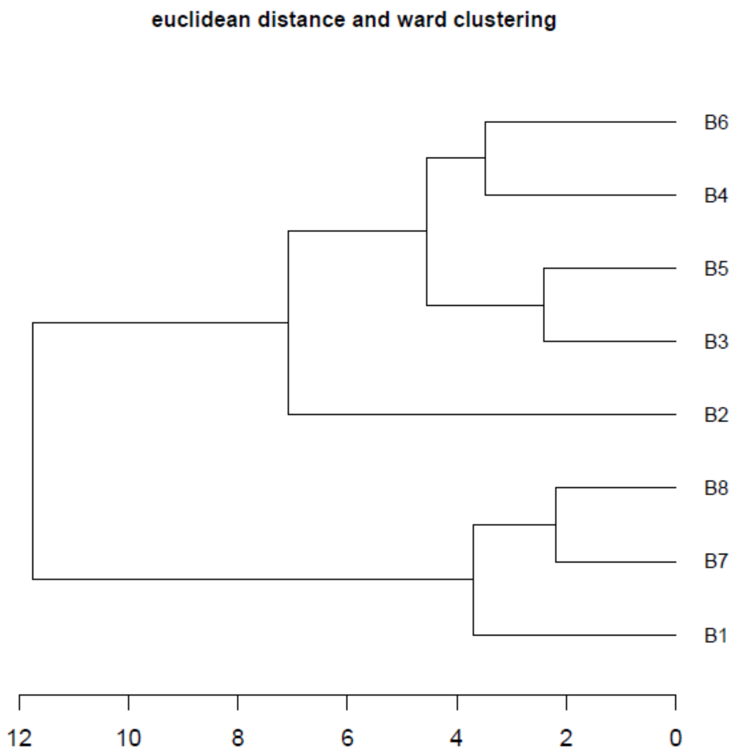

Figure 7.17 Hierarchical cluster analysis results of water bottles within Component 4

In the dendrogram, horizontal lines represent the height, which is the measure of closeness between clusters and vertical lines indicate where the clusters are merged. According to the analysis results, B8 and B7 were found as the most similar water bottle pair, followed by B5 and B3. Also another similarity was found between B6 and B4, yet this similarity is lesser compared to the other pairs. Figure 7.18 shows the clusters of similarly perceived water bottles.

Figure 7.18 Clusters of water bottles perceived similar within Component 4

Figure 7.19 contains the semantic differential graph of B7 and B8, based on participant ratings on eight water bottles through 10 attitudes within Component 4. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. As can be seen from the chart, both water bottles were perceived very similarly on most of the attitudes. Both of the water bottles were perceived nearly identical as quite *plain,* slightly *uncontrolled,* slightly *slippery* and neither *coarse* nor *gracious.* Moreover, both water bottles were perceived similarly as quite *smooth,* quite *simple* and quite *steady*. Yet, the two water bottles were perceived slightly different in some attitudes. B8 was perceived quite *mature,* quite *attractive* and slightly *vivid, whereas* B7 was perceived extremely *mature* and quite *pale.*

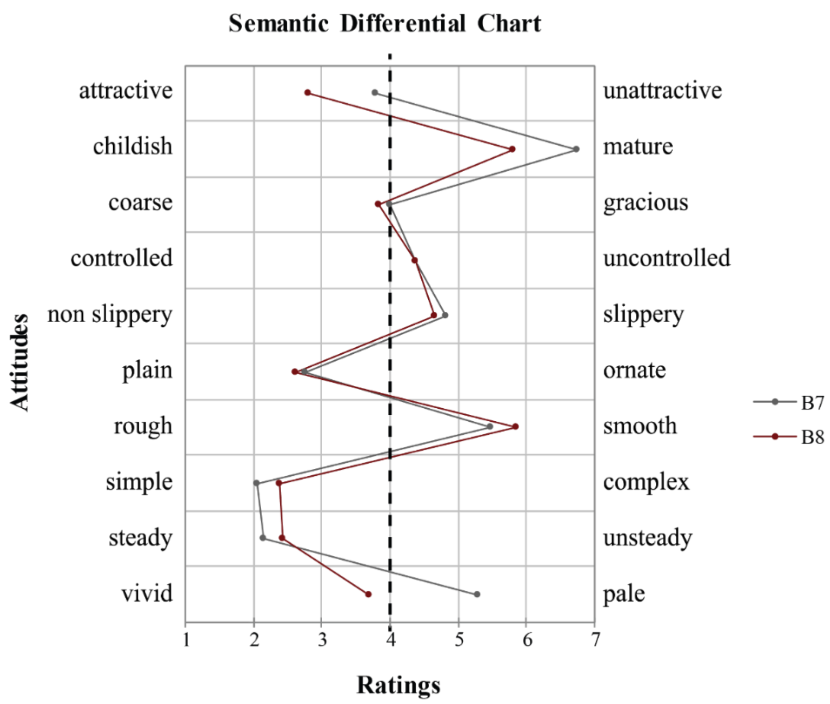

Figure 7.19 Semantic differential chart of B7 and B8 within Component 4

Figure 7.20 contains the semantic differential graph of B4 and B6, based on participant ratings on eight water bottles through 10 attitudes within Component 4. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. Although B4 and B6 were found similar in hierarchical cluster analysis, the similarity is limited because the distance among bottle pairs is not close. Because of that, some of the attitudinal ratings are seen scattered on the semantic differential chart. Both of the water bottles were perceived nearly identical as slightly *unattractive,* slightly *controlled* and slightly *steady.* Yet, the two water bottles were perceived differently in some attitudes. B4 was perceived quite *coarse,* slightly *mature* and slightly *pale,* whereas B6 was perceived quite *smooth*, quite *slippery,* slightly *childish,* slightly *ornate,* slightly *simple* and slightly *vivid*.

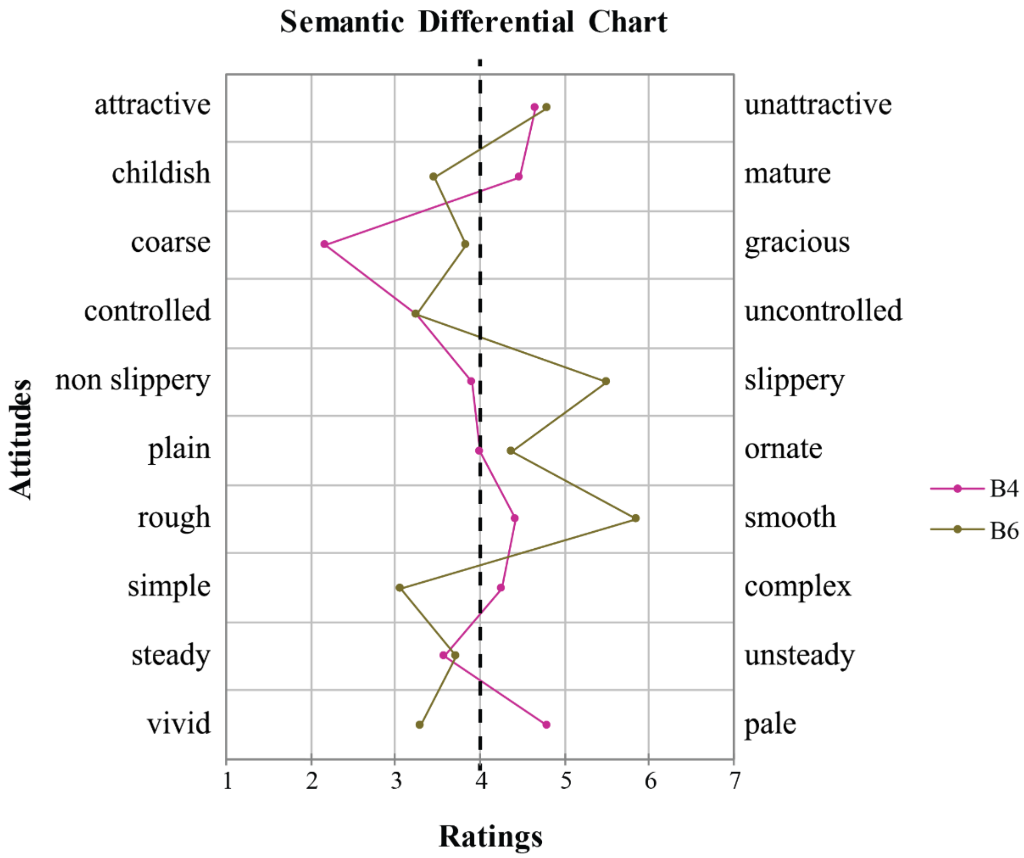

Figure 7.20 Semantic differential chart of B4 and B6 within Component 4

Figure 7.21 contains the semantic differential graph of B3 and B5, based on participant ratings on eight water bottles through 10 attitudes within Component 4. The dotted vertical line shows the neutral zone (4 as midpoint) of the ratings scale. As can be seen from the chart, both water bottles were perceived similarly on most of the attitudes. Both of the water bottles were perceived nearly identical as quite *vivid*. Also, both water bottles were perceived similarly as slightly *ornate,* slightly *complex,* slightly *steady* and neither *rough* nor *smooth*. Yet, the two water bottles were perceived differently in some attitudes. B3 was perceived quite *attractive* and slightly *coarse,* whereas B5 was perceived quite *childish,* slightly *uncontrolled,* slightly *gracious* and slightly *non slippery.*

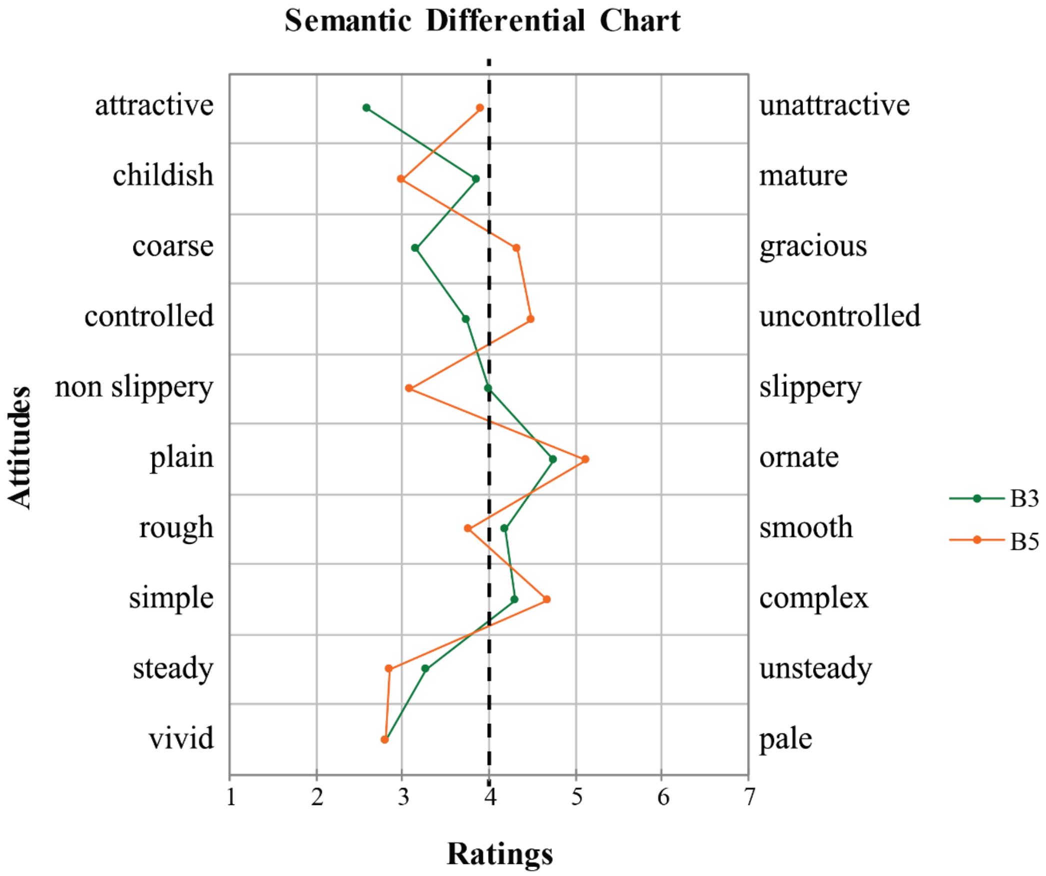

Figure 7.21 Semantic differential chart of B3 and B5 within Component 4

7.2.3 Relationships Between Water Bottles and Attitudes Through Mean Differences

In the final step of relationship analysis, water bottle-attitude relationships were investigated through mean differences. One sample *t*-test was used to compare the object's mean value with a predefined value (here the overall mean rating of the water bottle). So each average rating of an attitude for a water bottle would be compared with the overall mean rating of that water bottle. This test was applied within each component separately and independent from each other. After each comparison, significant differences would be revealed. The treshold for significant values were defined as 0.05. SPSS was used to calculate one sample *t*-test results.

7.2.3.1 One Sample *t*-Test Results of Element-Attitude Relationships Within Component 1

As all water bottles have different overall mean scores, calculations were made individually for each water bottle through 28 attitudes within Component 1 and those overall mean scores were taken as test values. If the mean score of an attitude is significantly different from the test value, that attitude is regarded as important and the significant pole of that attitude is highlighted depending on that difference. Also if the mean value of an attitude is significantly above the test value, this means the right pole is dominant and if the value is below the test value, the left pole is dominant. Detailed *t*-test scores of each water bottle can be seen in Appendix U. For a simple and clear interpretation, only the significant results (Sig. 2-tailed, $p < 0.05$) are represented in this section. Significant *t*-test results can be seen in Table 7.17. The interpretation of Table 7.17 is listed below.

B1 was perceived by the participants most considerably as *silent* (6,17) and *sportive* (1,36) as their ratings were furthest (above and below) from the overall mean score (4.14). *Being user friendly* (1,44), *flexible* (1,47), *entertaining* (2,00), *easy* (2,33), *deep* (2,43) and *cheap* (3,21) are the most important percepts following *sportive*, whereas *being loose* (5,71), *stale* (5,69), *light* (opposite of *heavy*) (5,60), *artificial* (5,50), *non hygienic* (5,50), *flat* (5,44), *matte* (5,21), *unhealthy* (5,10), *soft* (5,10) and *short lived* (5,00) are the most considerable after *silentness* in construing of B1.

B2 was perceived by the participants most considerably as *artificial* (6,36) and *cheap* (1,79) as their ratings were furthest from the overall mean score (4,13). *Being entertaining* (1,80), *uneven* (2,31), *deep* (2,57) and *ergonomic* (2,64) are the most important percepts following *cheapness*, whereas *being poor quality* (6,17), *light* (opposite of *heavy*) (6,15), *stale* (6,00), *unhealthy* (5,75) and *short lived* (5,53) are the most considerable after *artificialness* in construing of B2.

B3 was perceived by the participants most considerably as *light* (opposite of *heavy*) (5,50) and *ergonomic* (2,36) as their ratings were furthest from the overall mean score (3,82). *Being sportive* (2,36), *flexible* (2,87), *excited* (2,92) and *deep* (3,10) are the most important percepts following *being ergonomic*, whereas *being silent* (5,08), *artificial* (5,00) and *hot* (4,48) are the most considerable after *lightness* in construing of B3.

B4 was perceived by the participants most considerably as *light* (opposite of *heavy*) (5,65) and *uneven* (2,38) as their ratings were furthest from the overall mean score (3,74). *Being user friendly* (2,56) and *easy* (2,73) are the most important percepts following *being ergonomic*, whereas *being treble* (5,05) and *artificial* (4,17) are the most considerable after *lightness* in construing of B4.

B5 was perceived by the participants most considerably as *solid* (6,73) and *healthy* (1,40) as their ratings were furthest (above and below) from the overall mean score (3,44). *Being heavy* (1,45), *long lasting* (1,93), *fresh* (2,00), *hygienic* (2,25) and *natural* (2,50) are the most important percepts following *healthiness*, whereas *being* *formal* (5,09), *flat* (5,00), *silent* (5,00), *expensive* (4,79) and *difficult to use* (4,78) are the most considerable after *solidness* in construing of B5.

B6 was perceived by the participants most considerably as *solid* (6,80) and *heavy* (1,55) as their ratings were furthest (above and below) from the overall mean score (3,66). *Being fresh* (1,77), *hard* (1,80), *healthy* (1,85), *long lasting* (2,33), *hygienic* (2,50) and *natural* (2,50) are the most important percepts following *heaviness*, whereas *being flat* (5,63), *formal* (5,73), *non ergonomic* (5.27), *calm* (5,25), *sharp* (5,00) and *difficult* (4,67) are the most considerable after *solidness* in construing of B6.

B7 was perceived by the participants most considerably as *solid* (6,73) and *hard* (1,25) as their ratings were furthest from the overall mean score (3,81). *Being long lasting* (1,47), *cold* (1,76), *loud* (1,83), *high quality* (2,33), *healthy* (2,50) and *shiny* (2,50) are the most important percepts following *hardness*, whereas *being flat* (6,15), *serious* (6,60), *calm* (6,25), *expensive* (6,21), *boring* (6,17), *treble* (5,71) and *difficult* (4,87) are the most considerable after *solidness* in construing of B7.

B8 was perceived by the participants most considerably as *solid* (6,73) and *long lasting* (1,60) as their ratings were furthest from the overall mean score (3,79). *Being hard* (1,65), *shiny* (1,71), *loud* (1,83), *reliable* (2,33), *high quality* (2,44) and *healthy* (2,70) are the most important percepts following *being long lasting*, whereas *being serious* (6,60), *flat* (6,50), *expensive* (5,84), *treble* (5,71), *calm* (5,50) and *difficult* (4,87) are the most considerable after *solidness* in construing of B8.

Table 7.17 Significant one sample *t*-test results among eight water bottles within Component 1

Water Bottle 1 (B1) Test Value:4.14

Attitudes	t	df	Sig. (2- tailed)	Mean
cheap-expensive	-2,274	18	0,035	3,2105
deep-treble	-4,811	20	0,000	2,4286
easy-difficult	-3,585	14	0,003	2,3333
entertaining-serious	-6,767	4	0,002	2,0000
flexible-solid	-16,179	14	0,000	1,4667
fresh-stale	4,475	12	0,001	5,6923
hard-soft	2,240	19	0,037	5,1000
healthy-unhealthy	2,600	19	0,018	5,1000
heavy-light	3,917	19	0,001	5,6000
hygienic-non hygienic	3,585	11	0,004	5,5000
long lasting-short lived	2,544	14	0,023	5,0000
loud-silent	5,002	11	0,000	6,1667
natural-artificial	4,386	13	0,001	5,5000
shiny-matte	2,227	13	0,044	5,2143
sportive-formal	-13,658	10	0,000	1,3636
tight-loose	3,743	6	0,010	5,7143
uneven-flat	3,353	15	0,004	5,4375
user friendly-difficult to use	-15,343	8	0,000	1,4444

Water Bottle 2 (B2) Test Value:4.13

Attitudes	t	df	Sig. (2- tailed)	Mean
cheap-expensive	-11,118	18	0,000	1,7895
deep-treble	-5,724	20	0,000	2,5714
entertaining-serious	-6,227	4	0,003	1,8000
ergonomic-non ergonomic	-3,162	10	0,010	2,6364
fresh-stale	4,414	12	0,001	6,0000
healthy-unhealthy	4,390	19	0,000	5,7500
heavy-light	9,143	19	0,000	6,1500
high quality-poor quality	6,674	17	0,000	6,1667
long lasting-short lived	3,501	14	0,004	5,5333
natural-artificial	9,898	13	0,000	6,3571
uneven-flat	-4,177	15	0,001	2,3125

Water Bottle 3 (B3) Test Value:3.82

Attitudes	t	df	Sig. (2- tailed)	Mean
cold-hot	2,094	20	0,049	4,4762
deep-treble	-2,634	20	0,016	3,0952
ergonomic-non ergonomic	-3,755	10	0,004	2,3636
excited-calm	-2,523	11	0,028	2,9167
flexible-solid	-2,963	14	0,010	2,8667
heavy-light	5,701	19	0,000	5,5000
loud-silent	3,337	11	0,007	5,0833
natural-artificial	4,255	13	0,001	5,0000
sportive-formal	-3,370	10	0,007	2,3636

Table 7.17 (cont'd).

Water Bottle 4 (B4) Test Value:3.74

Attitudes	t	df	Sig. (2- tailed)	Mean
deep-treble	3,911	20	0,001	5,0476
easy-difficult	-2,400	14	0,031	2,7333
heavy-light	5,997	19	0,000	5,6500
natural-artificial	2,317	13	0,037	4,5714
uneven-flat	-4,339	15	0,001	2,3750
user friendly-difficult to use	-2,875	8	0,021	2,5556

Water Bottle 5 (B5) Test Value:3.44

Attitudes	t	df	Sig. (2- tailed)	Mean
cheap-expensive	3,799	18	0,001	4,7895
flexible-solid	21,487	14	0,000	6,7333
fresh-stale	-5,688	12	0,000	2,0000
healthy-unhealthy	-12,101	19	0,000	1,4000
heavy-light	-7,766	19	0,000	1,4500
hygienic-non hygienic	-2,408	11	0,035	2,2500
long lasting-short lived	-5,306	14	0,000	1,9333
loud-silent	2,643	11	0,023	5,0000
natural-artificial	-2,872	13	0,013	2,5000
sportive-formal	2,528	10	0,030	5,0909
uneven-flat	2,889	15	0,011	5,0000
user friendly-difficult to use	2,709	8	0,027	4,7778

Water Bottle 6 (B6) Test Value:3.66

Attitudes	t	df	Sig. (2- tailed)	Mean
easy-difficult	2,167	14	0,048	4,6667
ergonomic-non ergonomic	5,301	10	0,000	5,2727
excited-calm	3,321	11	0,007	5,2500
flexible-solid	29,372	14	0,000	6,8000
fresh-stale	-9,403	12	0,000	1,7692
hard-soft	-5,516	19	0,000	1,8000
healthy-unhealthy	-7,783	19	0,000	1,8500
heavy-light	-7,645	19	0,000	1,5500
hygienic-non hygienic	-2,665	11	0,022	2,5000
long lasting-short lived	-2,539	14	0,024	2,3333
natural-artificial	-3,099	13	0,008	2,5000
rounded-sharp	2,996	4	0,040	5,0000
sportive-formal	5,085	10	0,000	5,7273
uneven-flat	4,791	15	0,000	5,8125

Table 7.17 (cont'd).

Water Bottle 7 (B7)				Test Value:3.81
Attitudes	t	df	Sig. (2- tailed)	Mean
amusing-boring	7,668	5	0,001	6,1667
cheap-expensive	9,225	18	0,000	6,2105
cold-hot	-7,014	20	0,000	1,7619
deep-treble	4,793	20	0,000	5,7143
easy-difficult	2,562	14	0,023	4,8667
entertaining-serious	11,390	4	0,000	6,6000
excited-calm	4,936	11	0,000	6,2500
flexible-solid	14,174	14	0,000	6,7333
hard-soft	-20,811	19	0,000	1,2500
healthy-unhealthy	-3,894	19	0,001	2,5000
high quality-poor quality	-5,776	17	0,000	2,3333
long lasting-short lived	-14,182	14	0,000	1,4667
loud-silent	-4,879	11	0,000	1,8333
shiny-matte	-2,680	13	0,019	2,5000
uneven-flat	10,351	15	0,000	6,6250

Water Bottle 8 (B8)				Test Value:3.79
Attitudes	t	df	Sig. (2- tailed)	Mean
cheap-expensive	7,105	18	0,000	5,8421
deep-treble	4,919	20	0,000	5,7143
easy-difficult	2,610	14	0,021	4,8667
entertaining-serious	11,472	4	0,000	6,6000
excited-calm	2,699	11	0,021	5,5000
flexible-solid	14,271	14	0,000	6,7333
hard-soft	-7,547	19	0,000	1,6500
healthy-unhealthy	-3,866	19	0,001	2,7000
high quality-poor quality	-4,413	17	0,000	2,4444
long lasting-short lived	-11,512	14	0,000	1,6000
loud-silent	-4,621	11	0,001	1,8333
reliable-unreliable	-2,223	11	0,048	2,3333
shiny-matte	-4,885	13	0,000	1,7143
uneven-flat	6,997	15	0,000	6,5000

The interpretation results and the significantly perceived qualities of water bottles within Component 1 are summarized and can be seen in Table 7.18. The table illustrates the qualities that are statistically significant for each water bottle. There are no positivity or negativity for the attitudes as the attitudes were listed depending on their poles (left or right). Also the order of the attitudes were sorted based on their statistical significance values.

Table 7.18 Summarized table of construed water bottles within Component 1

								
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
Attitudes (Left Pole)	flexible sportive user friendly deep entertaining easy cheap	cheap deep uneven entertaining ergonomic	ergonomic sportive flexible deep excited	uneven user friendly easy	healthy heavy fresh long lasting natural hygienic	healthy heavy fresh hard natural hygienic long lasting	hard long lasting cold high quality loud healthy shiny	long lasting hard shiny high quality loud healthy reliable
Attitudes (Right Pole)	silent artificial stale light non hygienic flat loose unhealthy short lived soft matte	light* artificial poor quality unhealthy stale short lived	light* artificial silent hot	light* treble artificial	solid expensive flat silent difficult to use formal	solid flat non ergonomic formal calm sharp difficult	solid expensive flat treble serious calm boring difficult	solid expensive flat treble serious difficult calm

*opposite of heavy

7.2.3.2 One Sample *t*-Test Results of Element-Attitude Relationships Within Component 2

As all water bottles have different overall mean scores, calculations were made individually for each water bottle through 22 attitudes within Component 2 and those overall mean scores were taken as test values. If the mean score of an attitude is significantly different from the test value, that attitude is regarded as important and the significant pole of that attitude is highlighted depending on that difference. Also if the mean value of an attitude is significantly above the test value, this means the right pole is dominant and if the value is below the test value, the left pole is dominant. Detailed *t*-test scores of each water bottle can be seen in Appendix V. For a simple and clear interpretation, only the significant results (Sig. 2-tailed, $p < 0.05$)

are represented in this section. Significant *t*-test results can be seen in Table 7.19. The interpretation of Table 7.19 is listed below.

B1 was perceived by the participants most considerably as *opaque* (6,88) and *dynamic* (1,92) as their ratings were furthest (above and below) from the overall mean score (4.22). *Being durable* (2,89) is the most important percept following being *dynamic*, whereas *being short* (6,00), *irritating* (5,44) and *masculine* (5,35) are the most considerable after *being opaque* in construing of B1.

B2 was perceived by the participants most considerably as *irritating* (6,33) and *feminine* (2,59) as their ratings were furthest from the overall mean score (4,07). *Being durable* (3,19) is the most important percept following *being irritating*, whereas *being opaque* (5,12) is the most considerable after *being irritating* in construing of B2.

B3 was perceived by the participants most considerably as *irritating* (5,33) and *cool* (2,00) as their ratings were furthest from the overall mean score (3,71). *Being dynamic* (2,58), *protective* (2,64) and *portable* (2,75) are the most considerable after *coolness,* whereas *being masculine* (5,18) is the most considerable after *being irritating* in construing of B3.

B4 was perceived by the participants most considerably as *transparent* (1,32) and *masculine* (5,00) as their ratings were furthest from the overall mean score (3,60). *Being dynamic* (2,58) is the most important percept following *being transparent* in construing of B4.

B5 was perceived by the participants most considerably as *dishonest* (6,60) and *tall* (1,00) as their ratings were furthest from the overall mean score (3,55). *Being relieving* (1,33), *transparent* (1,60), *feminine* (1,82) and *sweet* (1,90) are the most important percepts following *being tall*, whereas *being flimsy* (5,48), *inactive* (5,42) and *uncomfortable* (4,57) are the most considerable after *being dishonest* in construing of B5.

B6 was perceived by the participants most considerably as *honest* (6,40) and *transparent* (1,16) as their ratings were furthest from the overall mean score (3,92). *Being relieving* (1,22), *feminine* (1,65), *sweet* (2,10) and *distinct* (2,50) are the most important percepts following *being transparent*, whereas *being inactive* (6,08), *stable* (5,83) and *flimsy* (5,78) are the most considerable after *being honest* in construing of B6.

B7 was perceived by the participants most considerably as *opaque* (6,92) and *outdoor* (1,00) as their ratings were furthest from the overall mean score (3,91). *Being portable* (1,25), *durable* (1,59), *dynamic* (2,58) and *protective* (2,64) are the most important percepts following *being outdoor*, whereas being *short* (6,60), *necessary* (5,88), *bitter* (5,80), *coherent* (5,73) and *masculine* (5,41) are the most considerable after *being opaque* in construing of B7.

B8 was perceived by the participants most considerably as *opaque* (6,92) and *portable* (1,25) as their ratings were furthest from the overall mean score (3,86). *Being durable* (1,78), *cool* (2,20), *dynamic* (2,58) and *protective* (2,73) are the most important percepts following *portableness*, whereas *being short* (6,40), *necessary* (5,88), *coherent* (5,73) and *masculine* (4,65) are the most considerable after *opaqueness* in construing of B8.

Table 7.19 Significant one sample *t*-test results among eight water bottles within Component 2

Water Bottle 1 (B1) Test Value:4.22

Attitudes	t	df	Sig. (2- tailed)	Mean
durable-flimsy	-3,551	26	0,001	2,8889
dynamic-inactive	-5,786	11	0,000	1,9167
feminine-masculine	3,673	16	0,002	5,3529
relieving-irritating	3,250	8	0,012	5,4444
tall-short	2,814	4	0,048	6,0000
transparent-opaque	40,101	24	0,000	6,8800

Water Bottle 2 (B2) Test Value:4.07

Attitudes	t	df	Sig. (2- tailed)	Mean
durable-flimsy	-2,653	26	0,013	3,1852
feminine-masculine	-4,184	16	0,001	2,5882
relieving-irritating	7,840	8	0,000	6,3333
transparent-opaque	4,370	24	0,000	5,1200

Water Bottle 3 (B3) Test Value:3.71

Attitudes	t	df	Sig. (2- tailed)	Mean
cool-despised	-3,824	4	0,019	2,0000
dynamic-inactive	-2,704	11	0,021	2,5833
feminine-masculine	5,346	16	0,000	5,1765
portable-stable	-2,338	11	0,039	2,7500
protective-vulnerable	-2,484	10	0,032	2,6364
relieving-irritating	4,356	8	0,002	5,3333

Water Bottle 4 (B4) Test Value:3.60

Attitudes	t	df	Sig. (2- tailed)	Mean
dynamic-inactive	-2,340	11	0,039	2,5833
feminine-masculine	4,528	16	0,000	5,0000
transparent-opaque	-16,512	24	0,000	1,3200

Water Bottle 5 (B5) Test Value:3.55

Attitudes	t	df	Sig. (2- tailed)	Mean
comfortable-uncomfortable	2,847	13	0,014	4,5714
dishonest-honest	12,452	4	0,000	6,6000
durable-flimsy	5,314	26	0,000	5,4815
dynamic-inactive	4,296	11	0,001	5,4167
feminine-masculine	-11,194	16	0,000	1,8235
relieving-irritating	-13,300	8	0,000	1,3333
sweet-bitter	-4,358	9	0,002	1,9000
tall-short	a	4	0,000	1,0000
transparent-opaque	-13,789	24	0,000	1,6000
comfortable-uncomfortable	2,847	13	0,014	4,5714

a. *t* cannot be computed because the standard deviation is 0.

Table 7.19 (cont'd).

Water Bottle 6 (B6)				Test Value:3.92
Attitudes	t	df	Sig. (2- tailed)	Mean
dishonest-honest	4,133	4	0,014	6,4000
distinct-ambiguous	-2,505	7	0,041	2,5000
durable-flimsy	4,811	26	0,000	5,7778
dynamic-inactive	6,916	11	0,000	6,0833
feminine-masculine	-13,352	16	0,000	1,6471
portable-stable	4,519	11	0,001	5,8333
relieving-irritating	-18,354	8	0,000	1,2222
sweet-bitter	-4,200	9	0,002	2,1000
transparent-opaque	-36,882	24	0,000	1,1600

Water Bottle 7 (B7)				Test Value:3.91
Attitudes	t	df	Sig. (2- tailed)	Mean
discordant-coherent	3,725	10	0,004	5,7273
durable-flimsy	-10,767	26	0,000	1,5926
dynamic-inactive	-3,505	11	0,005	2,5833
feminine-masculine	5,266	16	0,000	5,4118
outdoor-indoor	a	5	0,000	1,0000
portable-stable	-14,824	11	0,000	1,2500
protective-vulnerable	-2,417	10	0,036	2,6364
sweet-bitter	3,544	9	0,006	5,8000
tall-short	10,982	4	0,000	6,6000
transparent-opaque	54,354	24	0,000	6,9200
unnecessary-necessary	4,098	7	0,005	5,8750

Water Bottle 8 (B8)				Test Value:3.86
Attitudes	t	df	Sig. (2- tailed)	Mean
cool-despised	-4,437	4	0,011	2,2000
discordant-coherent	4,158	10	0,002	5,7273
durable-flimsy	-9,653	26	0,000	1,7778
dynamic-inactive	-3,207	11	0,008	2,5833
feminine-masculine	2,167	16	0,046	4,6471
portable-stable	-14,546	11	0,000	1,2500
protective-vulnerable	-2,238	10	0,049	2,7273
tall-short	6,350	4	0,003	6,4000
transparent-opaque	55,257	24	0,000	6,9200
unnecessary-necessary	4,202	7	0,004	5,8750

a. *t* cannot be computed because the standard deviation is 0.

The interpretation results and the significantly perceived qualities of water bottles within Component 2 are summarized and can be seen in Table 7.20. The table illustrates the qualities that are statistically significant for each water bottle. There are no positivity or negativity for the attitudes as the attitudes were listed depending on their poles (left or right). Also the order of the attitudes were sorted based on their statistical significance values.

Table 7.20 Summarized table of construed water bottles within Component 2

								
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
Attitudes (Left Pole)	dynamic durable	feminine durable	cool dynamic protective portable	transparent dynamic	feminine relieving tall transparent sweet	relieving feminine transparent sweet distinct	outdoor durable portable dynamic protective	durable portable dynamic cool protective
Attitudes (Right	opaque masculine irritating short	irritating opaque	masculine irritating	masculine	honest flimsy inactive uncomforta ble	flimsy inactive stable honest	opaque masculine short coherent necessary bitter	opaque coherent short necessary masculine

7.2.3.3 One Sample *t*-Test Results of Element-Attitude Relationships Within Component 3

As all water bottles have different overall mean scores, calculations were made individually for each water bottle through 7 attitudes within Component 3 and those overall mean scores were taken as test values. If the mean score of an attitude is significantly different from the test value, that attitude is regarded as important and the significant pole of that attitude is highlighted depending on that difference. Also if the mean value of an attitude is significantly above the test value, this means the right pole is dominant and if the value is below the test value, the left pole is dominant. Detailed *t*-test scores of each water bottle can be seen in Appendix W. For a simple and clear interpretation, only the significant results (Sig. 2-tailed, $p < 0.05$)

are represented in this section. Significant *t*-test results can be seen in Table 7.21. The interpretation of Table 7.21 is listed below.

B1 does not have any significantly perceived quality to interpret in this section.

B2 was perceived by the participants most considerably as *ugly* (5,73) and *accustomed* (3,00) as their ratings were furthest from the overall mean score (4,42).

B3 was perceived by the participants most considerably as *new* (5,33) and *elaborated* (2,35) as their ratings were furthest from the overall mean score (3,41). *Being fragmented* (2,43) is the most important percept in following *elaboratedness,* whereas *being eccentrical* (5,07) is the most considerable after *newness* in construing of B3.

B4 was perceived by the participants most considerably as *fragmented* (2,57) and *eccentrical* (5,21) as their ratings were furthest from the overall mean score (3,88). *Being functional* (2,63) is the most important percept in following *being fragmented* in construing of B4.

B5 does not have any significantly perceived quality to interpret in this section.

B6 was perceived by the participants most considerably as *accustomed* (2,64) as its rating was furthest from the overall mean score (3,62).

B7 was perceived by the participants most considerably as *functional* (2,38) as its rating was furthest from the overall mean score (3,67).

B8 was perceived by the participants most considerably as *functional* (2,38) as its rating was furthest from the overall mean score (3,74).

Table 7.21 Significant one sample *t*-test results among eight water bottles within Component 3

Water Bottle 2 (B2)				Test Value:4.42
Attitudes	t	df	Sig. (2- tailed)	Mean
accustomed-eccentrical	-2,290	13	0,039	3,0000
beautiful-ugly	2,911	10	0,016	5,7273

Water Bottle 3 (B3)				Test Value:3.41
Attitudes	t	df	Sig. (2- tailed)	Mean
accustomed-eccentrical	4,030	13	0,001	5,0714
elaborated-sloppy	-3,867	19	0,001	2,3500
fragmented-whole	-2,661	6	0,037	2,4286
old-new	3,229	4	0,032	5,6000

Water Bottle 4 (B4)				Test Value:3.88
Attitudes	t	df	Sig. (2- tailed)	Mean
accustomed-eccentrical	2,985	13	0,011	5,2143
fragmented-whole	-6,477	6	0,001	2,5714
functional-functionless	-4,771	7	0,002	2,6250

Water Bottle 6 (B6)				Test Value:3.62
Attitudes	t	df	Sig. (2- tailed)	Mean
accustomed-eccentrical	-2,527	13	0,025	2,6429

Water Bottle 7 (B6)				Test Value:3.67
Attitudes	t	df	Sig. (2- tailed)	Mean
functional-functionless	-3,453	7	0,011	2,3750

Water Bottle 8 (B8)				Test Value:3.74
Attitudes	t	df	Sig. (2- tailed)	Mean
functional-functionless	-3,640	7	0,008	2,3750

The interpretation results and the significantly perceived qualities of water bottles within Component 3 are summarized and can be seen in Table 7.22. The table illustrates the qualities that are statistically significant for each water bottle. There are no positivity or negativity for the attitudes as the attitudes were listed depending on their poles (left or right). Also the order of the attitudes were sorted based on their statistical significance values.

Table 7.22 Summarized table of construed water bottles within Component 3

								
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
Attitudes (Left Pole)		accustomed	elaborated fragmented	fragmented functional		accustomed	functional	functional
Attitudes (Right		ugly	eccentrical new	eccentrical				

7.2.3.4 One Sample *t*-Test Results of Element-Attitude Relationships Within Component 4

As all water bottles have different overall mean scores, calculations were made individually for each water bottle through 10 attitudes within Component 4 and those overall mean scores were taken as test values. If the mean score of an attitude is significantly different from the test value, that attitude would be regarded as important and the significant pole of that attitude would be highlighted depending on that difference. Also if the mean value of an attitude is significantly above the test value, this means the right pole is dominant and if the value is below the test value, the left pole is dominant. Detailed *t*-test scores of each water bottle can be seen in Appendix X. For a simple and clear interpretation, only the significant results (Sig. 2-tailed, $p < 0.05$) are represented on this section. Significant *t*-test results can be seen in Table 7.23. The interpretation of Table 7.23 is listed below.

B1 was perceived by the participants most considerably as *smooth* (6,05) and *plain* (1,75) as their ratings were furthest from the overall mean score (3,92). *Being simple* (1,81), *steady* (2,29) and *coarse* (2,67) are the most important percepts following *plainness*, whereas *being pale* (5,89), *mature* (5,33), *unattractive* (5,15) and *slippery* (4,67) are the most considerable after *smoothness* in construing of B1.

B2 was perceived by the participants most considerably as *unsteady* (6,57) and *childish* (1,73) as their ratings were furthest from the overall mean score (3,83). *Being rough* (2,38) and *slippery* (2,75) are the most important percepts following *being childish*, whereas *being gracious* (5,67) is the most considerable after *unsteadiness* in construing of B2.

B3 was perceived by the participants most considerably as *attractive* (2,60) as its rating was furthest from the overall mean score (3,67).

B4 was perceived by the participants most considerably as *coarse* (2,17) as its rating was furthest from the overall mean score (3,95).

B5 does not have any significantly perceived quality to interpret in this section.

B6 was perceived by the participants most considerably as *smooth* (6,40) and *simple* (3,06) as their ratings were furthest from the overall mean score (4,12). *Being slippery* (5,50) is the most important percept in following *smoothness* in construing of B6.

B7 was perceived by the participants most considerably as *mature* (6,73) and *simple* (2,06) as their ratings were furthest from the overall mean score (4,15). *Being steady* (2,14) is the most important percept in following *simpleness*, whereas *being pale* (5,56) and *smooth* (5,48) are the most considerable after *being mature* in construing of B7.

B8 was perceived by the participants most considerably as *smooth* (5,86) and *simple* (2,38) as their ratings were furthest from the overall mean score (3,85). *Being steady* (2,43), *plain* (2,63) and *attractive* (2,80) are the most important percepts following *simpleness*, whereas *being mature* (5,80) is the most considerable after *smoothness* in construing of B8.

Table 7.23 Significant one sample *t*-test results among eight water bottles within Component 4

Water Bottle 1 (B1) Test Value:3.92

Attitudes	t	df	Sig. (2- tailed)	Mean
attractive-unattractive	3,081	19	0,006	5,1500
childish-mature	3,042	14	0,009	5,3333
coarse-gracious	-2,973	5	0,031	2,6667
non slippery-slippery	1,887	11	0,086	4,6667
plain-ornate	-5,269	7	0,001	1,7500
rough-smooth	10,590	20	0,000	6,0476
simple-complex	-7,604	15	0,000	1,8125
steady-unsteady	-3,133	6	0,020	2,2857
vivid-pale	4,653	8	0,002	5,8889

Water Bottle 2 (B2) Test Value:3.83

Attitudes	t	df	Sig. (2- tailed)	Mean
childish-mature	-11,539	14	0,000	1,7333
coarse-gracious	4,356	5	0,007	5,6667
non slippery-slippery	-2,422	11	0,034	2,7500
rough-smooth	-4,244	20	0,000	2,3810
steady-unsteady	13,569	6	0,000	6,5714

Water Bottle 3 (B3) Test Value:3.67

Attitudes	t	df	Sig. (2- tailed)	Mean
attractive-unattractive	-4,811	19	0,000	2,6000

Water Bottle 4 (B4) Test Value:3.95

Attitudes	t	df	Sig. (2- tailed)	Mean
coarse-gracious	-5,803	5	0,002	2,1667

Water Bottle 6 (B6) Test Value:4.12

Attitudes	t	df	Sig. (2- tailed)	Mean
non slippery-slippery	3,051	11	0,011	5,5000
rough-smooth	4,501	20	0,000	5,8571
simple-complex	-2,444	15	0,027	3,0625

Water Bottle 7 (B7) Test Value:4.15

Attitudes	t	df	Sig. (2- tailed)	Mean
childish-mature	21,858	14	0,000	6,7333
rough-smooth	2,910	20	0,009	5,4762
simple-complex	-6,752	15	0,000	2,0625
steady-unsteady	-3,948	6	0,008	2,1429
vivid-pale	2,423	8	0,042	5,5556

Table 7.23 (cont'd).

Water Bottle 8 (B8)				Test Value:3.85
Attitudes	t	df	Sig. (2- tailed)	Mean
attractive-unattractive	-3,044	19	0,007	2,8000
childish-mature	4,446	14	0,001	5,8000
plain-ornate	-2,461	7	0,043	2,6250
rough-smooth	4,473	20	0,000	5,8571
simple-complex	-3,624	15	0,002	2,3750
steady-unsteady	-2,956	6	0,025	2,4286

The interpretation results and the significantly perceived qualities of water bottles within Component 4 are summarized and can be seen in Table 7.24. The table illustrates the qualities that are statistically significant for each water bottle. There are no positivity or negativity for the attitudes as the attitudes were listed depending on their poles (left or right). Also the order of the attitudes were sorted based on their statistical significance values.

Table 7.24 Summarized table of construed water bottles within Component 4

	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
Attitudes (Left	simple plain steady coarse	childish rough non slippery	attractive	coarse		simple	simple steady	simple attractive steady plain
Attitudes (Right	smooth pale unattractive mature slippery	unsteady gracious				smooth slippery	mature smooth pale	smooth mature

CHAPTER 8

DISCUSSION

The aim of this thesis was to explore how individuals construe noticeable material impressions in their own words with their sensory relevancies in different product contexts, and to investigate the relationships between attitudinal approaches in order to develop sensory and attitudinal maps (senso-attitudinal maps) of these relations. It is expected that senso-attitudinal maps of perceived material properties can serve designers as a reference in designing material experiences. For this end, three major questions were addressed:

- How do individuals construe material qualities that they perceive through sensory interactions in their own statements?
- How are senses, perceived material qualities, and individuals' attitudes related to each other?
- How can attitudinal and sensory information be merged to develop senso-attitudinal maps?

To find answers to these questions, idiosyncratic expressions of individuals were elicited through sensible product material properties. Individual construing of the material qualities that the participants are perceptually aware of in selected product contexts were explored through Repertory Grid Technique (RGT). RGT was utilized to explore how individuals verbalize their material impressions as their personal constructs in their own words and also to capture how they evaluate these elicited constructs including their sensory relevancies. Elicited constructs referred to the attitudinal approaches of individuals towards perceived material qualities, and the elicited attitudes were categorized based on their commonalities to explore if any similarity patterns existed between the ways of construing of the individuals.

As materials evoke different impressions within different contexts, two separate experiments were designed with physical product material samples. For the first experiment, computer mouses were selected and for the second experiment, water bottles were preferred. The major selection criteria of these product contexts were that they were expected to appeal to different sensory modalities. The experiments were held in a realistic environment prepared in an office at Anadolu University (the name of which has changed to Eskisehir Technical University during the research) Department of Industrial Design. The experiment environment was isolated from outer sounds and natural light, and was lighted up with artificial lighting to make sure the same conditions were provided for each participant.

Products were selected for the experiments to be used as stimuli. Product samples used in the study are defined as elements, and they were selected by the researcher during the experiment design phase. Eight different computer mouses and eight different reusable water bottles were selected. Selected computer mouses were carrying similar functions and they were not specialized (such as for gaming). Water bottles were chosen based on their liquid capacity (500 ml) and the materials that they were made of. Computer mouses and water bottles are everyday products that individuals interact with many times during a day. The products were chosen based on their similarity of usages, and it was avoided to select outlier products. Kuru (2015) suggested that each selected product should carry at least one similarity in between, otherwise the assessor may feel complicated and stressed and may think that s/he is being tested instead of the products. As one of the major aims of this research was to explore sensory relevancies of elicited attitudes, it was expected that the computer mouses would appeal mostly to the visual, tactile and auditory senses, and the water bottles would appeal more to the chemical senses (gustation and olfaction).

The experiments were conducted with sixty different undergraduate students from Anadolu University Department of Industrial Design. Thirty of the participants were female and 30 participants were male. The participants that met the criteria attended the experiments voluntarily upon invitation. Purposive sampling method was used as the invited participants required to have successfully passed the "MLZ219 Malzeme" materials course. By this, participants would be expected to be able to express material impressions based on their adequate knowledge on materials. Having adequate materials language was a cruical criterion in this research as most experiences are preverbal and have the potential to be labeled verbally (DelMonte, 2011). Thus, it would be more practical to obtain and explore richer and deeper data.

RGT was utilized to capture both the ratings of the product samples through elicited attitudes and the evaluations of elicited attitudes through their sensory relevancies. A pilot study was conducted in order to test and improve the structure and the procedures of the utilized RGT. In the pilot study, the efficiancy of triadic and dyadic procedures were compared through the factors such as complexity, duration and elicited construct counts. The pilot study resulted in deciding on using dyadic procedures, as they were more practical compared to triadic procedures. Also, it was decided to limit each interview with setting a constant number of dyadic comparisons instead of setting a time limit. A time limit could cause stress for the individuals who especially tend to be slow in their evaluations. The aim of this research was to verbalize perceived material impressions as many as possible and the participants should not be feeling judged or stressed. For each interview, five dyadic comparisons were set. Four of these comparisons contained all eight elements and the fifth comparison was planned to include a random pair to achieve the highest potential of compared element combinations. It was avoided to select dyads in full random order as there could be a possibility that one or more elements would never be compared throughout the study. To achieve selection fairness among dyadic pairs, a purposeful randomization algorithm was developed that was similar (but not identical) to balanced incomplete block design.

According to the pilot study results, it was estimated that five dyadic sessions would last around one hour, and scheduling of the experiments were made accordingly. In dyadic procedures, two elements are provided to be compared by the participant in order to construe material impressions. In the study, elements in pairs were experienced by the participant, during which s/he verbally provided similarities and contrasts. The researcher recorded the verbal definition as the emergent pole of the elicited attitude (construct). Then the researcher aimed to complete the construct by simply asking the opposite meaning of the emergent pole. Opposite of the emergent pole is recorded by the researcher as the implicit pole of that attitude. The researcher also used laddering and pyramiding procedures to explore latent meanings and definitions in the attitude eliciting process. As the attitude elicitation was completed with the particular element pair, sensory relevancies of elicited attitudes were evaluated by the participant. Each elicited attitude was rated through an eleven-point scale considering its relevance to five basic senses, and each attitude was rated twice based on its relationships with each of the two elements separately, as both elements took role in eliciting that attitude. Moreover, it was considered that each element had a different influence on eliciting the particular attitude. A session was concluded with the completion of sensory evalauations, and this procedure was repeated for four more different element pairs.

After five sessions were completed, all eight elements were rated through all elicited attitudes by using a seven-point scale. Numbers in the scale referred to the poles of the particular attitude that was expected to be rated. The number 1 represented extreme rating to the left pole and 7 represented extreme rating to the right pole. The participants verbally rated all the elements and the researcher filled the grid. Once all elements were rated through elicited attitudes, the interview ended. Sixty separate repertory grids carrying information of participants' idiosyncratic attitudes towards product materials and their attitudinal and sensory evaluations were collected as the raw data for this research.

8.1 Discussion on the Findings

Four objectives were set for this thesis, as follows:

- To investigate idiosyncratic attitudinal expressions of individuals towards perceived material qualities.
- To explore commonalities between the elicited attitudes and investigate sensory relevancies.
- To explore latent structure of the common elicited attitudes.
- To investigate relationships between the attitudes and the sample products.

8.1.1 Discussions on the Idiosyncratic Attitudinal Approaches of Individuals

A total of 60 interviews through two experiments resulted in 60 personal grid sheets (30 personal grid sheets for each experiment). Each personal grid sheet contained idiosyncratic attitudinal descriptions of individuals towards perceived material impressions participated in the study. The attitudinal descriptions are the construed meanings of the perceived material qualities that the participants are perceptually aware of. In regards to the first objective set for the thesis, content analysis was applied on the raw data for the first and second experiments separately.

Kelly (1955/1963) developed RGT to understand how an individual construes his/her own environment – the way s/he sees the world. Although RGT was developed to focus on single participant responses, it can be utilized to examine more than one grids. Depending on the aim of the research, Fallman and Waterworth (2010) pointed out that multiparticipant data can be reduced based on statistical similarities (based on ratings) or semantical similarities (based on meanings) of the elicited constructs. Rating driven approaches are often problematic with large amounts of data as grouped constructs could be semantically non-related. In a cross-cultural research (Tomico, Karapanos, Lévy, Mizutani, & Yamanaka, 2009) the constructs were accepted similar only if they were carrying similarities in both ratings and meanings, whereas Akbay (2013) looked for semantical similarities in investigating multi-attitudinal approaches towards perceived colors. In this thesis, it is considered to explore semantical similarities as a very large amount of data (over 1500 constructs) had to be processed. Therefore discourse analysis procedures were applied to group common bipolar attitude sets.

The first attempt was to record all 60 grid sheets into the computer separately. This process was taken by hand. The second attempt was to apply a content analysis procedure as grouping semantically similar constructs under themes based on their functional meanings. While doing this, identical and repeated constructs were spotted and removed as some construct repetitions were not noticed by the researcher in the data collection process. Constructs were gathered around main themes, themes and categories which were developed with the mutual agreement of three individual coders. Categories were on the lowest level of this categorization and each category was named with a label, which represented the general meaning of constructs included in that category. In the content analysis, 772 personal constructs in the experiment with computer mouses and 895 personal constructs in the experiment with water bottles were accepted as elicited personal attitudes towards material impressions on selected products as the outcome of a total of 300 dyadic procedures (150 for each experiment). There were 28 possibilites for dyad combinations in eight products, therefore each dyad appeared at least five times for each experiment. Moreover, it was ensured that every product appeared at least once in an interview session and each participant experienced all eight products at least once during an interview. Experiencing of every selected product materials was important for this thesis as participants became familar with material impressions and therefore they earned the control over making more in-depth evaluations.

8.1.2 Discussions on the Common Attitudes and Sensory Relevancies

The first step of the second objective was to look for commonly elicited attitudes to reveal shared attitudinal approaches towards material impressions. The RGT was customized to gather idiosyncratic data of each participant, while keeping the tested products, rating scales and procedures stable, and randomizing the order of presented product pairs for a variation in stimuli to enrich collected data. Therefore, it was expected to reveal similarities in the personal approaches of each participant through construing the same context and identify common understandings of material impressions in a particular product context.

For this, thematically analyzed construct sets were inspected again to prepare the data for statistical investigation. Every construct had two opposite poles referring to opposite meanings. The poles of each construct in a category were aligned to refer to the same direction to examine similar patterns in participant ratings. To do this, each construct that had to be aligned was reversed in terms of their direction of poles and the ratings. The ratings were made using a seven-point (1 to 7) scale, and the reversing of a rating consisted converting the value to the opposite pole by subtracting it from 8. Furthermore, it was noticed that some attitudes contained positive and negative adjectives (such as *durable-flimsy* and *clean-dirty*) and thus enabled mutual alignment of the direction of poles between categories, whereas others were not predictable in terms of positivity/negativity (such as *big-small* and *shiny-matte*). The pole alignment between categories was not concluded until the consistency test was applied to the data, where the consistency test provided information about the alignment of the poles among categories. After the poles of the attitudes were aligned within categories, the whole data were translated into English as they were collected in Turkish, the native language of the participants. Moreover, category labels were converted to new attitudinal labels that represent common meanings of the included attitudes in each category. First dimension reduction was achieved through thematic analysis, as 772 attitudes were grouped into

77 common attitudes for the experiment with computer mouses, and 895 attitudes were grouped into 83 common attitudes for the experiment with water bottles.

Thematic analysis results also enabled to view the distrubition weights of mentioning frequencies and thus provided interpretable outcomes. Tomico, et al. (2009) investigated the dominance (percentages) and importance (order of emergence) aspects of the elicited constructs in their cross-cultural study and they assumed that the constructs elicited first were more salient for the participant. However, Heckmann, Pries, Engelhardt, Meixner, Saúl, Perea-Luque and López-González (2017) tested this assumption with a significantly larger population (a total of 121 participants) and found no correlations between the elicitation order and importance, while emphasizing that the assumption is unreliable as the relations of order-importance were found unstable at a personal level. In this thesis, dominances of elicited attitudes (mentioning frequencies) were taken into consideration, with the assumption that the frequency of an elicited attitude could be a powerful indicator in evaluating the degree of awareness of individuals.

For the computer mouses, the most commonly elicited attitude was *big-small* (96% of the total population), followed by *old-new* (93%), *smooth-rough* (83%), *heavy-light* (77%) *comfortable-uncomfortable* (70%) and *shiny-matte* (70%), respectively. For the water bottles, the most commonly elicited attitude was *durable-flimsy* (90% of the total population), followed by *transparent-opaque* (83%), *smooth-rough* (70%), *cold-hot* (70%) and *deep-treble* (70%), respectively. Considering the attitudes that were elicited by more than half of the participants for each experiment, the attitudes *smooth-rough*, *heavy-light*, *soft-hard*, *attractive-unattractive* and *deep-treble* were assumed to be the most important attitudes that were commonly expressed towards materials in both product contexts. The attitude *smooth-rough* was one of the widely used attitudinal scale in material perception studies (Drewing, et al., 2018; Etzi, et al., 2014; Goda, et al., 2016; Guest, et al., 2002; Haverkamp, 2017; Guest & Spence, 2003; Lederman, et al., 2003; Özcan & van Egmond, 2012; Wastiels, et al., 2012; Wilkes, et al., 2015; Zampini, et al., 2003; Zampini, et al., 2006). The scope of these studies is majorly based on measuring roughness perception and physical roughness, and investigating their interrelations. Physical roughness is a physical dimension of material surface, and is objectively measured through coefficient of friction (Aktar, Chen, Ettelaie, Holmes, & Henson, 2017). For most of the studies, smoothness and roughness were investigated separately and the majority of the research focus was on visual and tactile roughness perception. Some studies also investigated auditory roughness perception and the relationship between gustation and roughness perception; whereas other studies focused on crossmodal interactions in perceiving roughness. The attitude *heavy-light* was another attitudinal scale that was widely used among the studies of material perception (Bergmann Tiest & Kappers, 2011; Buckingham & MacDonald, 2015; Dravnieks, 1982; Kahrimanovic, Vicovaro & Bugibana, 2017; Haverkamp, 2013; Lin, 2013; Nakatani, 1989; Plaisier & Smeets, 2016; Saccone & Choinard, 2019; Solomon, 1959; Vicovaro, Ruta & Vidotto, 2019; Walker, Francis & Walker, 2010). Most of these studies were concerned with the size-weight and material-weight illusions, whereas other studies investigated various factors that affect the perception of heaviness, such as shape and lightness.

Moreover, the attitude *soft-hard* was also another attitudinal scale investigated in many perception studies (Chen, et al., 2009; Di Luca, 2014; Etzi, et al., 2014; Imschloss & Kuehnl, 2019; Kitada, Doizaki, Kwon, Tanigawa, Nakagawa, Kochiyama, Kajimoto, Sakamoto & Sadato, 2019; Klatzky, et al., 2013; Okamato, et al., 2013; Pasqualatto et al., 2020). Physical softness and perceived softness were the two major research areas investigating softness of the materials and physical softness was measured through compliance and Young’s modulus (Di Luca, 2014). Perceived softness, on the other hand, is a cognitive and subjective process, thus it is idiosyncratic. Most frequently, visual and tactile perception of softness were investigated, yet a considerable amount of studies covered auditory perception of softness also. Reviewed studies included investigations about the discriminations of materials through softness, relationships between perceived softness and other attributes (such as pleasantness), and crossmodal correspondances.

Being regarded as a hedonic attitude scale, *attractive-unattractive* was also studied in some studies, yet their numbers are not as many as other mentioned attitude scales (Carbon, Mugge, & Schoormans, 2012; Chitturi, Londono, & Amezquita, 2019; Schnurr, Brunner-Sperdin, & Stokburger-Sauer, 2017; Störmer & Alvarez, 2016; Tanaka & Horiuchi, 2015; Blijlevens). Attractiveness was frequently considered as the aesthetical appraisal. The exploration of the underlying factors of perceived attractiveness of products was often limited to several aspects. Perception of attractiveness and its relations with the attitudes such as quality and price are particularly investigated in packaging design. Lastly, the attitude *deep-treble*, which also could be considered as pitch perception, was another attitude scale that was widely used in measuring psychophysical aspects of materials (Evans & Treisman, 2010; Gallace & Spence, 2006; Lim, 2001; Lowe & Haws, 2016; Marks, 1989; Marks, 1987; Özcan & van Egmund, 2012). The perception of deep sounds was described as low pitch sounds and the perception of treble sounds was described as high pitch sounds. Among these studies, the perception of auditory pitch was investigated through product sounds and visual aspects such as shape and brightness. The important attitude scales elicited in both experiments were seen to be used widely in psychology, psychometrics and perception studies.

Before analyzing the data quantitatively, normality test was applied on the data from two experiments separately. The data should be at least approximately normally distributed as a requirement for the most common statistical calculations (Siegel, 2016). Both datasets were found approximately normally distributed. Moreover, the goodness of fit test was applied to both datasets to investigate whether gender differences had influence on the construing of material impressions. The goodness of fit test is accepted valid, if the expected values of variables are at least five or more in the dataset (Kim, 2017; McHugh, 2013). In this context, 63 out of 76 common elicited attitudes for the first experiment, and 69 out of 83 common elicited attitudes for the second experiment, mentioned by at least five or more participants were taken into consideration. The goodness of fit test results for the first experiment (χ^2:15,108; df: 32, $p < 0.05$) and the second experiment (χ^2:33,116; df: 50, $p < 0.05$)

showed that gender differences did not play a significant role in the distribution of frequencies of elicited attitudes. Also, the elicited attitude counts for males and females were found balanced in both experiments.

The dataset of commonly elicited attitudes needed to be internally consistent in order to be analyzed quantitatively to produce reliable interpretations about how material impressions were construed. An internal consistency test, Cronbach's Alpha, was applied to both of the datasets separately. The alpha value was expected neither too low, nor too high to be accepted as internally consistent. A low alpha value is considered to indicate a weak internal consistency among the data, yet a very high alpha value could indicate a possibility of data redundancy (Streiner, 2003). Alpha values between 0.70 to 0.90 were regarded as reliable. Cronbach's Alpha values were calculated for the experiments with computer mouses (α=0,865) and water bottles (α=0,801), and the ratings in the datasets for both experiments were found highly reliable in terms of internal consistency.

The RGT was versatile in terms of collecting both qualitative and quantitative data through participant elicitations and evaluations. It was intended to bring individual attitudinal approaches together as common attitudes to reduce each 30 collected repertory grids into single sheets for each experiment. With regard to the qualitative analysis results, common elicited attitudes were gathered together based on their semantic similarities and therefore became ready to be analyzed quantitatively. Participants rated all products through a seven-point scale, and means and standard deviations of the datasets were calculated. Calculated mean ratings provided insights on whether the participants used one pole over another, or not. Also, the mean rating of an attitude closer to 4 (midpoint) was an indicator of that particular attitude not being lopsided. Further, the standard deviations of the ratings needed to be calculated for all common elicited attitudes to understand whether the ratings were scattered over a wide range, or not. The common elicited attitudes with higher standard deviation values were interpreted as the products carried apparent aspects and evoked distinctive material impressions such that the participants rated them by using the extreme values of the scale. In the experiment with computer mouses, participant ratings were scattered at most in the attitudes *dark-light*, *independent-constrained* and *classical-modern*, and in the experiment with water bottles, participant ratings were scattered at most in the attitudes *transparent-opaque*, *entertaining-serious* and *heavy-light*. In contrary to that, the attitudes with lowest standard deviation values were *durable-flimsy, ambiguous-distinct* and *long lasting-short lived* for the experiment with computer mouses, and *conductive-insulative*, *flexible-solid* and *comfortable-uncomfortable* for the experiment with water bottles, which meant that extreme values in the scale were not preferred by the participants. Therefore, it was considered that the products were not carrying distinct features that the participants could evaluate as explicit.

In addition to illustrating interrelations of attitudinal approaches towards perceived material qualities on products, it was also aimed to provide information about the sensory relevancies of elicited attitudes. For this, the RGT utilized for the experiments consisted of two different scales for participants to rate. As mentioned above, the seven-point scale was used to rate the products through all elicited attitudes during the interview and the ratings were explored to interpret the relationships between the attitudes and products. The other scale was an eleven-point scale that was used for evaluating sensory relevancies of elicited attitudes. At the end of each session, every elicited attitude was evaluated in terms of its relevancy to the basic sensory modalities separately through two products used as stimuli. In the eleven-point scale, 0 indicated that a particular sensory modality had no relevance in accordance with the elicited attitude, whereas 10 indicated extreme relevancy. Basic sensory modalities considered in this thesis were vision, touch, audition, olfaction and gustation. This experimental approach includes inspirations from the applications of modality differential scale (Suzuki, et al., 2006; Suzuki & Gyoba, 2003; Suzuki & Gyoba, 2001), the additive model of multisensory relations (Schifferstein et al., 2010) and the self reports of participants, which Schifferstein (2006a) used to assess sensory importance of interactions with particular products. Understanding sensory relevancies of elicited attitudes was considered to be valuable in exploring the position of the attitudinal approaches of individuals in sensory interactions. According to the overall sensory relevancy results of the experiments, the attitudinal approaches of individuals towards computer mouses were evaluated as mostly visual and tactile, where audition played a limited and olfaction and gustation played highly limited roles (V:80,1%, T:76,5%; A:29,7%; O:1,5%; G:0,3%). Schifferstein (2006a, p. 48) reported the sensory importance evaluation responses of users (without interacting with physical products) for a variety of products including computer mouses (V:72,2%; T:90,4%; A:57,2%; O:33,2%; G:21,8%), and significant differences were detected specifically in auditory, olfactory and gustatory evaluations. Possibly, the difference between two sensory evaluations of the same product was a result of the different methods used for collecting data. Schifferstein's (2006a) results relied on imaginative evaluations of participants through memorizing and in this thesis, physical products were used as stimuli. For the second experiment, the results showed that the participants also described the interactions with water bottles as mostly visual and tactile, and audition, olfaction and gustation played limited roles in the evaluations towards water bottles (V:82,5%; T:73,6%; A:38,4%; O:23,2%; G: 29,0%). In parallel with the literature review, vision and touch were evaluated as the most dominant senses in overall sensory ratings of both product contexts. Although a greater difference in the overall relevancy scores of the chemosensory modalities between two product types was expected, the difference was still significant as gustation and olfaction were regarded more important in water bottles than computer mouses. Participants elicited attitudes dominated by vision solely more than any other modalities, and thus the overall difference among sensory relevancies was not as great as expected. Fenko, et al. (2010) admitted that descriptions of product experiences vary in affective, sensory and symbolic dimensions and the majority of symbolic descriptors are visually dominated, and cross-cultural changes influence the evaluations of the sensory descriptions. Furthermore, one major aim of this thesis was to explore relationships between attitudes and therefore concerned with measuring attitudinal sensory relevancies individually.

Sensory aspects of common elicited attitudes were also examined through the participant evaluations to reveal the unimodal and multimodal roles of sensory modalities in forming each attitude. Visually dominated attitudes were *dark-light* and *non glittery-glittery* in the experiment with computer mouses, and *vivid-pale* and *transparent-opaque* in the experiment with water bottles. The attitudes dominated by touch were *cold-hot* and *controlled-uncontrolled* in the experiment with computer mouses, and *tight-loose* and *rough-smooth* in the experiment with water bottles. Moreover, audition dominated attitudes were *clear-blurry* and *loud-silent* in the experiment with computer mouses, and *loud-silent* and *deep-treble* in the experiment with water bottles; whereas for chemosenses, only gustation dominated attitudes were found as *fresh-stale* and *sweet-bitter* in the experiment with water bottles. For the multimodal relations, the attitude *durable-flimsy* and *sloppy-elaborated* were found as the highest multisensory attitude in the experiment with computer mouses; whereas *high quality-poor quality* and *healthy-unhealthy* were found highest in the experiment with water bottles.

Schifferstein (2006b) reported the sensory evaluations of some selected adjective labels regardless of any product context. According to the participant reports about sensory evaluations, some adjectives such as *good-bad* (V:72%; A:68%; T:64%; O:54%), *fast-slow* (V:84%; A:72%; T:56%; O:30%), *rough-soft* (V:84%; A:60%; T:100%; O:40%), *fresh-musty* (V:68%; A:38%; T:52%; O:100%) and *loud-quiet* (V:46%; A:98%; T:44%; O:26%) were found different than the findings of this thesis. In parallel to that, consumers found vision to be the major contributor in the quality perception, followed by touch, audition and olfaction respectively, according to a study related to the automotive industry (Stylidis, Wickman, & Söderberg, 2020). In this thesis, quality assessment of computer mouses was dominated by vision and touch with quite similar weights and in water bottles, all five senses contributed nearly equally. For the roughness example, sensory relevancies of the attitude *rough-smooth* for computer mouses (V:83,6%; T:95,4%; A:20,4%, O:0,0%; G:2,0%) and for water bottles (V:81,9%; T:96,9%; A:30,5%, O:3,1%; G:10,7%) were compared with Schifferstein's (2006b) report, in which participants evaluated roughness regardless of physical samples or context of use, and found that audition and olfaction were evaluated as contributing significantly higher. Moreover in the example of loudness, the results from sensory relevancy evaluation of the attitude *loud-silent* for computer mouses were (V:17,6%; T:53,8%; A:92,1%, O:0,0%; G:0,0%) and for water bottles were (V:48,8%; T:70,0%; A:98,8%, O:6,3%; G:14,6%); when compared with Schifferstein's (2006b) report, it was clearly seen that the sensory relevancies other than audition were significantly dispersed among the evaluations within different contexts and without context. Suzuki and Gyoba (2001) investigated the sensory relevancies in the perfume bottles context, and found that perceived warmth and softness were highly dominated by touch, and coefficients of other sensory modality scores had insignificant values. Furthermore, Fenko et al. (2010) stated that perceived softness is dominated by touch (V:84%; A:60%; T:100%; O:40%), alongside with the contributions of other modalities. In parallel with the findings of Fenko and her collegues, findings of this thesis showed that for both computer mouses (V:69,7%; T:96,9%; A:33,9%; O:0,0%; G: 0,0%) and water bottles (V:68,5%; T:88,8%; A:58,3%; O:15,0%; G:22,8%), touch was evaluated as highly dominant yet other senses also contributed. Fenko, Schifferstein, Huang and Hekkert (2009) emphasized that sensory relevancies of certain experiences differ based on the main function of the product. In their example with freshness experience, olfaction was considered more important in soft drinks whereas vision and olfaction contributed equally in scented candles (Fenko et al., 2009). In this thesis, it is inferred that attitudinal approaches contain particular sensory dominancies (such as auditory dominance in loudness perception) that remain constant in most contexts, while the relevancies of other sensory modalities tend to change depending on the context. It is also considered that in order to compare sensory relevancies among studies, the context of use and the product types need to be similar.

8.1.3 Discussions on the Latent Structure of the Findings

The purpose of this objective was to explore the underlying structure of the common elicited attitudes by reducing the data into components by bringing the common elicited attitudes together based on their similar patterns in participant ratings. For this, rating patterns were investigated through a systematical approach by employing the principal component analysis (PCA). PCA was applied to develop components within the highly complex data. The benefits of using PCA were twofold as exploring the interrelations between the common elicited attitudes and the products, and simplifying the data for a more clear interpretation. PCA was applied on 63 common elicited attitudes for the experiment with computer mouses and 69 common elicited attitudes for the experiment with water bottles. The literature review presented that it was common to encounter cross-loaded items in behavorial research as the obtained data are highly subjective, and the procedures of PCA contained a strict rule that all cross-loaded items had to be removed from the study (Büyüköztürk, 2020). Several cross-loaded items were found in the analysis of data from both experiments. Every common attitude had a potential in terms of providing rich in-depth information, so various rotation methods were tested to find the optimum result with least amount of cross-loaded items. Six cross-loaded items (*inappropriate-appropriate, long lasting-short lived*, *independent-constrained*, *expensive-cheap*, *beautiful-ugly* and *easy-difficult*) from the experiment with computer mouses and two cross-loaded items (*safe-insecure* and *clean-dirty*) from the experiment with water bottles were excluded from further analyses. Before advancing to the discussions on the details of PCA and developed components, the excluded items will be briefly discussed.

8.1.3.1 Discussions on the Excluded Attitudes

Cross-loaded attitudes were excluded from the study because they were significantly correlated with attitudes that were loaded under at least two different components. Every common elicited attitude had a potential of carrying valuable information that could contribute to the exploration of interpersonal attitudinal relationships. In this manner, it was considered that excluded common attitudes were worth examining in terms of their descriptive statistics and their relationships with other attitudes in this section.

The PCA analysis of the data collected through the experiment with computer mouses produced six cross-loaded items. Descriptive statistics of the first excluded item *independent-constrained* can be seen in Table 8.1. According to the table, M8 was found *extremely constrained* as all the participants elicited that attitude used the extreme value to the right pole in the ratings scale. M1, M4, M5 and M6 were also regarded as *highly independent*, where participents preferred to use the left pole of the scale. Further, for the products where participant ratings were scattered, M3 was found *slightly independent* (SD:2,41) and M2 was found *slightly constrained* (SD:2,28).

Table 8.1 Descriptive statistics of the attitude *independent-constrained*

Descriptive Statistics (*independent-constrained*)					
Elements	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
M1	5	1	2	1,2	0,45
M2	5	2	7	4,8	2,28
M3	5	1	6	3,4	2,41
M4	5	1	3	1,4	0,89
M5	5	1	3	1,4	0,89
M6	5	1	3	1,4	0,89
M7	5	2	4	2,4	0,89
M8	5	7	7	7	0,00

Descriptive statistics of the excluded attitude *expensive-cheap* can be seen in Table 8.2. According to the table, M1 was found *extremely expensive* as all the participants used the extreme values to the left pole (SD:0,32). M4 and M6 were found *neither expensive nor cheap* as the ratings were gathered around the midpoint. M3 and M8 were found *highly cheap* where participants' ratings were slightly scattered as they preferred more to use the extreme ratings to the right pole. The ratings of the participants were scattered in the evaluation of M7 (SD:1,81) and M2 (SD:1,75), where both products were regarded as *moderately cheap*.

Table 8.2 Descriptive statistics of the attitude *expensive-cheap*

Descriptive Statistics (*expensive-cheap*)					
Elements	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
M1	10	1,00	2,00	1,10	0,32
M2	10	2,00	7,00	5,20	1,75
M3	10	2,00	7,00	6,00	1,49
M4	10	2,00	5,00	3,90	1,10
M5	10	2,00	5,00	3,60	1,07
M6	10	2,00	5,00	4,10	0,99
M7	10	2,00	7,00	4,80	1,81
M8	10	3,00	7,00	6,40	1,26

Descriptive statistics of the excluded attitude *beautiful-ugly* can be seen in Table 8.3. According to the table, M8 was found *extremely ugly* as majority of the participants used the extreme values to the right pole (SD:0,85). M1 was found *highly beautiful* as the ratings were made by preferring the left pole majorly (SD:1,11). Further, M2 and M3 were found *moderately ugly* and M4, M5 and M6 were regarded as *moderately beautiful*; whereas M7 was found *neither beautiful nor ugly*.

Table 8.3 Descriptive statistics of the attitude beautiful-ugly

Descriptive Statistics (***beautiful-ugly***)					
Elements	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
M1	18	1,00	4,00	1,78	1,11
M2	18	1,00	7,00	4,83	2,12
M3	18	3,00	7,00	5,33	1,41
M4	18	2,00	6,00	3,22	1,06
M5	18	2,00	6,00	3,06	1,16
M6	18	2,00	6,00	3,44	1,25
M7	18	1,00	7,00	4,33	2,06
M8	18	4,00	7,00	6,61	0,85

Descriptive statistics of the excluded attitude *easy-dificult* can be seen in Table 8.4. According to the table, the ratings of M6 (SD:1,01) and M4 (SD:2,41) were not scattered widely as they were both regarded as *extremely easy*, where all participants preferred using the values to the left pole. Further M2 and M3 were found *neither easy nor difficult*; M1, M5 and M7 were regarded as *moderately easy* and M8 was regarded as *slightly difficult*.

Table 8.4 Descriptive statistics of the attitude easy-difficult

Descriptive Statistics (***easy-difficult***)					
Elements	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
M1	11	1,00	7,00	2,45	2,34
M2	11	1,00	7,00	3,73	2,41
M3	11	1,00	7,00	4,00	2,24
M4	11	1,00	4,00	2,27	1,10
M5	11	1,00	5,00	2,55	1,51
M6	11	1,00	4,00	2,27	1,01
M7	11	1,00	6,00	3,09	2,17
M8	11	1,00	7,00	4,45	1,97

Descriptive statistics of the excluded attitude *inappropriate-proper* can be seen in Table 8.5. According to the table, the ratings were scattered in the evaluations of M8 (SD:2,95), M7 (SD:2,53), M1 (SD:2,53) and M3 (SD:2,32); where M1 and M3 were found *moderately proper*, M8 was found *slightly inappropriate*, and M7 was found *neither inappropriate nor proper*. Further, M2 (SD:0,82), M6 (SD:0,84), M4 (SD:1,17) and M5 (SD:1,21) were found *moderately proper* as all participants preferred the right pole while rating.

Table 8.5 Descriptive statistics of the attitude inappropriate-proper

Descriptive Statistics (*inappropriate-proper*)					
Elements	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
M1	6	1,00	7,00	5,00	2,53
M2	6	5,00	7,00	5,67	0,82
M3	6	2,00	7,00	4,83	2,32
M4	6	4,00	7,00	5,83	1,17
M5	6	4,00	7,00	5,67	1,21
M6	6	4,00	6,00	5,50	0,84
M7	6	1,00	7,00	4,00	2,53
M8	6	1,00	7,00	3,50	2,95

Descriptive statistics of the excluded attitude *long-lasting-short lived* can be seen in Table 8.6. According to the table, all ratings were scattered widely in various degrees in the evaluation of the products. M2, M4, M5, M7 and M8 were found *neither long lasting-nor short lived*, where M1 was regarded as slightly *long lasting*, and M3 and M6 were regarded as *slightly short lived*.

Table 8.6 Descriptive statistics of the attitude long lasting-short lived

Descriptive Statistics (*long lasting-short lived*)					
Elements	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
M1	6	1,00	6,00	3,00	2,28
M2	6	1,00	7,00	4,33	2,34
M3	6	3,00	7,00	4,83	1,47
M4	6	2,00	7,00	3,67	2,25
M5	6	2,00	7,00	4,17	1,94
M6	6	2,00	7,00	4,67	1,97
M7	6	2,00	7,00	4,33	1,63
M8	6	2,00	7,00	4,00	1,90

Computer mouses with their explicit attitudinal features are represented in Table 8.7.

Table 8.7 Computer mouses and their explicit attitudinal features
(Att LP: Attitudes (Left Pole), Att RP: Attitudes (Right Pole))

	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Att LP	independent expensive beautiful			independent easy	independent	independent easy		
Att RP		cheap	cheap ugly					constrained cheap ugly

The relationships between excluded and retained common attitudes were also investigated. Pearson's product moment correlation coefficient was used to understand the correlations between mentioned attitudes in the experiment with computer mouses. Analysis results can be seen in Table 8.8. According to the correlation analysis, the relationships were interpreted as follows:

- *Independent* products had a tendency to be construed as *handy*, *necessary*, *easy*, *good*, *comfortable*, *unproblematic*, *elaborated* and *beautiful*. *Constrained* products had a tendency to be construed as *impractical*, *unnecessary*, *bad*, *uncomfortable*, *problematic*, *sloppy* and *ugly*.
- *Expensive* products had a tendency to be construed as *attractive*, *beautiful*, *high quality*, *elaborated*, *technological* and *clean*. *Cheap* products had a tendency to be construed as *unattractive*, *ugly*, *poor quality*, *sloppy*, *outdated* and *dirty*.
- *Beautiful* products had a tendency to be construed as *elaborated*, *technological*, *high quality*, *expensive*, *good* and *easy*. *Ugly* products had a tendency to be construed as *sloppy*, *outdated*, *poor quality*, *cheap*, *bad* and *difficult*.

- *Easy* products had a tendency to be construed as *comfortable*, *elaborated*, *good* and *beautiful*. *Difficult* products had a tendency to be construed as *uncomfortable*, *sloppy*, *bad* and *ugly*.
- *Inappropriate* products had a tendency to be construed as *stable*, *uncomfortable*, *bulky* and *slow*. *Proper* products had a tendency to be construed as *fluid*, *comfortable*, *dynamic* and *fast*.
- *Long lasting* products had a tendency to be construed as *low*, *whole*, *eccentrical* and *expensive*. *Short lived* products had a tendency to be construed as *high*, *fragmented*, *accustomed* and *cheap*.

Table 8.8 Correlations table of the cross-loaded items from the experiment with computer mouses. Values represent correlations between the attitudes. Negative numbers reflect negative correlations. Shadings represent excluded items.

independent-constrained	**expensive-cheap**	**beautiful-ugly**	**easy-difficult**	**inappropriate-proper**	**long lasting-short lived**
handy-impractical (.94)	attractive-unattractive (.98)	sloppy-elaborated (-.99)	comfortable-uncomfortable (.95)	fluid-stable (-.86)	high-low (-.85)
unnecessary-necessary (-.94)	beautiful-ugly (.96)	technological-outdated (.96)	sloppy-elaborated (-.94)	comfortable-uncomfortable (-.80)	whole-fragmented (.77)
easy-difficult (.93)	high quality-poor quality (.95)	high quality-poor quality (.96)	good-bad (.93)	dynamic-bulky (-.80)	eccentrical-accustomed (.76)
good-bad (.92)	sloppy-elaborated (-.95)	expensive-cheap (.96)	beautiful-ugly (.92)	fast-slow (-.79)	expensive-cheap (.72)
comfortable-uncomfortable (.91)	technological-outdated (.93)	good-bad (.94)			
problematic-unproblematic (-.91)	clean-dirty (.91)	easy-difficult (0.92)			
sloppy-elaborated (-.91)					
beautiful-ugly (.90)					

The PCA analysis of the data collected through the experiment with water bottles produced two cross-loaded items. Descriptive statistics of the first excluded item *safe-insecure* can be seen in Table 8.9. According to the table, majority of the participant ratings were scattered widely in evaluating the water bottles. B1 and B5 were found *slightly safe*, whereas B3, B7 and B8 were regarded as *moderately safe*. B2 was found *slightly insecure*, and B4 and B6 were found *neither safe nor insecure*.

Table 8.9 Descriptive statistics of the attitude safe-insecure

Descriptive Statistics (*safe-insecure*)					
Elements	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
B1	14	1,00	6,00	3,50	1,79
B2	14	1,00	7,00	4,64	2,31
B3	14	1,00	6,00	2,86	1,23
B4	14	1,00	7,00	4,00	1,57
B5	14	1,00	7,00	3,14	2,32
B6	14	1,00	7,00	3,93	2,43
B7	14	1,00	7,00	2,43	2,14
B8	14	1,00	7,00	2,57	2,06

Descriptive statistics of the excluded item *safe-insecure* can be seen in Table 8.10. According to the table, the ratings of B5 (SD:0,51) and B6 (SD:0,60) were not scattered and the participants preferred using extreme values to the left pole more and regarded B5 and B6 as *extremely clean*. B1 and B2 were found *moderately dirty*, whereas B4 was regarded as *slightly clean*, and B3, B7 and B8 were regarded as *neither clean nor dirty*.

Table 8.10 Descriptive statistics of the attitude clean-dirty

Descriptive Statistics (*clean-dirty*)					
Elements	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
B1	16	3,00	7,00	5,19	1,42
B2	16	3,00	7,00	5,75	1,39
B3	16	2,00	7,00	4,25	1,73
B4	16	1,00	5,00	3,44	1,55
B5	16	1,00	2,00	1,44	0,51
B6	16	1,00	3,00	1,31	0,60
B7	16	1,00	7,00	3,50	2,13
B8	16	1,00	7,00	3,63	2,09

The relationships between excluded and retained common attitudes were also investigated. Pearson's product moment correlation coefficient was used to understand the correlations between mentioned attitudes in the experiment with water bottles. Analysis results can be seen in Table 8.11. According to the correlation analysis, the relationships were interpreted as follows:

- *Safe* products had a tendency to be construed as *high quality*, *expensive*, *reliable*, *coherent* and *necessary*. *Insecure* products had a tendency to be construed as *poor quality*, *cheap*, *unreliable*, *discordant* and *unnecessary*.
- *Clean* products had a tendency to be construed as *relieving*, *fresh*, *heavy*, *healthy* and *natural*. *Dirty* products had a tendency to be construed as *irritating*, *stale*, *light*, *unhealthy* and *artificial*.

Table 8.11 Correlations table of the cross-loaded items from the experiment with water bottles. Values represent correlations between the attitudes. Negative numbers reflect negative correlations.

safe-insecure	high quality-poor quality (.94)	expensive-cheap (.91)	reliable-unreliable (.91)	discordant-coherent (-.85)	unnecessary-necessary (-.85)
clean-dirty	relieving-irritating (.99)	fresh-stale (.95)	heavy-light (.92)	healthy-unhealthy (.92)	natural-artificial (.91)

Water bottles with their explicit attitudinal features are represented in

Table 8.12.

Table 8.12 Water bottles and their explicit attitudinal features
(Att LP: Attitudes (Left Pole), Att RP: Attitudes (Right Pole))

								
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
Att LP					clean	clean	safe	
Att RP		dirty						

8.1.3.2 Discussions on the Components of Latent Structure

PCA was applied on the highly complex data to reduce the data in order to generate simple and meaningful components that included common elicited attitudes depending on their closeness to each other. PCA is an empirical approach that aims to create a limited number of components that summarize the data in the optimum way (Lever et al., 2017). Several orthogonal and oblique rotation methods with various numbers of extracted components as combinations were systematically tested to achieve the most simple and clear result alongside producing the least amount of cross-loaded items. The best results were reached through cluster rotation with four-component extraction. *Cluster rotation is an oblique rotation* that *is capable of clustering even the loadings that are not perfect* (Yamamoto & Jennrich, 2013). Cronbach's alpha was applied on each produced component to understand whether the data within components were reliable or not. Although naming of the components was not a crucial concern for this thesis, each component was defined with a label that considered to be representing the general concept of the grouped attitudes. Four components produced for the experiment with computer mouses were labeled as **evaluation** (Component 1), **usability** (Component 2), **capacity** (Component 3) and **clarity** (Component 4), and four components produced for the experiment with water bottles were labeled as **evaluation** (Component 1), **assurance** (Component 2), **familiarity** (Component 3) and **elegancy** (Component 4). Osgood et al. (1957) developed three factors as potency, evaluation and activity for categorizing meanings into dimensions which were widely used in the literature. Evaluation dimension was used as a label in the components of both experiments, however other dimensions of Osgood remained abstract in representing the remaining attitudes.

Details for the components developed in the experiment with computer mouses are discussed in the following.

The first component of the experiment with computer mouses, **evaluation**, consisted of the items with high loadings such as *plain-ornate, simple-complex, healthy-unhealthy* and *clean-dirty.* The evaluation component covered the biggest part (33% of proportional variance) of the total variance. Quadratic mean scores showed that the attitude *clean-dirty* had the greatest average relation with all other attitudes.

The second component of the experiment with computer mouses, **usability**, consisted of the items with high loadings such as *user friendly-difficult to use, controlled-uncontrolled* and *functional-functionless.* These items were regarded as related to function and ergonomics, and the component covered the third most (23% of proportional variance) portion of the total variance. Quadratic mean scores showed that the attitude *user friendly-difficult to use* had the greatest average relation with all other attitudes.

The third component of the experiment with computer mouses, **capacity**, consisted of the items with high loadings such as *thick-thin, big-small, heavy-light* and *dynamic-bulky.* These items were regarded as related to size and appearance of the computer mouses and the component covered the second most (30% of proportional variance) part of the total variance. Quadratic mean scores showed that the attitude *reassuring-insecure* had the greatest average relation with all other attitudes.

The fourth component of the experiment with computer mouses, **clarity**, consisted of only two items, *clear-blurry* and *non glittery-glittery* and the component covered the smallest part (6% of proportional variance) of the total variance.

Details for the components developed in the experiment with water bottles are discussed in the following.

The first component of the experiment with water bottles, **evaluation**, consisted of the items with high loadings such as *hard-soft, long lasting-short lived, hygienic-non hygienic, excited-calm* and *natural-artificial.* These items were mostly evaluative and the component covered the biggest part (32% of proportional variance) of the total variance. Quadratic mean scores showed that the attitude *long lasting-short lived* had the greatest average relation with all other attitudes.

The second component of the experiment with water bottles, **assurance**, consisted of the items with high loadings such as *portable-stable, protective-vulnerable* and *durable-flimsy.* These items reflected meanings related to reliability issues mostly and the component covered the second most (28% of proportional variance) part of the total variance. Quadratic mean scores showed that the attitude *flimsy-durable* had the greatest average relation with all other attitudes.

The third component of the experiment with water bottles, **familiarity**, consisted of the items with high loadings such as *elaborated-sloppy, old-new* and *accustomed-eccentrical.* These items were regarded as carrying habitual meanings and the component covered 14% of the total variance. Quadratic mean scores showed that the attitude *new-old* had the greatest average relation with all other attitudes.

The fourth component of the experiment with water bottles, **elegancy**, consisted of the items with high loadings such as *attractive-unattractive*, *vivid-pale*, *coarse-gracious* and *plain-ornate.* These attitudes were considered as related to style and classiness and the component covered 14% of the total variance. Quadratic mean scores showed that the attitude *rough-smooth* had the greatest average relation with all other attitudes.

8.1.4 Discussions on the Relationships Between the Attitudes and the Products

The purpose of this final objective was to explore possible relationships between the attitudes and the products. Firstly, the attitude-attitude relationships were investigated through bivariate statistics, and Pearson's product moment correlation coefficient was used to measure distances between attitudes. Secondly, the product-product relationships were investigated through hierarchical cluster analysis, and clustered products were analyzed through semantic differential charts. Thirdly, the product-attitude relationships were investigated through mean differences, and one sample *t*-test was applied on the data between each component separately.

8.1.4.1 Discussions on the Relationships Among Attitudes

In the first step of analysis for the fourth objective, the relationships between the attitudes were investigated. To achieve statistically reliable results, all eight components were investigated separately and Pearson's product moment correlation test was applied on the items within each component. Based on the test results, all correlations between the attitudes in each component were revealed and Senso-Attitudinal Maps (SAM) were prepared specifically for each component. SAM represent the relationships between the attitudes through paths. The significance of the correlations were represented through the thickness of the paths, where stronger correlations were shown with thicker paths and weaker correlations were shown with thinner paths. Moreover, the type of correlations were represented through the color of the paths, where blue paths indicated a positive correlation and orange paths indicated a negative correlation.

In the SAM, sensory relevancies of each attitude were also provided alongside their correlations. Sensory relevancies were formed through the sensory ratings of participants, and represented as a circle around the attitude as a pie chart. The role of each sensory modality in forming of an attitude was shown as particular colours.

SAM for Component 1 Evaluation

To investigate the relationships among the attitudes in the evaluation component of the experiment with computer mouses, Pearson's product moment correlation test was applied on 21 items. All the correlations of the items were revealed. Attitude correlations with their sensory relevancies was illustrated as a Senso-Attitudinal Map (SAM). The SAM of the evaluation component for computer mouses can be seen in Figure 8.1.

The most significant correlations of each attitude are summarized as follows:

Plain products showed a tendency to be also construed as *symmetric, hidden* and *simple*. *Ornate* products were conceivably construed as *asymmetric, open* and *complex*.

Hidden products showed a tendency to be also construed as *coherent*, *simple* and *whole*. *Open* products were conceivably construed as *discordant*, *complex* and *fragmented*.

Coherent products showed a tendency to be also construed as *hidden*, *simple* and *whole*. *Discordant* products were conceivably construed as *open*, *complex* and *fragmented*.

Simple products showed a tendency to be also construed as *coherent*, *hidden* and *whole*. *Complex* products were conceivably construed as *discordant*, *open* and *fragmented*.

Senso-Attitudinal Map
Component I (Evaluation)

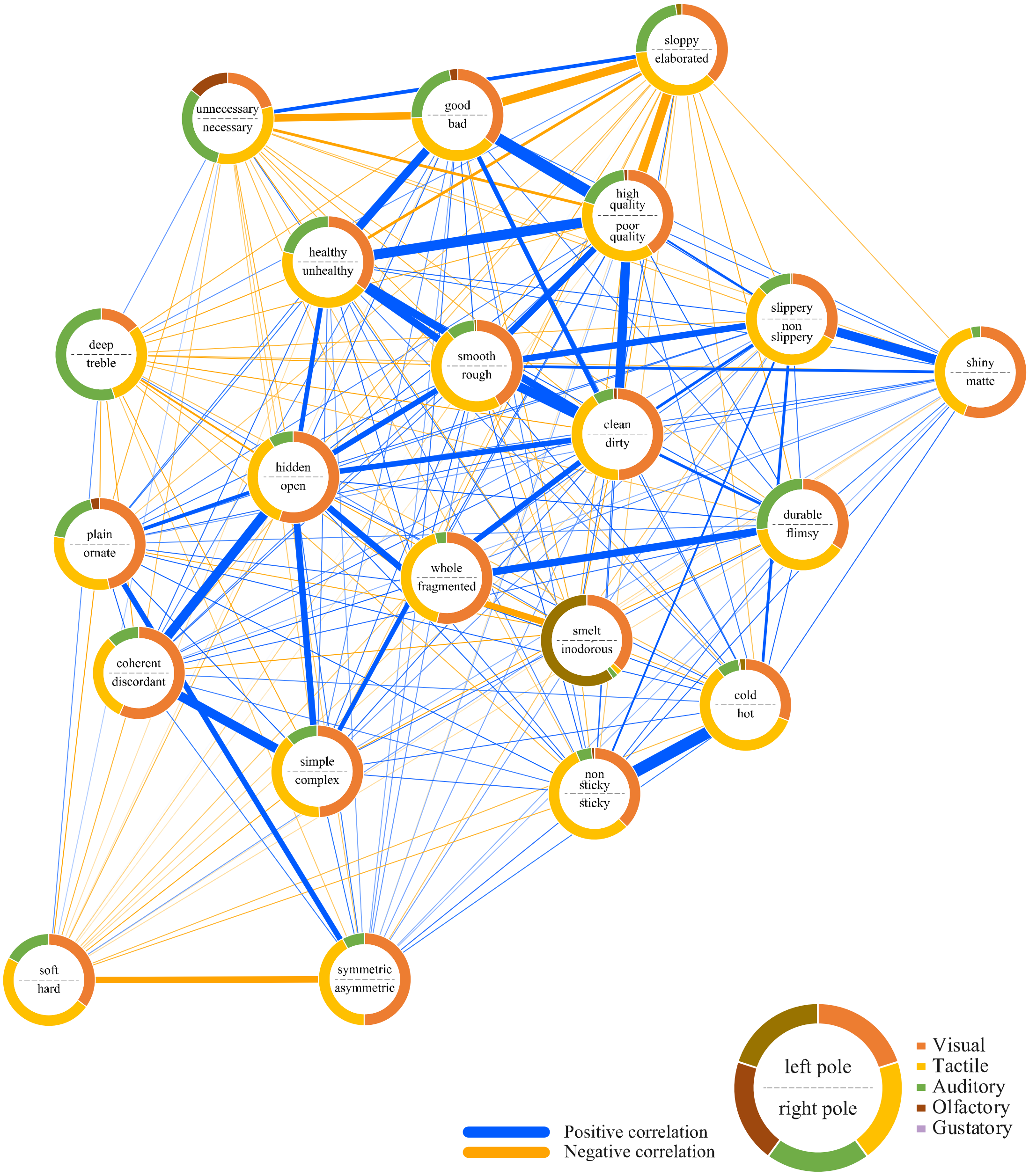

Figure 8.1 Senso-attitudinal map (SAM) of the evaluation component for computer mouses

Symmetric products showed a tendency to be also construed as *hard* and *plain*. *Asymmetric* products were conceivably construed as *soft* and *ornate*.

Deep products showed a tendency to be also construed as *open*, *dirty* and *rough*. *Treble* products were conceivably construed as *hidden*, *clean* and *smooth*.

Smelt products showed a tendency to be also construed as *sticky*. *Inodorous* products were conceivably construed as *non sticky*.

Healthy products showed a tendency to be also construed as *high quality*, *good*, *smooth* and *clean*. *Unhealthy* products were conceivably construed as *poor quality*, *bad*, *rough* and *dirty*.

Clean products showed a tendency to be also construed as *high quality*, *smooth* and *healthy*. *Dirty* products were conceivably construed as *poor quality*, *rough* and *unhealthy*.

Non sticky products showed a tendency to be also construed as *cold*, *slippery* and *smooth*. *Sticky* products were conceivably construed as *hot*, *non slippery* and *rough*.

Smooth products showed a tendency to be also construed as *clean*, *healthy*, *high quality* and *slippery*. *Rough* products were conceivably construed as *dirty*, *unhealthy*, *poor quality* and *non slippery*.

Whole products showed a tendency to be also construed as *durable*, *hidden* and *clean*. *Fragmented* products were conceivably construed as *flimsy*, *open* and *dirty*.

Unnecessary products showed a tendency to be also construed as *bad*, *sloppy* and *poor quality*. *Necessary* products were conceivably construed as *good*, *elaborated* and *high quality*.

Good products showed a tendency to be also construed as *high quality*, *healthy* and *elaborated*. *Bad* products were conceivably construed as *poor quality*, *unhealthy* and *sloppy*.

Soft products showed a tendency to be also construed as *asymmetric* and *ornate*. *Hard* products were conceivably construed as *symmetric* and *plain*.

Cold products showed a tendency to be also construed as *non sticky*, *slippery* and *smooth*. *Hot* products were conceivably construed as *sticky*, *non slippery* and *rough*.

High quality products showed a tendency to be also construed as *good*, *healthy*, *clean* and *smooth*. *Poor quality* products were conceivably construed as *bad*, *unhealthy*, *dirty* and *rough*.

Slippery products showed a tendency to be also construed as *shiny*, *whole*, *clean* and *cold*. *Non slippery* products were conceivably construed as *matte*, *fragmented*, *dirty* and *hot*.

Durable products showed a tendency to be also construed as *whole*, *clean* and *smooth*. *Flimsy* products were conceivably construed as *fragmented*, *dirty* and *rough*.

Sloppy products showed a tendency to be also construed as *poor quality*, *bad*, *unnecessary* and *unhealthy*. *Elaborated* products were conceivably construed as *high quality*, *good*, *necessary* and *healthy*.

Shiny products showed a tendency to be also construed as *slippery* and *smooth*. *Matte* products were conceivably construed as *non slippery* and *rough*.

Perceived smoothness was found highly correlated with the perceived high quality in bioplastic products (Karana & Nijkamp, 2014; Karana, 2012). The SAM of the evaluation component also showed that in computer mouses, *smoothness* was significantly correlated with the perception of *high quality*. Moreover, the experience of auditory roughness is correlated negatively with the perception of high quality in steering wheels (Haverkamp, 2017), and pleasantness in elecric toothbrushes (Zampini et al., 2003). According to the SAM, the role of audition in the attitude *rough-smooth* was significantly lower than touch and vision. Sensory relevance of user considerations vary in different product categories (Schoormans, J, Van de Laar, & Van den Berg, 2010), and SAM was able to provide comparable results among different product categories.

Visual perception of roughness was found to be correlated with perceived *healthiness* in foods industry, and particularly important as consumers are not able to taste most of the food products before buying (Jansson-Boyd & Kobescak, 2020). The SAM of computer mouses showed that *rough* products were perceived as *unhealthy*, as they were also perceived as *dirty*. Similarly, Etzi et al. (2014) mentioned that roughness arouses unpleasant experiences. Jansson-Boyd and Kobescak (2020) also underlined that during the consumption of the food product, the taste of the food product was influenced by also biting sounds (audition) through the crossmodal correspondance. According to the SAM of computer mouses, touch contributed mostly to the perception of *roughness*, followed by vision and audition, respectively. On the other hand, it can be inferred from the SAM that *touch* contributed mostly in the perception of *healthiness*, followed by *vision* and *audition*. The map represented the interplay between sensory modalities while illustrating the correlations among elicited attitudes.

Aktar, et al. (2017) found out that temperature does not significantly influence roughness perception. However, in the experiment with computer mouses, *coldness* was found significantly correlated with *smoothness* (r= 0,84).

SAM for Component 2 Usability

To investigate the relationships among the attitudes in the usability component of the experiment with computer mouses, Pearson's product moment correlation test was applied on 14 items. Attitude correlations with their sensory relevancies were illustrated as a Senso-Attitudinal Map (SAM). The SAM of the usability component for computer mouses can be seen in Figure 8.2.

The most significant correlations of each attitude are summarized as follows:

User friendly products showed a tendency to be also construed as *curved*, *controlled* and *handy*. *Difficult to use* products were conceivably construed as *flat*, *uncontrolled* and *impractical*.

Curved products showed a tendency to be also construed as *rounded*, *user friendly* and *common*. *Flat* products were conceivably construed as *sharp*, *difficult to use* and *extraordinary*.

Senso-Attitudinal Map

Component II (Usability)

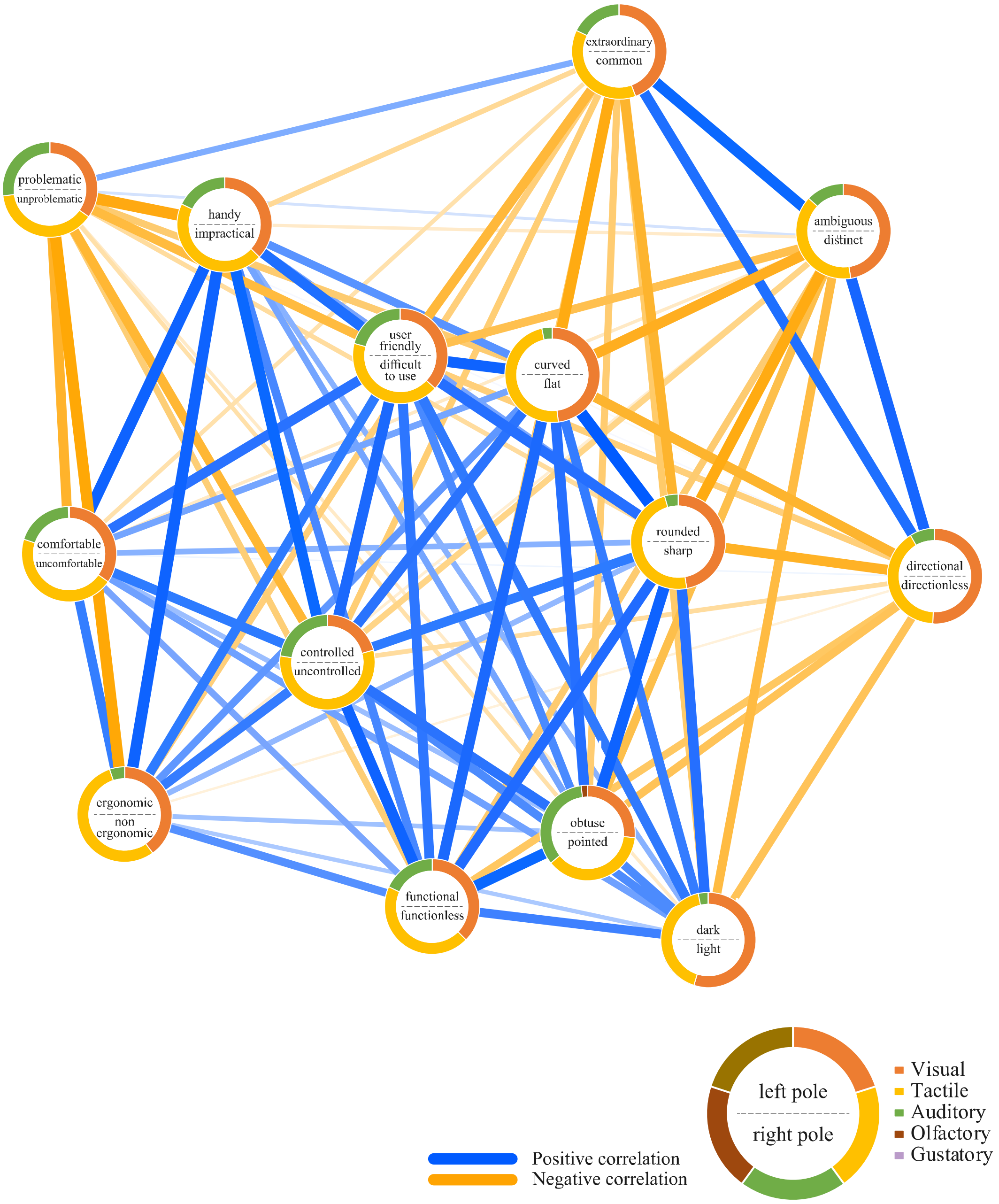

Figure 8.2 Senso-attitudinal map (SAM) of the usability component for computer mouses

Common products showed a tendency to be also construed as *curved and distinct*. *Extraordinary* products were conceivably construed as *flat* and *ambiguous*.

Controlled products showed a tendency to be also construed as *functional, handy* and *user friendly*. *Uncontrolled* products were conceivably construed as *functionless, impractical* and *difficult to use*.

Rounded products showed a tendency to be also construed as *curved, obtuse, distinct* and *functional*. *Sharp* products were conceivably construed as *flat, pointed, ambiguous* and *functionless*.

Functional products showed a tendency to be also construed as *controlled, obtuse* and *curved*. *Functionless* products were conceivably construed as *uncontrolled, pointed* and *flat*.

Ergonomic products showed a tendency to be also construed as *unproblematic* and *handy*. *Non ergonomic* products were conceivably construed as *problematic* and *impractical*.

Handy products showed a tendency to be also construed as *comfortable, ergonomic* and *unproblematic*. *Impractical* products were conceivably construed as *uncomfortable, non ergonomic* and *problematic*.

Problematic products showed a tendency to be also construed as *non ergonomic* and *impractical*. *Unproblematic* products were conceivably construed as *ergonomic* and *handy*.

Ambiguous products showed a tendency to be also construed as *directionless, sharp* and *extraordinary*. *Distinct* products were conceivably construed as *directional, rounded* and *common*.

Comfortable products showed a tendency to be also construed as *handy, user friendly* and *unproblematic*. *Uncomfortable* products were conceivably construed as *impractical, difficult to use* and *problematic*.

Dark products showed a tendency to be also construed as *rounded*. *Light* products were conceivably construed as *sharp*.

Obtuse products showed a tendency to be also construed as *rounded*, *functional* and *curved*. *Pointed* products were conceivably construed as *sharp*, *functionless* and *flat*.

Directionless products showed a tendency to be also construed as *ambiguous*, *extraordinary* and *sharp*. *Directional* products were conceivably construed as *distinct*, *common* and *rounded*.

In a study about developing new computer mouse concepts, benchmark concepts with various shapes and heights were tested by users, and it was found that flat computer mouses were found uncomfortable and the increase in height and angling (curve) influenced ergonomy positively (Odell & Johnson, 2015). In parallel to that, one result of this experiment was that *flatness* was significantly correlated with *difficulty of use*, and curved products were significantly perceived as *user friendly* and perceived curvedness was also linked with *comfortableness*.

SAM for Component 3 Capacity

To investigate the relationships among the attitudes in the capacity component of the experiment with computer mouses, Pearson's product moment correlation test was applied on 20 items. The SAM of the capacity component for computer mouses can be seen in Figure 8.3.

The most significant correlations of each attitude are summarized as follows:

Thin products showed a tendency to be also construed as *gracious*, *reassuring*, *low* and *particular*. *Thick* products were conceivably construed as *coarse, insecure, high* and *standard*.

Small products showed a tendency to be also construed as *short*, *dynamic*, *fast* and *light*. *Big* products were conceivably construed as *long*, *bulky*, *slow* and *heavy*.

Heavy products showed a tendency to be also construed as *slow*, *insecure*, *bulky* and *coarse*. *Light* products were conceivably construed as *fast*, *reassuring*, *dynamic* and *gracious*.

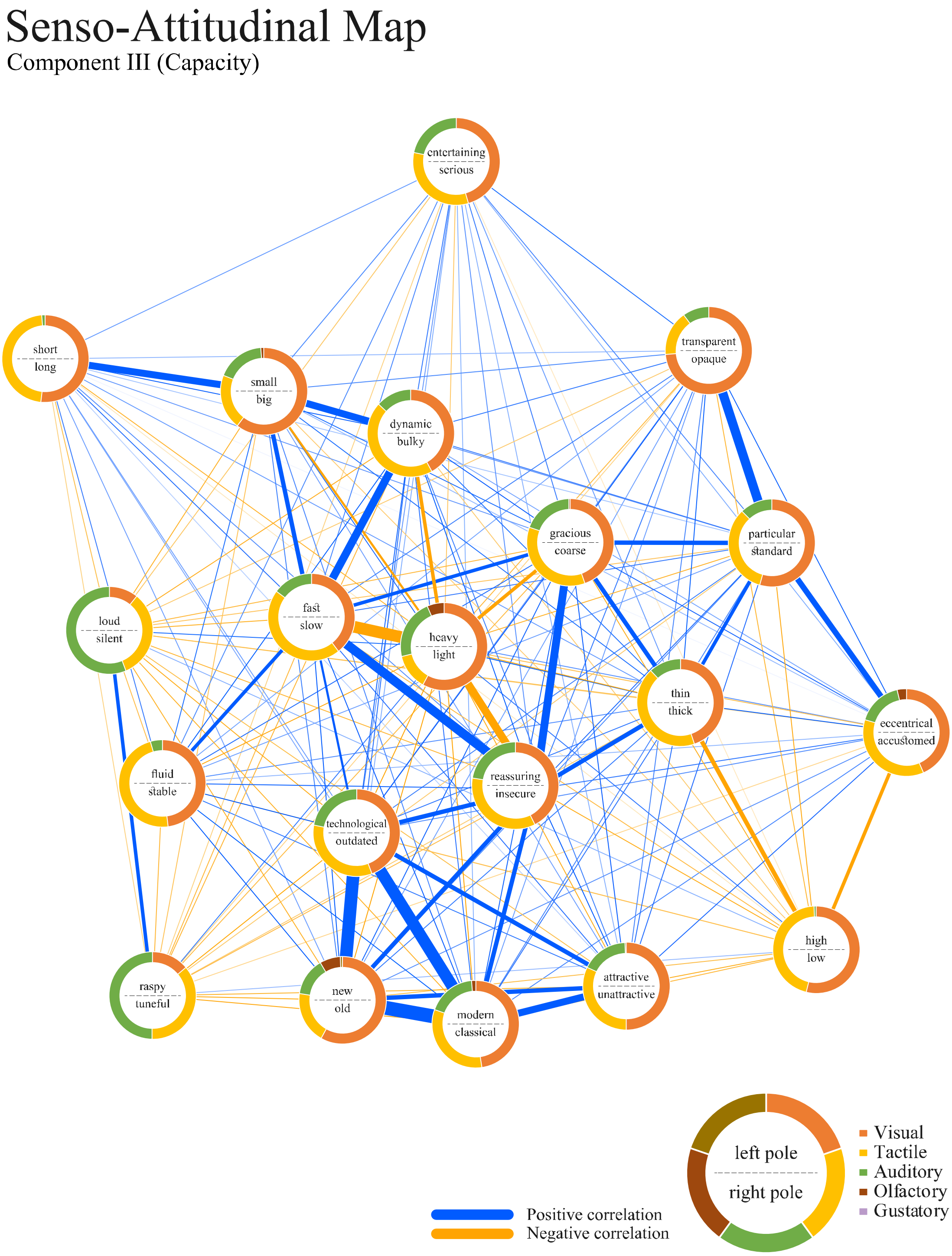

Figure 8.3 Senso-attitudinal map (SAM) of the capacity component for computer mouses

Gracious products showed a tendency to be also construed as *reassuring*, *light*, *thin*, *particular* and *fast*. *Coarse* products were conceivably construed as *insecure, heavy*, *thick*, *standard* and *slow*.

Fast products showed a tendency to be also construed as *light*, *reassuring*, *dynamic*, *small*, *gracious*, *fluid* and *technological*. *Slow* products were conceivably construed as *heavy*, *insecure*, *bulky*, *big*, *coarse*, *stable* and *outdated*.

Dynamic products showed a tendency to be also construed as *fast*, *small*, *light* and *gracious*. *Bulky* products were conceivably construed as *slow, big, heavy* and *coarse*.

Reassuring products showed a tendency to be also construed as *fast, light*, *gracious*, *thin*, *new*, *technological* and *modern*. *Insecure* products were conceivably construed as *slow, heavy, coarse, thick, old, outdated* and *classic*.

Transparent products showed a tendency to be also construed as *particular* and *gracious*. *Opaque* products were conceivably construed as *standard* and *coarse*.

Particular products showed a tendency to be also construed as *transparent, eccentrical, gracious* and *thin*. *Standard* products were conceivably construed as *opaque, accustomed, coarse* and *thick.*

Short products showed a tendency to be also construed as *small* and *dynamic*. *Long* products were conceivably construed as *big* and *bulky*.

High products showed a tendency to be also construed as *thick* and *accustomed*. *Low* products were conceivably construed as *thin* and *eccentrical*.

Loud products showed a tendency to be also construed as *raspy, outdated* and *bulky*. *Silent* products were conceivably construed as *tuneful, technological* and *dynamic*.

Technological products showed a tendency to be also construed as *new, modern*, *attractive, reassuring* and *fast*. *Outdated* products were conceivably construed as *classical, unattractive, insecure,* and *slow*.

Entertaining products showed a tendency to be also construed as *transparent* and *dynamic*. *Serious* products were conceivably construed as *opaque* and *bulky*.

Eccentrical products showed a tendency to be also construed as *particular, low* and *thin*. *Accustomed* products were conceivably construed as *standard, high* and *thick*.

Modern products showed a tendency to be also construed as *new*, *technological, attractive* and *reassuring*. *Classical* products were conceivably construed as *old, outdated, unattractive* and *insecure*.

New products showed a tendency to be also construed as *modern, technological, attractive* and *reassuring*. *Old* products were conceivably construed as *classical, outdated, unattractive* and *insecure*.

Fluid products showed a tendency to be also construed as *fast, technological, new* and *dynamic*. *Stable* products were conceivably construed as *slow, outdated, old* and *bulky*.

Attractive products showed a tendency to be also construed as *modern*, *new, technological*, *reassuring* and *gracious*. *Unattractive* products were conceivably construed as *classical, old, outdated*, *insecure* and *coarse*.

Raspy products showed a tendency to be also construed as *loud, outdated*, *classical* and *old*. *Tuneful* products were conceivably construed as *silent*, *technological, modern* and *new*.

In a study, atypical product designs were perceived more attractive than their typical counterparts (Blijlevens, Carbon, Mugge, & Schoormans, 2012). In other words, users felt attracted to the product designs that they were unfamiliar with. Further, Schnurr, Brunner-Sperdin and Stokburger-Sauer (2017) found that perceived attractiveness was correlated with quality, and unfamiliar products were perceived higher quality and attractive. In parallel with the findings of both studies, the SAM of the experiment with computer mouses indicated that the attitude scale *attractive* was found significantly correlated with the attitude scale *eccentrical* (r= 0,82).

In a study about passenger car window system sounds, Lim (2001) found that annoyance was significantly corelated with high intensity sounds (loudness). In another study, mechanical sounds were perceived as high pitch, sharp and fast, and therefore perceived as unpleasant (Özcan & van Egmund, 2012). According to the SAM of the evaluation component, perceived *loudness* was highly correlated with perceived *raspiness* for the computer mouses. On the other hand, sound qualities were found to be influencing the perception of individuals while comparing two objects with similar sizes through a synesthetic process (Gallace & Spence, 2006). According to Lowe and Haws (2016), high pitch sounds were associated with smaller objects and low pitch sounds were associated with larger objects. In contrast with that, *small* was correlated with *silent* and *big* was correlated with *loud* in the experiment with computer mouses.

SAM for Component 4 Clarity

To investigate the relationships among the attitudes in the clarity component of the experiment with computer mouses, Pearson's product moment correlation test was applied on 2 items. The SAM of the usability clarity for computer mouses can be seen in Figure 8.4.

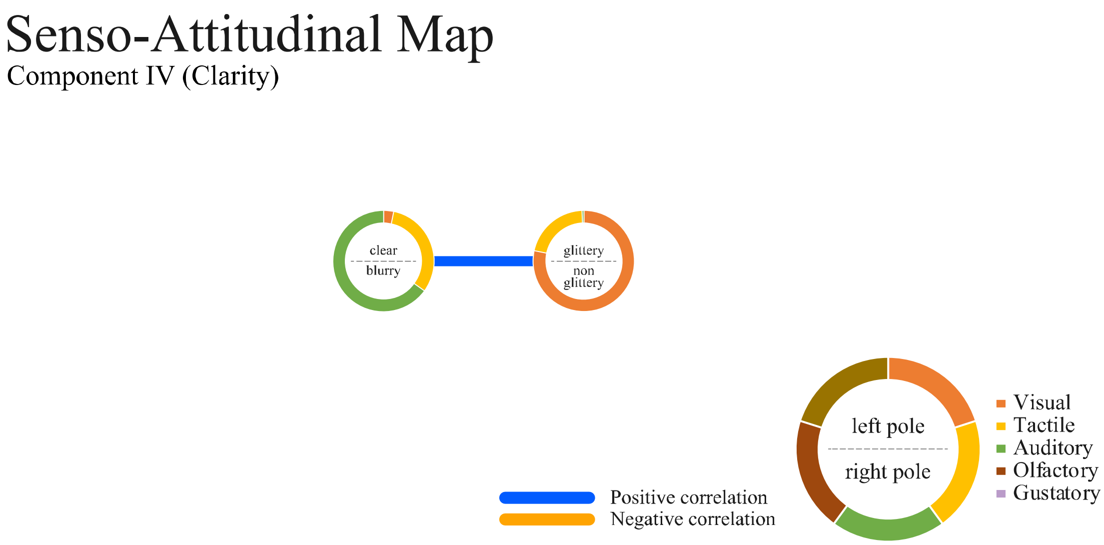

Figure 8.4 Senso-attitudinal map (SAM) of the clarity component for computer mouses

The most significant correlations of each attitude are summarized as follows:

Clear products showed a tendency to be also construed as *glittery*. *Blurry* products were conceivably construed as *non glittery*.

SAM for Component 1 Evaluation

To investigate the relationships among the attitudes in the evaluation component of the experiment with water bottles, Pearson's product moment correlation test was applied on 28 items. The SAM of the evaluation component for water bottles can be seen in Figure 8.5.

The most significant correlations of each attitude are summarized as follows:

Hard products showed a tendency to be also construed as *long lasting, tight, difficult, shiny* and *loud*. *Soft* products were conceivably construed as *short lived, loose, easy, matte* and *silent*.

Long lasting products showed a tendency to be also construed as *natural, hard, hygienic, healthy* and *expensive*. *Short lived* products were conceivably construed as *artificial, soft, non hygienic, unhealthy* and *cheap*.

Easy products showed a tendency to be also construed as *loose, user friendly, soft, short lived* and *non hygienic*. *Difficult* products were conceivably construed as *tight, difficult to use, hard, long lasting* and *hygienic*.

Tight products showed a tendency to be also construed as *hygienic, difficult to use, difficult, hard, long lasting* and *fresh*. *Loose* products were conceivably construed as *non hygienic, user friendly, easy, soft, short lived* and *stale*.

Hygienic products showed a tendency to be also construed as *fresh, healthy, tight, natural* and *long lasting*. *Non hygienic* products were conceivably construed as *stale, unhealthy, loose, artificial* and *short lived*.

Calm products showed a tendency to be also construed as *sharp, cold, directionless, flat* and *hard*. *Excited* products were conceivably construed as *rounded, hot, directional, uneven* and *soft*.

Senso-Attitudinal Map

Component I (Evaluation)

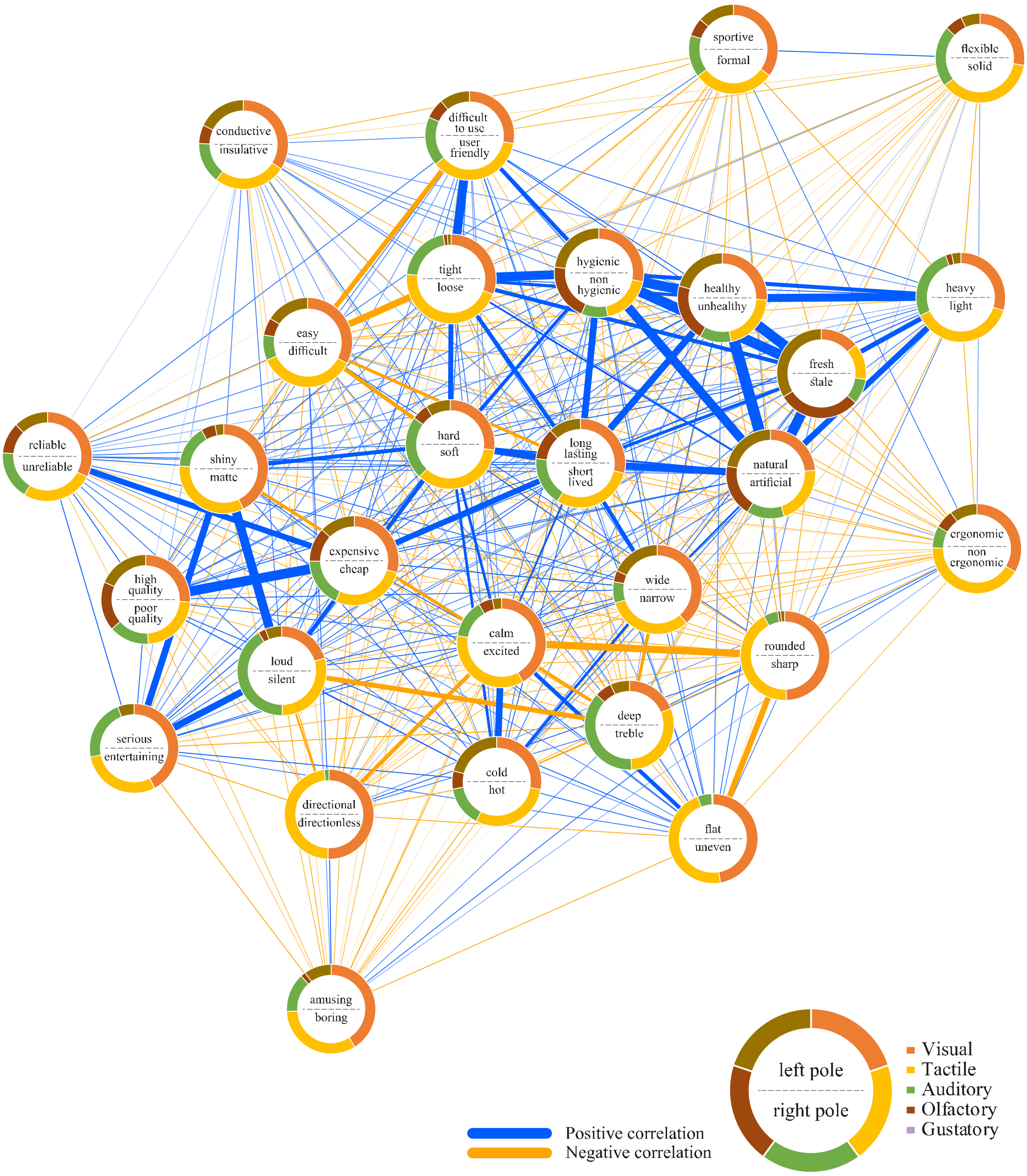

Figure 8.5 Senso-attitudinal map (SAM) of the evaluation component for water bottles

Natural products showed a tendency to be also construed as *healthy, fresh, hygienic, long lasting* and *heavy*. *Artificial* products were conceivably construed as *unhealthy, stale, non hygienic, short lived* and *light*.

Rounded products showed a tendency to be also construed as *excited, uneven, short lived* and *soft*. *Sharp* products were conceivably construed as *calm, flat, long lasting* and *hard*.

Healthy products showed a tendency to be also construed as *natural, fresh, hygienic, heavy* and *long lasting*. *Unhealthy* products were conceivably construed as *artificial, stale, non hygienic, light* and *short lived.*

Shiny products showed a tendency to be also construed as *loud, serious, hard* and *treble*. *Matte* products were conceivably construed as *silent, entertaining, soft* and *deep.*

Directional products showed a tendency to be also construed as *excited, silent, entertaining* and *matte*. *Directionless* products were conceivably construed as *calm, loud, serious* and *shiny.*

Fresh products showed a tendency to be also construed as *hygienic, natural, healthy, heavy* and *tight*. *Stale* products were conceivably construed as *non hygienic, artificial, unhealthy, light* and *loose.*

Difficult to use products showed a tendency to be also construed as *tight, difficult, hygienic* and *long lasting*. *User friendly* products were conceivably construed as *loose, easy, non hygienic* and *short lived.*

Loud products showed a tendency to be also construed as *shiny, serious, treble* and *hard*. *Silent* products were conceivably construed as *matte, entertaining, deep* and *soft.*

Cold products showed a tendency to be also construed as *calm, hard, wide, loud* and *serious*. *Hot* products were conceivably construed as *excited, soft, narrow, silent* and *entertaining.*

Expensive products showed a tendency to be also construed as *high quality, long lasting, reliable, wide, serious* and *cold*. *Cheap* products were conceivably construed as *poor quality, short lived, unreliable, narrow, entertaining* and *hot.*

Heavy products showed a tendency to be also construed as *healthy, natural, fresh* and *hygienic*. *Light* products were conceivably construed as *unhealthy, artificial, stale* and *non hygienic.*

Sportive products showed a tendency to be also construed as *flexible* and *light*. *Formal* products were conceivably construed as *solid* and *heavy.*

Flat products showed a tendency to be also construed as *sharp, calm* and *high quality*. *Uneven* products were conceivably construed as *rounded, excited* and *poor quality.*

Deep products showed a tendency to be also construed as *silent, matte, narrow* and *soft*. *Treble* products were conceivably construed as *loud, shiny, wide* and *hard.*

Serious products showed a tendency to be also construed as *shiny, loud, directionless, expensive,* and *cold*. *Entertaining* products were conceivably construed as *matte, silent, directional, cheap* and *hot.*

Ergonomic products showed a tendency to be also construed as *artificial, stale, narrow* and *soft. Non ergonomic* products were conceivably construed as *natural, fresh, wide* and *hard.*

Reliable products showed a tendency to be also construed as *expensive, serious* and *high quality. Non ergonomic* products were conceivably construed as *cheap, entertaining* and *poor quality.*

Conductive products showed a tendency to be also construed as *hard* and *formal. Insulative* products were conceivably construed as *soft* and *sportive.*

High quality products showed a tendency to be also construed as *expensive, reliable, long lasting* and *flat. Poor quality* products were conceivably construed as *cheap, unreliable, short lived* and *uneven.*

Flexible products showed a tendency to be also construed as *sportive. Solid* products were conceivably construed as *formal.*

Amusing products showed a tendency to be also construed as *directional, excited* and *hot. Boring* products were conceivably construed as *directionless, calm* and *cold.*

Piqueras-Fiszman and Spence (2012a) found that heavy bottles were perceived as more expensive and better quality. The SAM of the evaluation component of water bottles represented that *heaviness* was linked with *expensive* and *high quality* by following the path through *naturalness* and *healthiness*; where naturalness and healthiness were connected to *long lastingness*. Labbe, et al. (2007) found out that perceived coldness was one of the important aspects of refreshing experience. In the SAM, it was seen that *cold* was linked with *fresh* by following the path through *wide* and *long lasting,* respectively. According to Arboleda and Arce-Lopera (2020), perceived price increased when the bottle shapes became more curved. Contrary to that, *flat* was found positively correlated with *high quality* (r= 0,82).

In the food industry, shape influenced the perceived healthiness in food products, and angular shapes were found healthier (Fenko, Lotterman, & Galetzka, 2016). In contrast to that, Festila and Chrysochou (2018) found no significant correlations between the shape and perceived healthiness, rather they admitted that lighter colours on package were perceived healthier and transparency was positively correlated with perceived healthiness. According to the SAM of the evaluation component, the perception of *healthiness* was significantly correlated with the perception of *naturalness, freshness, hygienicness, heaviness* and *long lastingness.*

The perception of high pitch (treble) is correlated with the perception of bright, and low pitch (deep) is correlated with dim (Marks, 1989). Similarly, according to the SAM of the evaluation component, the attitude scale *deep* was correlated with *matte* and *treble* was correlated with *shiny*.

Marks (1987) also found that low pitch (deep sounds) is correlated with smooth and round shapes, and high pitch (treble sounds) with jagged and sharp shapes through a crossmodal correspondance. Similary in another study, the perception of high pitch was found correlated with the perception of smaller sizes and angular shapes (Evans & Treisman, 2010). The SAM for the evaluation component presented similar results, as it was seen that *deep* was correlated with *calm*, and *calm* was correlated to *round* by following the path from *deep* to *round*. It can be understood from the thickness of the followed path that the correlation between *deep* and *round* was moderate (*r*= 0,58). Moreover, in relation to the findings of Marks (1987), the perception of deep was regarded as audition dominated, whereas the perception of roundness was vision dominated through a crossmodal correspondance.

SAM for Component 2 Assurance

To investigate the relationships among the attitudes in the assurance component of the experiment with water bottles, Pearson's product moment correlation test was applied on 22 items. The SAM of the assurance component for water bottles can be seen in Figure 8.6.

The most significant correlations of each attitude are summarized as follows:

Flimsy products showed a tendency to be also construed as *stable, sweet, indoor, inactive* and *transparent*. *Durable* products were conceivably construed as *portable, bitter, outdoor, active* and *opaque*.

Stable products showed a tendency to be also construed as *flimsy*, *indoor*, *discordant* and *impractical*. *Portable* products were conceivably construed as *durable, outdoor*, *coherent* and *handy*.

Sweet products showed a tendency to be also construed as *flimsy*, *stable* and *transparent*. *Bitter* products were conceivably construed as *durable*, *portable* and *opaque*.

Big products showed a tendency to be also construed as *relieving*, *flimsy* and *honest*. *Small* products were conceivably construed as *irritating*, *durable* and *dishonest*.

Figure 8.6 Senso-attitudinal map (SAM) of the assurance component for water bottles

Particular products showed a tendency to be also construed as *dynamic*, *protective* and *necessary*. *Standard* products were conceivably construed as *inactive*, *vulnerable* and *unnecessary*.

Honest products showed a tendency to be also construed as *thick*, *flimsy*, *big* and *relieving*. *Dishonest* products were conceivably construed as *thin*, *durable*, *small* and *irritating*.

Inactive products showed a tendency to be also construed as *feminine*, *sincere* and *flimsy*. *Dynamic* products were conceivably construed as *masculine*, *insincere* and *durable*.

Protective products showed a tendency to be also construed as *cool*, *portable* and *particular*. *Vulnerable* products were conceivably construed as *despised*, *stable* and *standard*.

Indoor products showed a tendency to be also construed as *stable*, *discordant*, *unnecessary* and *flimsy*. *Outdoor* products were conceivably construed as *portable*, *coherent*, *necessary* and *durable*.

Transparent products showed a tendency to be also construed as *flimsy*, *sweet* and *easy to clean*. *Opaque* products were conceivably construed as *durable*, *bitter* and *hard to clean*.

Handy products showed a tendency to be also construed as *portable* and *outdoor*. *Impractical* products were conceivably construed as *stable* and *indoor*.

Relieving products showed a tendency to be also construed as *big*, *distinct* and *honest*. *Irritating* products were conceivably construed as *stable*, *indoor* and *dishonest*.

Unnecessary products showed a tendency to be also construed as *discordant*, *indoor* and *stable*. *Necessary* products were conceivably construed as *coherent*, *outdoor* and *portable*.

Discordant products showed a tendency to be also construed as *unnecessary*, *indoor* and *stable*. *Coherent* products were conceivably construed as *necessary*, *outdoor* and *portable*.

Feminine products showed a tendency to be also construed as *inactive*, *indoor*, *uncomfortable* and *flimsy*. *Masculine* products were conceivably construed as *dynamic*, *outdoor*, *comfortable* and *durable*.

Distinct products showed a tendency to be also construed as *relieving* and *big*. *Ambiguous* products were conceivably construed as *irritating* and *small*.

Comfortable products showed a tendency to be also construed as *masculine*, *necessary* and short. *Uncomfortable* products were conceivably construed as *feminine*, *unnecessary* and *tall*.

Thin products showed a tendency to be also construed as *dishonest*. *Thick* products were conceivably construed as *honest*.

Easy to clean products showed a tendency to be also construed as *transparent*. *Hard to clean* products were conceivably construed as *opaque*.

Cool products showed a tendency to be also construed as *protective* and *necessary*. *Despised* products were conceivably construed as *vulnerable* and *unnecessary*.

Sincere products showed a tendency to be also construed as *inactive*. *Insincere* products were conceivably construed as *dynamic*.

Tall products showed a tendency to be also construed as *uncomfortable*, *indoor* and *feminine*. *Short* products were conceivably construed as *comfortable*, *outdoor* and *masculine*.

According to Hess, Singh, Metcalf and Danes (2014), thick water bottles were perceived higher quality. In parallel with that, in the SAM of water bottles, although perceived thickness and perceived quality were loaded under different components, *thick* products were found to be perceived as *honest* in the assurance component, and *wide* was correlated with *high quality* (r= 0,79) in the evaluation component.

SAM for Component 3 Familiarity

To investigate the relationships among the attitudes in the familiarity component of the experiment with water bottles, Pearson's product moment correlation test was applied on 7 items. The SAM of the familiarity component for water bottles can be seen in Figure 8.7.

The most significant correlations of each attitude are summarized as follows:

Elaborated products showed a tendency to be also construed as *new* and *fragmented. Sloppy* products were conceivably construed as *old* and *whole.*

New products showed a tendency to be also construed as *elaborated*, *functional* and *beautiful. Old* products were conceivably construed as *sloppy*, *functionless* and *ugly*.

Eccentrical products showed a tendency to be also construed as *elaborated, fragmented* and *new*. *Accustomed* products were conceivably construed as *sloppy, whole* and *old.*

Fragmented products showed a tendency to be also construed as *elaborated, eccentrical* and *new. Whole* products were conceivably construed as *sloppy, accustomed* and *old.*

Functional products showed a tendency to be also construed as *new* and *beautiful. Functionless* products were conceivably construed as *old* and *ugly.*

Beautiful products showed a tendency to be also construed as *new, functional* and *elaborated. Ugly* products were conceivably construed as *old, functionless* and *sloppy.*

Pleasurable products showed a tendency to be also construed as *elaborated. Ugly* products were conceivably construed as *sloppy.*

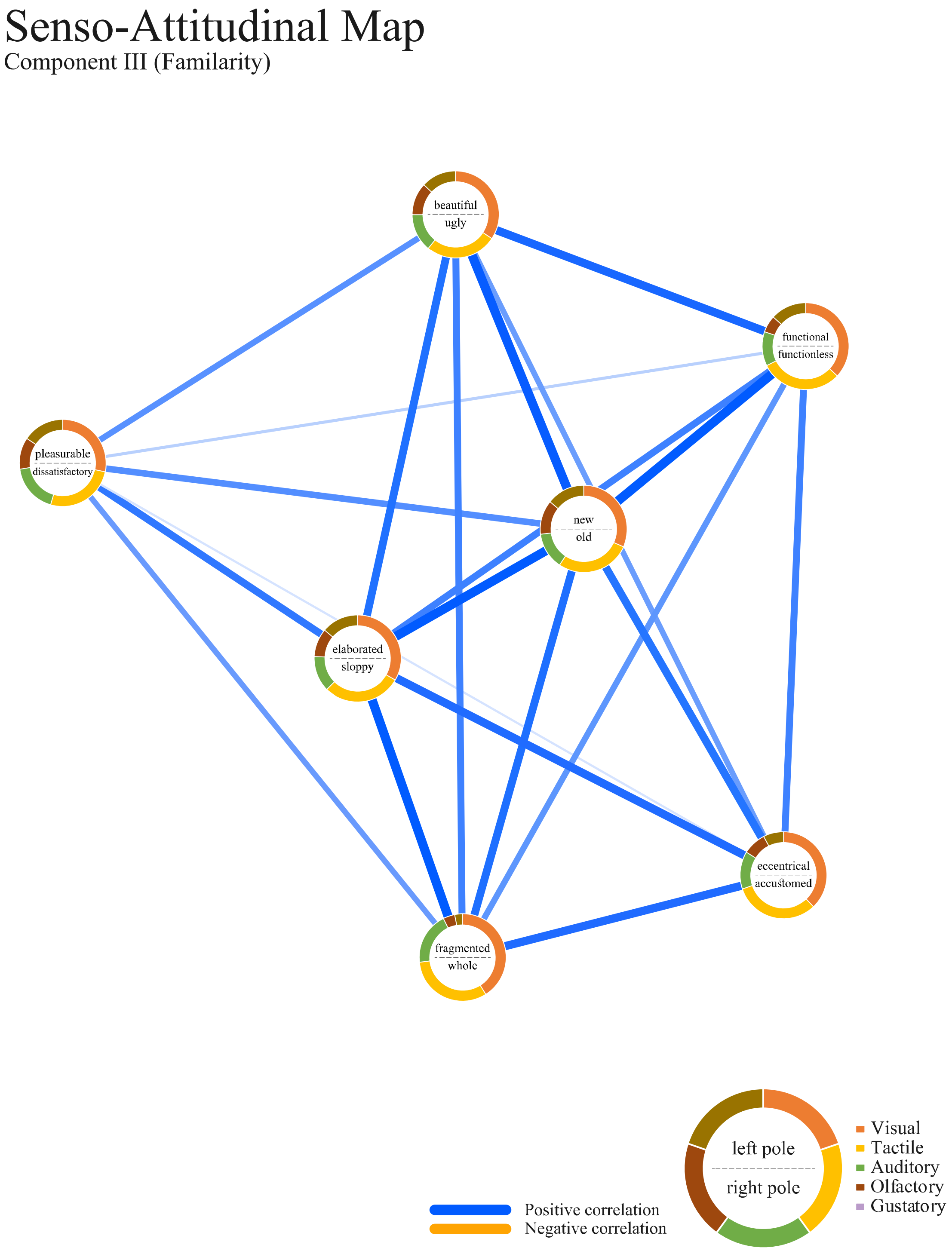

Figure 8.7 Senso-attitudinal map (SAM) of the familiarity component for water bottles

SAM for Component 4 Elegancy

To investigate the relationships among the attitudes in the elegancy component of the experiment with water bottles, Pearson's product moment correlation test was applied on 10 items. The SAM of the elegancy component for water bottles can be seen in Figure 8.8.

The most significant correlations of each attitude are summarized as follows:

Attractive products showed no tendency to be also construed significantly as another attitude in this component.

Vivid products showed a tendency to be also construed as *ornate* and *childish. Pale* products were conceivably construed as *plain* and *mature.*

Rough products showed a tendency to be also construed as *non slippery* and *complex. Smooth* products were conceivably construed as *slippery* and *simple.*

Non slippery products showed a tendency to be also construed as *rough* and *complex. Slippery* products were conceivably construed as *smooth* and *simple.*

Controlled products showed a tendency to be also construed as *coarse. Uncontrolled* products were conceivably construed as *gracious.*

Coarse products showed a tendency to be also construed as *controlled. Gracious* products were conceivably construed as *uncontrolled.*

Ornate products showed a tendency to be also construed as *complex, vivid* and *childish. Plain* products were conceivably construed as *simple, pale* and *mature.*

Complex products showed a tendency to be also construed as *ornate* and *rough. Simple* products were conceivably construed as *plain* and *smooth.*

Unsteady products showed a tendency to be also construed as *childish* and *rough. Steady* products were conceivably construed as *mature* and *smooth.*

Childish products showed a tendency to be also construed as *ornate* and *unsteady. Mature* products were conceivably construed as *plain* and *steady.*

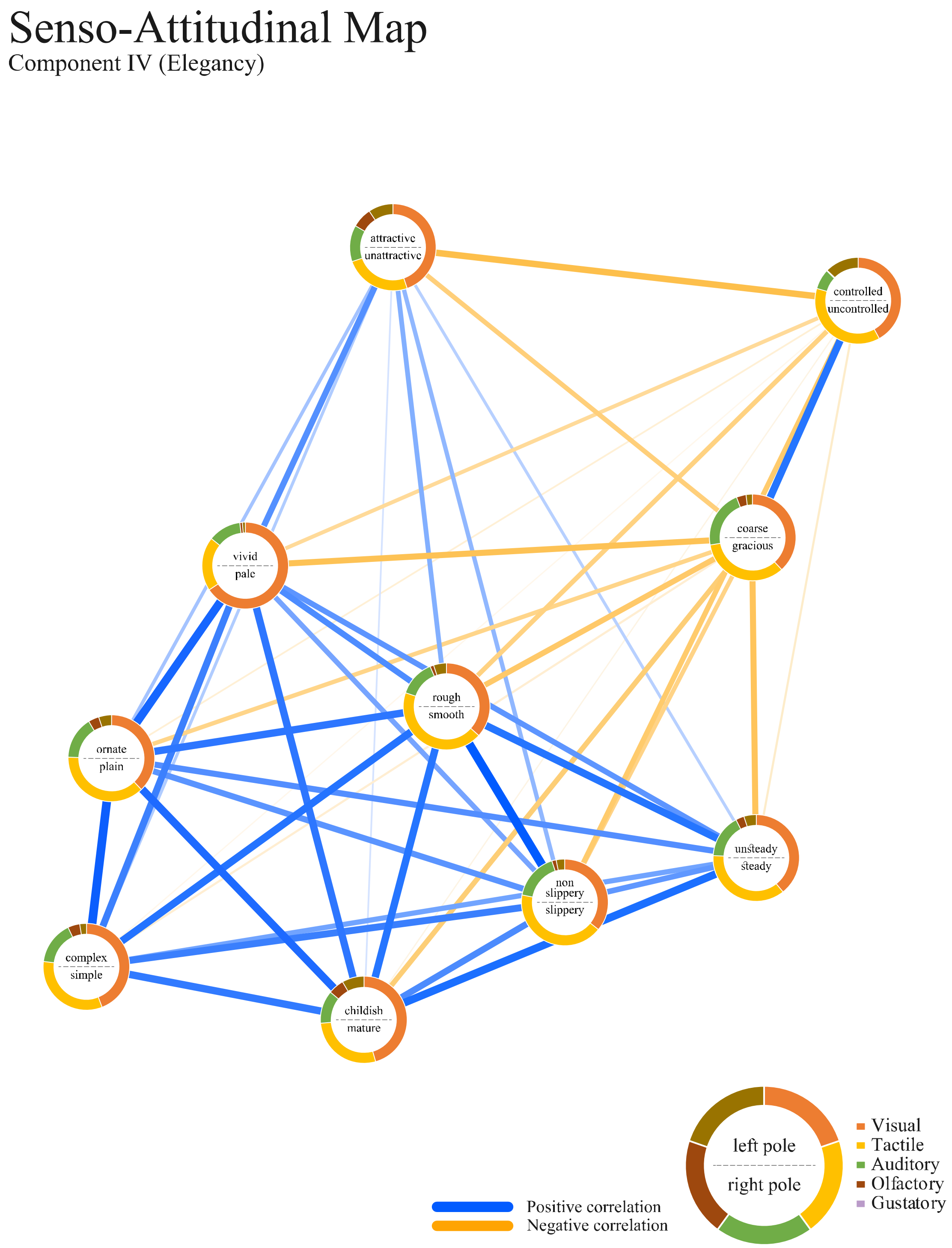

Figure 8.8 Senso-attitudinal map (SAM) of the elegancy component for water bottles

In a study about the orange juice packaging, it was found that the synergy of shape and color was important in perceived attractiveness of bottles, such that anthropomorphic bottle shapes and white bottle caps were perceived as the most attractive (Chitturi, Londono, & Amezquita, 2019). According to the SAM of water bottles (which are reusable), *vivid* bottles were found to be moderately correlated with perceived *attractiveness.* For Chitturi et al. (2019), there is also a relationship between expected price and attractiveness that elongated shapes are perceived as offering a better value for the price (volume perception). A finding parallel to that was not found in this thesis, and it is assumed that the volume of a bottle is perceived differently for reusable and disposable bottles.

8.1.4.2 Discussions on the Relationships Among Products

In the second step of analysis for the fourth objective, the relationships among products were investigated. To achieve statistically reliable results, each component was investigated separately. Eight different computer mouses and eight different water bottles were used as stimuli in two separate experiments to explore attitudinal approaches of individuals towards product materials. As the goal of this thesis was to develop SAM as supplementary sources for design processes, it was also necessary to investigate the relationships between the products used in the experiment for a comprehensive understanding. A two-step procedure was used to investigate relationships between the products. In the first step, hierarchical cluster analysis was applied on the datasets within each generated component and clustered products were investigated through a semantic differential graph. Clustering method was found useful as clusters were grouped based on their similarities in ratings and therefore provided information about similarly perceived products. Cluster cards were prepared for practical interpretation and also to serve as a supportive tool for SAM to comprehensively understand the relations between the attitudes, products and senses. It was assumed that as a part of SAM, cluster cards would enable designers to interpret findings through comparing similarities and differences in product pairs.

In the evaluation component, two different computer mouse pairs were clustered. The first pair, M4 and M6 were perceived quite similarly through a number of attitude scales such as being *symmetric*, *coherent*, *elaborated*, *healthy*, *high quality*, *good* and *plain*. The second pair, M3 and M8 were perceived similarly through a number of attitude scales such as being *symmetric*, *dirty*, *poor quality*, *hard* and *sloppy*. Cluster analysis results showed that only two pairs of computer mouses were perceived significantly similar. Similarly clustered computer mouse pairs (M4-M6 and M3-M8) in the evaluation component can be seen as a cluster card in Table 8.13. According to the cluster card, it was inferred that the cluster M4-M6 was evaluated more positively through the attitudes related with evaluation, when compared to the other cluster M3-M8.

Table 8.13 Cluster card of the evaluation component

Component 1 (Evaluation)	 M4 M6	**Similarities:** extremely symmetric; quite coherent, elaborated, healthy, high quality, good and plain
		Differences: more cold, clean and shiny (M6) more sticky and smelt (M4)
	 M3 M8	**Similarities:** extremely symmetric; quite dirty, poor quality, hard and sloppy
		Differences: more coherent, simple, non slippery, matte and sloppy (M8) more discordant, deep, open and cold (M3)

In the usability component, three different computer mouse pairs were clustered. The first pair, M3 and M7 were perceived similarly through a number of attitude scales such as being *directional*, *common* and *distinct*. The second pair, M4 and M5 were perceived very similarly through a number of attitude scales such as being *directional* and *dark*, alongside being *distinct*, *comfortable*, *controlled*, *obtuse* and *handy*. The third pair, M1 and M8 were perceived very similarly through a number of attitude scales such as being *light, pointed, flat* and *functionless.* Cluster analysis results showed that three pairs of computer mouses were perceived significantly similar. Clustered computer mouse pairs (M3-M7, M4-M5 and M3-M8) in the usability component can be seen as a cluster card in Table 8.14. Arguably, it was inferred from the cluster card for the usability component that the similarities between M4 and M5 were mostly positively evaluated and *controllability* and *comfortableness* could be two of the factors that influenced positively, while M1 and M8 were clustered through more negative evaluations and one reason for this could be *flatness* of the computer mouses, where Odell and Johnson (2015) reported that flat computer mouses were found uncomfortable.

Table 8.14 Cluster card of the usability component

Component 2 (Usability)	 M3 M7	**Similarities:** extremely directional; quite common; slightly distinct **Differences:** more controlled, curved, light, obtuse and unproblematic (M7) more impractical and pointed (M3)
	 M4 M5	**Similarities:** extremely directional and dark; quite distinct, comfortable, controlled and common; slightly handy and obtuse **Differences:** more curved (M5)
	 M1 M8	**Similarities:** extremely light; quite pointed, flat and functionless **Differences:** more directionless, extraordinary, handy and unproblematic (M1) more uncomfortable, impractical and problematic (M8)

In the capacity component, two different computer mouse pairs were clustered. The first pair, M3 and M7 were perceived similarly through many of the attitude scales such as being *directional*, *common* and *distinct*. The second pair, M4 and M6 were also perceived very similarly through many of the attitude scales such as being *opaque*, *accustomed, fast, short*, *new, technological* and so on. Clustered computer mouse pairs (M3-M7 and M4-M6) in the capacity component can be seen as a cluster card in Table 8.15. According to the cluster card, similarities between M4 and M6 were more positively evaluated compared to the similarities between M3 and M7, which were assumed as clustered through more negative evaluations.

Table 8.15 Cluster card of the capacity component

Component 3 (Capacity)	 M3 M7	**Similarities:** extremely big, long, thick and opaque; quite classical, accustomed, slow, coarse, heavy, high, old, stable, insecure and outdated
		Differences: more loud and raspy (M3) more tuneful and serious (M7)
	 M4 M6	**Similarities:** extremely opaque; quite accustomed, fast, short, new, tuneful, standard and technological
		Differences: more silent and stable (M4) more fluid and light (M6)

In the clarity component, three different computer mouse pairs were clustered. This component consisted only of two items as *clear-blurry* and *glittery-non glittery*. Results of the semantical differential analysis of created clusters showed that clusters M2-M7 and M4-M6 were similarly perceived as being *clear* and *non glittery* on different levels, and M3 and M5 were similarly perceived as being *clear*. Clustered computer mouse pairs (M3-M7 and M4-M6) in the clarity component can be seen as a cluster card in Table 8.16.

Hierarchical cluster analysis was applied on the components of the experiment with water bottles and the produced clusters were investigated through semantic differential graphs.

Table 8.16 Cluster card of the clarity component

Component 4 (Clarity)	 M2 M7	**Similarities:** quite clear and non glittery
		Differences: -
	 M3 M5	**Similarities:** quite clear
		Differences: more glittery (M3)
	 M4 M6	**Similarities:** extremely non glittery; slightly clear
		Differences: -

In the evaluation component, four different water bottle pairs were clustered. The first pair, B1 and B2 were perceived similarly through a number of the attitude scales such as being *entertaining*, *stale*, *deep* and *unreliable*. The second pair, B3 and B4 were also perceived similarly through some of the attitude scales such as being *light* (opposite of *heavy*), *excited* and *unhealthy*. The third pair, B5 and B6 were also perceived similarly through a number of attitude scales such as being *heavy*, *healthy*, *fresh*, *natural* and *tight*. The fourth pair, B7 and B8 were perceived similarly through many attitude scales such as being *serious*, *flat*, *treble*, *natural*, *fresh*, and so on. Clustered water bottle pairs (B1-B2, B3-B4, B5-B6 and B7-B8) in the evaluation component can be seen as a cluster card in Table 8.17. According to the cluster card, it was noticed that the products were clustered through material classes; while the bottles in first two clusters were made of polymer based materials, the third cluster contained bottles made of glass mostly and the fourth cluster consisted of metallic water bottles. Also as a general assumption, it was noticed that plastic bottles were seen similarly as *entertaining* and *light*, yet *unreliable* and *unhealthy*; whereas glass bottles were perceived as *heavy*, *healthy* and *fresh* and metals were perceived as *serious* and *reliable*.

Table 8.17 Cluster card of the evaluation component

Component 1 (Evaluation)		
	 B1 B2	**Similarities:** extremely entertaining; quite stale and deep; slightly unreliable
		Differences: more sportive, loose, flat, user friendly, silent and soft (B1) more cheap, amusing, artificial, narrow, poor quality and light (B2)
	 B3 B4	**Similarities:** quite light and excited; slightly unhealthy
		Differences: more hot, ergonomic, silent, artificial, reliable and sportive (B3) more cheap, treble, easy, poor quality, uneven and user friendly (B4)
	 B5 B6	**Similarities:** extremely heavy, healthy and fresh; quite natural and tight
		Differences: more reliable, ergonomic, silent, entertaining and amusing (B5) more loud, boring, calm, sharp, formal and flat (B6)
	 B7 B8	**Similarities:** extremely serious and flat; quite treble, tight, reliable, natural, wide, fresh and directionless; slightly difficult
		Differences: more boring, expensive, cold, calm and hard (B7) more shiny and heavy (B8)

In the assurance component, three different water bottle pairs were clustered. The first pair, B1 and B3 were perceived similarly through several attitude scales such as being *masculine*, *irritating* and *excited*. The second pair, B5 and B6 were also perceived very similarly through many of the attitude scales such as being *honest*, *relieving*, *transparent*, *feminine*, *sweet* and so on. The third pair, B7 and B8 were also perceived nearly identical as *opaque*, *portable*, *dynamic*, *protective*, *particular* and so on. Clustered water bottle pairs (B1-B3, B5-B6 and B7-B8) in the assurance component can be seen as a cluster card in Table 8.18Table 8.15. As can be seen from the cluster card, similarities brought similar classes of materials together as clusters; where plastics were found irritating and excited, glasses were regarded as honest, relieving yet flimsy, and metals were perceived as opaque, portable and protective.

Table 8.18 Cluster card of the assurance component

Component 2 (Assurance)	Products	Similarities / Differences
	 B1 B3	**Similarities:** quite masculine, irritating and excited
		Differences: more opaque, short, dynamic, honest, insincere (B1) more cool, protective, portable, transparent and sincere (B3)
	 B5 B6	**Similarities:** extremely honest, relieving, transparent, feminine and sweet; quite thick, distinct, flimsy, big and easy to clean; slightly uncomfortable
		Differences: more big, tall, protective and handy (B5) more inactive, impractical, standard, stable and vulnerable (B6)
	 B7 B8	**Similarities:** extremely opaque and portable; quite coherent, necessary, handy, dynamic and protective; slightly distinct, hard to clean and particular
		Differences: more masculine, thick, outdoor and bitter (B7) more cool, insincere and irritating (B8)

In the familiarity component, three different water bottle pairs were clustered. The first pair, B4 and B5 were perceived similarly through several attitude scales such as being *fragmented*, *new*, *functional* and *elaborated*. The second pair, B1 and B6 were perceived similarly through several attitude scales such as being *accustomed* and *pleasurable*. The third pair, B7 and B8 were also perceived nearly identical as *beautiful*. Clustered water bottle pairs (B4-B5, B1-B6 and B7-B8) in the familiarity component can be seen as a cluster card in Table 8.18Table 8.15. As can be seen from the cluster card, products made of different materials were brought together in first two clusters.

Table 8.19 Cluster card of the familiarity component

Component 3 [Familiarity]	 B4 B5	**Similarities:** quite fragmented, new and functional; slightly elaborated
		Differences: more eccentrical, dissatisfactory and beautiful [B4] more pleasurable [B5]
	 B1 B6	**Similarities:** quite accustomed; slightly pleasurable
		Differences: more whole and ugly [B1] more fragmented and functionless [B6]
	 B7 B8	**Similarities:** slightly beautiful
		Differences: more functional [B7] more accustomed, new and pleasurable [B8]

In the elegancy component, three different water bottle pairs were clustered. The first pair, B3 and B5 were perceived similarly as *vivid*. The second pair, B4 and B6 were perceived similarly through several attitude scales such as being *unattractive*, *controlled* and *steady*. The third pair, B7 and B8 were also perceived nearly identical as *plain*, *smooth*, *uncontrolled* and *slippery*. Clustered water bottle pairs (B3-B5, B4-B6 and B7-B8) in the elegancy component can be seen as a cluster card in Table 8.18Table 8.15. As can be seen from the cluster card, it was assumed that vivid products were perceived as childish and attractive and pale products were regarded as more mature regardless of material category.

Table 8.20 Cluster card of the elegancy component

Component	Products	Attributes
Component 4 [Elegancy]	  B3 B5	**Similarities:** quite vivid
		Differences: more attractive, coarse, smooth and controlled [B3] more childish, ornate, complex, steady and non slippery [B5]
	  B4 B6	**Similarities:** slightly unattractive, controlled and steady
		Differences: more mature, coarse, pale and complex [B4] more childish, slippery, ornate, smooth, vivid and simple [B6]
	  B7 B8	**Similarities:** quite plain and smooth; slightly uncontrolled and slippery
		Differences: more mature, simple, steady and pale [B7] more attractive and vivid [B8]

8.1.4.3 Discussions on the Attitude-Product Relationships

In the third step of analysis for the fourth objective, the relationships between the attitudes and the products were investigated. One sample *t*-test was used to find out the most significant attitudinal features of products based on participant ratings. To achieve statistically reliable results, each component was investigated separately, and the findings were merged to develop product cards for each product used in the experiments. Product cards consisted of the most distinct attitudinal aspects that the participants perceived. On the product cards, attitudinal aspects were listed under the components, regardless of being either left/right pole or positive/negative. It was aimed that the developed product cards would be used together with the cluster cards as complementary tools for SAM.

For the experiment with computer mouses, the product card of M1 was prepared, and the card can be seen in Table 8.21. As can be seen from the card, M1 was significantly perceived as *non sticky*, *smooth*, *high quality*, *whole*, *shiny*, *cold*, *symmetric*, *simple*, *good*, *healthy*, *elaborated*, *coherent*, *hard*, *treble*, *inodorous* and *necessary* in the evaluation component, *directionless, extraordinary*, *light* (opposite of *dark*), *flat* and *sharp* in the usability component, *particular, technological*, *gracious*, *attractive*, *fast*, *reassuring*, *eccentrical*, *small*, *light (weight)*, *thin*, *new*, *low* and *modern* in the capacity component, and *clear* in the clarity component.

Table 8.21 Product card of M1 in the experiment with computer mouses

	Evaluation	Usability	Capacity	Clarity
M1	non sticky	directionless	particular	clear
	smooth	extraordinary	technological	
	high quality	light (color)	gracious	
	whole	flat	attractive	
	shiny	sharp	fast	
	cold		reassuring	
	symmetric		eccentrical	
	simple		small	
	good		light (weight)	
	healthy		thin	
	elaborated		new	
	coherent		low	
	hard		modern	
	treble			
	inodorous			
	necessary			

For the experiment with computer mouses, the product card of M2 was prepared, and the card can be seen in Table 8.22. As can be seen from the card, M2 was significantly perceived as *soft*, *discordant*, *unnecessary*, *deep*, *smelt*, *complex, dirty, fragmented, poor quality, non slippery*, *open*, *ornate* and *matte* in the evaluation component, *dark, rounded, obtuse* and *directional* in the usability component, and *dynamic, fast, gracious, short, small* and *light* (opposite of *heavy*) in the capacity component.

Table 8.22 Product card of M2 in the experiment with computer mouses

	Evaluation	Usability	Capacity	Clarity
M2 	soft discordant unnecessary deep smelt complex dirty fragmented poor quality non slippery open ornate matte	dark rounded obtuse directional	dynamic fast gracious short small light (weight)	-

For the experiment with computer mouses, the product card of M3 was prepared, and the card can be seen in Table 8.23. As can be seen from the card, M3 was significantly perceived as *symmetric*, *fragmented*, *hard*, *poor quality*, *dirty* and *complex* in the evaluation component, *directional* and *common* in the usability component, *big*, *thick*, *long*, *classical*, *loud*, *heavy*, *old*, *high*, *opaque*, *coarse*, *standard*, *slow*, *outdated*, *unattractive*, *accustomed* and *stable* in the capacity component, and *glittery* in the clarity component.

Table 8.23 Product card of M3 in the experiment with computer mouses

	Evaluation	Usability	Capacity	Clarity
M3 	symmetric fragmented hard poor quality dirty complex	directional common	big thick long classical loud heavy old high opaque coarse standard slow outdated unattractive accustomed stable	glittery

For the experiment with computer mouses, the product card of M4 was prepared, and the card can be seen in Table 8.24. As can be seen from the card, M4 was significantly perceived as *high quality*, *symmetric*, *good*, *matte*, *elaborated* and *hard* in the evaluation component, *dark*, *rounded*, *comfortable*, *user friendly*, *curved*, *directional*, *common*, *distinct* and *unproblematic* in the usability component, *technological*, *fast*, *dynamic*, *opaque*, *accustomed*, *silent* and *new* in the capacity component, and *non glittery* in the clarity component

Table 8.24 Product card of M4 in the experiment with computer mouses

	Evaluation	Usability	Capacity	Clarity
M4 	high quality symmetric good matte elaborated hard	dark rounded comfortable user friendly curved directional common distinct unproblematic	technological fast dynamic opaque accustomed silent new	non glittery

For the experiment with computer mouses, the product card of M5 was prepared, and the card can be seen in Table 8.25. As can be seen from the card, M5 was significantly perceived as *symmetric, shiny, smooth, high quality, healthy, good, elaborated, hard, treble, coherent* and *fragmented* in the evaluation component, cu*rved, dark, rounded, comfortable, user friendly, directional, common, distinct* and *unproblematic* in the usability component, and *technological, fast, dynamic, new, accustomed* and *opaque* in the capacity component.

Table 8.25 Product card of M5 in the experiment with computer mouses

	Evaluation	Usability	Capacity	Clarity
M5 	symmetric	curved	technological	-
	shiny	dark	fast	
	smooth	rounded	dynamic	
	high quality	comfortable	new	
	healthy	user friendly	accustomed	
	good	directional	opaque	
	elaborated	common		
	hard	distinct		
	treble	unproblematic		
	coherent			
	fragmented			

For the experiment with computer mouses, the product card of M6 was prepared, and the card can be seen in Table 8.26. As can be seen from the card, M6 was significantly perceived as *symmetric, good, high quality, healthy, elaborated, matte* and *coherent* in the evaluation component, *curved, rounded, dark, user friendly, comfortable, directional, common, distinct* and *unproblematic* in the usability component, and *technological, fast, fluid, thick, dynamic, opaque, accustomed, new, light* (opposite of *heavy*) and *standard* in the capacity component.

Table 8.26 Product card of M6 in the experiment with computer mouses

	Evaluation	Usability	Capacity	Clarity
M6 	symmetric	curved	technological	-
	good	rounded	fast	
	high quality	dark	fluid	
	healthy	user friendly	thick	
	elaborated	comfortable	dynamic	
	matte	directional	opaque	
	coherent	common	accustomed	
		distinct	new	
		unproblematic	light (weight)	
			standard	

For the experiment with computer mouses, the product card of M7 was prepared, and the card can be seen in Table 8.27. As can be seen from the card, M7 was significantly perceived as *symmetric, deep, matte, non slippery* and *dirty* in the evaluation component, *curved, rounded, obtuse, light* (opposite of *dark*), *directional* and *common* in the usability component, and *big, thick, long, old, classical, heavy, high, slow, opaque, stable* and *accustomed* in the capacity component.

Table 8.27 Product card of M7 in the experiment with computer mouses

	Evaluation	Usability	Capacity	Clarity
M7	symmetric	curved	big	-
	deep	rounded	thick	
	matte	obtuse	long	
	non slippery	light (color)	old	
	dirty	directional	classical	
		common	heavy	
			high	
			slow	
			opaque	
			stable	
			accustomed	

For the experiment with computer mouses, the product card of M8 was prepared, and the card can be seen in Table 8.28. As can be seen from the card, M8 was significantly perceived as *symmetric, simple, sloppy, unnecessary, hard, matte, poor quality* and *non slippery* in the evaluation component, *problematic, impractical, light* (opposite of *dark*), *functionless* and *sharp* in the usability component, and *classical, old, big, loud, long, heavy, thick, outdated, opaque, coarse, stable, slow, unattractive, serious* and *standard* in the capacity component.

Table 8.28 Product card of M8 in the experiment with computer mouses

M8

Evaluation	Usability	Capacity	Clarity
symmetric simple sloppy unnecessary hard matte poor quality non slippery	problematic impractical light (color) functionless sharp	classical old big loud long heavy thick outdated opaque coarse stable slow unattractive serious standard	-

For the experiment with water bottles, the product card of B1 was prepared, and the card can be seen in Table 8.29. As can be seen from the card, B1 was significantly perceived as *flexible, sportive*, *user friendly, deep, entertaining*, *easy*, *cheap, silent, artificial, stale, light* (opposite of *heavy*), n*on hygienic*, *flat*, *loose, unhealthy*, *short lived, soft* and *matte* in the evaluation component, *dynamic, durable, opaque, masculine, irritating* and *short* in the assurance component, and *simple, plain, steady, coarse, smooth, pale, unattractive, mature* and *slippery* in the elegancy component.

Table 8.29 Product card of B1 in the experiment with water bottles

	Evaluation	Usability	Capacity	Clarity
B1 	flexible sportive user friendly deep entertaining easy cheap silent artificial stale light (weight) non hygienic flat loose unhealthy short lived soft matte	dynamic durable opaque masculine irritating short	-	simple plain steady coarse smooth pale unattractive mature slippery

For the experiment with water bottles, the product card of B2 was prepared, and the card can be seen in Table 8.30. As can be seen from the card, B2 was significantly perceived as *cheap, deep, uneven, entertaining, ergonomic, light* (opposite of *heavy*), *artificial, poor quality, unhealthy, stale* and *short lived* in the evaluation component, *feminine, durable, irritating* and *opaqu*e in the assurance component, *accustomed* and *ugly* in the familiarity component, and c*hildish, rough, non slippery, unsteady* and *gracious* in the elegancy component.

Table 8.30 Product card of B2 in the experiment with water bottles

	Evaluation	Usability	Capacity	Clarity
B2 	cheap deep uneven entertaining ergonomic light (weight) artificial poor quality unhealthy stale short lived	feminine durable irritating opaque	accustomed ugly	childish rough non slippery unsteady gracious

For the experiment with water bottles, the product card of B3 was prepared, and the card can be seen in Table 8.31. As can be seen from the card, B3 was significantly perceived as *ergonomic*, *sportive*, *flexible*, *deep*, *excited*, *light* (opposite of *heavy*), *artificial*, *silent* and hot in the evaluation component, *cool*, *dynamic*, *protective*, *portable*, *masculine* and *irritating* in the assurance component, *elaborated*, *fragmented*, *eccentrical* and *new* in the familiarity component, and *attractive* in the elegancy component.

Table 8.31 Product card of B3 in the experiment with water bottles

	Evaluation	Usability	Capacity	Clarity
B3	ergonomic	cool	elaborated	attractive
	sportive	dynamic	fragmented	
	flexible	protective	eccentrical	
	deep	portable	new	
	excited	masculine		
	light (weight)	irritating		
	artificial			
	silent			
	hot			

For the experiment with water bottles, the product card of B4 was prepared, and the card can be seen in Table 8.32. As can be seen from the card, B4 was significantly perceived as *uneven*, *user friendly*, *easy*, *light* (opposite of *heavy*), *treble* and *artificial* in the evaluation component, *transparent*, *dynamic* and *masculine* in the assurance component, *fragmented*, *functional* and *eccentrical* in the familiarity component, and *coarse* in the elegancy component.

Table 8.32 Product card of B4 in the experiment with water bottles

	Evaluation	Usability	Capacity	Clarity
B4 	uneven user friendly easy light (weight) treble artificial	transparent dynamic masculine	fragmented functional eccentrical	coarse

For the experiment with water bottles, the product card of B5 was prepared, and the card can be seen in Table 8.33. As can be seen from the card, B5 was significantly perceived as *healthy*, *heavy*, *fresh*, *long lasting*, *natural*, *hygienic*, *solid*, *expensive*, *flat*, *silent*, *difficult to use* and *formal* in the evaluation component, and *feminine*, *relieving*, *tall*, *transparent*, *sweet*, *honest*, *flimsy*, *inactive* and *uncomfortable* in the assurance component.

Table 8.33 Product card of B5 in the experiment with water bottles

	Evaluation	Usability	Capacity	Clarity
B5 	healthy heavy fresh long lasting natural hygienic solid expensive flat silent difficult to use formal	feminine relieving tall transparent sweet honest flimsy inactive uncomfortable	-	-

For the experiment with water bottles, the product card of B6 was prepared, and the card can be seen in Table 8.34. As can be seen from the card, B6 was significantly perceived as *healthy, heavy, fresh, hard, natural, hygienic, long lasting, solid, flat, non ergonomic, formal, calm, sharp* and *difficult* in the evaluation component, *relieving, feminine, transparent, sweet, distinct, flimsy, inactive, stable* and *honest* in the assurance component, *accustomed* in the familiarity component, and *simple, smooth* and *slippery* in the elegancy component.

Table 8.34 Product card of B6 in the experiment with water bottles

	Evaluation	Usability	Capacity	Clarity
B6 	healthy heavy fresh hard natural hygienic long lasting solid flat non ergonomic formal calm sharp difficult	relieving feminine transparent sweet distinct flimsy inactive stable honest	accustomed	simple smooth slippery

For the experiment with water bottles, the product card of B7 was prepared, and the card can be seen in Table 8.35. As can be seen from the card, B7 was significantly perceived as *hard, long lasting, cold, high quality, loud, healthy, shiny, solid, expensive, flat, treble, serious, calm, boring* and *difficult* in the evaluation component, *outdoor, durable, portable, dynamic, protective, opaque, masculine, short, coherent, necessary* and *bitter* in the assurance component, *functional* in the familiarity component, and *simple, steady, mature, smooth* and *pale* in the elegancy component.

Table 8.35 Product card of B7 in the experiment with water bottles

	Evaluation	Usability	Capacity	Clarity
B7 	hard long lasting cold high quality loud healthy shiny solid expensive flat treble serious calm boring difficult	outdoor durable portable dynamic protective opaque masculine short coherent necessary bitter	functional	simple steady mature smooth pale

For the experiment with water bottles, the product card of B8 was prepared, and the card can be seen in Table 8.36. As can be seen from the card, B8 was significantly perceived as *hard*, *long lasting*, *cold*, *high quality*, *loud*, *healthy*, *shiny*, *solid*, *expensive*, *flat*, *treble*, *serious*, *calm*, *boring* and *difficult* in the evaluation component, *durable*, *portable*, *dynamic*, *cool*, *protective*, *opaque*, *coherent*, *short*, *necessary* and *masculine* in the assurance component, *functional* in the familiarity component, and *simple*, *attractive*, *steady*, *plain*, *smooth* and *mature* in the elegancy component.

Table 8.36 Product card of B8 in the experiment with water bottles

	Evaluation	Usability	Capacity	Clarity
B8 	long lasting hard shiny high quality loud healthy reliable solid expensive flat treble serious difficult calm	durable portable dynamic cool protective opaque coherent short necessary masculine	functional	simple attractive steady plain smooth mature

8.1.4.4 Practical Uses of SAM, Cluster Cards and Product Cards

The SAM of different product contexts could be used to reveal contextual differences in perceiving certain experiences. In a study, the experience of warmth was related to comfortableness, relaxedness and cosiness in terms of physical comfort (Fenko, et al., 2010). As a multisensory attitude, in this research, perceived warmth (*cold-hot*) was regarded as calmness and seriousness in the water bottle context, whereas it was related with stickiness and smoothness in the computer mouse context.

When SAM, cluster cards and product cards are taken together, they enable to achieve a comprehensive understanding of the relationships between the items used in the research. For example, Festila and Chrysochou (2018) found that lighter colours were perceived healthier and transparency was positively correlated with perceived healthiness in food packages. As mentioned before, the SAM of the evaluation component represented that the perception of *healthiness* was significantly correlated with the perception of *naturalness, freshness, hygienicness, heaviness* and *long lastingness.* However, as two classes of transparent materials were used in the water bottles (plastics and glasses), it was quite understandable that transparency solely did not correlate directly with healthiness. When the SAM of the evaluation component in water bottles is interpreted together with the cluster cards and the product cards, it can be understood that transparent products are made of plastics and glass, whereas plastics are perceived as *unhealthy* and glasses are perceived as *healthy*. Therefore for water bottles, transparency can be meaningfully related to the perceived healthiness through glass products. In their study on the perception of packages, Simmonds and Spence (2016) analyzed the relationship between transparency and perceived healthiness from a dualist perspective, and reported that transparency would either enhance or alter perceived heathliness depending on the content and the context. Another finding was that transparency increases trustworthiness, however when transparency was used with a tinted color that was perceived as unpleasant, trustworthiness decreased (Billeter, Zhu, & Inman, 2012). According to the product cards of water bottles prepared in this research, the water bottle B3 made of a blue tinted polymer, was found *irritating*, and the green tinted plastic water bottle, B2, was regarded as *irritating* and *unhealthy*. Chadran, Batra and Lawrence (2009) investigated transparent food packages and found that reliability and trustworthiness became more viable with the decrease in accustomedness. Such a correlation was not found in this research. It is assumed that this correlation could be related with the disposability context.

The proposed SAM represents the overall relationships between the attitudes and the products that are statistically reliable throughout the experiments. However, some attitudes that needed to be investigated could have been loaded under different components according to the statistical calculations. In such situations, specific relations of products can also be investigated manually through the proposed methodology. As an example, the attitude *dark-light* was loaded in the usability component and the attitudes *small-big* and *heavy-light* were loaded in the capacity component in the experiment with computer mouses. Various illusory effects occur between the perception of the products that are similar in size, weight and brightness, and these illusory effects were investigated in many studies (Buckingham & MacDonald, 2015; Kahrimanovic et al., 2011; Nakatani, 1989; Plaisier & Smeets, 2016; Saccone & Chouinard, 2019). These studies investigated the size-weight illusions (when two objects are equally weighted, the smaller one is perceived heavier when lifted), material-weight illusions (when one surface material is more dense than the other between the objects with same size and weight, the object with dense surface material is perceived as heavier), and lightness-size illusions (when dark and light objects with same size are compared, darker objects are perceived heavier). According to the participant ratings, the computer mouses M4, M5 and M6 were perceived quite similar in terms of darkness, size and weight. When the participant ratings were investigated, it was found that M4 was perceived darker than M5 and M6, respectively. This was similar with the evaluations for heaviness as M4 was perceived heavier than M5 and M6, respectively. However, M5 was perceived bigger than M6 and M4, respectively. Interestingly, Walker, Francis and Walker (2010) reported that darker products looked heavier among visually similar products, yet this perception was reversed while hefting the objects as darker products were visually perceived lighter in weight due to an illusory effect.

Also in the experiment with water bottles, B7 (stainless steel) and B8 (aluminium) were found visually almost identical by the participants, as most of them thought that both water bottles were made of the same material and only differed in color during the interviews. Although B7 was heavier than B8, B8 was perceived slightly heavier than B7, and this condition could also be investigated through proposed tools.

Multiple usages of proposed SAM, cluster cards and product cards were described in examples above and various combination of uses could be offered. Proposed tools were versatile and can be interpreted in many ways. They can be used to enhance particular sensory experience of a product that was found as weak; whereas the tools can be investigated for grounding new experiences based on pure user feedback. Alongside SAM, cluster cards and product cards, it was recommended to present the physical products that were used as stimuli in the research for an enhanced inspiration for designing experiences.

8.1.5 Comparison of Themes Between Product Contexts

During the analysis of the collected data for both experiments, it was noticed that a total of 36 common elicited attitudes were found semantically identical for both experiments. It was considered necessary to examine the common attitude scales for both experiments to understand whether they were significantly correlated with similar attitude scales in each experiment, or not. The intent of this investigation was to look for opportunities in establishing a common ground for a standardized measurement among different product contexts based on participant evaluations that are derived from a very similar culture. The most significant correlations of these common attitude scales for both experiments were investigated to find out similar connections among different product contexts. Thirty-six common elicited attitudes alongside their two most significant correlations are represented in Appendix Y.

Interestingly, almost none of the common attitudes were found correlated with semantically similar attitudes. A common attitude scale, *shiny-matte* was found significantly correlated with the attitudes *slippery-non slippery* and *smooth-rough* in the experiment with computer mouses, and significantly correlated with the attitudes *loud-silent* and *serious-entertaining* in the experiment with water bottles. Another finding showed that heavy computer mouses were perceived as *slow* and *insecure*, whereas heavy water bottles were perceived as *healthy* and *natural*. In similar contexts, heavier containers had a negative effect on the pleasantness of the mineral water (Maggioni et al., 2015), while heavy containers were perceived more expensive and better quality in wine bottles (Piqueras-Fiszman & Spence, 2012a). Once again, it was seen that experiences were highly context specific.

Chou (2016) applied a questionnaire in an experiment with computer mouses, which was developed for measuring user experiences in interactive products. The questionnaire[50] consisted of bipolar adjectives generated by usability experts, many of which were similar with the common attitudes elicited in this research (such as *good-bad*, *pleasant-unpleasant*, *attractive-unattractive*, *fast-slow* and *practical-impractical*). As a limitation of the questionnaire method, Chou (2016) emphasized that the adjectives selected for measuring the interactive products was problematic, as participants were not consistent in interpreting them. Chou (2016) suggested that the focus of further research could be to develop a product specific measurement method, in which the dimensions are adjusted specifically for the computer mouses, as different product types evoke different dimensions of experiences. Results of this thesis showed that even semantically identical attitude scales were grasped differently by the individuals in different contexts.

In parallel with the literature findings, the experience of product materials were found highly context specific. In other words, specific measurement scales were

[50] Laugwitz, B., Held, T., & Schrepp, M. (2008). Construction and evaluation of a user experience questionnaire. In A. Holzinger (Ed.), USAB 2008, LNCS 5298, pp. 63-76.

found to be essential in investigating experiential aspects of products and materials. The methodology used in this thesis enabled the development of a specific measurement scale through participant elicitations from a selected and standard set of stimuli (selected products) and simultaneously collect the data from the same participants by their ratings through scales. Thus, it was possible to ground measurement scales on the semantic space derived from the participants of the study.

8.2 Developing Senso-Attitudinal Maps

The major aim of Senso-Attitudinal Maps (SAM) is to merge sensory and attitudinal data together and represent the results in a simple and interactive way. Structurally, SAM were based on the correlations between the attitudes elicited by the participants. The sensory relevancies of the attitudes that were also evaluated by the participants, served as supplementary feedback for the attitudes. It was aimed to represent this highly complex data in a way that could be easily interpreted. Before examining the features of SAM, a final review will be made on related research and the capabilities and possible contributions of the maps will be discussed.

8.2.1 Related Research

There is a growing interest recently, over investigating experiential characterization of materials. In their extensive review on the topic, Veelaert, Du Bois, Moons and Karana (2020) defined the aspects used in the materials experience research as the variables, stimuli, interaction modalities, experimental set-up, methods and respondents. These aspects needed to be addressed in an investigation of material experiences. For more productive results in characterizing material experiences, it was recommended to use free exploration methods to experience physical material samples as it is not possible to isolate senses while investigating human behaviors (d'Olivo et al., 2013; Veelaert et al., 2020). In this thesis, RGT was found capable of enabling participants to experience physical product materials through free exploration methods. Experience is achieved through user-product interactions and with their sensorial qualities, materials act as user-interfaces in products (Pedgley, 2014). Attitudinal approaches of participants were elicited through construing the user-product interactions.

In the last decade, there has been a recent but growing interest in designing through certain material experiences, and various methods and strategies have been proposed. Several material selection tools and methods are proposed for the use of designers. The Materials in Product Selection (Kesteren, Stappers & Brujin, 2007), Meaning Driven Materials Selection (Karana, Hekkert & Kandachar, 2010), Material Aesthetics Database (Zuo, 2010), Expressive Sensorial Atlas (Rognoli, 2010), Meaning Driven Design (Karana et al., 2015), Experience Map (Camere, Schifferstein, & Bordegoni, 2015) and Materials-to-Experiences at four levels (Ma2E4) (Camere & Karana, 2018) are some of the tools and methods that have been developed in the recent years. These were developed to offer material selection guidelines for professional designers and design students to be used in product design processes. Some of these studies were reviewed in Chapter 2, and others are discussed in the following.

The Materials in Product Selection (MiPS) tool was developed to integrate user interaction aspects into the material selection activity (Kesteren, Stappers & Brujin, 2007). The aim of this tool is to improve communication between the designer and client. The tool contains three elements: picture tool (sheets that contain meanings and product images), sample tool (real material samples), and question tool (questions about sensorial properties). The results of this study show that the picture and sample tools are found to be user-friendly and were used efficiently to define the desired meanings. The question tool was found to be difficult to use, because it created confusions on defining the subjective terms between the client and the designer (Kesteren, et al., 2007). This thesis aimed to develop SAM to illustrate the relationships of subjective terms, while developing a semantic space related with the context used in the study. Thus, subjectivity related confusions between stakeholders could be minimized.

In their Meaning Driven Materials Selection (MDMS) tool, Karana, et al. (2010) requested the definition of the intended meaning that is expected to be set by designers. It can be said that this tool is meaning driven as it takes meaning as the starting point. Further, the designers are expected to show product images to the participants to gather data about sensorial properties. The last step is to evaluate materials-meaning relationships provided by the participants. According to Karana et al. (2010), the MDMS tool could be supported by a digital materials database that contains technical aspects of materials.

Karana, Barati, Rognoli and Van Der Laan (2015) developed a four-step Material Driven Design (MDD) method that takes the material as the starting point and the experience as an outcome in the process. The MDD method consists of the phases of *understanding the material* (studying material samples with practical applications and revealing their technical and experiential aspects), *creating materials experience vision* (the type of experience aimed to be achieved with the material), *manifesting materials experience patterns* (stating the connections between the materials and intended meanings) and *creating material/product concepts* (final product). The first phase relies on collecting materials (samples and images) and comparing them by their technical properties (i.e. manufacturing limitations and measurable functional aspects), while exploring their intangible characteristics by hands-on (i.e. cutting, shaping, touching) applications. With their capability of representing relationships between experiences, SAM could be used as a supportive tool particulary in manifesting experience patterns.

Camere and Karana (2018) proposed a multidimensional toolkit about the experiential characterization of material experiences, that consisted of sensorial, interpretive, affective and performative levels. The sensorial level of the toolkit grounded on the sensorial scale of the Meanings of Materials model (Karana, 2009) that included a collection of sensorial aspects frequently used by designers and users, and the interpretive level was also based on the same model, including 22 material meanings. The affective level relied on the findings of Desmet’s (2012) study about the emotions evoked through product interactions. The performative level consisted of a set of pictures related to actions in user-material interactions. The aim of the tool was to make experiential characterization of a specific material in an easier and inspirational way to design material experiences (Camere & Karana, 2018). Canvas of the experiential characterization of materials can be seen in Figure 8.9.

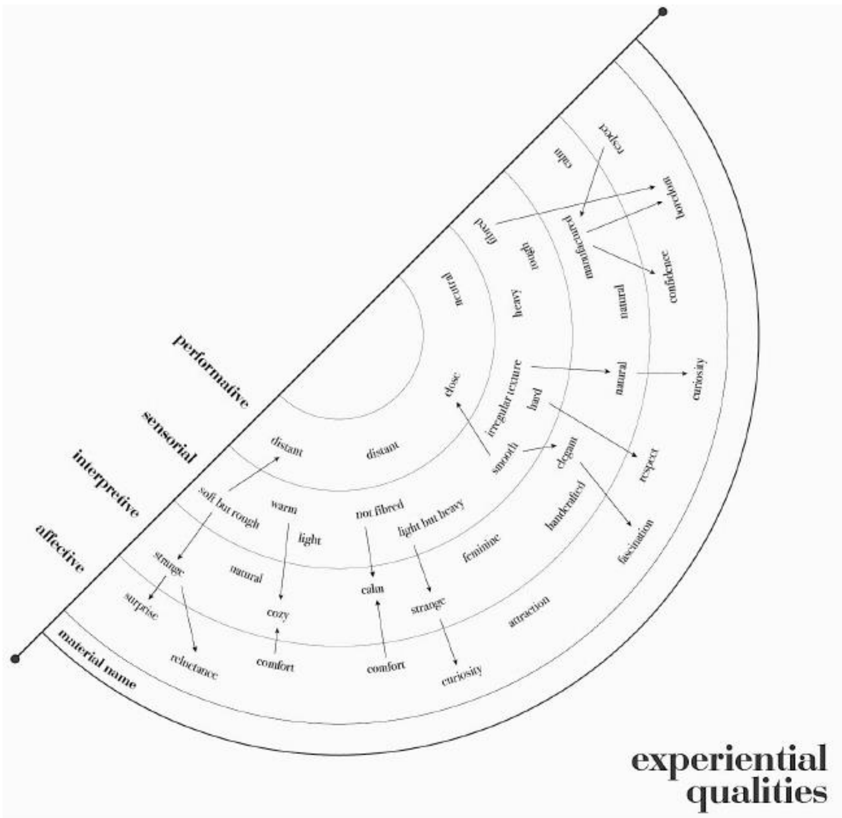

Figure 8.9 Canvas of the experiential characterization of materials (Camere & Karana, 2018, p. 15)

The toolkit of Camere and Karana (2018) was a bottom-up approach that relied on using previously determined scales gathered through previous sensorial and experiential studies mentioned above. Taking a specific material as a starting point to design experiences within a particular context was considered to be a challenging process, as the material experiences are shaped significantly by the product context. Rather, this thesis proposes a top-down approach, in which the individual construes contextual experiences of product materials. It was assumed that the proposed SAMs that provide context-based attitudinal approaches towards product materials alongside their sensory relevancies could be combined with the toolkit to develop a comprehensive and therefore congruent understanding of product materials experience.

Camere, et al. (2015) proposed The Experience Map, which is a structured form to be filled by designers to design a purposive multisensory experience. The aim of this tool is to support designers' creativity during the materialization of desired experiences in five steps. These steps are *statement of product vision* (stating the aimed experience), *conceptual exploration* (insertion of a mood board), *selection of expression* (desired expression of the product), *sensory exploration* (choosing from the sensory properties provided through the literature) and *sensory analysis* (rating of the selected sensory properties) (Camere et al., 2015). Designers are free to add non provided elements into the steps of the map. The Experience Map could be regarded as a format of an interactive design brief that provokes designers to think from a wider perspective with a focus on aimed experiences. An exemplary usage of the tool can be seen in Figure 8.10.

In the following study, the Experience Map was put in practice and tested through several case studies (Camere, Schifferstein, & Bordegoni, 2018). Designers participated in the study also evaluated the tool. According to the evaluations, Camere et al. (2018 found that the tool was evaluated as efficient in the transformation of abstract ideas into tangible results. Yet, most of the designers who used this tool struggled in the statement of the aimed experience to be evoked in users, therefore a stronger guidance would be expected to provide better results (Camere et al., 2018, p.65). A representational source of relationships between the elements of the experience (such as attitudinal expressions of users) specific to the product type could be supportive for designers in clarifying the statement of the experience. It is assumed that SAM can also be used as a complementary tool for the Experience Map (Camere et al., 2018) providing both attitudinal and sensory feedback.

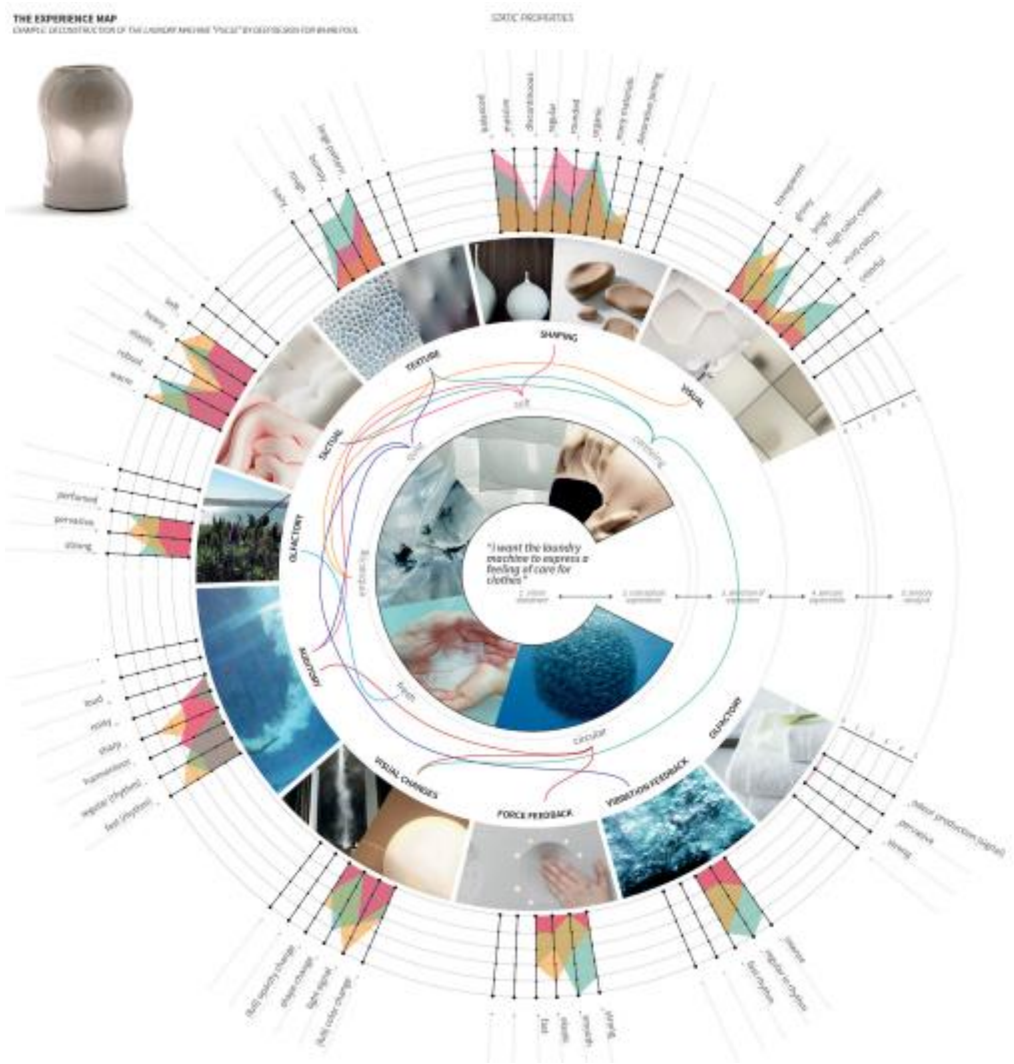

Figure 8.10 Exemplary usage of The Experience Map (Camere, et al., 2018, p.56)

The impressions from a product material do not solely rely on the material properties or product features (Yardım Şener, Şen, Pedgley, Şener Pedgley, & Murray, 2016). For example, Şener Pedgley et al. (2016) investigated luxury perception in products and reported that four values (symbolic, financial, experimental and functional) were found to be influential. To understand how a concept was perceived, various levels of dimensions needed to be comprehensively revealed. In parallel to that, Şener and Pedgley (2015) proposed the meaningful interactions approach, that aims to develop strategies for creating multisensory interactions by making use of developed concepts and descriptions such as verbs and adjectives generated in particular contexts. In this thesis, the attitudinal approaches of individuals towards perceived material qualities were the results of construed interactions with product materials, and therefore represented meaningful interactions between the user and the product, and can be used as a basis for developing design strategies.

Coşkun and Şener Pedgley (2018) qualitatively investigated the multisensory relations of user-product interactions through vacuum cleaners and tea makers. Twelve participants reported their sensory experiences with the products, and the four phases of product uses were defined as preparation, usage, cleaning and storage, and sensory aspects of these phases were collected through observations, post-usage questionnaires and interviews (Coşkun & Şener Pedgley, 2018). In this thesis, a pragmatic mixed methods approach was adopted and the interactions between the user and the product material were not separately investigated. It was intended to represent the interrelations of attitudinal approaches of individuals comprehensively as senso-attitudinal maps and enable designers to interpret these maps in their creative ways.

SAM could also be used for educational purposes as several strategies were proposed to design multisensory product and material experiences in design education. Sonneveld, Ludden and Schifferstein (2008) developed a course that was intended to increase the awareness of students in using sensory modalities effectively in designing multisensory experiences through design scenerios. Similar to that, Şener and Pedgley (2015) introduced a multisensory design project, which aimed to create meaningful sensory interactions between the product and the user using storytelling techniques. The aim of this project was to propose multisensory design strategies for encouraging design students to think about the sensory modalities other than vision in their design projects (Şener & Pedgley, 2015). The senso-attitudinal maps proposed in this thesis could be used as supplementary sources in understanding interrelationships between the attitudes and the senses; and also how individuals construe their interactions with product materials.

A huge amount of effort was given for reviewing the literature about both the subjective and the objective measurement of experience to make a decision on using a methodology for investigating sensory and experiential impressions of product materials. The methodology utilized for this thesis, RGT, is regarded as a versatile tool in capturing idiosyncratic data and has been frequently used for assessing behaviors in marketing and consumer research. As Fallman and Waterworth (2010, p. 264) stated, "Experiences can never be captured with the absolute precision of some physical measurements. Experiences can only ever be judged relative to other experiences, and the RGT approach emphasizes this fact". Further, they underlined that RGT enables the research not to be limited by using the existing dimensions. Rather than using pre-structured measuring dimensions that are likely to remain abstract in capturing context specific aspects, RGT is highly useful in developing specific dimensions for measuring. Although it can be utilized for the requirements of the reserach inquiry, only a limited usage of RGT was found in the literature of product design research. In their study about prioritization of product attributes among different cultures, Tomico et al. (2009) investigated how Dutch and Japanese designers perceive japanese pens differently by measuring dominance, importance and descriptive richness of the constructs elicited through triadic procedures. The majority of their focus was the qualitative side of the RGT. Bang (2013) used triadic procedures of RGT to explore tactile impressions of textiles among designers and other stakeholders, where she utilized RGT interviews to compare tactile and tactile-visual impressions of textiles for establishing common ground for dialog.

8.2.2 Visualization of the Findings

Practical interpretation of the proposed SAM was also considered as an important issue for this thesis. This data driven research consisted of vast numbers of numerical data and it was aimed to provide simple results. For example, the correlation matrix of the evaluation component consisted of 392 pieces of numerical data, and looking for correlations between attitudes through such crowded components could be confusing. Also, it was not considered as a good idea to represent sensory data alongside complex correlation tables. In representing five-sense data, one of the most widely used method was to use a star diagram (Adank & Warell, 2006; Lindstrom, 2005), which was found insufficient in representing multisensory data. An interactive solution for representing both correlations and sensory relevancies was achieved through an experimental visualization method that was designed by utilizing correlations network mapping. Basically, Senso-Attitudinal Maps (SAM) consist of bipolar attitudes within circles that are connected to other attitudes through paths with various thicknesses. A close up view from a SAM prepared in this research can be seen in Figure 8.11.

Figure 8.11 Close-up view of exemplary correlations from a Senso-Attitudinal Map

As can be seen from the close-up view, four attitudes are correlated in different levels. Thickness of the paths represents the strength of a correlation, as thicker strokes indicate a stronger correlation, and thinner strokes indicate a weaker correlation. However, there are both positive and negative correlations available between attitudes. To indicate whether a correlation is positive or negative, color codes are used. Blue paths represent positive correlations and orange paths represent negative correlation. Attitudes are also positioned together depending on their correlation significance for a more practical usage. In the close up view, it can be seen that the attitude *fast-slow* is negatively correlated with the attitude *heavy-light*, and depending on the thickness of the path in between, it is inferred that the correlation is significant. Attitudes are represented in circles, where left pole is written on the top and right pole is writen on the bottom. Poles are divided by dotted lines horizontally from the middle for an easier discrimination between poles. When an orange path between two attitudes needs to be interpreted, one pole of the attitude needs to be linked with the opposite pole of the other attitude. In the example, *fast* was found significantly correlated with *light* (negative correlation), and *reassuring* (positive correlation).

Sensory relevancies of attitudes are also provided in the map. Sensory relevancies of each attitude is prepared as a pie chart and positioned around the circle of that attitude. The relevancies of five basic sensory modalities are represented as color codes, where each color represents a modality. It is aimed to provide sensorial data within the attitudinal data, so that a designer can easily understand how senses are related to elicited attitudes. An informative legend describing color relations is provided in each SAM. An overview of an exemplary SAM can be seen in Figure 8.12.

Senso-Attitudinal Map

Component IV (Clarity)

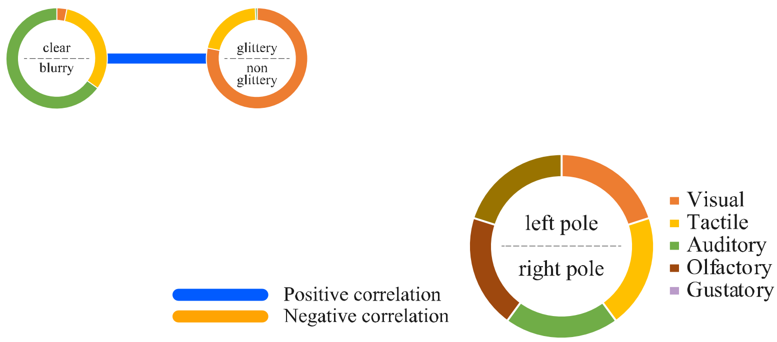

Figure 8.12 Overview of an exemplary Senso-Attitudinal Map (SAM)

Although the cluster cards and product cards provide the necessary information about the findings, they also need to be designed. It is assumed that a more practical and interactive representation of cards will be more appropriate for designerly use. Figure 8.13 represents a conceptual visualization of an exemplary cluster card.

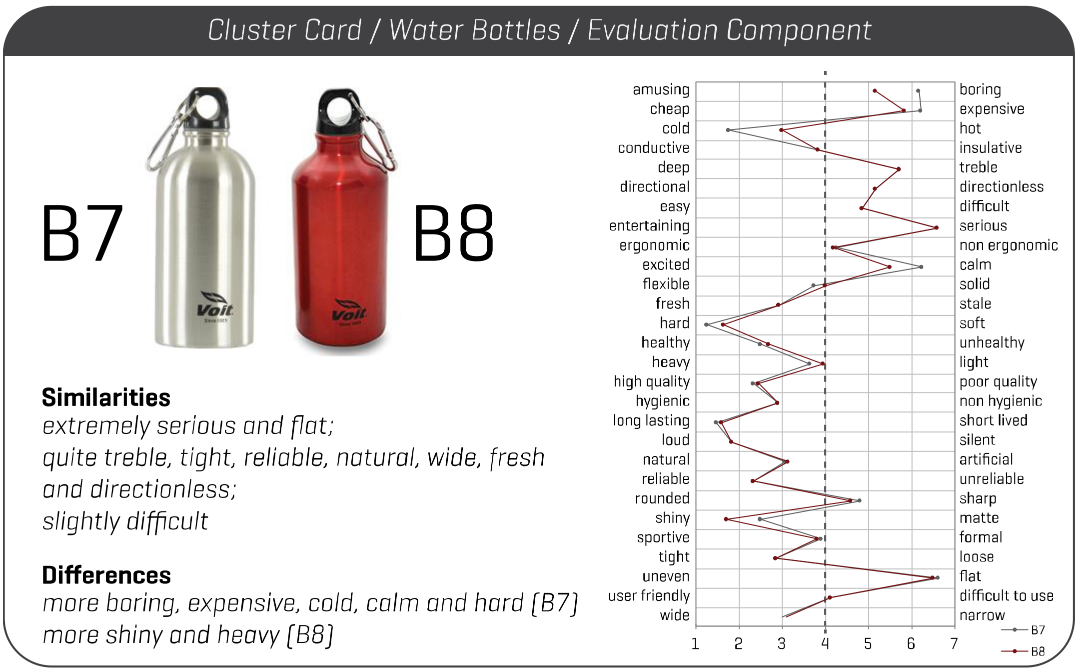

Figure 8.13 An alternative visualization of the cluster card of B7 and B8

An alternative conceptual visualization proposal for product cards can be seen in Figure 8.14 and Figure 8.15. However, it is considered that the design needs to be tested in terms of efficiency of use and the requirements of the designers. The cards can be improved through feedback from a design activity, such as a design workshop.

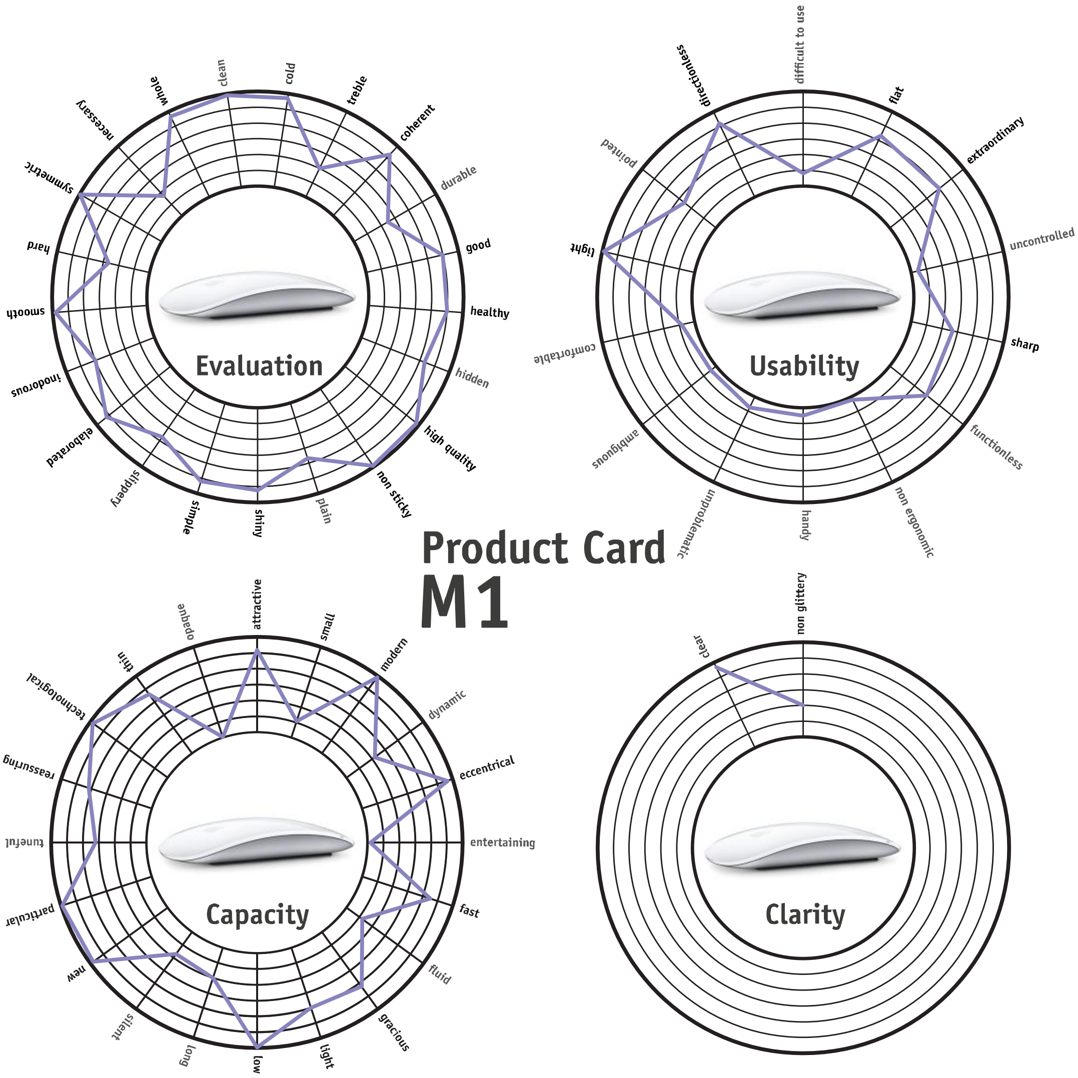

Figure 8.14 An alternative visualization of the product card of M1 (Based on *t*-test results, explicit attitude scales are written in bold)

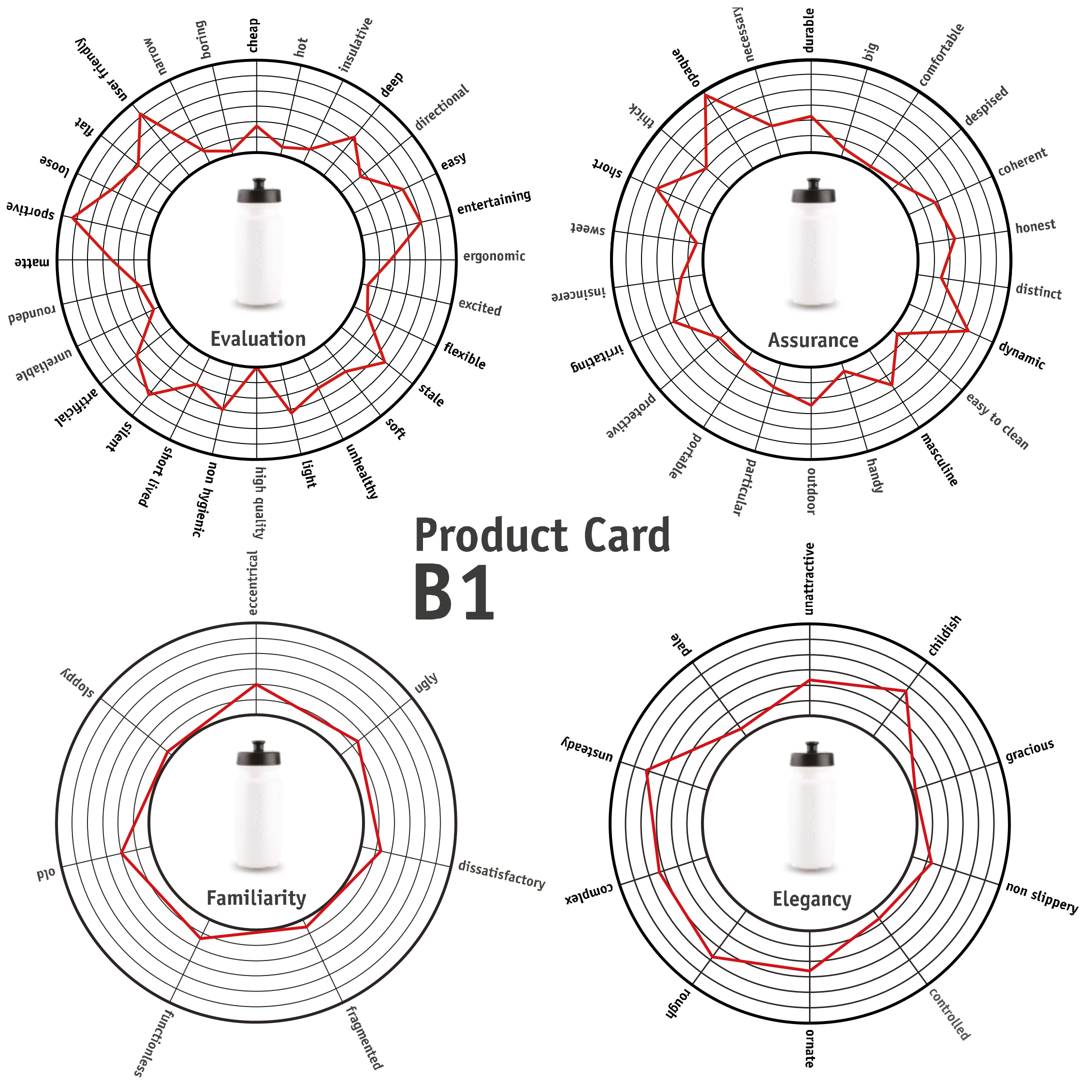

Figure 8.15. An alternative visualization of the product card of B1 (Based on *t*-test results, explicit attitude scales are written in bold)

CHAPTER 9

CONCLUSION

The exploratory mixed methods research carried out for this thesis, utilized RGT to capture idiosyncratic attitudes of individuals towards perceived product material qualities in computer mouse and water bottle contexts. Two separate experiments were concluded with 60 industrial design undergraduate students as informed users with similar backgrounds while carrying similar cultural aspects. RGT was used in both experiments as the data collection instrument, enabling the researcher to obtain in-depth data through the comparison of perceived material qualities through different product pairs as stimuli.

RGT was not only used to collect data, but also to reach in-depth preverbal meanings that had a potential to be elicited verbally by the individual and to observe individual anticipations towards the stimuli. To do this, several interviewing techniques were used. RGT also allowed the researcher to implement two different rating scales within the data collecting instrument without distracting the nature of the research intent. The utilized RGT is unique to its content as it allowed participants to develop their own particular measurement scale (elicitation of the constructs as individual attitudes) for the selected contexts (computer mouses and water bottles), while enabling the researcher to collect quantitative data from two different scales (sensory evaluation of the attitudes and evaluation of the products through elicited attitudes) from the same participants sequentially. Up to date, no such introspective study was found in the literature that collects five-sense data and evaluations of the contextual stimuli about product materials based on participants' generated measures. As a result, two different measurement scales were developed for each product context without being limited to using researcher generated or previously developed scales, which often remain abstract in capturing idiosyncratic statements of individuals.

Collected idiosyncratic data of the individuals were transformed into common attitudinal approaches through content analysis based on their semantic similarities. Following this qualitative phase, the relationships between common elicited attitudes were quantitatively investigated through the participant ratings, while attaching the sensory relevancy evaluation ratings of each attitude. Expected outcome of these analyses was to find relationships between the elicited attitudes, products and their sensory aspects and also to represent them as sensory and attitudinal maps, while offering complementary tools as cluster cards and product cards to be used for a comprehensive understanding of the relationships. The term is offered as Senso-Attitudinal Maps (SAM), which are conceptually designed to represent qualitative and quantitative findings in a practical and interactive way.

The proposed SAM would be expected to contribute to the educational, professional and theoretical fields. Current design pedagogical approaches about multisensory material experiences are concerned with encouraging design students to think outside of the box, using the experiential features of materials by focusing on senses other than vision. As vision is a dominant sense among all other senses, students tend to ground their design processes on mostly visual cues. The proposed tools of this research could also be used as a reference and inspiration source to help design students develop scenarios of material experiences in particular product contexts.

The proposed tools and maps as the outcomes of this research could also contribute to the professional design fields. Firstly, the proposed tools and maps can be used as inspirational sources to overcome creative blocks that professionals are prone to have in having designed similar products for years. The design professional would be able to develop his/her creative design strategies grounded on the findings. Secondly, any kind of product can be selected as stimuli for the research. Thus, designers could use the tools and maps to interpret relationships in particular contexts or compare differences among contexts. Thirdly, the proposed tools and methodology can be used as a benchmarking activity, which is an essential element for every design project. Lastly, the proposed methodology offers insights into consumer and user preferences and perceptions, and therefore could be regarded as a consumer research activity. Consumer insights could also be investigated both at individual and group level.

The results reflect the features of the Turkish culture towards perceived material qualities. It could be used to investigate cross-cultural facts in terms of comparing perceived qualities to find out differences or similarities among cultures. The findings of the research could also be used as a reference to develop materials languages for a better communication between various disciplines. It is assumed that the results could also contribute to experiential characterization of materials, on which a growing interest is emerging currently among scholars.

The research approach developed in this study is unique to its content as it also enables to achieve sensory aspects of attitudinal approaches towards product materials in various particular contexts. The materials experience literature is lacking sensory investigation of the experiences obtained from materials and the research approach could provide supportive outputs to fit the needs of the research field. The findings of this research could also be utilized to understand contextual differences about attitudinal approaches towards materials among different product types. Roughness, weight, softness, attractiveness, pitch, comfort, glossiness, quality and simplicity are commonly mentioned aspects significantly higher than other attitudinal aspects in both experiments conducted in this research and they are regarded as significant aspects for both computer mouses and water bottles. They are potentially containing common understanding of product materials and could be utilized as a general measure to investigate other product contexts. Moreover, size and newness are found significant for computer mouses, and sturdiness and transparency are found significant for water bottles. These findings could provide insights about the importance of attitudinal approaches for particular product contexts and possibly contain clues for understanding the relations in other product contexts. Size (in terms of comfort and usability) and newness (as an indicator of technological level) could be important aspects of technological products used by hand, and sturdiness and transparency could be most important for food and beverage containers that are portable.

9.1 Limitations of the Study

The first limitation of the research was about the duration of the interviews. Although it was estimated that a total of five dyadic rounds would take around 40-60 minutes for each participant, this estimated duration was exceeded by most of the participants. Participants attended the experiments voluntarily, and they were informed that they could end the experiment whenever they wanted without asserting any excuse. None of the participants left early or asked to end the interview before the sessions were completed. Although all of the participants seemed to enjoy the interviews, both the researcher and the participants became tired from time to time, especially in the late phases of the interviews. A solution for this issue could be decreasing the amount of trials in each session while increasing the number of participants to maintain a balance in eliciting an adequate number of constructs.

The participants were invited from among the undergraduate industrial design students at Anadolu University (afterwards Eskişehir Technical University) Faculty of Architecture and Design. All the participants were Turkish, and the research is assumed to be reflecting characteristic features of the Turkish culture. In the pilot study, it was noticed that some participant elicitations focused on mostly technical aspects of product materials in the beginning of the interviews. Following a conversation with one of the pilot study participants, it was mentioned that the technical perspective of the design education given in the department could have influenced their way of thinking while construing. The elicitation order did not influence the results of this research as this research was concerned with the richness of the elicitations. The issue of elicitation of technical aspects to begin with in the session, was resolved as the participants became familiar with the procedure.

9.2 Suggestions for Further Research

This thesis intended to explore senso-attitudinal approaches of individuals towards product material impressions through construing of interactions between the user and the material. Two different product contexts were used to develop Senso-Attitudinal Maps (SAM) that included relationships between the attitudes and the products, alongside their sensory relevancies. Although the data used to develop SAM were proven to be reliable by statistical analyses, the maps need to be tested in practice either by designers or design students to evaluate practicability and usefulness. Further research could be planned on designing workshops or educational exercises to test SAM effectiveness.

RGT was a time consuming and challenging technique as the researcher had to deal with a huge amount of data in both the collecting and analysis phases. The methodology used in this thesis partly benefited from digital algorithms that make several processes of RGT more practical and faster. A completely digitalized methodology would be a perfect solution to decrease the amount of time to deal with mentioned issues. Digital networks of attitudes or semantics can be developed through algorithms such as deep learning, and the data would be instantly analyzed and interpreted automatically. Further experiments with product materials through different contexts could enable the development of digital senso-attitudinal libraries that can be used to achieve more generalizable results. This type of a digital medium could also find a wide range of use in UX and consumer behavior research.

It is assumed that SAM could be useful in developing expressive languages among stakeholders in the design field. RGT was found effective in developing semantic spaces for different contexts. A structured way of developing semantic spaces for specific product contexts and connecting these contextual semantic spaces as a network of materials language is required. This may also point to a research direction.

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APPENDICES

A. Repertory Grid Sheet Design of Computer Mouses

Ürün Örnekleri Üzerinden Ayırt Edici Malzeme Özellikleri
İkili Karşılaştırma / Repertuar Çizelgesi

Katılımcı Numarası: Yaş: Öğrenim Süresi: Cinsiyet: ☐K ☐E Tarih:

Testte Kullanılan Ürünler

M1 **M2** **M3** **M4** **M5** **M6** **M7** **M8**

Lütfen aşağıdaki ürünlerin (*M1,...,M8*) belirtilen özellikleri ne ölçüde (*1,...,7*) taşıdığını derecelendiriniz.

Derecelendirme Ölçeği:

Sol Kutup 1 2 3 4 5 6 7 *Sağ Kutup*

Karşılaştırılan ürünlerin, hitap ettiği duyuları her satırda yer alan gruplara göre ne derecede uyardığını 1 ile 10 puan arasında puanlayınız:

0: hiç uyarmamaktadır
5: orta derecede uyarmaktadır
10:çok uyarmaktadır

ÜRÜNLER								YAPI		Ürün I					Ürün II				
M1	M2	M3	M4	M5	M6	M7	M8	Sol Kutup	Sağ Kutup	Görme	Dokunma	İşitme	Koklama	Tatma	Görme	Dokunma	İşitme	Koklama	Tatma

B. Repertory Grid Sheet of Water Bottles

Ürün Örnekleri Üzerinden Ayırt Edici Malzeme Özellikleri
İkili Karşılaştırma / Repertuar Çizelgesi

Katılımcı Numarası: Yaş: Öğrenim Süresi: Cinsiyet: ☐K ☐E Tarih:

Testte Kullanılan Ürünler

M1 M2 M3 M4 M5 M6 M7 M8

Lütfen aşağıdaki ürünlerin (*M1,...,M8*) belirtilen özellikleri ne ölçüde (*1,...,7*) taşıdığını derecelendiriniz.

Derecelendirme Ölçeği:

Sol Kutup 1 2 3 4 5 6 7 *Sağ Kutup*

Karşılaştırılan ürünlerin, hitap ettiği duyuları her satırda yer alan gruplara göre ne derecede uyardığını 1 ile 10 puan arasında puanlayınız:

0: hiç uyarmamaktadır
5: orta derecede uyarmaktadır
10:çok uyarmaktadır

ÜRÜNLER								YAPI	Ürün I					Ürün II				
M1	M2	M3	M4	M5	M6	M7	M8	Sol Kutup Sağ Kutup	Görme	Dokunma	İşitme	Koklama	Tatma	Görme	Dokunma	İşitme	Koklama	Tatma

C. Experiment Information and Instructions

Bu bir mülakattır.

Bu mülakatta sekiz adet bilgisayar faresinin üretildikleri malzemeleri üzerinden katılımcılar tarafından nasıl algılandığı ve hangi duyu organının ne derecede uyarıldığı ölçümlenecektir. Bu bağlamda size önceden belirlenmiş olan sekiz adet bilgisayar faresi içerisinden, yine önceden ve rastgele şekilde belirlenmiş ikili fare eşlerini sunup, bu eşlerin malzeme özellikleri üzerinden benzer veya farklı olup olmadıklarını soracağım. Ardından bu benzerlik veya farklılıkların hangi özelliklerden ötürü oluştuğunu açıklamanızı rica edeceğim. Bu aşamada karşılaştırma yaparken ürünleri dilediğiniz gibi deneyleyebilirsiniz. Sizden beklediğim, bu benzerlik veya farklılıkları tanımlarken kullandığınız öznel değerlendirmeleri sıfat, çağrışım vb. şekillerde kelimeler halinde ifade etmenizdir. Yapacağınız öznel değerlendirmelerde herhangi bir doğruluk veya yanlışlık aranmayacaktır. Bu aşamada rahat olmanız ve değerlendirmeleri aklınıza gelen şekliyle ifade etmeniz önemlidir. Karşılaştırma esnasında ortaya çıkan öznel değerlendirmenizi ilk olarak çizelgenin ortasında, yapı bölümünde bulunan “sol kutup” alanına yazacağım. Ardından size bu ifadenin anlamsal olarak karşıtını soracak ve verdiğiniz cevabı “sağ kutup” kısmına yazarak yapıyı tamamlayacağım. Karşıt anlamlı ifade ikilisi bir yapıyı oluşturmaktadır. Yapı tamamlandıktan sonra aynı fare eşlisi üzerinde yeni yapı çıkaramayana kadar size aynı soru prosedürünü uygulayacağım. İlgili fare eşleri üzerine yeni yapı çıkamadığı durumda ikinci aşamaya geçilecektir.

İkinci aşamada ortaya çıkardığınız yapıları duyular çerçevesinde değerlendirmenizi isteyeceğim. Her bir yapının oluşumunda, eşleşmedeki her fare için hangi duyunuzun (görme, dokunma, işitme, koklama ve tatma) ne derecede etkin rol oynadığını soracak ve bu etkinliği 0-10 puan arasında puanlamanızı isteyeceğim (0: hiç etkisi yok, 5 orta derecede etkili, 10 çok etkili). Verdiğiniz puanları çizelgenin sağ tarafındaki ilgili alana işaretleyeceğim. Bu uygulamayı ilgili turda ortaya çıkan tüm yapılar üzerinden tekrar ettikten sonra fareleri diğer farelerin arasına koyup sıradaki önceden rastgele belirlenmiş fare ikilisine geçip aynı prosedürleri uygulayacağız. Bu iki aşama, karşılaştıracağımız tüm fare eşlerinde uygulandıktan sonra son aşamaya geçilecektir.

Son aşamada, ilgili turda ortaya çıkan yapılar üzerinden tüm fareleri sırayla 1-7 ölçeği üzerinden değerlendirmenizi rica edeceğim. Bir yapı sol ve sağ kutup olmak üzere iki kutuptan oluşmaktadır. 1-7 ölçeğindeki 1 sol kutba olan yakınlığı, 7 sağ kutba olan yakınlığı; ortadaki değer 4 ise tarafsız (ne sağ ne sol) değeri temsil etmektedir. Yaptığınız değerlendirmeleri çizelgenin sol kısmında bulunan bölgeye yazacağım. Her bir fare, ilgili turda ortaya çıkan tüm yapılar üzerinden değerlendirildiğinde tur tamamlanmış olacaktır. Ardından, önceden rastgele olarak belirlenmiş yeni bir fare ikilisini size sunacağım ve aynı prosedürü tekrar uygulayacağız.

Mülakatın siz yeni yapılar oluşturamayana kadar sürmesi planlanmaktadır. Herhangi bir zaman kısıtlaması bulunmamasına rağmen ortalama 50 dakika süreceği hesaplanmıştır. Mülakatı dilediğiniz zaman sonlandırabilirsiniz. Aklınıza takılan herhangi bir soru varsa lütfen sorunuz.

Sorunuz yoksa mülakata başlayabiliriz.

D. Randomization Algorithm Developed for Dyadic Sessions

Randomization algorithm is presented as pseudocode in the following:

```
Session Length ← 5
Number of Total Sessions ← User Input
Number of Specimens ← 8
Number of Unique Pairs ← C(Number of Specimens, Number of Specimens -1) = C(8, 7) = 28
PROCEDURE main()
loop for Number of Current Sessions < Number of Total Sessions
        call initiate_possible_pairs()
        call initiate_fifth_pairs()
        if batch_fails > batch_fail_threshold
                restart procedure
        end if
        loop for (Number of Unique Pairs) / 4        //5th pair uses a different set of pairs
                if session_creation_fail > threshold
                        batch_fail++
                        end loop
                end if
                ineligible_pairs ← null
                ineligible_fifth_pairs ← null
                session ← null
                loop until (size(session) ==4)
                        if size(possible_pairs) = 0
                                session_creation_fail++
                                break
                        candidate ← possible_pairs[random(1, size(possible_pairs))]
                        else if check_if_eligible(session, candidate)
                                session.add(candidate)
                                possible_pairs.remove(candidate)
                        else
                                ineligible_pairs.add(candidate)
                                possible_pairs.remove(candidate)
                        end if
                end loop
                if size(session) != 4
                        break
                end if
                loop until size(session) = 5
                        if size(possible_fifth_pairs) = 0
                                session_creation_fails++
                                break
                        candidate ← possible_fifth_pairs[random(1, size(possible_pairs))]
                        else if check_if_eligible_for_fifth(session, candidate)
                                session.add(candidate)
                                possible_fifth_pairs.remove(candidate)
                        else
                                ineligible_fifth_pairs.add(candidate)
                                possible_fifth_pairs.remove(candidate)
                        end if
                end loop
                possible_pairs.add(ineligible_pairs)
                possible_fifth_pairs.add(ineligible_fifth_pairs)
                if size(session) = 5
                        session_list.add(session)
                end if
        end loop
end loop
write sessions to file
PROCEDURE  check_if_eligible_for_fifth:
        foreach pair in session
                if candidate = pair
                        return false
                end if
        end foreach
        return true
PROCEDURE  check_if_eligible_for_fifth:
        foreach individual in session
                if candidate.first_specimen = individual
                        return false
                end if

                if candidate.second_specimen = individual
                        return false
                end if
        end foreach
        return
```

E. List of Random Dyads Generated for Both Experiments

SESSION #1
1 – 8
4 – 5
6 – 7
2 – 3
3 – 7
SESSION #2
4 – 7
1 – 2
3 – 8
5 – 6
1 – 4
SESSION #3
4 – 7
2 – 8
3 – 6
1 – 5
2 – 6
SESSION #4
2 – 8
1 – 4
5 – 6
3 – 7
4 – 8
SESSION #5
5 – 8
3 – 6
1 – 7
2 – 4
3 – 5
SESSION #6
1 – 4
2 – 7
3 – 8
5 – 6
1 – 2
SESSION #7
2 – 6
1 – 3
4 – 8
5 – 7
5 – 6
SESSION #8
1 – 2
4 – 6
5 – 8
3 – 7
3 – 6
SESSION #9
7 – 8
2 – 4
3 – 5
1 – 6
1 – 5
SESSION #10
4 – 5
6 – 8
1 – 7
2 – 3
2 – 7
SESSION #11
1 – 4
2 – 7
5 – 8
3 – 6
1 – 6
SESSION #12
4 – 8
3 – 5
2 – 6
1 – 7
2 – 3
SESSION #13
1 – 6
5 – 7
4 – 8
2 – 3
3 – 7
SESSION #14
6 – 8
1 – 5
3 – 7
2 – 4
5 – 7
SESSION #15
3 – 4
6 – 8
2 – 7
1 – 5
1 – 4
SESSION #16
1 – 6
2 – 3
4 – 7
5 – 8
4 – 5
SESSION #17
5 – 7
1 – 3
2 – 8
4 – 6
5 – 8
SESSION #18
2 – 8
1 – 4
6 – 7
3 – 5
7 – 8
SESSION #19
7 – 8
2 – 5
4 – 6
1 – 3
4 – 7
SESSION #20
6 – 8
2 – 7
1 – 5
3 – 4
6 – 7
SESSION #21
5 – 7
3 – 6
4 – 8
1 – 2
1 – 7
SESSION #22
1 – 3
7 – 8
4 – 6
2 – 5
6 – 8
SESSION #23
6 – 7
1 – 8
3 – 4
2 – 5
4 – 6
SESSION #24
6 – 7
4 – 5
3 – 8
1 – 2
2 – 4
SESSION #25
1 – 8
3 – 5
2 – 6
4 – 7
2 – 5
SESSION #26
1 – 7
3 – 8
2 – 4
5 – 6
1 – 3
SESSION #27
2 – 6
1 – 8
3 – 7
4 – 5
2 – 8
SESSION #28
7 – 8
1 – 6
2 – 5
3 – 4
1 – 8
SESSION #29
4 – 6
1 – 7
2 – 5
3 – 8
1 – 8
SESSION #30
3 – 5
4 – 7
1 – 2
6 – 8
1 – 3

F. Full List of Translations for the Experiment With Computer Mouses

No	English (Translated)	Turkish (Original)
1	big-small	büyük-küçük
2	old-new	eski-yeni
3	smooth-rough	pürüzsüz-pürüzlü
4	heavy-light	ağır-hafif
5	comfortable-uncomfortable	rahat-rahatsız
6	shiny-matte	parlak-mat
7	beautiful-ugly	güzel-çirkin
8	soft-hard	yumuşak-sert
9	curved-flat	eğimli-düz
10	loud-silent	yüksek ses-sessiz
11	attractive-unattractive	çekici-albenisiz
12	simple-complex	basit-karmaşık
13	deep-treble	tok-tiz
14	high quality-poor quality	kaliteli-kalitesiz
15	high-low	yüksek-alçak
16	slippery-non slippery	kaygan-kaymaz
17	ergonomic-non ergonomic	ergonomik-ergonomik değil
18	fluid-stable	akışkan-durağan
19	dark-light	koyu-açık
20	rounded-sharp	yumuşak-keskin
21	non glittery-glittery	simsiz-simli
22	technological-outdated	teknolojik-eski teknoloji
23	durable-flimsy	sağlam-dayanıksız
24	classical-modern	klasik-modern
25	easy-difficult	kolay-zor
26	expensive-cheap	pahalı-ucuz
27	whole-fragmented	bütün-parçalı
28	ambiguous-distinct	belirsiz-tanımlı
29	clean-dirty	temiz-kirli
30	gracious-coarse	zarif-kaba
31	long-short	uzun-kısa
32	thick-thin	kalın-ince
33	cold-hot	soğuk-sıcak
34	eccentrical-accustomed	alışılmadık-alışılmış
35	entertaining-serious	eğlenceli-ciddi
36	sloppy-elaborated	özensiz-düşünülmüş
37	fast-slow	hızlı-yavaş
38	handy-impractical	kullanışlı-kullanışsız
39	extraordinary-common	farklı-sıradan
40	obtuse-pointed	yumuşak-sivri
41	transparent-opaque	şeffaf-opak
42	dynamic-bulky	dinamik-hantal
43	reassuring-insecure	güvenli-güvensiz
44	functional-functionless	fonksiyonel-işlevsiz
45	smelt-inodorous	kokulu-kokusuz
46	inappropriate-proper	uygunsuz-uygun
47	controlled-uncontrolled	kontollü-kontrolsüz
48	long lasting-short lived	uzun ömürlü-kısa ömürlü
49	good-bad	iyi-kötü
50	discordant-coherent	uyumsuz-uyumlu
51	particular-standard	özelleşmiş-standart
52	healthy-unhealthy	sağlıklı-sağlıksız
53	raspy-tuneful	rahatsız edici ses-hoş ses

No	English (Translated)	Turkish (Original)
54	plain-ornate	sade-süslü
55	hidden-open	kapalı-açık
56	symmetric-asymmetric	simetrik-asimetrik
57	directional-directionless	yönlü-yönsüz
58	user friendly-difficult to use	kolay kullanılan-kullanışı zor
59	independent-constrained	özgür-kısıtlı
60	problematic-unproblematic	problemli-problemsiz
61	unnecessary-necessary	gereksiz-gerekli
62	clear-blurry	net-flu
63	non sticky-sticky	yapışmaz-yapışkan
64	portable-stable	taşınabilir-sabit
65	inadequate-adequate	yetersiz-yeterli
66	loose-strict	gevşek-sıkı
67	unwanted-wanted	istenmeyen-istenen
68	pale-vivid	soluk-canlı
69	professional-amateur	profesyonel-amatör
70	balmy-stinky	hoş kokan-kötü kokan
71	masculine-feminine	erkeksi-kadınsı
72	advanced-primitive	gelişmiş-ilkel
73	organic-mechanic	organik-mekanik
74	insincere-sincere	samimiyetsiz-içten
75	easy to clean-hard to clean	temizlemesi kolay-temizlemesi zor
76	glassy-plastic like	camsı-plastiki
77	mechanic-aromatic	makine kokulu-aromatik
78	metallic-plastic like	metalik-plastiki
79	reflective-opaque	yansıtıcı-opak
80	aerodynamic-not aerodynamic	aerodinamik-aerodinamik olmayan
81	confident-unsure	kendinden emin-hoppalak
82	classy-low class	yüksek mevki-alçak mevki
83	unattainable-attainable	ulaşılmaz-ulaşılabilir
84	fixable-non fixable	tamir edilebilir-tamir edilemez
85	atonic-tonic	vurgusuz-vurgulu
86	childish-mature	çocuksu-olgun
87	strange-nostalgic	yabancı-nostaljik
88	young-old	genç-yaşlı

G. Themes and Categories of the Experiment with Computer Mouses

Main Theme	Theme	Category
Physical Qualities	Objective	Size, Height, Length, Width, Thickness, Weight
	Lines of Form	Symmetry, Corner Lines, Edge Lines, Surface Lines
	Surface Qualities	Roughness, Stickiness, Greasiness, Softness, Elasticity, Thermal
	Optical	Glitteriness, Hue, Transparency, Glossiness
	Auditory	Pitch, Loudness
	Olfactory	Smelliness
Evaluation	Tranquility	Comfortableness, Coziness, Seriousness, Healthiness, Raspiness
	Purity	Simplicity, Difficulty, Decoratedness
	Impressiveness	Attractiveness, Grace, Aesthetics, Sincerity, Desirability, Quality of Smell
	Dynamism	Fluidity, Directionality, Agility, Organicness
Functionality	User Friendliness	Controllability, Portability, Ease of Use, Restrictiveness, Ease of Cleaning
	Suitability for Use	Ergonomy, Safety, Problemacy, Appropriateness
	Performance	Functionality, Velocity, Usefulness, Necessity, Sufficiency
Perceived Value	Durableness	Quality, Sturdiness, Durability, Cleanness
	Degree of Value	Value, Technology, Development Level, Modernity
	Sensitivity	Elaboratedness, Wholeness, Goodness
Familiarity	Identifiability	Newness, Accustomedness, Discrepancy, Compatibleness, Glassiness
	Specificness	Specialization, Professionalism, Gender, Maturity
	Lucidness	Clarity, Sound Clarity, Openness

H. Full List of Common Elicited Attitudes with Their Distributional Weights

Full list of common elicited attitudes for computer mouses (F: Frequency, W: Weight of distribution among 30 participants)

Attitude	F	W	Attitude	F	W
big-small	29	97%	extraordinary-common	8	27%
old-new	28	93%	obtuse-pointed	7	23%
smooth-rough	25	83%	transparent-opaque	7	23%
heavy-light	23	77%	dynamic-bulky	7	23%
comfortable-uncomfortable	21	70%	reassuring-insecure	7	23%
shiny-matte	21	70%	functional-functionless	6	20%
beautiful-ugly	18	60%	smelt-inodorous	6	20%
soft-hard	18	60%	inappropriate-proper	6	20%
curved-flat	17	57%	controlled-uncontrolled	6	20%
loud-silent	17	57%	long lasting-short lived	6	20%
attractive-unattractive	16	53%	good-bad	6	20%
simple-complex	15	50%	discordant-coherent	6	20%
deep-treble	15	50%	particular-standard	6	20%
high quality-poor quality	14	47%	healthy-unhealthy	6	20%
high-low	14	47%	raspy-tuneful	6	20%
slippery-non slippery	14	47%	plain-ornate	5	17%
ergonomic-non ergonomic	14	47%	hidden-open	5	17%
fluid-stable	13	43%	symmetric-asymmetric	5	17%
dark-light	13	43%	directional-directionless	5	17%
rounded-sharp	13	43%	user friendly-difficult to use	5	17%
glittery-non glittery	12	40%	independent-constrained	5	17%
technological-outdated	12	40%	problematic-unproblematic	5	17%
durable-flimsy	11	37%	unnecessary-necessary	5	17%
classical-modern	11	37%	clear-blurry	5	17%
easy-difficult	11	37%	non sticky-sticky	5	17%
expensive-cheap	10	33%	portable-stable	4	13%
whole-fragmented	10	33%	inadequate-adequate	4	13%
ambiguous-distinct	10	33%	loose-strict	4	13%
clean-dirty	10	33%	unwanted-wanted	4	13%
gracious-coarse	9	30%	pale-vivid	3	10%
long-short	9	30%	professional-amateur	3	10%
thick-thin	9	30%	balmy-stinky	3	10%
cold-hot	9	30%	masculine-feminen	3	10%
eccentrical-accustomed	9	30%	advanced-primitive	3	10%
entertaining-serious	8	27%	organic-mechanic	2	7%
sloppy-elaborated	8	27%	insincere-sincere	2	7%
fast-slow	8	27%	easy to clean-hard to clean	2	7%
handy-impractical	8	27%	glassy-plastic like	2	7%

I. Chi-Square Test Results for Gender Differences in the Experiment with Computer Mouses and Water Bottles

Chi-Square test results in the experiment with computer mouses

Chi-Square Tests

	Value	df	Asym. Sign. (2-sided)
Pearson Chi-Square	15,108[a]	32	,995
Likelihood Ratio	15,485	32	,994
N of Valid Cases	491		

a. 12 cells (18,2%) have expected count less than 5. The minimum expected count is 4,25.

Chi-Square test results in the experiment with water bottles

Chi-Square Tests

	Value	df	Asym. Sign. (2-sided)
Pearson Chi-Square	33,116[a]	50	,968
Likelihood Ratio	33,870	50	,961
N of Valid Cases	713		

a. 20 cells (19,6%) have expected count less than 5. The minimum expected count is 3,50.

J. Full List of Translations for the Experiment With Water Bottles

No	English (Translated)	Turkish (Original)
1	adequate-inadequate	yeterli-yetersiz
2	advanced-primitive	gelişmiş-ilkel
3	amusing-boring	eğlendirici-sıkıcı
4	artificial-odourless	yapay-kokusuz
5	asocial-social	asosyal-sosyal
6	attractive-unattractive	çekici-albenisiz
7	beautiful-ugly	güzel-çirkin
8	big-small	büyük-küçük
9	brave-classic	cesur-klasik
10	bright-dim	aydınlık-karanlık
11	cheap-expensive	ucuz-pahalı
12	childish-mature	çocuksu-olgun
13	childish-sportive	çocuksu-sportif
14	clean-dirty	temiz-kirli
15	coarse-gracious	kaba-zarif
16	cold-hot	soğuk-sıcak
17	comfortable-uncomfortable	rahat-rahatsız
18	conductive-insulative	iletken-yalıtkan
19	constrained-independent	kısıtlı-kısıtsız
20	controlled-uncontrolled	kontrollü-kontrolsüz
21	cool-despised	havalı-sönük
22	current-outdated	güncel-demode
23	cute-hateful	tatlı-kötü
24	dark-light	koyu-açık
25	decent-fake	kabul edilebilir-uyduruk
26	deep-treble	tok-tiz
27	dense-sparse	yoğun-seyrek
28	different-normal	farklı-normal
29	directional-directionless	yönlü-yössüz
30	discordant-coherent	uyumsuz-uyumlu
31	dishonest-honest	aldatıcı-dürüst
32	disorganised-neat	dağınık-toplu
33	distinct-ambiguous	tanımlı-belirsiz
34	durable-flimsy	sağlam-dayanıksız
35	dynamic-inactive	dinamik-durağan
36	easy to clean-hard to clean	temizlemesi kolay-temizlemesi zor
37	easy-difficult	kolay-zor
38	elaborated-sloppy	düşünülmüş-özensiz
39	entertaining-serious	eğlenceli-ciddi
40	ergonomic-non ergonomic	ergonomik-ergonomik değil
41	excited-calm	coşkulu-sakin
42	exciting-boring	heyecan verici-sıkıcı
43	familiar-industrial	tanıdık-endüstriyel
44	fast-slow	hızlı-yavaş
45	feminine-masculine	kadınsı-erkeksi
46	flamboyant-functional	gösterişli-fonksiyonel
47	flexible-solid	esnek-katı
48	foreign-familiar	yabancı-tanıdık
49	fragmented-whole	parçalı-bütün
50	fresh-stale	taze-bayat
51	functional-functionless	fonksiyonel-işlevsiz
52	hairy-non hairy	tüylü-tüysüz
53	handy-impractical	kullanışlı-kullanışsız

No	English (Translated)	Turkish (Original)
54	hard-soft	sert-yumuşak
55	healthy-unhealthy	sağlıklı-sağlıksız
56	heavy-light	ağır-hafif
57	hidden-open	kapalı-açık
58	high quality-poor quality	kaliteli-kalitesiz
59	hygienic-non hygienic	hijyenik-hijyenik değil
60	inappropriate-proper	uygunsuz-uygun
61	innocent-guilty	masum-suçlu
62	intense-odourless	yoğun-kokusuz
63	long lasting-short lived	uzun ömürlü-kısa ömürlü
64	loud-silent	gürültülü-sessiz
65	mechanical-analog	mekanik-analog
66	medical-daily	medikal-günlük
67	modern-classical	modern-klasik
68	natural-artificial	doğal-yapay
69	non slippery-slippery	kaymaz-kaygan
70	old-new	eski-yeni
71	organic-raw	organik-ham
72	outdoor-indoor	dış mekan-iç mekan
73	particular-standard	camsı-plastiki
74	plain-ornate	sade-süslü
75	pleasurable-dissatisfactory	memnun edici-hoşnutsuz
76	politic-impolitic	politik-apolitik
77	portable-stable	taşınabilir-sabit
78	prejudiced-open minded	ön yargılı-açık fikirli
79	protective-vulnerable	koruyucu-savunmasız
80	reliable-unreliable	güvenilir-güvenilmez
81	relieving-irritating	ferahlatıcı-irite edici
82	rough-smooth	pürüzlü-pürüzsüz
83	rounded-sharp	yumuşak-keskin
84	safe-insecure	güvenli-güvensiz
85	shiny-matte	parlak-mat
86	simple-complex	basit-karmaşık
87	sincere-insincere	samimiyetsiz-içten
88	sportive-elegant	sportif-elegant
89	sportive-formal	sportif-formal
90	stainable-unstainable	paslanır-paslanmaz
91	stainless-solvable	paslanmaz-çözünebilir
92	steady-unsteady	oturaklı-dengesiz
93	sticky-non sticky	yapışkan-yapışmaz
94	sweet-bitter	tatlı-acı
95	sweet-dominant	tatlı-baskın
96	tall-short	uzun-kısa
97	technological-outdated	teknolojik-eski teknoloji
98	thin-thick	ince-kalın
99	tight-loose	sıkı-gevşek
100	transparent-opaque	transparan-opak
101	ugly-silent	çirkin-sessiz
102	uneven-flat	engebeli-düz
103	unimportant-important	önemsiz-önemli
104	unnecessary-necessary	gereksiz-gerekli
105	unsavory-vigorous	yavan-coşkulu
106	user friendly-difficult to use	kolay kullanılan-kullanışı zor
107	vivid-pale	canlı-soluk
108	wide-narrow	geniş-dar
109	young-old	genç-yaşlı

K. Themes and Categories of the Experiment With Water Bottles

Main Theme	Theme	Category
Physical Qualities	Objective	Size, Height, Width, Thickness, Weight
	Lines of Form	Edge Lines, Surface Lines
	Surface Qualities	Roughness, Stickiness, Greasiness, Softness, Elasticity, Tightness, Thermal, Conductivity
	Optical	Hue, Transparency, Glossiness
	Auditory	Pitch, Loudness
	Chemosensory	Bitterness
Evaluation	Tranquility	Comfortableness, Pleasantness, Seriousness, Steadiness, Amusingness, Healthiness, Hygiene, Freshness
	Purity	Simplicity, Difficulty, Decoratedness, Naturality, Relief, Density
	Impressiveness	Attractiveness, Grace, Aesthetics, Sincerity, Vividness, Popularity, Sociality
	Dynamism	Enthusiasm, Directionality, Activeness
Functionality	User Friendliness	Controllability, Portability, Ease of Use, Restrictiveness, Ease of Cleaning
	Suitability for Use	Ergonomy, Safety, Reliability, Appropriateness
	Performance	Functionality, Velocity, Usefulness, Necessity, Sufficiency
Perceived Value	Durableness	Quality, Sturdiness, Durability, Cleanness, Stainability
	Degree of Value	Value, Technology, Development Level, Modernity
	Sensitivity	Elaboratedness, Wholeness, Neatness
Familiarity	Identifiability	Newness, Accustomedness, Foreigness, Honesty, Differency, Compatibleness
	Specificness	Specialization, Gender,Maturity, Youthfulness, Sportiveness, Area of Usage
	Lucidness	Clarity, Protectiveness, Openness

L. Full List of Common Elicited Attitudes with Their Distributional Weights

Full list of common elicited attitudes for water bottles (F: Frequency, W: Weight of distribution among 30 participants)

Attitude	F	W	Attitude	F	W
durable-flimsy	27	90%	relieving-irritating	9	30%
transparent-opaque	25	83%	user friendly-difficult to use	9	30%
rough-smooth	21	70%	big-small	8	27%
cold-hot	21	70%	plain-ornate	8	27%
deep-treble	21	70%	controlled-uncontrolled	8	27%
heavy-light	20	67%	handy-impractical	8	27%
hard-soft	20	67%	unnecessary-necessary	8	27%
healthy-unhealthy	20	67%	distinct-ambiguous	8	27%
attractive-unattractive	20	67%	thin-thick	7	23%
elaborated-sloppy	20	67%	tight-loose	7	23%
cheap-expensive	19	63%	steady-unsteady	7	23%
high quality-poor quality	18	60%	sincere-insincere	7	23%
feminen-masculine	17	57%	fragmented-whole	7	23%
uneven-flat	16	53%	particular-standard	7	23%
simple-complex	16	53%	conductive-insulative	6	20%
flexible-solid	15	50%	amusing-boring	6	20%
easy-difficult	15	50%	coarse-gracious	6	20%
long lasting-short lived	15	50%	directional-directionless	6	20%
childish-mature	15	50%	easy to clean-hard to clean	6	20%
shiny-matte	14	47%	functional-functionless	6	20%
comfortable-uncomfortable	14	47%	outdoor-indoor	6	20%
natural-artificial	14	47%	tall-short	5	17%
safe-insecure	14	47%	rounded-sharp	5	17%
clean-dirty	14	47%	entertaining-serious	5	17%
accustomed-eccentrical	14	47%	cool-despised	5	17%
fresh-stale	13	43%	old-new	5	17%
non slippery-slippery	12	40%	dishonest-honest	5	17%
loud-silent	12	40%	sticky-non sticky	4	13%
hygienic-non hygienic	12	40%	dark-light	4	13%
excited-calm	12	40%	constrained-independent	4	13%
dynamic-inactive	12	40%	inappropriate-proper	4	13%
reliable-unreliable	12	40%	foreign-familiar	4	13%
wide-narrow	11	37%	hidden-open	4	13%
pleasurable-dissatisfactory	11	37%	dense-sparse	3	10%
beautiful-ugly	11	37%	adequate-inadequate	3	10%
portable-stable	11	37%	stainable-unstainable	3	10%
ergonomic-non ergonomic	11	37%	modern-classical	3	10%
discordant-coherent	11	37%	different-normal	3	10%
sportive-formal	11	37%	young-old	3	10%
protective-vulnerable	11	37%	asocial-social	2	7%
sweet-bitter	10	33%	fast-slow	2	7%
vivid-pale	10	33%	disorganized-neat	2	7%

M. The Full List of Thematic Comparison

Full list of thematic comparison between two experiments. Colors represent the type of categories (Green: Common categories with same attitudes, Blue: Common categories with different attitudes, Orange: Common categories with inadequate ratings, Grey: Significant product specific categories, Yellow: Non-significant categories)(F: Frequency of mentioning)

Experiment 1 (Computer Mouse)			Experiment 2 (Water Bottle)		
Category	**Attitude Pairs**	**F**	**Category**	**Attitude Pairs**	**F**
Aesthetics	beautiful-ugly	18	Aesthetics	beautiful-ugly	11
Ambiguousness	ambiguous-distinct	10	Ambiguousness	distinct-ambiguous	8
Appropriateness	inappropriate-proper	6	Appropriateness	inappropriate-proper	4
Attractiveness	attractive-unattractive	16	Attractiveness	attractive-unattractive	20
Cleanness	clean-dirty	10	Cleanness	clean-dirty	16
Comfort	comfortable-uncomfortable	21	Comfort	comfortable-uncomfortable	14
Compatibility	discordant-coherent	6	Compatibility	discordant-coherent	11
Controllability	controlled-uncontrolled	6	Controllability	controlled-uncontrolled	8
Decoratedness	plain-ornate	5	Decoratedness	plain-ornate	8
Difficulty	easy-difficult	11	Difficulty	easy-difficult	15
Directionality	directionless-directional	5	Directionality	directional-directionless	6
Durability	long lasting-short lived	6	Durability	long lasting-short lived	15
Ease of Cleaning	easy to clean-hard to clean	2	Ease of Cleaning	easy to clean-hard to clean	6
Ease of Use	user friendly-difficult to use	5	Ease of Use	user friendly-difficult to use	9
Edge Lines	rounded-sharp	13	Edge Lines	rounded-sharp	5
Eloboratedness	sloppy-elaborated	8	Eloboratedness	elaborated-sloppy	20
Ergonomy	ergonomic-non ergonomic	14	Ergonomy	ergonomic-non ergonomic	11
Functionality	functional-functionless	6	Functionality	functional-functionless	6
Gender	masculine-feminine	3	Gender	feminine-masculine	17
Glossiness	shiny-matte	21	Glossiness	shiny-matte	14
Grace	gracious-coarse	9	Grace	coarse-gracious	6
Greasiness	slippery-non slippery	14	Greasiness	non slippery-slippery	12
Healthiness	healthy-unhealthy	6	Healthiness	healthy-unhealthy	20
Height	high-low	14	Height	tall-short	5
Hue	dark-light	13	Hue	dark-light	4
Loudness	loud-silent	17	Loudness	loud-silent	12
Maturity	childish-mature	1	Maturity	childish-mature	15
Modernity	classical-modern	11	Modernity	modern-classical	3
Necessity	unnecessary-necessary	5	Necessity	unnecessary-necessary	8
Newness	old-new	28	Newness	old-new	5
Openness	hidden-open	5	Openness	hidden-open	4
Pitch	deep-treble	15	Pitch	deep-treble	21
Portability	portable-stable	4	Portability	portable-stable	12
Quality	high quality-poor quality	14	Quality	high quality-poor quality	18
Restrictiveness	independent-constrained	5	Restrictiveness	constrained-independent	4
Roughness	smooth-rough	25	Roughness	rough-smooth	21
Seriousity	entertaining-serious	8	Seriousity	entertaining-serious	5
Simplicity	simple-complex	15	Simplicity	simple-complex	16
Sincerity	insincere-sincere	2	Sincerity	sincere-insincere	7
Size	big-small	29	Size	big-small	8
Softness	soft-hard	18	Softness	hard-soft	20
Specialization	particular-standard	6	Specialization	particular-standard	7
Stickiness	non sticky-sticky	5	Stickiness	sticky-non sticky	4
Sturdiness	durable-flimsy	11	Sturdiness	durable-flimsy	27
Sufficiency	inadequate-adequate	4	Sufficiency	adequate-inadequate	3

Experiment 1 (Computer Mouse)			Experiment 2 (Water Bottle)		
Category	**Attitude Pairs**	**F**	**Category**	**Attitude Pairs**	**F**
Technology	technological-outdated	12	Technology	technological-outdated	1
Thermal	cold-hot	9	Thermal	cold-hot	21
Thickness	thick-thin	9	Thickness	thin-thick	7
Transparency	transparent-opaque	7	Transparency	transparent-opaque	25
Usefulness	handy-impractical	8	Usefulness	handy-impractical	8
Value	expensive-cheap	10	Value	cheap-expensive	19
Velocity	fast-slow	8	Velocity	fast-slow	2
Vividness	pale-vivid	3	Vividness	vivid-pale	10
Weight	heavy-light	23	Weight	heavy-light	20
Wholeness	whole-fragmented	10	Wholeness	fragmented-whole	7
Agility	dynamic-bulky	7	Activeness	dynamic-inactive	12
Safety	reassuring-insecure	7	Safety	safe-insecure	14
Surface Lines	curved-flat	17	Surface Lines	uneven-flat	16
Development Level	advanced-primitive	3	Development Level	advanced-primitive	1
Youthfulness	young-old	1	Youthfulness	young-old	3
Fluidity	fluid-stable	13	Elasticity	flexible-solid	15
Glitteriness	non glittery-glittery	12	Naturality	natural-artificial	14
Length	long-short	9	Freshness	fresh-stale	13
Discrepancy	extraordinary-common	8	Enthusiasm	excited-calm	12
Corner Lines	obtuse-pointed	7	Hygiene	hygienic-non hygienic	12
Goodness	good-bad	6	Reliability	reliable-unreliable	12
Raspiness	raspy-tuneful	6	Pleasantness	pleasurable-dissatisfactory	11
Smelliness	smelt-inodorous	6	Protectiveness	protective-vulnerable	11
Problemacy	problematic-unproblematic	5	Sportiveness	sportive-formal	11
Sound Clarity	clear-blurry	5	Width	wide-narrow	11
Symmetry	symmetric-asymmetric	5	Bitterness	sweet-bitter	10
Coziness	loose-strict	4	Relief	relieving-irritating	9
Desirability	unwanted-wanted	4	Tightness	tight-loose	7
Professionalism	professional-amateur	3	Steadiness	steady-unsteady	7
Quality of Smell	balmy-stinky	3	Amusingness	amusing-boring	6
Glassiness	glassy-plastic like	2	Area of Usage	outdoor-indoor	6
Organicness	organic-mechanic	2	Conductivity	conductive-insulative	6
	aerodynamic-not aerodyn.	1	Honesty	dishonest-honest	5
	unattainable-attainable	1	Popularity	cool-despised	5
	classy-low class	1	Foreignness	foreign-familiar	4
	confident-unsure	1	Density	dense-sparse	3
	fixable-non fixable	1	Differency	different-normal	3
	metallic-plastic like	1	Stainability	stainable-unstainable	3
	mechanic-aromatic	1	Neatness	disorganised-neat	2
	reflective-opaque	1	Sociality	asocial-social	2
	strange-nostalgic	1		childish-sportive	1
	atonic-tonic	1		bright-dim	1
				brave-classic	1
				cute-hateful	1
				exciting-boring	1
				decent-fake	1
				hairy-non hairy	1
				unimportant-important	1
				intense-odourless	1
				artificial-odourless	1
				organic-raw	1
				politic-impolitic	1
				sportive-elegant	1
				mechanical-analog	1
				innocent-guilty	1
				sweet-dominant	1
				prejudiced-open minded	1
				current-outdated	1
				ugly-silent	1
				stainless-solvable	1
				medical-daily	1
				unsavory-vigorous	1
				flamboyant-functional	1
				familiar-industrial	1

N. PCA Results of Four and Five Components Extraction

PCA five components extraction with varimax rotation. Cross-loaded items were written in bold.

Rotated Component Matrix

	Component				
	1	2	3	4	5
hidden-open	0,961				
simple-complex	0,961				
discordant-coherent	-0,960				
plain-ornate	0,932				
deep-treble	-0,901				
whole-fragmented	0,855				
clean-dirty	0,831				
smelt-inodorous	-0,823				
smooth-rough	0,796				
healthy-unhealthy	0,785				
soft-hard	-0,775				
symmetric-asymmetric	0,772				
non sticky-sticky	0,769				
cold-hot	0,736				
durable-flimsy	0,707				
high quality-poor quality	0,702				
good-bad	**0,686**		**0,591**		
slippery-non slippery	**0,627**				**0,603**
long lasting-short lived	0,624				
expensive-cheap	**0,587**	**0,568**			
obtuse-pointed	**-0,583**		**0,560**		
fast-slow		0,961			
big-small		-0,952			
heavy-light		-0,929			
dynamic-bulky		0,919			
reassuring-insecure		0,915			
thick-thin		-0,871			
gracious-coarse		0,864			
long-short		-0,850			
fluid-stable		0,814			
technological-outdated		0,753			
inappropriate-proper		-0,750			
old-new		0,749			
classical-modern		0,729			
transparent-opaque		**0,709**		**0,663**	
particular-standard		**0,703**		**0,699**	
high-low		-0,651			
loud-silent		**-0,647**	**-0,571**		
attractive-unattractive		0,646			
entertaining-serious	**-0,542**	**0,638**			
ergonomic-non ergonomic			0,946		
handy-impractical			0,944		
problematic-unproblematic			-0,922		
controlled-uncontrolled			0,869		
independent-constrained			0,853		
user friendly-difficult to use			0,770		
unnecessary-necessary			-0,769		
raspy-tuneful			-0,766		
functional-functionless			0,743		
easy-difficult			0,735		
comfortable-uncomfortable			0,732		
curved-flat			**0,651**	**-0,640**	
sloppy-elaborated			-0,649		
beautiful-ugly		**0,555**	**0,632**		
ambiguous-distinct				0,890	
extraordinary-common				0,792	
clear-blurry				0,786	
eccentrical-accustomed				0,771	
directionless-directional				0,709	
dark-light				-0,674	
rounded-sharp				-0,653	
non silvery-silvery					-0,948
shiny-matte					0,681

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

PCA Results of Four and Five Components Extraction (Continued)

PCA four components extraction with cluster rotation. Cross-loaded items were written in bold.

Loadings:				
	RC1	RC2	RC3	RC4
plain - ornate	1.03			
hidden - open	1.01			
discordant - coherent	-0.97			
simple - complex	0.93			
symmetric - asymmetric	0.90			
healthy - unhealthy	0.89			
smelt - inodorous	-0.88			
deep - treble	-0.87			
clean - dirty	0.87			
unnecessary - necessary	-0.86			
smooth - rough	0.85			
whole - fragmented	0.85			
good - bad	0.85			
non sticky - sticky	0.83			
high quality - poor quality	0.82			
cold - hot	0.79			
soft - hard	-0.78			
durable - flimsy	0.74			
slippery - non slippery	0.73			
sloppy - elaborated	-0.68			
easy - difficult	0.68			
independent - constrained	**0.65**		**0.60**	
expensive - cheap	**0.64**	**0.56**		
beautiful - ugly	0.62			
shiny - matte	0.54			
long lasting - short lived	**0.50**	**0.54**		
thick - thin		-1.01		
big - small		-0.98		
heavy - light		-0.96		
gracious - coarse		0.96		
transparent - opaque		0.95		
dynamic - bulky		0.95		
fast - slow		0.94		
particular - standard		0.93		
reassuring - insecure		0.91		
high - low		-0.79		
long - short		-0.79		
loud - silent		-0.76		
entertaining - serious		0.75		
eccentrical - accustomed		0.74		
technological - outdated		0.72		
classical - modern		-0.68		
old - new		-0.67		
fluid - stable		0.67		
attractive - unattractive		0.66		
inappropriate - proper		**-0.58**	**-0.59**	
raspy - tuneful		-0.55		
user friendly - difficult to use			0.99	
curved - flat			0.98	
rounded - sharp			0.90	
extraordinary - common			-0.88	
controlled - uncontrolled			0.88	
functional - functionless			0.84	
handy - impractical			0.79	
ergonomic - non ergonomic			0.78	
ambiguous - distinct			-0.76	
dark - light			0.75	
problematic - unproblematic			-0.74	
obtuse - pointed			0.74	
comfortable - uncomfortable			0.70	
directional - directionless			-0.67	
clear - blurry				0.74
non glittery - glittery				-0.73

Number of components extracted: 4 / Type of rotation: cluster

O. Full List of One Sample *t*-Test Results of the Computer Mouses in Component 1

Full list of one sample *t*-test results of M1

One-Sample Test							
Test Value =2.69						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
plain-ornate	-0,667	4	0,541	2,2000	-0,49000	-2,5303	1,5503
hidden-open	-1,113	4	0,328	1,8000	-0,89000	-3,1112	1,3312
discordant-coherent	**11,930**	**5**	**0,000**	**6,6667**	3,97667	3,1198	4,8335
simple-complex	**-3,848**	**14**	**0,002**	**1,4000**	-1,29000	-2,0090	-0,5710
symmetric-asymmetric	**a**	**4**	**0,000**	**1,0000**	0,00000	0,00000	0,00000
deep-treble	**4,322**	**14**	**0,001**	**5,0000**	2,31000	1,1636	3,4564
smelt-inodorous	**3,310**	**5**	**0,021**	**6,0000**	3,31000	0,7394	5,8806
healthy-unhealthy	**-3,484**	**5**	**0,018**	**1,5000**	-1,19000	-2,0680	-0,3120
clean-dirty	**a**	**9**	**0,000**	**1,0000**	0,00000	0,00000	0,00000
non sticky-sticky	**a**	**4**	**0,000**	**1,0000**	0,00000	0,00000	0,00000
smooth-rough	**-41,250**	**24**	**0,000**	**1,0400**	-1,65000	-1,7326	-1,5674
whole-fragmented	**-15,900**	**9**	**0,000**	**1,1000**	-1,59000	-1,8162	-1,3638
unnecessary-necessary	**2,871**	**4**	**0,045**	**4,8000**	2,11000	0,0697	4,1503
good-bad	**-5,322**	**5**	**0,003**	**1,5000**	-1,19000	-1,7648	-0,6152
soft-hard	**5,143**	**17**	**0,000**	**5,3889**	2,69889	1,5917	3,8061
cold-hot	**-9,986**	**8**	**0,000**	**1,2222**	-1,46778	-1,8067	-1,1288
high quality-poor quality	**-22,660**	**13**	**0,000**	**1,0714**	-1,61857	-1,7729	-1,4643
slippery-non slippery	-1,047	13	0,314	2,1429	-0,54714	-1,6762	0,5820
durable-flimsy	0,063	10	0,951	2,7273	0,03727	-1,2755	1,3500
sloppy-elaborated	**21,505**	**7**	**0,000**	**6,6250**	3,93500	3,5023	4,3677
shiny-matte	**-6,938**	**20**	**0,000**	**1,3810**	-1,30905	-1,7026	-0,9155

a. *t* cannot be computed because the standard deviation is 0.

Full list of one sample *t*-test results of M2

One-Sample Test							
Test Value = 4.62						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
plain-ornate	**3,086**	**4**	**0,037**	**6,0000**	1,38000	0,1383	2,6217
hidden-open	**3,225**	**4**	**0,032**	**6,2000**	1,58000	0,2198	2,9402
discordant-coherent	**-6,943**	**5**	**0,001**	**1,8333**	-2,78667	-3,8185	-1,7549
simple-complex	**8,127**	**14**	**0,000**	**6,3333**	1,71333	1,2612	2,1655
symmetric-asymmetric	-0,566	4	0,602	4,0000	-0,62000	-3,6614	2,4214
deep-treble	**-3,509**	**14**	**0,003**	**2,6000**	-2,02000	-3,2548	-0,7852
smelt-inodorous	**-3,720**	**5**	**0,014**	**2,3333**	-2,28667	-3,8666	-0,7067
healthy-unhealthy	0,846	5	0,436	5,3333	0,71333	-1,4544	2,8810
clean-dirty	**7,871**	**9**	**0,000**	**6,3000**	1,68000	1,1972	2,1628
non sticky-sticky	0,840	4	0,448	5,6000	0,98000	-2,2579	4,2179
smooth-rough	1,974	24	0,060	5,3200	0,70000	-0,0318	1,4318
whole-fragmented	**5,437**	**9**	**0,000**	**6,2000**	1,58000	0,9226	2,2374
unnecessary-necessary	**-6,468**	**4**	**0,003**	**2,2000**	-2,42000	-3,4589	-1,3811
good-bad	0,627	5	0,558	5,1667	0,54667	-1,6960	2,7893
soft-hard	**-7,860**	**17**	**0,000**	**2,0000**	-2,62000	-3,3233	-1,9167
cold-hot	1,009	8	0,343	5,3333	0,71333	-0,9173	2,3439
high quality-poor quality	**2,864**	**13**	**0,013**	**5,6429**	1,02286	0,2513	1,7944
slippery-non slippery	**2,849**	**13**	**0,014**	**5,7143**	1,09429	0,2644	1,9242
durable-flimsy	-0,810	10	0,437	4,0909	-0,52909	-1,9841	0,9259
sloppy-elaborated	-1,440	7	0,193	3,3750	-1,24500	-3,2898	0,7998
shiny-matte	**2,207**	**20**	**0,039**	**5,4762**	0,85619	0,0468	1,6656

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 1 (Continued)

Full list of one sample *t*-test results of M3

One-Sample Test							
Test Value = 3.87						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
plain-ornate	-0,403	4	0,708	3,4000	-0,47000	-3,7079	2,7679
hidden-open	1,077	4	0,342	5,0000	1,13000	-1,7820	4,0420
discordant-coherent	-1,427	5	0,213	2,6667	-1,20333	-3,3710	0,9644
simple-complex	**2,487**	**14**	**0,026**	**4,8667**	0,99667	0,1371	1,8563
symmetric-asymmetric	**a**	**4**	**0,000**	**1,0000**	0,000	0,000	0,000
deep-treble	-1,359	14	0,196	3,1333	-0,73667	-1,8995	0,4262
smelt-inodorous	-0,991	5	0,367	2,8333	-1,03667	-3,7259	1,6526
healthy-unhealthy	1,731	5	0,144	5,1667	1,29667	-0,6289	3,2222
clean-dirty	**2,825**	**9**	**0,020**	**5,4000**	1,53000	0,3048	2,7552
non sticky-sticky	-1,563	4	0,193	2,6000	-1,27000	-3,5256	0,9856
smooth-rough	1,175	24	0,251	4,2800	0,41000	-0,3101	1,1301
whole-fragmented	**5,304**	**9**	**0,000**	**5,5000**	1,63000	0,9348	2,3252
unnecessary-necessary	-0,838	4	0,449	3,2000	-0,67000	-2,8912	1,5512
good-bad	0,549	5	0,606	4,3333	0,46333	-1,7044	2,6310
soft-hard	**3,656**	**17**	**0,002**	**5,1667**	1,29667	0,5483	2,0450
cold-hot	-1,740	8	0,120	2,8889	-0,98111	-2,2813	0,3191
high quality-poor quality	**3,835**	**13**	**0,002**	**5,2143**	1,34429	0,5871	2,1015
slippery-non slippery	-0,028	13	0,978	3,8571	-0,01286	-0,9963	0,9706
durable-flimsy	0,313	10	0,761	4,0909	0,22091	-1,3533	1,7951
sloppy-elaborated	-1,329	7	0,226	3,0000	-0,87000	-2,4180	0,6780
shiny-matte	-0,297	20	0,770	3,7619	-0,10810	-0,8685	0,6523

a. *t* cannot be computed because the standard deviation is 0.

Full list of one sample *t*-test results of M4

One-Sample Test							
Test Value = 3.85						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
plain-ornate	-1,583	4	0,189	2,8000	-1,05000	-2,8917	0,7917
hidden-open	-0,308	4	0,774	3,6000	-0,25000	-2,5056	2,0056
discordant-coherent	2,426	5	0,060	5,1667	1,31667	-0,0782	2,7115
simple-complex	-1,019	14	0,326	3,4667	-0,38333	-1,1904	0,4237
symmetric-asymmetric	**-6,125**	**4**	**0,004**	**1,4000**	-2,45000	-3,5606	-1,3394
deep-treble	1,086	14	0,296	4,4667	0,61667	-0,6014	1,8347
smelt-inodorous	0,348	5	0,742	4,1667	0,31667	-2,0221	2,6554
healthy-unhealthy	-1,874	5	0,120	2,8333	-1,01667	-2,4115	0,3782
clean-dirty	-0,129	9	0,900	3,8000	-0,05000	-0,9294	0,8294
non sticky-sticky	0,132	4	0,902	4,0000	0,15000	-3,0156	3,3156
smooth-rough	-1,447	24	0,161	3,4000	-0,45000	-1,0917	0,1917
whole-fragmented	0,750	9	0,472	4,2000	0,35000	-0,7057	1,4057
unnecessary-necessary	1,939	4	0,124	4,8000	0,95000	-0,4102	2,3102
good-bad	**-4,550**	**5**	**0,006**	**2,3333**	-1,51667	-2,3735	-0,6598
soft-hard	**2,381**	**17**	**0,029**	**4,6667**	0,81667	0,0930	1,5403
cold-hot	0,271	8	0,793	4,0000	0,15000	-1,1247	1,4247
high quality-poor quality	**-4,723**	**13**	**0,000**	**2,9286**	-0,92143	-1,3429	-0,4999
slippery-non slippery	1,266	13	0,228	4,3571	0,50714	-0,3584	1,3727
durable-flimsy	0,115	10	0,911	3,9091	0,05909	-1,0832	1,2013
sloppy-elaborated	**5,797**	**7**	**0,001**	**5,3750**	1,52500	0,9030	2,1470
shiny-matte	**4,389**	**20**	**0,000**	**5,0952**	1,24524	0,6534	1,8371

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 1 (Continued)

Full list of one sample *t*-test results of M5

One-Sample Test							
Test Value = 3.24						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
plain-ornate	-0,229	4	0,830	3,0000	-0,24000	-3,1520	2,6720
hidden-open	-0,253	4	0,813	3,0000	-0,24000	-2,8740	2,3940
discordant-coherent	**3,753**	**5**	**0,013**	**5,3333**	2,09333	0,6595	3,5271
simple-complex	1,665	14	0,118	3,8667	0,62667	-0,1804	1,4337
symmetric-asymmetric	**a**	**4**	**0,000**	**1,0000**	0,00000	0,0000	0,0000
deep-treble	**2,901**	**14**	**0,012**	**4,5333**	1,29333	0,3372	2,2495
smelt-inodorous	0,393	5	0,710	3,6667	0,42667	-2,3631	3,2164
healthy-unhealthy	**-4,577**	**5**	**0,006**	**1,8333**	-1,40667	-2,1967	-0,6167
clean-dirty	-0,068	9	0,948	3,2000	-0,04000	-1,3804	1,3004
non sticky-sticky	-1,122	4	0,324	2,4000	-0,84000	-2,9177	1,2377
smooth-rough	**-4,746**	**24**	**0,000**	**2,0800**	-1,16000	-1,6644	-0,6556
whole-fragmented	**2,900**	**9**	**0,018**	**4,4000**	1,16000	0,2551	2,0649
unnecessary-necessary	2,667	4	0,056	4,6000	1,36000	-0,0557	2,7757
good-bad	**-2,674**	**5**	**0,044**	**2,1667**	-1,07333	-2,1051	-0,0415
soft-hard	**2,909**	**17**	**0,010**	**4,4444**	1,20444	0,3310	2,0779
cold-hot	-0,252	8	0,808	3,1111	-0,12889	-1,3100	1,0522
high quality-poor quality	**-4,698**	**13**	**0,000**	**2,4286**	-0,81143	-1,1845	-0,4383
slippery-non slippery	-0,948	13	0,361	2,8571	-0,38286	-1,2558	0,4901
durable-flimsy	0,382	10	0,711	3,4545	0,21455	-1,0374	1,4665
sloppy-elaborated	**5,377**	**7**	**0,001**	**5,0000**	1,76000	0,9860	2,5340
shiny-matte	**-10,840**	**20**	**0,000**	**1,7619**	-1,47810	-1,7625	-1,1937

a. *t* cannot be computed because the standard deviation is 0.

Full list of one sample *t*-test results of M6

One-Sample Test							
Test Value = 3.69						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
plain-ornate	-1,817	4	0,143	2,8000	-0,89000	-2,2502	0,4702
hidden-open	-0,111	4	0,917	3,6000	-0,09000	-2,3456	2,1656
discordant-coherent	**3,094**	**5**	**0,027**	**5,1667**	1,47667	0,2498	2,7035
simple-complex	-0,403	14	0,693	3,5333	-0,15667	-0,9904	0,6771
symmetric-asymmetric	**-5,725**	**4**	**0,005**	**1,4000**	-2,29000	-3,4006	-1,1794
deep-treble	0,981	14	0,343	4,0667	0,37667	-0,4465	1,1998
smelt-inodorous	1,662	5	0,157	5,3333	1,64333	-0,8985	4,1852
healthy-unhealthy	**-2,672**	**5**	**0,044**	**3,0000**	-0,69000	-1,3537	-0,0263
clean-dirty	-0,609	9	0,558	3,4000	-0,29000	-1,3670	0,7870
non sticky-sticky	-0,771	4	0,483	3,0000	-0,69000	-3,1733	1,7933
smooth-rough	-0,035	24	0,972	3,6800	-0,01000	-0,6025	0,5825
whole-fragmented	0,485	9	0,640	3,9000	0,21000	-0,7703	1,1903
unnecessary-necessary	1,775	4	0,151	4,4000	0,71000	-0,4006	1,8206
good-bad	**-4,070**	**5**	**0,010**	**2,3333**	-1,35667	-2,2135	-0,4998
soft-hard	1,926	17	0,071	4,3889	0,69889	-0,0666	1,4643
cold-hot	-1,168	8	0,277	3,2222	-0,46778	-1,3916	0,4560
high quality-poor quality	**-2,368**	**13**	**0,034**	**3,1429**	-0,54714	-1,0463	-0,0480
slippery-non slippery	0,579	13	0,573	3,9286	0,23857	-0,6520	1,1291
durable-flimsy	-0,395	10	0,701	3,5455	-0,14455	-0,9598	0,6707
sloppy-elaborated	**4,978**	**7**	**0,002**	**5,2500**	1,56000	0,8189	2,3011
shiny-matte	**2,714**	**20**	**0,013**	**4,4762**	0,78619	0,1820	1,3904

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 1 (Continued)

Full list of one sample *t*-test results of M7

One-Sample Test

Test Value = 4.06	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
plain-ornate	-1,100	4	0,333	3,4000	-0,66000	-2,3259	1,0059
hidden-open	-0,060	4	0,955	4,0000	-0,06000	-2,8364	2,7164
discordant-coherent	2,102	5	0,090	5,0000	0,94000	-0,2096	2,0896
simple-complex	-0,707	14	0,491	3,8000	-0,26000	-1,0487	0,5287
symmetric-asymmetric	**a**	**4**	**0,000**	**1,0000**	0,00000	0,0000	0,0000
deep-treble	**-2,873**	**14**	**0,012**	**2,8000**	-1,26000	-2,2007	-0,3193
smelt-inodorous	0,576	5	0,590	4,5000	0,44000	-1,5233	2,4033
healthy-unhealthy	-0,260	5	0,805	3,8333	-0,22667	-2,4693	2,0160
clean-dirty	**2,932**	**9**	**0,017**	**5,3000**	1,24000	0,2832	2,1968
non sticky-sticky	-0,368	4	0,731	3,6000	-0,46000	-3,9278	3,0078
smooth-rough	0,410	24	0,686	4,2000	0,14000	-0,5650	0,8450
whole-fragmented	0,655	9	0,529	4,3000	0,24000	-0,5895	1,0695
unnecessary-necessary	0,367	4	0,732	4,4000	0,34000	-2,2348	2,9148
good-bad	-0,303	5	0,774	3,8333	-0,22667	-2,1522	1,6989
soft-hard	1,242	17	0,231	4,6111	0,55111	-0,3853	1,4875
cold-hot	-0,631	8	0,546	3,6667	-0,39333	-1,8314	1,0447
high quality-poor quality	1,027	13	0,323	4,4286	0,36857	-0,4065	1,1437
slippery-non slippery	**3,135**	**13**	**0,008**	**5,1429**	1,08286	0,3366	1,8291
durable-flimsy	-0,789	10	0,448	3,5455	-0,51455	-1,9668	0,9377
sloppy-elaborated	0,558	7	0,595	4,3750	0,31500	-1,0210	1,6510
shiny-matte	**5,938**	**20**	**0,000**	**5,6190**	1,55905	1,0114	2,1067

a. *t* cannot be computed because the standard deviation is 0.

Full list of one sample *t*-test results of M8

One-Sample Test

Test Value = 4.14	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
plain-ornate	-1,026	4	0,363	3,2000	-0,94000	-3,4847	1,6047
hidden-open	-0,274	4	0,798	3,8000	-0,34000	-3,7855	3,1055
discordant-coherent	2,484	5	0,056	5,6667	1,52667	-0,0533	3,1066
simple-complex	**-2,980**	**14**	**0,010**	**2,6667**	-1,47333	-2,5337	-0,4129
symmetric-asymmetric	**a**	**4**	**0,000**	**1,0000**	0,00000	0,0000	0,0000
deep-treble	0,084	14	0,935	4,2000	0,06000	-1,4810	1,6010
smelt-inodorous	-0,313	5	0,767	3,8333	-0,30667	-2,8268	2,2134
healthy-unhealthy	0,737	5	0,494	4,6667	0,52667	-1,3111	2,3644
clean-dirty	2,164	9	0,059	5,2000	1,06000	-0,0482	2,1682
non sticky-sticky	-0,574	4	0,596	3,4000	-0,74000	-4,3172	2,8372
smooth-rough	0,551	24	0,587	4,3600	0,22000	-0,6045	1,0445
whole-fragmented	0,537	9	0,605	4,5000	0,36000	-1,1575	1,8775
unnecessary-necessary	**-3,327**	**4**	**0,029**	**2,2000**	-1,94000	-3,5589	-0,3211
good-bad	1,299	5	0,251	5,3333	1,19333	-1,1689	3,5555
soft-hard	**8,773**	**17**	**0,000**	**5,9444**	1,80444	1,3705	2,2384
cold-hot	-0,311	8	0,764	3,8889	-0,25111	-2,1120	1,6098
high quality-poor quality	**4,486**	**13**	**0,001**	**5,9286**	1,78857	0,9273	2,6499
slippery-non slippery	**2,919**	**13**	**0,012**	**5,5000**	1,36000	0,3536	2,3664
durable-flimsy	-0,316	10	0,759	3,9091	-0,23091	-1,8615	1,3997
sloppy-elaborated	**-3,414**	**7**	**0,011**	**2,0000**	-2,14000	-3,6221	-0,6579
shiny-matte	**6,122**	**20**	**0,000**	**5,8095**	1,66952	1,1006	2,2384

a. *t* cannot be computed because the standard deviation is 0.

P. Full List of One Sample *t*-Test Results of the Computer Mouses in Component 2

Full list of one sample *t*-test results of M1

One-Sample Test							
Test Value = 4.35						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
ambiguous-distinct	-0,665	9	0,523	3,8000	-0,55000	-2,4215	1,3215
comfortable-uncomfortable	-2,065	20	0,052	3,5238	-0,82619	-1,6608	0,0084
controlled-uncontrolled	-0,181	5	0,864	4,1667	-0,18333	-2,7894	2,4227
curved-flat	**5,645**	**16**	**0,000**	**6,1765**	1,82647	1,1406	2,5123
dark-light	**a**	**12**	**0,000**	**7,0000**	0,00000	0,0000	0,0000
directionless-directional	**-7,375**	**4**	**0,002**	**1,4000**	-2,95000	-4,0606	-1,8394
ergonomic-non ergonomic	-0,481	13	0,638	4,0714	-0,27857	-1,5286	0,9714
extraordinary-common	**-2,997**	**7**	**0,020**	**2,1250**	-2,22500	-3,9808	-0,4692
functional-functionless	1,506	5	0,192	5,5000	1,15000	-0,8133	3,1133
handy-impractical	-0,733	7	0,487	3,7500	-0,60000	-2,5350	1,3350
obtuse-pointed	1,544	6	0,174	5,2857	0,93571	-0,5473	2,4188
problematic-unproblematic	0,062	4	0,954	4,4000	0,05000	-2,2056	2,3056
rounded-sharp	**2,182**	**12**	**0,050**	**5,3846**	1,03462	0,0015	2,0678
user friendly-difficult to use	0,040	4	0,970	4,4000	0,05000	-3,4178	3,5178

a. *t* cannot be computed because the standard deviation is 0.

Full list of one sample *t*-test results of M2

One-Sample Test							
Test Value = 3.62						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
ambiguous-distinct	2,195	9	0,056	5,1000	1,48000	-0,0450	3,0050
comfortable-uncomfortable	2,022	20	0,057	4,4286	0,80857	-0,0255	1,6426
controlled-uncontrolled	-0,325	5	0,758	3,3333	-0,28667	-2,5537	1,9804
curved-flat	-0,911	16	0,376	3,1765	-0,44353	-1,4756	0,5885
dark-light	**-7,337**	**12**	**0,000**	**1,6923**	-1,92769	-2,5002	-1,3552
directionless-directional	**15,900**	**4**	**0,000**	**6,8000**	3,18000	2,6247	3,7353
ergonomic-non ergonomic	2,125	13	0,053	4,8571	1,23714	-0,0209	2,4952
extraordinary-common	1,245	7	0,253	4,5000	0,88000	-0,7920	2,5520
functional-functionless	-1,050	5	0,342	2,8333	-0,78667	-2,7122	1,1389
handy-impractical	0,993	7	0,354	4,5000	0,88000	-1,2160	2,9760
obtuse-pointed	**-5,184**	**6**	**0,002**	**1,8571**	-1,76286	-2,5950	-0,9307
problematic-unproblematic	-1,256	4	0,278	2,6000	-1,02000	-3,2756	1,2356
rounded-sharp	**-6,020**	**12**	**0,000**	**2,2308**	-1,38923	-1,8920	-0,8864
user friendly-difficult to use	-0,171	4	0,873	3,4000	-0,22000	-3,7972	3,3572

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 2 (Continued)

Full list of one sample *t*-test results of M3

One-Sample Test							
Test Value = 4.33						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
ambiguous-distinct	0,598	9	0,565	4,8000	0,47000	-1,3080	2,2480
comfortable-uncomfortable	0,733	20	0,472	4,6667	0,33667	-0,6218	1,2951
controlled-uncontrolled	-0,196	5	0,852	4,1667	-0,16333	-2,3055	1,9788
curved-flat	-1,193	16	0,250	3,7647	-0,56529	-1,5697	0,4391
dark-light	-1,767	12	0,103	3,8462	-0,48385	-1,0803	0,1127
directionless-directional	**12,350**	**4**	**0,000**	**6,8000**	2,47000	1,9147	3,0253
ergonomic-non ergonomic	-1,715	13	0,110	3,6429	-0,68714	-1,5527	0,1784
extraordinary-common	**2,406**	**7**	**0,047**	**5,7500**	1,42000	0,0246	2,8154
functional-functionless	-0,639	5	0,551	4,0000	-0,33000	-1,6574	0,9974
handy-impractical	0,300	7	0,773	4,5000	0,17000	-1,1706	1,5106
obtuse-pointed	0,395	6	0,707	4,5714	0,24143	-1,2553	1,7382
problematic-unproblematic	-0,496	4	0,646	3,8000	-0,53000	-3,4944	2,4344
rounded-sharp	-1,944	12	0,076	3,6154	-0,71462	-1,5155	0,0863
user friendly-difficult to use	-0,903	4	0,417	3,4000	-0,93000	-3,7885	1,9285

Full list of one sample *t*-test results of M4

One-Sample Test							
Test Value = 3.67						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
ambiguous-distinct	**2,648**	**9**	**0,027**	**5,3000**	1,63000	0,2376	3,0224
comfortable-uncomfortable	**-2,974**	**20**	**0,008**	**2,9048**	-0,76524	-1,3020	-0,2285
controlled-uncontrolled	-1,498	5	0,194	3,0000	-0,67000	-1,8196	0,4796
curved-flat	**-2,330**	**16**	**0,033**	**2,7647**	-0,90529	-1,7289	-0,0817
dark-light	**-7,711**	**12**	**0,000**	**1,6154**	-2,05462	-2,6352	-1,4740
directionless-directional	**11,962**	**4**	**0,000**	**6,6000**	2,93000	2,2499	3,6101
ergonomic-non ergonomic	-0,101	13	0,921	3,6429	-0,02714	-0,6093	0,5550
extraordinary-common	**6,036**	**7**	**0,001**	**5,6250**	1,95500	1,1891	2,7209
functional-functionless	-0,010	5	0,992	3,6667	-0,00333	-0,8602	0,8535
handy-impractical	-1,555	7	0,164	3,1250	-0,54500	-1,3735	0,2835
obtuse-pointed	-1,535	6	0,176	3,0000	-0,67000	-1,7379	0,3979
problematic-unproblematic	**3,393**	**4**	**0,027**	**5,4000**	1,73000	0,3143	3,1457
rounded-sharp	**-6,035**	**12**	**0,000**	**2,3846**	-1,28538	-1,7495	-0,8213
user friendly-difficult to use	**-3,929**	**4**	**0,017**	**2,2000**	-1,47000	-2,5089	-0,4311

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 2 (Continued)

Full list of one sample *t*-test results of M5

One-Sample Test

Test Value = 3.61	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
ambiguous-distinct	**3,187**	**9**	**0,011**	**5,4000**	1,79000	0,5192	3,0608
comfortable-uncomfortable	**-2,989**	**20**	**0,007**	**2,7619**	-0,84810	-1,4399	-0,2563
controlled-uncontrolled	-1,671	5	0,156	3,0000	-0,61000	-1,5486	0,3286
curved-flat	**-6,199**	**16**	**0,000**	**2,1176**	-1,49235	-2,0027	-0,9820
dark-light	**-5,454**	**12**	**0,000**	**1,9231**	-1,68692	-2,3608	-1,0130
directionless-directional	**12,207**	**4**	**0,000**	**6,6000**	2,99000	2,3099	3,6701
ergonomic-non ergonomic	-1,328	13	0,207	3,2857	-0,32429	-0,8519	0,2034
extraordinary-common	**5,774**	**7**	**0,001**	**5,5000**	1,89000	1,1160	2,6640
functional-functionless	-0,830	5	0,444	3,3333	-0,27667	-1,1335	0,5802
handy-impractical	-1,384	7	0,209	3,1250	-0,48500	-1,3135	0,3435
obtuse-pointed	-0,771	6	0,470	3,2857	-0,32429	-1,3534	0,7048
problematic-unproblematic	**4,475**	**4**	**0,011**	**5,4000**	1,79000	0,6794	2,9006
rounded-sharp	**-5,080**	**12**	**0,000**	**2,3846**	-1,22538	-1,7510	-0,6998
user friendly-difficult to use	**-3,600**	**4**	**0,023**	**2,0000**	-1,61000	-2,8517	-0,3683

Full list of one sample *t*-test results of M6

One-Sample Test

Test Value = 3.58	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
ambiguous-distinct	**3,015**	**9**	**0,015**	**5,5000**	1,92000	0,4794	3,3606
comfortable-uncomfortable	**-2,390**	**20**	**0,027**	**2,9524**	-0,62762	-1,1753	-0,0799
controlled-uncontrolled	-0,370	5	0,727	3,3333	-0,24667	-1,9604	1,4671
curved-flat	**-4,430**	**16**	**0,000**	**2,2353**	-1,34471	-1,9882	-0,7013
dark-light	**-3,882**	**12**	**0,002**	**2,5385**	-1,04154	-1,6261	-0,4569
directionless-directional	**12,329**	**4**	**0,000**	**6,6000**	3,02000	2,3399	3,7001
ergonomic-non ergonomic	-0,258	13	0,800	3,5000	-0,08000	-0,7499	0,5899
extraordinary-common	**6,314**	**7**	**0,000**	**5,6250**	2,04500	1,2791	2,8109
functional-functionless	-0,234	5	0,824	3,5000	-0,08000	-0,9580	0,7980
handy-impractical	-1,600	7	0,154	2,8750	-0,70500	-1,7470	0,3370
obtuse-pointed	-2,353	6	0,057	2,5714	-1,00857	-2,0572	0,0401
problematic-unproblematic	**3,261**	**4**	**0,031**	**4,8000**	1,22000	0,1811	2,2589
rounded-sharp	**-8,056**	**12**	**0,000**	**2,0000**	-1,58000	-2,0073	-1,1527
user friendly-difficult to use	**-3,633**	**4**	**0,022**	**1,8000**	-1,78000	-3,1402	-0,4198

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 2 (Continued)

Full list of one sample *t*-test results of M7

One-Sample Test							
Test Value = 4.12						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
ambiguous-distinct	1,288	9	0,230	5,0000	0,88000	-0,6653	2,4253
comfortable-uncomfortable	0,440	20	0,665	4,3333	0,21333	-0,7977	1,2244
controlled-uncontrolled	-1,586	5	0,173	3,1667	-0,95333	-2,4981	0,5914
curved-flat	**-3,330**	**16**	**0,004**	**2,7647**	-1,35529	-2,2181	-0,4925
dark-light	**10,647**	**12**	**0,000**	**6,1538**	2,03385	1,6176	2,4500
directionless-directional	**10,125**	**4**	**0,001**	**6,6000**	2,48000	1,7999	3,1601
ergonomic-non ergonomic	-1,761	13	0,102	3,2857	-0,83429	-1,8579	0,1893
extraordinary-common	**2,526**	**7**	**0,039**	**5,6250**	1,50500	0,0963	2,9137
functional-functionless	-1,866	5	0,121	3,3333	-0,78667	-1,8705	0,2972
handy-impractical	-1,319	7	0,229	3,3750	-0,74500	-2,0810	0,5910
obtuse-pointed	**-3,220**	**6**	**0,018**	**2,5714**	-1,54857	-2,7254	-0,3718
problematic-unproblematic	2,182	4	0,095	5,6000	1,48000	-0,4031	3,3631
rounded-sharp	**-3,171**	**12**	**0,008**	**2,7692**	-1,35077	-2,2789	-0,4226
user friendly-difficult to use	-0,949	4	0,396	3,2000	-0,92000	-3,6119	1,7719

Full list of one sample *t*-test results of M8

One-Sample Test							
Test Value = 5.25						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
ambiguous-distinct	-0,301	9	0,770	5,0000	-0,25000	-2,1276	1,6276
comfortable-uncomfortable	1,465	20	0,158	5,8095	0,55952	-0,2370	1,3560
controlled-uncontrolled	0,136	5	0,897	5,3333	0,08333	-1,4966	1,6633
curved-flat	0,240	16	0,813	5,3529	0,10294	-0,8049	1,0108
dark-light	**6,616**	**12**	**0,000**	**6,4615**	1,21154	0,8126	1,6105
directionless-directional	0,567	4	0,601	5,8000	0,55000	-2,1419	3,2419
ergonomic-non ergonomic	1,702	13	0,113	5,9286	0,67857	-0,1827	1,5399
extraordinary-common	0,145	7	0,889	5,3750	0,12500	-1,9198	2,1698
functional-functionless	**5,590**	**5**	**0,003**	**6,5000**	1,25000	0,6752	1,8248
handy-impractical	**7,514**	**7**	**0,000**	**6,6250**	1,37500	0,9423	1,8077
obtuse-pointed	-0,211	6	0,840	5,1429	-0,10714	-1,3512	1,1369
problematic-unproblematic	**-9,221**	**4**	**0,001**	**1,8000**	-3,45000	-4,4889	-2,4111
rounded-sharp	**-2,784**	**12**	**0,017**	**4,3846**	-0,86538	-1,5427	-0,1880
user friendly-difficult to use	-0,045	4	0,966	5,2000	-0,05000	-3,1417	3,0417

Q. Full List of One Sample *t*-Test Results of the Computer Mouses in Component 3

Full list of one sample *t*-test results of M1

One-Sample Test							
Test Value = 3.83						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
thick-thin	**5,310**	**8**	**0,001**	**6,3333**	2,50333	1,4163	3,5904
big-small	**2,632**	**27**	**0,014**	**4,5000**	0,67000	0,1476	1,1924
heavy-light	**6,199**	**22**	**0,000**	**6,0000**	2,17000	1,4441	2,8959
gracious-coarse	**-11,735**	**8**	**0,000**	**1,2222**	-2,60778	-3,1202	-2,0953
fast-slow	**-6,637**	**7**	**0,000**	**1,7500**	-2,08000	-2,8211	-1,3389
dynamic-bulky	-1,135	6	0,300	2,8571	-0,97286	-3,0702	1,1245
reassuring-insecure	**-4,883**	**6**	**0,003**	**1,8571**	-1,97286	-2,9616	-0,9842
transparent-opaque	0,159	6	0,879	4,0000	0,17000	-2,4459	2,7859
particular-standard	**a**	**5**	**0,000**	**1,0000**	0,00000	0,0000	0,0000
long-short	-1,575	8	0,154	3,0000	-0,83000	-2,0454	0,3854
high-low	**a**	**13**	**0,000**	**7,0000**	0,00000	0,0000	0,0000
loud-silent	2,078	16	0,054	4,8824	1,05235	-0,0213	2,1260
technological-outdated	**-32,960**	**11**	**0,000**	**1,0833**	-2,74667	-2,9301	-2,5633
entertaining-serious	0,078	7	0,940	3,8750	0,04500	-1,3278	1,4178
eccentrical-accustomed	**-2,835**	**8**	**0,022**	**2,0000**	-1,83000	-3,3185	-0,3415
classical-modern	**a**	**10**	**0,000**	**7,0000**	0,00000	0,0000	0,0000
old-new	**87,760**	**27**	**0,000**	**6,9643**	3,13429	3,0610	3,2076
fluid-stable	-0,610	12	0,553	3,3846	-0,44538	-2,0354	1,1446
attractive-unattractive	**-6,547**	**15**	**0,000**	**1,3750**	-2,45500	-3,2543	-1,6557
raspy-tuneful	1,924	5	0,112	5,6667	1,83667	-0,6170	4,2903

a. t cannot be computed because the standard deviation is 0.

Full list of one sample *t*-test results of M2

One-Sample Test							
Test Value = 4.04						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
thick-thin	1,989	8	0,082	5,1111	1,07111	-0,1710	2,3132
big-small	**19,399**	**28**	**0,000**	**6,5172**	2,47724	2,2157	2,7388
heavy-light	**3,793**	**22**	**0,001**	**5,2609**	1,22087	0,5533	1,8885
gracious-coarse	**-3,620**	**8**	**0,007**	**2,3333**	-1,70667	-2,7937	-0,6196
fast-slow	**-4,891**	**7**	**0,002**	**2,2500**	-1,79000	-2,6554	-0,9246
dynamic-bulky	**-5,579**	**6**	**0,001**	**2,1429**	-1,89714	-2,7293	-1,0650
reassuring-insecure	-1,508	6	0,182	3,1429	-0,89714	-2,3525	0,5582
transparent-opaque	-0,037	6	0,972	4,0000	-0,04000	-2,7098	2,6298
particular-standard	-2,487	5	0,055	2,5000	-1,54000	-3,1315	0,0515
long-short	**15,760**	**8**	**0,000**	**6,6667**	2,62667	2,2423	3,0110
high-low	1,189	13	0,256	4,4286	0,38857	-0,3173	1,0944
loud-silent	1,751	16	0,099	4,8235	0,78353	-0,1651	1,7322
technological-outdated	-0,569	11	0,581	3,7500	-0,29000	-1,4111	0,8311
entertaining-serious	-2,007	7	0,085	2,8750	-1,16500	-2,5378	0,2078
eccentrical-accustomed	-0,211	8	0,838	3,8889	-0,15111	-1,8017	1,4995
classical-modern	-1,573	10	0,147	3,2727	-0,76727	-1,8543	0,3198
old-new	-0,885	27	0,384	3,7500	-0,29000	-0,9627	0,3827
fluid-stable	-0,366	12	0,721	3,8462	-0,19385	-1,3469	0,9592
attractive-unattractive	0,557	15	0,586	4,3125	0,27250	-0,7702	1,3152
raspy-tuneful	0,682	5	0,526	4,6667	0,62667	-1,7355	2,9889

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 3 (Continued)

Full list of one sample *t*-test results of M3

One-Sample Test							
Test Value = 3.86						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
thick-thin	**-13,750**	**8**	**0,000**	**1,4444**	-2,41556	-2,8207	-2,0104
big-small	**-29,081**	**28**	**0,000**	**1,2069**	-2,65310	-2,8400	-2,4662
heavy-light	**-5,540**	**22**	**0,000**	**2,0870**	-1,77304	-2,4368	-1,1093
gracious-coarse	**6,484**	**8**	**0,000**	**6,2222**	2,36222	1,5221	3,2023
fast-slow	**3,381**	**7**	**0,012**	**5,7500**	1,89000	0,5681	3,2119
dynamic-bulky	1,909	6	0,105	5,2857	1,42571	-0,4018	3,2533
reassuring-insecure	1,975	6	0,096	5,0000	1,14000	-0,2727	2,5527
transparent-opaque	**15,476**	**6**	**0,000**	**6,7143**	2,85429	2,4030	3,3056
particular-standard	**3,384**	**5**	**0,020**	**6,0000**	2,14000	0,5142	3,7658
long-short	**-9,975**	**8**	**0,000**	**1,4444**	-2,41556	-2,9740	-1,8571
high-low	**-3,954**	**13**	**0,002**	**2,2857**	-1,57429	-2,4345	-0,7140
loud-silent	**-5,176**	**16**	**0,000**	**2,0588**	-1,80118	-2,5389	-1,0634
technological-outdated	**5,509**	**11**	**0,000**	**5,5833**	1,72333	1,0348	2,4118
entertaining-serious	0,284	7	0,785	4,1250	0,26500	-1,9441	2,4741
eccentrical-accustomed	**2,323**	**8**	**0,049**	**5,1111**	1,25111	0,0090	2,4932
classical-modern	**-6,574**	**10**	**0,000**	**1,4545**	-2,40545	-3,2207	-1,5902
old-new	**-8,184**	**27**	**0,000**	**2,1071**	-1,75286	-2,1923	-1,3134
fluid-stable	**2,185**	**12**	**0,049**	**4,9231**	1,06308	0,0031	2,1231
attractive-unattractive	**4,307**	**15**	**0,001**	**5,2500**	1,39000	0,7021	2,0779
raspy-tuneful	-0,733	5	0,496	3,1667	-0,69333	-3,1245	1,7378

Full list of one sample *t*-test results of M4

One-Sample Test							
Test Value = 4.53						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
thick-thin	-1,754	8	0,118	3,5556	-0,97444	-2,2556	0,3067
big-small	1,067	28	0,295	4,7586	0,22862	-0,2105	0,6677
heavy-light	0,137	22	0,893	4,5652	0,03522	-0,4996	0,5700
gracious-coarse	-0,959	8	0,366	4,0000	-0,53000	-1,8047	0,7447
fast-slow	**-4,010**	**7**	**0,005**	**3,1250**	-1,40500	-2,2335	-0,5765
dynamic-bulky	**-2,599**	**6**	**0,041**	**3,5714**	-0,95857	-1,8611	-0,0560
reassuring-insecure	-1,928	6	0,102	3,4286	-1,10143	-2,4997	0,2968
transparent-opaque	**16,290**	**6**	**0,000**	**6,8571**	2,32714	1,9776	2,6767
particular-standard	1,057	5	0,339	5,3333	0,80333	-1,1506	2,7573
long-short	0,951	8	0,369	5,1111	0,58111	-0,8281	1,9903
high-low	-1,665	13	0,120	3,8571	-0,67286	-1,5458	0,2001
loud-silent	**2,716**	**16**	**0,015**	**5,2941**	0,76412	0,1677	1,3605
technological-outdated	**-5,030**	**11**	**0,000**	**3,0833**	-1,44667	-2,0796	-0,8137
entertaining-serious	0,485	7	0,642	4,7500	0,22000	-0,8516	1,2916
eccentrical-accustomed	**3,115**	**8**	**0,014**	**5,7778**	1,24778	0,3240	2,1716
classical-modern	0,217	10	0,833	4,6364	0,10636	-0,9882	1,2009
old-new	**2,352**	**27**	**0,026**	**5,0357**	0,50571	0,0645	0,9470
fluid-stable	-0,862	12	0,405	4,1538	-0,37615	-1,3267	0,5744
attractive-unattractive	-1,302	15	0,213	4,0625	-0,46750	-1,2328	0,2978
raspy-tuneful	1,059	5	0,338	5,1667	0,63667	-0,9081	2,1814

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 3 (Continued)

Full list of one sample *t*-test results of M5

One-Sample Test							
Test Value = 4.14						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
thick-thin	-1,074	8	0,314	3,4444	-0,69556	-2,1896	0,7985
big-small	1,318	28	0,198	4,4138	0,27379	-0,1517	0,6993
heavy-light	1,955	22	0,063	4,6957	0,55565	-0,0337	1,1450
gracious-coarse	0,177	8	0,864	4,2222	0,08222	-0,9896	1,1541
fast-slow	**-4,435**	**7**	**0,003**	**2,7500**	-1,39000	-2,1311	-0,6489
dynamic-bulky	**-2,794**	**6**	**0,031**	**2,8571**	-1,28286	-2,4065	-0,1592
reassuring-insecure	-1,144	6	0,296	3,2857	-0,85429	-2,6818	0,9733
transparent-opaque	**3,367**	**6**	**0,015**	**6,1429**	2,00286	0,5475	3,4582
particular-standard	0,625	5	0,560	4,6667	0,52667	-1,6410	2,6944
long-short	1,720	8	0,124	5,0000	0,86000	-0,2930	2,0130
high-low	-0,678	13	0,510	3,8571	-0,28286	-1,1847	0,6190
loud-silent	-1,320	16	0,206	3,5294	-0,61059	-1,5915	0,3703
technological-outdated	**-4,061**	**11**	**0,002**	**2,8333**	-1,30667	-2,0149	-0,5985
entertaining-serious	0,852	7	0,422	4,5000	0,36000	-0,6392	1,3592
eccentrical-accustomed	**4,134**	**8**	**0,003**	**5,8889**	1,74889	0,7732	2,7246
classical-modern	1,555	10	0,151	4,9091	0,76909	-0,3329	1,8711
old-new	**5,545**	**27**	**0,000**	**5,3571**	1,21714	0,7667	1,6675
fluid-stable	-1,885	12	0,084	3,2308	-0,90923	-1,9604	0,1419
attractive-unattractive	-2,041	15	0,059	3,3125	-0,82750	-1,6915	0,0365
raspy-tuneful	0,795	5	0,463	4,8333	0,69333	-1,5493	2,9360

Full list of one sample *t*-test results of M6

One-Sample Test							
Test Value = 4.39						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
thick-thin	**-2,915**	**8**	**0,019**	**3,2222**	-1,16778	-2,0916	-0,2440
big-small	1,549	28	0,133	4,7241	0,33414	-0,1078	0,7761
heavy-light	**2,192**	**22**	**0,039**	**5,0435**	0,65348	0,0353	1,2716
gracious-coarse	-1,411	8	0,196	3,7778	-0,61222	-1,6128	0,3884
fast-slow	**-3,438**	**7**	**0,011**	**2,8750**	-1,51500	-2,5570	-0,4730
dynamic-bulky	**-2,607**	**6**	**0,040**	**3,4286**	-0,96143	-1,8640	-0,0589
reassuring-insecure	-1,260	6	0,254	3,5714	-0,81857	-2,4077	0,7705
transparent-opaque	**7,335**	**6**	**0,000**	**6,5714**	2,18143	1,4538	2,9091
particular-standard	**2,582**	**5**	**0,049**	**5,6667**	1,27667	0,0057	2,5476
long-short	1,339	8	0,217	5,1111	0,72111	-0,5210	1,9632
high-low	-1,352	13	0,199	3,7857	-0,60429	-1,5699	0,3613
loud-silent	-0,664	16	0,516	4,1176	-0,27235	-1,1419	0,5972
technological-outdated	**-4,544**	**11**	**0,001**	**3,0833**	-1,30667	-1,9396	-0,6737
entertaining-serious	0,336	7	0,747	4,5000	0,11000	-0,6640	0,8840
eccentrical-accustomed	**3,543**	**8**	**0,008**	**5,8889**	1,49889	0,5232	2,4746
classical-modern	0,285	10	0,781	4,5455	0,15545	-1,0599	1,3708
old-new	**2,795**	**27**	**0,009**	**5,0000**	0,61000	0,1623	1,0577
fluid-stable	**-2,937**	**12**	**0,012**	**3,2308**	-1,15923	-2,0193	-0,2992
attractive-unattractive	-0,452	15	0,658	4,2500	-0,14000	-0,7998	0,5198
raspy-tuneful	1,627	5	0,165	5,1667	0,77667	-0,4502	2,0035

Full List of One Sample *t*-Test Results of the Computer Mouses in Component 3 (Continued)

Full list of one sample *t*-test results of M7

One-Sample Test

Test Value = 4.18	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
thick-thin	**-16,343**	**8**	**0,000**	**1,7778**	-2,40222	-2,7412	-2,0633
big-small	**-11,900**	**28**	**0,000**	**1,6552**	-2,52483	-2,9594	-2,0902
heavy-light	**-3,707**	**22**	**0,001**	**2,7826**	-1,39739	-2,1792	-0,6156
gracious-coarse	1,685	8	0,131	5,2222	1,04222	-0,3844	2,4688
fast-slow	**7,481**	**7**	**0,000**	**5,8750**	1,69500	1,1592	2,2308
dynamic-bulky	0,748	6	0,483	4,7143	0,53429	-1,2135	2,2821
reassuring-insecure	1,955	6	0,098	5,2857	1,10571	-0,2779	2,4893
transparent-opaque	**8,042**	**6**	**0,000**	**6,5714**	2,39143	1,6638	3,1191
particular-standard	1,730	5	0,144	5,3333	1,15333	-0,5604	2,8671
long-short	**-15,571**	**8**	**0,000**	**1,4444**	-2,73556	-3,1407	-2,3304
high-low	**-3,274**	**13**	**0,006**	**2,8571**	-1,32286	-2,1958	-0,4499
loud-silent	-0,428	16	0,674	4,0000	-0,18000	-1,0705	0,7105
technological-outdated	1,848	11	0,092	5,0000	0,82000	-0,1568	1,7968
entertaining-serious	1,308	7	0,232	5,0000	0,82000	-0,6621	2,3021
eccentrical-accustomed	**2,898**	**8**	**0,020**	**5,5556**	1,37556	0,2810	2,4701
classical-modern	**-4,683**	**10**	**0,001**	**2,3636**	-1,81636	-2,6805	-0,9522
old-new	**-6,330**	**27**	**0,000**	**2,6071**	-1,57286	-2,0827	-1,0630
fluid-stable	**3,067**	**12**	**0,010**	**5,4615**	1,28154	0,3712	2,1918
attractive-unattractive	0,944	15	0,360	4,6875	0,50750	-0,6390	1,6540
raspy-tuneful	1,245	5	0,268	5,1667	0,98667	-1,0501	3,0234

Full list of one sample *t*-test results of M8

One-Sample Test

Test Value = 4.28	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
thick-thin	**-2,467**	**8**	**0,039**	**2,8889**	-1,39111	-2,6913	-0,0909
big-small	**-10,540**	**28**	**0,000**	**2,0000**	-2,28000	-2,7231	-1,8369
heavy-light	**-3,249**	**22**	**0,004**	**2,8261**	-1,45391	-2,3819	-0,5260
gracious-coarse	**9,397**	**8**	**0,000**	**6,5556**	2,27556	1,7171	2,8340
fast-slow	**3,095**	**7**	**0,017**	**5,8750**	1,59500	0,3763	2,8137
dynamic-bulky	2,111	6	0,079	5,5714	1,29143	-0,2053	2,7882
reassuring-insecure	0,995	6	0,358	5,0000	0,72000	-1,0509	2,4909
transparent-opaque	**18,040**	**6**	**0,000**	**6,8571**	2,57714	2,2276	2,9267
particular-standard	**2,585**	**5**	**0,049**	**5,8333**	1,55333	0,0086	3,0981
long-short	**-7,012**	**8**	**0,000**	**2,1111**	-2,16889	-2,8822	-1,4556
high-low	0,337	13	0,742	4,4286	0,14857	-0,8046	1,1017
loud-silent	**-7,249**	**16**	**0,000**	**1,6471**	-2,63294	-3,4029	-1,8630
technological-outdated	**31,640**	**11**	**0,000**	**6,9167**	2,63667	2,4533	2,8201
entertaining-serious	**2,744**	**7**	**0,029**	**6,0000**	1,72000	0,2379	3,2021
eccentrical-accustomed	-0,070	8	0,946	4,2222	-0,05778	-1,9709	1,8553
classical-modern	**a**	**10**	**0,000**	**1,0000**	0,00000	0,0000	0,0000
old-new	**-13,538**	**27**	**0,000**	**1,3214**	-2,95857	-3,4070	-2,5102
fluid-stable	**3,684**	**12**	**0,003**	**6,0000**	1,72000	0,7028	2,7372
attractive-unattractive	**2,657**	**15**	**0,018**	**5,5625**	1,28250	0,2535	2,3115
raspy-tuneful	-1,737	5	0,143	2,5000	-1,78000	-4,4141	0,8541

a. t cannot be computed because the standard deviation is 0.

R. Full List of One Sample *t*-Test Results of the Computer Mouses in Component 4

Full list of one sample *t*-test results of M1

One-Sample Test							
Test Value = 2.10						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
clear-blurry	**-4,500**	**4**	**0,011**	**1,2000**	-0,90000	-1,4553	-0,3447
non glittery-glittery	1,219	11	0,248	3,0000	0,90000	-0,7255	2,5255

Full list of one sample *t*-test results of M2

One-Sample Test							
Test Value = 1.93						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
clear-blurry	0,278	4	0,794	2,2000	0,27000	-2,4219	2,9619
non glittery-glittery	-0,635	11	0,538	1,6667	-0,26333	-1,1754	0,6487

Full list of one sample *t*-test results of M3

One-Sample Test							
Test Value = 4.38						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
clear-blurry	-2,191	4	0,094	2,6000	-1,78000	-4,0356	0,4756
non glittery-glittery	**3,648**	**11**	**0,004**	**6,1667**	1,78667	0,7086	2,8647

Full list of one sample *t*-test results of M4

One-Sample Test							
Test Value = 2.68						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
clear-blurry	0,737	4	0,502	3,6000	0,92000	-2,5478	4,3878
non glittery-glittery	**-2,830**	**11**	**0,016**	**1,7500**	-0,93000	-1,6532	-0,2068

Full List of One Sample t-Test Results of the Computer Mouses in

Component 4 (Continued)

Full list of one sample *t*-test results of M5

One-Sample Test							
Test Value = 4.00						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
clear-blurry	-1,195	4	0,298	3,0000	-1,00000	-3,3229	1,3229
non glittery-glittery	1,773	11	0,104	5,0000	1,00000	-0,2415	2,2415

Full list of one sample *t*-test results of M6

One-Sample Test							
Test Value = 2.60						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
clear-blurry	0,750	4	0,495	3,2000	0,60000	-1,6212	2,8212
non glittery-glittery	-1,541	11	0,151	2,0000	-0,60000	-1,4567	0,2567

Full list of one sample *t*-test results of M7

One-Sample Test							
Test Value = 2.03						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
clear-blurry	-1,150	4	0,314	1,8000	-0,23000	-0,7853	0,3253
non glittery-glittery	0,357	11	0,728	2,2500	0,22000	-1,1380	1,5780

Full list of one sample *t*-test results of M8

One-Sample Test							
Test Value = 3.65						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
clear-blurry	0,848	4	0,444	4,8000	1,15000	-2,6162	4,9162
non glittery-glittery	-1,639	11	0,130	2,5000	-1,15000	-2,6945	0,3945

S. Six Components PCA Results with Varimax Rotation

Rotated Component Matrix

	Component					
	1	**2**	**3**	**4**	**5**	**6**
hard-soft	0,982					
long lasting-short lived	0,971					
hygienic-non hygienic	0,944					
tight-loose	0,934					
natural-artificial	0,933					
healthy-unhealthy	0,911					
fresh-stale	0,909					
wide-narrow	0,897					
easy-difficult	-0,887					
excited-calm	-0,867					
shiny-matte	0,863					
cold-hot	0,847					
cheap-expensive	-0,843					
deep-treble	-0,841					
loud-silent	0,831					
rounded-sharp	-0,820					
user friendly-difficult to use	-0,811					
heavy-light	0,789					
ergonomic-non ergonomic	-0,772					
entertaining-serious	-0,753					
directional-directionless	-0,748					
clean-dirty	0,740					
high quality-poor quality	0,722					
reliable-unreliable	0,719					
sportive-formal	-0,703					
uneven-flat	-0,695					
relieving-irritating	**0,687**	**0,640**				
stable-portable		0,974				
flimsy-durable		0,961				
indoor-outdoor		0,906				
unnecessary-necessary		0,897				
discordant-coherent		0,884				
inactive-dynamic		0,874				
particular-standard		-0,876				
feminine-masculine		0,868				
sweet-bitter		0,848				
comfortable-uncomfortable		-0,825				
big-small		0,815				
handy-impractical		-0,803				
protective-vulnerable		-0,796				
transparent-opaque		0,785				
tall-short		0,780				
dishonest-honest		-0,768				
childish-mature		0,710				
sincere-insincere		0,695				
cool-despised		**-0,635**			**0,563**	
safe-insecure	**0,559**	**-0,629**				
flexible-solid	**-0,568**	**-0,600**				
amusing-boring		0,588				
accustomed-eccentrical			-0,928			
fragmented-whole			0,922			
elaborated-sloppy			0,885			
old-new			-0,870			
functional-functionless			0,714			
easy to clean-hard to clean			0,687			
beautiful-ugly			0,681			
distinct-ambiguous		**0,493**	**0,560**	**-0,533**		
vivid-pale				0,858		
attractive-unattractive				0,856		
rough-smooth				0,789		
plain-ornate				-0,720		
coarse-gracious			**0,651**	**-0,700**		
non slippery-slippery				0,696		
controlled-uncontrolled				-0,682		
complex-simple			**0,545**	**0,635**		
steady-unsteady				-0,565		
pleasurable-dissatisfactory					0,859	
thin-thick					-0,706	
conductive-insulative	**0,630**					**-0,711**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

T. Four Components PCA Results with Cluster Rotation

PCA rotated component matrix. Variables with cross-loadings were written in bold

Loadings:

	RC1	RC2	RC3	RC4
plain - ornate	1.03			
hidden - open	1.01			
discordant - coherent	-0.97			
simple - complex	0.93			
symmetric - asymmetric	0.90			
healthy - unhealthy	0.89			
smelt - inodorous	-0.88			
deep - treble	-0.87			
clean - dirty	0.87			
unnecessary - necessary	-0.86			
smooth - rough	0.85			
whole - fragmented	0.85			
good - bad	0.85			
non sticky - sticky	0.83			
high quality - poor quality	0.82			
cold - hot	0.79			
soft - hard	-0.78			
durable - flimsy	0.74			
slippery - non slippery	0.73			
sloppy - elaborated	-0.68			
easy - difficult	0.68			
independent - constrained	**0.65**		**0.60**	
expensive - cheap	**0.64**	**0.56**		
beautiful - ugly	0.62			
shiny - matte	0.54			
long lasting - short lived	**0.50**	**0.54**		
thick - thin		-1.01		
big - small		-0.98		
heavy - light		-0.96		
gracious - coarse		0.96		
transparent - opaque		0.95		
dynamic - bulky		0.95		
fast - slow		0.94		
particular - standard		0.93		
reassuring - insecure		0.91		
high - low		-0.79		
long - short		-0.79		
loud - silent		-0.76		
entertaining - serious		0.75		
eccentrical - accustomed		0.74		
technological - outdated		0.72		
classical - modern		-0.68		
old - new		-0.67		
fluid - stable		0.67		
attractive - unattractive		0.66		
inappropriate - proper		**-0.58**	**-0.59**	
raspy - tuneful		-0.55		
user friendly - difficult to use			0.99	
curved - flat			0.98	
rounded - sharp			0.90	
extraordinary - common			-0.88	
controlled - uncontrolled			0.88	
functional - functionless			0.84	
handy - impractical			0.79	
ergonomic - non ergonomic			0.78	
ambiguous - distinct			-0.76	
dark - light			0.75	
problematic - unproblematic			-0.74	
obtuse - pointed			0.74	
comfortable - uncomfortable			0.70	
directional - directionless			-0.67	
clear - blurry				0.74
non glittery - glittery				-0.73

Number of components extracted: 4
Type of rotation: cluster

U. Full List of One Sample *t*-Test Results of the Water Bottles in Component 1

Full list of one sample *t*-test results of B1

One-Sample Test							
Test Value = 4.14						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
amusing-boring	0,203	5	0,847	4,3333	0,19333	-2,2603	2,6470
cheap-expensive	**-2,274**	**18**	**0,035**	**3,2105**	-0,92947	-1,7884	-0,0706
cold-hot	0,228	20	0,822	4,2381	0,09810	-0,7997	0,9959
conductive-insulative	0,376	5	0,722	4,5000	0,36000	-2,1011	2,8211
deep-treble	**-4,811**	**20**	**0,000**	**2,4286**	-1,71143	-2,4534	-0,9694
directional-directionless	-1,228	5	0,274	3,1667	-0,97333	-3,0101	1,0634
easy-difficult	**-3,585**	**14**	**0,003**	**2,3333**	-1,80667	-2,8875	-0,7258
entertaining-serious	**-6,767**	**4**	**0,002**	**2,0000**	-2,14000	-3,0180	-1,2620
ergonomic-non ergonomic	-1,787	10	0,104	3,1818	-0,95818	-2,1531	0,2367
excited-calm	-0,608	11	0,555	3,7500	-0,39000	-1,8010	1,0210
flexible-solid	**-16,179**	**14**	**0,000**	**1,4667**	-2,67333	-3,0277	-2,3189
fresh-stale	**4,475**	**12**	**0,001**	**5,6923**	1,55231	0,7966	2,3081
hard-soft	**2,240**	**19**	**0,037**	**5,1000**	0,96000	0,0630	1,8570
healthy-unhealthy	**2,600**	**19**	**0,018**	**5,1000**	0,96000	0,1872	1,7328
heavy-light	**3,917**	**19**	**0,001**	**5,6000**	1,46000	0,6798	2,2402
high quality-poor quality	-0,306	17	0,763	4,0000	-0,14000	-1,1049	0,8249
hygienic-non hygienic	**3,585**	**11**	**0,004**	**5,5000**	1,36000	0,5250	2,1950
long lasting-short lived	**2,544**	**14**	**0,023**	**5,0000**	0,86000	0,1349	1,5851
loud-silent	**5,002**	**11**	**0,000**	**6,1667**	2,02667	1,1350	2,9184
natural-artificial	**4,386**	**13**	**0,001**	**5,5000**	1,36000	0,6901	2,0299
reliable-unreliable	0,186	10	0,856	4,2727	0,13273	-1,4596	1,7251
rounded-sharp	-0,501	4	0,642	3,6000	-0,54000	-3,5303	2,4503
shiny-matte	**2,227**	**13**	**0,044**	**5,2143**	1,07429	0,0321	2,1165
sportive-formal	**-13,658**	**10**	**0,000**	**1,3636**	-2,77636	-3,2293	-2,3234
tight-loose	**3,743**	**6**	**0,010**	**5,7143**	1,57429	0,5452	2,6034
uneven-flat	**3,353**	**15**	**0,004**	**5,4375**	1,29750	0,4727	2,1223
user friendly-difficult to use	**-15,343**	**8**	**0,000**	**1,4444**	-2,69556	-3,1007	-2,2904
wide-narrow	0,404	10	0,695	4,4545	0,31455	-1,4208	2,0499

Full List of One Sample *t*-Test Results of the Water Bottles in Component 1 (Continued)

Full list of one sample *t*-test results of B2

One-Sample Test							
Test Value = 4.13						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
amusing-boring	-0,756	5	0,484	3,3333	-0,79667	-3,5063	1,9130
cheap-expensive	**-11,118**	**18**	**0,000**	**1,7895**	-2,34053	-2,7828	-1,8982
cold-hot	1,689	20	0,107	4,7143	0,58429	-0,1375	1,3061
conductive-insulative	-0,206	5	0,845	4,0000	-0,13000	-1,7558	1,4958
deep-treble	**-5,724**	**20**	**0,000**	**2,5714**	-1,55857	-2,1266	-0,9906
directional-directionless	-0,615	5	0,566	3,5000	-0,63000	-3,2641	2,0041
easy-difficult	-1,688	14	0,114	3,2667	-0,86333	-1,9603	0,2336
entertaining-serious	**-6,227**	**4**	**0,003**	**1,8000**	-2,33000	-3,3689	-1,2911
ergonomic-non ergonomic	**-3,162**	**10**	**0,010**	**2,6364**	-1,49364	-2,5462	-0,4411
excited-calm	-1,993	11	0,072	2,9167	-1,21333	-2,5532	0,1265
flexible-solid	-1,412	14	0,180	3,6000	-0,53000	-1,3352	0,2752
fresh-stale	**4,414**	**12**	**0,001**	**6,0000**	1,87000	0,9469	2,7931
hard-soft	0,657	19	0,519	4,3500	0,22000	-0,4804	0,9204
healthy-unhealthy	**4,390**	**19**	**0,000**	**5,7500**	1,62000	0,8476	2,3924
heavy-light	**9,143**	**19**	**0,000**	**6,1500**	2,02000	1,5576	2,4824
high quality-poor quality	**6,674**	**17**	**0,000**	**6,1667**	2,03667	1,3928	2,6805
hygienic-non hygienic	1,566	11	0,146	5,0833	0,95333	-0,3865	2,2932
long lasting-short lived	**3,501**	**14**	**0,004**	**5,5333**	1,40333	0,5437	2,2629
loud-silent	1,542	11	0,151	5,0000	0,87000	-0,3715	2,1115
natural-artificial	**9,898**	**13**	**0,000**	**6,3571**	2,22714	1,7410	2,7132
reliable-unreliable	0,853	11	0,412	4,4167	0,28667	-0,4532	1,0266
rounded-sharp	-1,546	4	0,197	2,8000	-1,33000	-3,7184	1,0584
shiny-matte	0,904	13	0,383	4,5714	0,44143	-0,6139	1,4967
sportive-formal	-0,201	10	0,845	4,0000	-0,13000	-1,5709	1,3109
tight-loose	0,564	6	0,593	4,5714	0,44143	-1,4732	2,3560
uneven-flat	**-4,177**	**15**	**0,001**	**2,3125**	-1,81750	-2,7449	-0,8901
user friendly-difficult to use	-2,186	8	0,060	2,7778	-1,35222	-2,7788	0,0744
wide-narrow	2,269	10	0,047	5,1818	1,05182	0,0190	2,0847

Full List of One Sample *t*-Test Results of the Water Bottles in Component 1 (Continued)

Full list of one sample *t*-test results of B3

One-Sample Test							
Test Value = 3.82						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
amusing-boring	-0,984	5	0,370	3,3333	-0,48667	-1,7576	0,7843
cheap-expensive	1,973	18	0,064	4,3684	0,54842	-0,0355	1,1324
cold-hot	**2,094**	**20**	**0,049**	**4,4762**	0,65619	0,0026	1,3098
conductive-insulative	0,402	5	0,704	4,0000	0,18000	-0,9696	1,3296
deep-treble	**-2,634**	**20**	**0,016**	**3,0952**	-0,72476	-1,2988	-0,1507
directional-directionless	-1,131	5	0,309	2,8333	-0,98667	-3,2293	1,2560
easy-difficult	0,423	14	0,679	4,0000	0,18000	-0,7324	1,0924
entertaining-serious	-1,657	4	0,173	3,2000	-0,62000	-1,6589	0,4189
ergonomic-non ergonomic	**-3,755**	**10**	**0,004**	**2,3636**	-1,45636	-2,3205	-0,5922
excited-calm	**-2,523**	**11**	**0,028**	**2,9167**	-0,90333	-1,6913	-0,1154
flexible-solid	**-2,963**	**14**	**0,010**	**2,8667**	-0,95333	-1,6433	-0,2634
fresh-stale	1,265	12	0,230	4,3846	0,56462	-0,4079	1,5371
hard-soft	0,738	19	0,470	4,0500	0,23000	-0,4227	0,8827
healthy-unhealthy	1,453	19	0,163	4,3500	0,53000	-0,2334	1,2934
heavy-light	**5,701**	**19**	**0,000**	**5,5000**	1,68000	1,0632	2,2968
high quality-poor quality	-1,738	17	0,100	3,3333	-0,48667	-1,0775	0,1042
hygienic-non hygienic	0,870	11	0,403	4,2500	0,43000	-0,6579	1,5179
long lasting-short lived	0,821	14	0,425	4,0667	0,24667	-0,3973	0,8907
loud-silent	**3,337**	**11**	**0,007**	**5,0833**	1,26333	0,4301	2,0965
natural-artificial	**4,255**	**13**	**0,001**	**5,0000**	1,18000	0,5808	1,7792
reliable-unreliable	-1,543	11	0,151	3,1667	-0,65333	-1,5853	0,2786
rounded-sharp	-1,715	4	0,162	3,4000	-0,42000	-1,1001	0,2601
shiny-matte	0,991	13	0,340	4,0000	0,18000	-0,2123	0,5723
sportive-formal	**-3,370**	**10**	**0,007**	**2,3636**	-1,45636	-2,4193	-0,4934
tight-loose	0,055	6	0,958	3,8571	0,03714	-1,6024	1,6767
uneven-flat	-0,292	15	0,774	3,6875	-0,13250	-1,0999	0,8349
user friendly-difficult to use	0,102	8	0,921	3,8889	0,06889	-1,4897	1,6274
wide-narrow	1,935	10	0,082	4,7273	0,90727	-0,1374	1,9520

Full List of One Sample *t*-Test Results of the Water Bottles in Component 1 (Continued)

Full list of one sample *t*-test results of B4

One-Sample Test

Test Value = 3.74	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
amusing-boring	-2,027	5	0,099	3,0000	-0,74000	-1,6786	0,1986
cheap-expensive	-1,181	18	0,253	3,3158	-0,42421	-1,1787	0,3303
cold-hot	0,397	20	0,696	3,8571	0,11714	-0,4984	0,7327
conductive-insulative	0,356	5	0,736	4,0000	0,26000	-1,6173	2,1373
deep-treble	**3,911**	**20**	**0,001**	**5,0476**	1,30762	0,6102	2,0051
directional-directionless	-1,273	5	0,259	2,6667	-1,07333	-3,2410	1,0944
easy-difficult	**-2,400**	**14**	**0,031**	**2,7333**	-1,00667	-1,9061	-0,1072
entertaining-serious	-1,170	4	0,307	3,0000	-0,74000	-2,4960	1,0160
ergonomic-non ergonomic	0,497	10	0,630	4,0909	0,35091	-1,2233	1,9251
excited-calm	-1,667	11	0,124	3,0000	-0,74000	-1,7168	0,2368
flexible-solid	0,461	14	0,652	3,9333	0,19333	-0,7061	1,0928
fresh-stale	0,574	12	0,577	4,0000	0,26000	-0,7268	1,2468
hard-soft	-0,093	19	0,927	3,7000	-0,04000	-0,9396	0,8596
healthy-unhealthy	1,915	19	0,071	4,3500	0,61000	-0,0566	1,2766
heavy-light	**5,997**	**19**	**0,000**	**5,6500**	1,91000	1,2434	2,5766
high quality-poor quality	2,089	17	0,052	4,5000	0,76000	-0,0076	1,5276
hygienic-non hygienic	0,871	11	0,402	4,1667	0,42667	-0,6514	1,5047
long lasting-short lived	2,041	14	0,061	4,5333	0,79333	-0,0404	1,6271
loud-silent	0,845	11	0,416	4,1667	0,42667	-0,6849	1,5382
natural-artificial	**2,317**	**13**	**0,037**	**4,5714**	0,83143	0,0563	1,6065
reliable-unreliable	0,343	11	0,738	3,9167	0,17667	-0,9553	1,3087
rounded-sharp	-1,919	4	0,127	2,8000	-0,94000	-2,3002	0,4202
shiny-matte	0,531	13	0,604	3,9286	0,18857	-0,5782	0,9554
sportive-formal	-1,655	10	0,129	3,0000	-0,74000	-1,7365	0,2565
tight-loose	0,731	6	0,493	4,2857	0,54571	-1,2818	2,3733
uneven-flat	**-4,339**	**15**	**0,001**	**2,3750**	-1,36500	-2,0355	-0,6945
user friendly-difficult to use	**-2,875**	**8**	**0,021**	**2,5556**	-1,18444	-2,1345	-0,2343
wide-narrow	0,108	10	0,916	3,8182	0,07818	-1,5347	1,6910

Full List of One Sample *t*-Test Results of the Water Bottles in Component 1 (Continued)

Full list of one sample *t*-test results of B5

One-Sample Test							
Test Value = 3.44						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
amusing-boring	-2,195	5	0,080	2,5000	-0,94000	-2,0407	0,1607
cheap-expensive	**3,799**	**18**	**0,001**	**4,7895**	**1,34947**	**0,6032**	**2,0958**
cold-hot	0,729	20	0,474	3,7619	0,32190	-0,5987	1,2425
conductive-insulative	0,717	5	0,506	4,1667	0,72667	-1,8794	3,3327
deep-treble	1,153	20	0,263	3,9524	0,51238	-0,4147	1,4394
directional-directionless	-0,101	5	0,923	3,3333	-0,10667	-2,8163	2,6030
easy-difficult	1,487	14	0,159	4,2667	0,82667	-0,3660	2,0193
entertaining-serious	-0,906	4	0,416	2,6000	-0,84000	-3,4148	1,7348
ergonomic-non ergonomic	0,858	10	0,411	3,9091	0,46909	-0,7496	1,6878
excited-calm	1,368	11	0,198	4,2500	0,81000	-0,4928	2,1128
flexible-solid	**21,487**	**14**	**0,000**	**6,7333**	**3,29333**	**2,9646**	**3,6221**
fresh-stale	**-5,688**	**12**	**0,000**	**2,0000**	**-1,44000**	**-1,9916**	**-0,8884**
hard-soft	-1,946	19	0,067	2,7500	-0,69000	-1,4319	0,0519
healthy-unhealthy	**-12,101**	**19**	**0,000**	**1,4000**	**-2,04000**	**-2,3929**	**-1,6871**
heavy-light	**-7,766**	**19**	**0,000**	**1,4500**	**-1,99000**	**-2,5263**	**-1,4537**
high quality-poor quality	-0,330	17	0,746	3,3333	-0,10667	-0,7889	0,5756
hygienic-non hygienic	**-2,408**	**11**	**0,035**	**2,2500**	**-1,19000**	**-2,2779**	**-0,1021**
long lasting-short lived	**-5,306**	**14**	**0,000**	**1,9333**	**-1,50667**	**-2,1157**	**-0,8976**
loud-silent	**2,643**	**11**	**0,023**	**5,0000**	**1,56000**	**0,2607**	**2,8593**
natural-artificial	**-2,872**	**13**	**0,013**	**2,5000**	**-0,94000**	**-1,6471**	**-0,2329**
reliable-unreliable	-0,611	11	0,553	3,0833	-0,35667	-1,6406	0,9272
rounded-sharp	0,617	4	0,570	3,8000	0,36000	-1,2589	1,9789
shiny-matte	1,602	13	0,133	3,9286	0,48857	-0,1703	1,1474
sportive-formal	**2,528**	**10**	**0,030**	**5,0909**	**1,65091**	**0,1959**	**3,1059**
tight-loose	-1,127	6	0,303	2,7143	-0,72571	-2,3020	0,8505
uneven-flat	**2,889**	**15**	**0,011**	**5,0000**	**1,56000**	**0,4089**	**2,7111**
user friendly-difficult to use	**2,709**	**8**	**0,027**	**4,7778**	**1,33778**	**0,1991**	**2,4765**
wide-narrow	0,022	10	0,983	3,4545	0,01455	-1,4377	1,4668

Full List of One Sample *t*-Test Results of the Water Bottles in Component 1 (Continued)

Full list of one sample *t*-test results of B6

One-Sample Test							
Test Value = 3.66						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
amusing-boring	0,620	5	0,562	4,3333	0,67333	-2,1164	3,4631
cheap-expensive	1,922	18	0,071	4,2632	0,60316	-0,0562	1,2625
cold-hot	-1,250	20	0,226	3,2381	-0,42190	-1,1257	0,2819
conductive-insulative	-0,310	5	0,769	3,3333	-0,32667	-3,0363	2,3830
deep-treble	1,903	20	0,071	4,4762	0,81619	-0,0783	1,7107
directional-directionless	0,310	5	0,769	4,0000	0,34000	-2,4759	3,1559
easy-difficult	**2,167**	**14**	**0,048**	**4,6667**	**1,00667**	**0,0102**	**2,0032**
entertaining-serious	-0,339	4	0,752	3,2000	-0,46000	-4,2262	3,3062
ergonomic-non ergonomic	**5,301**	**10**	**0,000**	**5,2727**	**1,61273**	**0,9348**	**2,2906**
excited-calm	**3,321**	**11**	**0,007**	**5,2500**	**1,59000**	**0,5364**	**2,6436**
flexible-solid	**29,372**	**14**	**0,000**	**6,8000**	**3,14000**	**2,9107**	**3,3693**
fresh-stale	**-9,403**	**12**	**0,000**	**1,7692**	**-1,89077**	**-2,3289**	**-1,4526**
hard-soft	**-5,516**	**19**	**0,000**	**1,8000**	**-1,86000**	**-2,5657**	**-1,1543**
healthy-unhealthy	**-7,783**	**19**	**0,000**	**1,8500**	**-1,81000**	**-2,2967**	**-1,3233**
heavy-light	**-7,645**	**19**	**0,000**	**1,5500**	**-2,11000**	**-2,6877**	**-1,5323**
high quality-poor quality	0,161	17	0,874	3,7222	0,06222	-0,7523	0,8768
hygienic-non hygienic	**-2,665**	**11**	**0,022**	**2,5000**	**-1,16000**	**-2,1179**	**-0,2021**
long lasting-short lived	**-2,539**	**14**	**0,024**	**2,3333**	**-1,32667**	**-2,4473**	**-0,2060**
loud-silent	-0,280	11	0,784	3,5000	-0,16000	-1,4162	1,0962
natural-artificial	**-3,099**	**13**	**0,008**	**2,5000**	**-1,16000**	**-1,9687**	**-0,3513**
reliable-unreliable	0,163	11	0,873	3,7500	0,09000	-1,1254	1,3054
rounded-sharp	**2,996**	**4**	**0,040**	**5,0000**	**1,34000**	**0,0983**	**2,5817**
shiny-matte	-0,783	13	0,448	3,3571	-0,30286	-1,1382	0,5325
sportive-formal	**5,085**	**10**	**0,000**	**5,7273**	**2,06727**	**1,1614**	**2,9731**
tight-loose	-1,198	6	0,276	2,8571	-0,80286	-2,4424	0,8367
uneven-flat	**4,791**	**15**	**0,000**	**5,8125**	**2,15250**	**1,1950**	**3,1100**
user friendly-difficult to use	1,160	8	0,279	4,1111	0,45111	-0,4457	1,3479
wide-narrow	0,128	10	0,900	3,7273	0,06727	-1,0999	1,2344

Full List of One Sample *t*-Test Results of the Water Bottles in Component 1 (Continued)

Full list of one sample *t*-test results of B7

One-Sample Test							
Test Value = 3.81						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
amusing-boring	**7,668**	**5**	**0,001**	**6,1667**	2,35667	1,5667	3,1467
cheap-expensive	**9,225**	**18**	**0,000**	**6,2105**	2,40053	1,8538	2,9472
cold-hot	**-7,014**	**20**	**0,000**	**1,7619**	-2,04810	-2,6572	-1,4390
conductive-insulative	0,020	5	0,985	3,8333	0,02333	-2,9757	3,0223
deep-treble	**4,793**	**20**	**0,000**	**5,7143**	1,90429	1,0756	2,7330
directional-directionless	1,491	5	0,196	5,1667	1,35667	-0,9821	3,6954
easy-difficult	**2,562**	**14**	**0,023**	**4,8667**	1,05667	0,1719	1,9414
entertaining-serious	**11,390**	**4**	**0,000**	**6,6000**	2,79000	2,1099	3,4701
ergonomic-non ergonomic	0,987	10	0,347	4,2727	0,46273	-0,5820	1,5074
excited-calm	**4,936**	**11**	**0,000**	**6,2500**	2,44000	1,3521	3,5279
flexible-solid	**14,174**	**14**	**0,000**	**6,7333**	2,92333	2,4810	3,3657
fresh-stale	-1,468	12	0,168	2,9231	-0,88692	-2,2031	0,4292
hard-soft	**-20,811**	**19**	**0,000**	**1,2500**	-2,56000	-2,8175	-2,3025
healthy-unhealthy	**-3,894**	**19**	**0,001**	**2,5000**	-1,31000	-2,0141	-0,6059
heavy-light	-0,448	19	0,659	3,6500	-0,16000	-0,9081	0,5881
high quality-poor quality	**-5,776**	**17**	**0,000**	**2,3333**	-1,47667	-2,0161	-0,9373
hygienic-non hygienic	-1,360	11	0,201	2,9167	-0,89333	-2,3386	0,5519
long lasting-short lived	**-14,182**	**14**	**0,000**	**1,4667**	-2,34333	-2,6977	-1,9889
loud-silent	**-4,879**	**11**	**0,000**	**1,8333**	-1,97667	-2,8684	-1,0850
natural-artificial	-1,686	13	0,116	3,0714	-0,73857	-1,6850	0,2078
reliable-unreliable	-1,307	11	0,218	2,8333	-0,97667	-2,6209	0,6676
rounded-sharp	1,698	4	0,165	4,8000	0,99000	-0,6289	2,6089
shiny-matte	**-2,680**	**13**	**0,019**	**2,5000**	-1,31000	-2,3662	-0,2538
sportive-formal	0,146	10	0,887	3,9091	0,09909	-1,4167	1,6149
tight-loose	-1,352	6	0,225	2,8571	-0,95286	-2,6772	0,7715
uneven-flat	**10,351**	**15**	**0,000**	**6,6250**	2,81500	2,2353	3,3947
user friendly-difficult to use	1,156	8	0,281	4,1111	0,30111	-0,2998	0,9020
wide-narrow	-2,124	10	0,060	3,0000	-0,81000	-1,6598	0,0398

Full List of One Sample *t*-Test Results of the Water Bottles in Component 1 (Continued)

Full list of one sample *t*-test results of B8

One-Sample Test							
Test Value = 3.79						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
amusing-boring	2,537	5	0,052	5,1667	1,37667	-0,0182	2,7715
cheap-expensive	**7,105**	**18**	**0,000**	**5,8421**	2,05211	1,4453	2,6589
cold-hot	-1,652	20	0,114	3,0000	-0,79000	-1,7873	0,2073
conductive-insulative	0,037	5	0,972	3,8333	0,04333	-2,9557	3,0423
deep-treble	**4,919**	**20**	**0,000**	**5,7143**	1,92429	1,1082	2,7404
directional-directionless	1,513	5	0,191	5,1667	1,37667	-0,9621	3,7154
easy-difficult	**2,610**	**14**	**0,021**	**4,8667**	1,07667	0,1919	1,9614
entertaining-serious	**11,472**	**4**	**0,000**	**6,6000**	2,81000	2,1299	3,4901
ergonomic-non ergonomic	0,782	10	0,453	4,1818	0,39182	-0,7250	1,5086
excited-calm	**2,699**	**11**	**0,021**	**5,5000**	1,71000	0,3153	3,1047
flexible-solid	**14,271**	**14**	**0,000**	**6,7333**	2,94333	2,5010	3,3857
fresh-stale	-1,435	12	0,177	2,9231	-0,86692	-2,1831	0,4492
hard-soft	**-7,547**	**19**	**0,000**	**1,6500**	-2,14000	-2,7335	-1,5465
healthy-unhealthy	**-3,866**	**19**	**0,001**	**2,7000**	-1,09000	-1,6800	-0,5000
heavy-light	0,400	19	0,694	3,9500	0,16000	-0,6782	0,9982
high quality-poor quality	**-4,413**	**17**	**0,000**	**2,4444**	-1,34556	-1,9888	-0,7023
hygienic-non hygienic	-1,330	11	0,210	2,9167	-0,87333	-2,3186	0,5719
long lasting-short lived	**-11,512**	**14**	**0,000**	**1,6000**	-2,19000	-2,5980	-1,7820
loud-silent	**-4,621**	**11**	**0,001**	**1,8333**	-1,95667	-2,8886	-1,0247
natural-artificial	-1,966	13	0,071	3,1429	-0,64714	-1,3582	0,0639
reliable-unreliable	**-2,223**	**11**	**0,048**	**2,3333**	-1,45667	-2,8988	-0,0146
rounded-sharp	1,589	4	0,187	4,6000	0,81000	-0,6057	2,2257
shiny-matte	**-4,885**	**13**	**0,000**	**1,7143**	-2,07571	-2,9936	-1,1578
sportive-formal	0,040	10	0,969	3,8182	0,02818	-1,5277	1,5841
tight-loose	-1,324	6	0,234	2,8571	-0,93286	-2,6572	0,7915
uneven-flat	**6,997**	**15**	**0,000**	**6,5000**	2,71000	1,8845	3,5355
user friendly-difficult to use	1,232	8	0,253	4,1111	0,32111	-0,2798	0,9220
wide-narrow	-1,783	10	0,105	3,0909	-0,69909	-1,5727	0,1745

V. Full List of One Sample *t*-Test Results of the Water Bottles in Component 2

Full list of one sample *t*-test results of B1

One-Sample Test							
Test Value = 4.22						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
big-small	-0,671	7	0,524	3,7500	-0,47000	-2,1270	1,1870
comfortable-uncomfortable	-0,540	13	0,598	3,9286	-0,29143	-1,4565	0,8736
cool-despised	-0,016	4	0,988	4,2000	-0,02000	-3,4655	3,4255
discordant-coherent	1,190	10	0,262	4,9091	0,68909	-0,6016	1,9798
dishonest-honest	1,011	4	0,369	5,2000	0,98000	-1,7119	3,6719
distinct-ambiguous	-1,384	7	0,209	3,2500	-0,97000	-2,6270	0,6870
durable-flimsy	**-3,551**	**26**	**0,001**	**2,8889**	-1,33111	-2,1017	-0,5605
dynamic-inactive	**-5,786**	**11**	**0,000**	**1,9167**	-2,30333	-3,1795	-1,4272
easy to clean-hard to clean	-0,409	5	0,700	3,8333	-0,38667	-2,8178	2,0445
feminine-masculine	**3,673**	**16**	**0,002**	**5,3529**	1,13294	0,4790	1,7869
handy-impractical	-0,550	5	0,606	3,8333	-0,38667	-2,1942	1,4209
outdoor-indoor	-1,524	5	0,188	2,8333	-1,38667	-3,7254	0,9521
particular-standard	-1,182	6	0,282	3,1429	-1,07714	-3,3063	1,1520
portable-stable	-1,592	11	0,140	3,5000	-0,72000	-1,7154	0,2754
protective-vulnerable	-0,879	10	0,400	3,5455	-0,67455	-2,3837	1,0346
relieving-irritating	**3,250**	**8**	**0,012**	**5,4444**	1,22444	0,3556	2,0933
sincere-insincere	0,948	6	0,380	4,7143	0,49429	-0,7821	1,7707
sweet-bitter	-0,821	9	0,433	3,7000	-0,52000	-1,9527	0,9127
tall-short	**2,814**	**4**	**0,048**	**6,0000**	1,78000	0,0240	3,5360
thin-thick	0,955	6	0,376	5,0000	0,78000	-1,2179	2,7779
transparent-opaque	**40,101**	**24**	**0,000**	**6,8800**	2,66000	2,5231	2,7969
unnecessary-necessary	1,846	7	0,107	5,0000	0,78000	-0,2192	1,7792

Full list of one sample *t*-test results of B2

One-Sample Test							
Test Value = 4.07						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
big-small	-0,166	7	0,873	4,0000	-0,07000	-1,0692	0,9292
comfortable-uncomfortable	0,880	13	0,395	4,5000	0,43000	-0,6262	1,4862
cool-despised	0,454	4	0,673	4,6000	0,53000	-2,7079	3,7679
discordant-coherent	-1,065	10	0,312	3,4545	-0,61545	-1,9029	0,6720
dishonest-honest	-0,233	4	0,827	3,8000	-0,27000	-3,4840	2,9440
distinct-ambiguous	1,385	7	0,209	4,7500	0,68000	-0,4810	1,8410
durable-flimsy	**-2,653**	**26**	**0,013**	**3,1852**	-0,88481	-1,5703	-0,1993
dynamic-inactive	-0,269	11	0,793	3,9167	-0,15333	-1,4083	1,1017
easy to clean-hard to clean	0,203	5	0,847	4,1667	0,09667	-1,1302	1,3235
feminine-masculine	**-4,184**	**16**	**0,001**	**2,5882**	-1,48176	-2,2326	-0,7310
handy-impractical	0,835	5	0,442	4,6667	0,59667	-1,2411	2,4344
outdoor-indoor	0,708	5	0,511	4,6667	0,59667	-1,5710	2,7644
particular-standard	0,088	6	0,933	4,1429	0,07286	-1,9554	2,1011
portable-stable	-0,142	11	0,890	4,0000	-0,07000	-1,1537	1,0137
protective-vulnerable	-0,375	10	0,716	3,8182	-0,25182	-1,7486	1,2449
relieving-irritating	**7,840**	**8**	**0,000**	**6,3333**	2,26333	1,5976	2,9290
sincere-insincere	-0,257	6	0,806	3,8571	-0,21286	-2,2411	1,8154
sweet-bitter	0,481	9	0,642	4,4000	0,33000	-1,2227	1,8827
tall-short	-0,684	4	0,532	3,4000	-0,67000	-3,3903	2,0503
thin-thick	-0,143	6	0,891	4,0000	-0,07000	-1,2640	1,1240
transparent-opaque	**4,370**	**24**	**0,000**	**5,1200**	1,05000	0,5541	1,5459
unnecessary-necessary	-2,058	7	0,079	2,8750	-1,19500	-2,5678	0,1778

Full List of One Sample *t*-Test Results of the Water Bottles in Component 2 (Continued)

Full list of one sample *t*-test results of B3

One-Sample Test							
Test Value = 3.71						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
big-small	1,177	7	0,278	4,3750	0,66500	-0,6710	2,0010
comfortable-uncomfortable	-0,918	13	0,375	3,2857	-0,42429	-1,4225	0,5739
cool-despised	**-3,824**	**4**	**0,019**	**2,0000**	-1,71000	-2,9517	-0,4683
discordant-coherent	1,703	10	0,119	4,6364	0,92636	-0,2856	2,1383
dishonest-honest	0,122	4	0,908	3,8000	0,09000	-1,9503	2,1303
distinct-ambiguous	-0,308	7	0,767	3,5000	-0,21000	-1,8212	1,4012
durable-flimsy	-1,965	26	0,060	3,1852	-0,52481	-1,0738	0,0242
dynamic-inactive	**-2,704**	**11**	**0,021**	**2,5833**	-1,12667	-2,0437	-0,2096
easy to clean-hard to clean	-0,057	5	0,957	3,6667	-0,04333	-1,9973	1,9106
feminine-masculine	**5,346**	**16**	**0,000**	**5,1765**	1,46647	0,8849	2,0480
handy-impractical	-0,652	5	0,543	3,1667	-0,54333	-2,6855	1,5988
outdoor-indoor	-0,047	5	0,964	3,6667	-0,04333	-2,4055	2,3189
particular-standard	-1,067	6	0,327	2,8571	-0,85286	-2,8096	1,1038
portable-stable	**-2,338**	**11**	**0,039**	**2,7500**	-0,96000	-1,8636	-0,0564
protective-vulnerable	**-2,484**	**10**	**0,032**	**2,6364**	-1,07364	-2,0366	-0,1107
relieving-irritating	**4,356**	**8**	**0,002**	**5,3333**	1,62333	0,7639	2,4827
sincere-insincere	-0,460	6	0,662	3,4286	-0,28143	-1,7782	1,2153
sweet-bitter	-0,761	9	0,466	3,3000	-0,41000	-1,6282	0,8082
tall-short	1,537	4	0,199	5,2000	1,49000	-1,2019	4,1819
thin-thick	1,657	6	0,149	4,7143	1,00429	-0,4788	2,4873
transparent-opaque	-0,911	24	0,371	3,4800	-0,23000	-0,7510	0,2910
unnecessary-necessary	1,682	7	0,137	4,8750	1,16500	-0,4731	2,8031

Full list of one sample *t*-test results of B4

One-Sample Test							
Test Value = 3.60						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
big-small	-0,686	7	0,515	3,1250	-0,47500	-2,1131	1,1631
comfortable-uncomfortable	0,530	13	0,605	3,7857	0,18571	-0,5715	0,9429
cool-despised	1,980	4	0,119	5,0000	1,40000	-0,5632	3,3632
discordant-coherent	0,766	10	0,461	4,0000	0,40000	-0,7636	1,5636
dishonest-honest	0,187	4	0,861	3,8000	0,20000	-2,7644	3,1644
distinct-ambiguous	-1,521	7	0,172	2,7500	-0,85000	-2,1719	0,4719
durable-flimsy	-0,337	26	0,739	3,4815	-0,11852	-0,8411	0,6040
dynamic-inactive	**-2,340**	**11**	**0,039**	**2,5833**	-1,01667	-1,9729	-0,0604
easy to clean-hard to clean	-1,400	5	0,220	2,6667	-0,93333	-2,6471	0,7804
feminine-masculine	**4,528**	**16**	**0,000**	**5,0000**	1,40000	0,7446	2,0554
handy-impractical	-0,878	5	0,420	3,0000	-0,60000	-2,3560	1,1560
outdoor-indoor	-0,332	5	0,753	3,3333	-0,26667	-2,3303	1,7969
particular-standard	0,852	6	0,427	4,4286	0,82857	-1,5508	3,2080
portable-stable	-0,356	11	0,728	3,4167	-0,18333	-1,3153	0,9487
protective-vulnerable	0,407	10	0,693	3,8182	0,21818	-0,9767	1,4131
relieving-irritating	0,234	8	0,821	3,7778	0,17778	-1,5741	1,9297
sincere-insincere	1,838	6	0,116	4,7143	1,11429	-0,3688	2,5973
sweet-bitter	-0,722	9	0,488	3,2000	-0,40000	-1,6527	0,8527
tall-short	1,565	4	0,193	5,0000	1,40000	-1,0833	3,8833
thin-thick	0,291	6	0,781	3,8571	0,25714	-1,9071	2,4214
transparent-opaque	**-16,512**	**24**	**0,000**	**1,3200**	-2,28000	-2,5650	-1,9950
unnecessary-necessary	0,040	7	0,969	3,6250	0,02500	-1,4529	1,5029

Full List of One Sample *t*-Test Results of the Water Bottles in Component 2 (Continued)

Full list of one sample *t*-test results of B5

One-Sample Test

Test Value = 3.55						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
big-small	-1,800	7	0,115	2,3750	-1,17500	-2,7190	0,3690
comfortable-uncomfortable	**2,847**	**13**	**0,014**	**4,5714**	1,02143	0,2463	1,7965
cool-despised	0,216	4	0,840	3,8000	0,25000	-2,9640	3,4640
discordant-coherent	0,575	10	0,578	3,9091	0,35909	-1,0325	1,7507
dishonest-honest	**12,452**	**4**	**0,000**	**6,6000**	3,05000	2,3699	3,7301
distinct-ambiguous	-2,009	7	0,085	2,6250	-0,92500	-2,0139	0,1639
durable-flimsy	**5,314**	**26**	**0,000**	**5,4815**	1,93148	1,1844	2,6786
dynamic-inactive	**4,296**	**11**	**0,001**	**5,4167**	1,86667	0,9104	2,8229
easy to clean-hard to clean	-0,059	5	0,955	3,5000	-0,05000	-2,2262	2,1262
feminine-masculine	**-11,194**	**16**	**0,000**	**1,8235**	-1,72647	-2,0534	-1,3995
handy-impractical	-0,586	5	0,583	3,1667	-0,38333	-2,0646	1,2979
outdoor-indoor	1,872	5	0,120	5,0000	1,45000	-0,5412	3,4412
particular-standard	0,981	6	0,365	4,4286	0,87857	-1,3137	3,0709
portable-stable	1,907	11	0,083	4,7500	1,20000	-0,1848	2,5848
protective-vulnerable	-0,500	10	0,628	3,1818	-0,36818	-2,0088	1,2724
relieving-irritating	**-13,300**	**8**	**0,000**	**1,3333**	-2,21667	-2,6010	-1,8323
sincere-insincere	-0,841	6	0,432	2,7143	-0,83571	-3,2659	1,5945
sweet-bitter	**-4,358**	**9**	**0,002**	**1,9000**	-1,65000	-2,5064	-0,7936
tall-short	**a**	**4**	**0,000**	**1,0000**	0,00000	0,0000	0,0000
thin-thick	1,992	6	0,093	5,1429	1,59286	-0,3638	3,5496
transparent-opaque	**-13,789**	**24**	**0,000**	**1,6000**	-1,95000	-2,2419	-1,6581
unnecessary-necessary	-0,213	7	0,838	3,3750	-0,17500	-2,1197	1,7697

a. t cannot be computed because the standard deviation is 0.

Full list of one sample *t*-test results of B6

One-Sample Test

Test Value = 3.92						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
big-small	-1,904	7	0,099	2,8750	-1,04500	-2,3430	0,2530
comfortable-uncomfortable	0,698	13	0,498	4,2143	0,29429	-0,6166	1,2052
cool-despised	0,518	4	0,632	4,4000	0,48000	-2,0948	3,0548
discordant-coherent	-0,784	10	0,451	3,4545	-0,46545	-1,7875	0,8566
dishonest-honest	**4,133**	**4**	**0,014**	**6,4000**	2,48000	0,8141	4,1459
distinct-ambiguous	**-2,505**	**7**	**0,041**	**2,5000**	-1,42000	-2,7606	-0,0794
durable-flimsy	**4,811**	**26**	**0,000**	**5,7778**	1,85778	1,0641	2,6515
dynamic-inactive	**6,916**	**11**	**0,000**	**6,0833**	2,16333	1,4748	2,8518
easy to clean-hard to clean	-1,187	5	0,289	3,3333	-0,58667	-1,8576	0,6843
feminine-masculine	**-13,352**	**16**	**0,000**	**1,6471**	-2,27294	-2,6338	-1,9121
handy-impractical	0,865	5	0,427	4,5000	0,58000	-1,1444	2,3044
outdoor-indoor	1,538	5	0,185	5,3333	1,41333	-0,9489	3,7755
particular-standard	1,636	6	0,153	5,4286	1,50857	-0,7478	3,7650
portable-stable	**4,519**	**11**	**0,001**	**5,8333**	1,91333	0,9814	2,8453
protective-vulnerable	0,921	10	0,379	4,5455	0,62545	-0,8876	2,1386
relieving-irritating	**-18,354**	**8**	**0,000**	**1,2222**	-2,69778	-3,0367	-2,3588
sincere-insincere	-1,773	6	0,127	2,7143	-1,20571	-2,8699	0,4585
sweet-bitter	**-4,200**	**9**	**0,002**	**2,1000**	-1,82000	-2,8003	-0,8397
tall-short	0,289	4	0,787	4,2000	0,28000	-2,4119	2,9719
thin-thick	1,755	6	0,130	5,2857	1,36571	-0,5382	3,2697
transparent-opaque	**-36,882**	**24**	**0,000**	**1,1600**	-2,76000	-2,9144	-2,6056
unnecessary-necessary	-1,217	7	0,263	3,0000	-0,92000	-2,7075	0,8675

Full List of One Sample *t*-Test Results of the Water Bottles in Component 2 (Continued)

Full list of one sample *t*-test results of B7

One-Sample Test							
Test Value = 3.91						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
big-small	0,151	7	0,885	4,0000	0,09000	-1,3231	1,5031
comfortable-uncomfortable	-1,250	13	0,233	3,2143	-0,69571	-1,8979	0,5065
cool-despised	-1,218	4	0,290	3,2000	-0,71000	-2,3289	0,9089
discordant-coherent	**3,725**	**10**	**0,004**	**5,7273**	1,81727	0,7302	2,9043
dishonest-honest	0,082	4	0,938	4,0000	0,09000	-2,9514	3,1314
distinct-ambiguous	-0,296	7	0,776	3,6250	-0,28500	-2,5609	1,9909
durable-flimsy	**-10,767**	**26**	**0,000**	**1,5926**	-2,31741	-2,7598	-1,8750
dynamic-inactive	**-3,505**	**11**	**0,005**	**2,5833**	-1,32667	-2,1599	-0,4935
easy to clean-hard to clean	0,428	5	0,686	4,3333	0,42333	-2,1185	2,9652
feminine-masculine	**5,266**	**16**	**0,000**	**5,4118**	1,50176	0,8973	2,1063
handy-impractical	-1,115	5	0,316	3,0000	-0,91000	-3,0089	1,1889
outdoor-indoor	**a**	**5**	**0,000**	**1,0000**	0,00000	0,0000	0,0000
particular-standard	-0,802	6	0,453	3,2857	-0,62429	-2,5282	1,2797
portable-stable	**-14,824**	**11**	**0,000**	**1,2500**	-2,66000	-3,0549	-2,2651
protective-vulnerable	**-2,417**	**10**	**0,036**	**2,6364**	-1,27364	-2,4478	-0,0995
relieving-irritating	0,118	8	0,909	4,0000	0,09000	-1,6712	1,8512
sincere-insincere	0,272	6	0,795	4,1429	0,23286	-1,8645	2,3302
sweet-bitter	**3,544**	**9**	**0,006**	**5,8000**	1,89000	0,6835	3,0965
tall-short	**10,982**	**4**	**0,000**	**6,6000**	2,69000	2,0099	3,3701
thin-thick	0,757	6	0,478	4,4286	0,51857	-1,1579	2,1950
transparent-opaque	**54,354**	**24**	**0,000**	**6,9200**	3,01000	2,8957	3,1243
unnecessary-necessary	**4,098**	**7**	**0,005**	**5,8750**	1,96500	0,8312	3,0988

Full list of one sample *t*-test results of B8

One-Sample Test							
Test Value = 3.86						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
big-small	0,234	7	0,821	4,0000	0,14000	-1,2731	1,5531
comfortable-uncomfortable	-0,578	13	0,573	3,5714	-0,28857	-1,3679	0,7908
transparent-opaque	**55,257**	**24**	**0,000**	**6,9200**	2,01500	0,8812	3,1488
durable-flimsy	**-9,653**	**26**	**0,000**	**1,7778**	1,86727	0,8667	2,8678
dishonest-honest	0,128	4	0,904	4,0000	0,14000	-2,9014	3,1814
distinct-ambiguous	-0,244	7	0,814	3,6250	-0,23500	-2,5109	2,0409
portable-stable	**-14,546**	**11**	**0,000**	**1,2500**	-1,66000	-2,6989	-0,6211
discordant-coherent	**4,158**	**10**	**0,002**	**5,7273**	-1,13273	-2,2605	-0,0049
easy to clean-hard to clean	0,479	5	0,652	4,3333	0,47333	-2,0685	3,0152
tall-short	**6,350**	**4**	**0,003**	**6,4000**	3,06000	2,9457	3,1743
handy-impractical	-0,656	5	0,541	3,3333	-0,52667	-2,5903	1,5369
outdoor-indoor	-2,278	5	0,072	2,0000	-1,86000	-3,9589	0,2389
particular-standard	-0,574	6	0,587	3,4286	-0,43143	-2,2701	1,4072
unnecessary-necessary	**4,202**	**7**	**0,004**	**5,8750**	2,54000	1,4294	3,6506
dynamic-inactive	**-3,207**	**11**	**0,008**	**2,5833**	-1,27667	-2,1528	-0,4005
relieving-irritating	0,605	8	0,562	4,3333	0,47333	-1,3294	2,2760
sincere-insincere	0,794	6	0,457	4,5714	0,71143	-1,4809	2,9037
sweet-bitter	1,582	9	0,148	4,9000	1,04000	-0,4472	2,5272
cool-despised	**-4,437**	**4**	**0,011**	**2,2000**	-2,08222	-2,5256	-1,6388
thin-thick	-0,187	6	0,858	3,7143	-0,14571	-2,0497	1,7582
feminine-masculine	**2,167**	**16**	**0,046**	**4,6471**	-2,61000	-3,0049	-2,2151
protective-vulnerable	**-2,238**	**10**	**0,049**	**2,7273**	0,78706	0,0171	1,5570

W. Full List of One Sample *t*-Test Results of the Water Bottles in Component 3

Full list of one sample *t*-test results of B1

One-Sample Test

Test Value = 3.96	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
accustomed-eccentrical	-1,754	13	0,103	2,9286	-1,03143	-2,3018	0,2389
beautiful-ugly	1,302	10	0,222	4,7273	0,76727	-0,5455	2,0800
elaborated-sloppy	-0,267	19	0,792	3,8500	-0,11000	-0,9726	0,7526
fragmented-whole	0,872	6	0,417	4,7143	0,75429	-1,3624	2,8710
functional-functionless	-0,238	7	0,818	3,7500	-0,21000	-2,2941	1,8741
old-new	0,200	4	0,851	4,2000	0,24000	-3,0917	3,5717
pleasurable-dissatisfactory	-0,776	10	0,456	3,4545	-0,50545	-1,9577	0,9468

Full list of one sample *t*-test results of B2

One-Sample Test

Test Value = 3.96	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
accustomed-eccentrical	**-2,290**	**13**	**0,039**	**3,0000**	-1,42000	-2,7598	-0,0802
beautiful-ugly	**2,911**	**10**	**0,016**	**5,7273**	1,30727	0,3067	2,3078
elaborated-sloppy	0,634	19	0,534	4,7000	0,28000	-0,6449	1,2049
fragmented-whole	1,159	6	0,290	5,2857	0,86571	-0,9618	2,6933
functional-functionless	-0,818	7	0,440	3,8750	-0,54500	-2,1210	1,0310
old-new	-1,883	4	0,133	2,8000	-1,62000	-4,0084	0,7684
pleasurable-dissatisfactory	0,508	10	0,622	4,7273	0,30727	-1,0394	1,6539

Full list of one sample *t*-test results of B3

One-Sample Test

Test Value = 3.41	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
accustomed-eccentrical	**4,030**	**13**	**0,001**	**5,0714**	1,66143	0,7709	2,5520
beautiful-ugly	-2,128	10	0,059	2,6364	-0,77364	-1,5839	0,0366
elaborated-sloppy	**-3,867**	**19**	**0,001**	**2,3500**	-1,06000	-1,6337	-0,4863
fragmented-whole	**-2,661**	**6**	**0,037**	**2,4286**	-0,98143	-1,8840	-0,0789
functional-functionless	-0,519	7	0,620	3,1250	-0,28500	-1,5830	1,0130
old-new	**3,229**	**4**	**0,032**	**5,6000**	2,19000	0,3069	4,0731
pleasurable-dissatisfactory	-1,709	10	0,118	2,6364	-0,77364	-1,7824	0,2351

Full list of one sample *t*-test results of B4

One-Sample Test

Test Value = 3.88	t	df	Sig. (2-tailed)	Mean	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
accustomed-eccentrical	**2,985**	**13**	**0,011**	**5,2143**	1,33429	0,3687	2,2999
beautiful-ugly	-0,613	10	0,553	3,5455	-0,33455	-1,5499	0,8808
elaborated-sloppy	-1,622	19	0,121	3,3500	-0,53000	-1,2137	0,1537
fragmented-whole	**-6,477**	**6**	**0,001**	**2,5714**	-1,30857	-1,8029	-0,8142
functional-functionless	**-4,771**	**7**	**0,002**	**2,6250**	-1,25500	-1,8770	-0,6330
old-new	2,264	4	0,086	5,2000	1,32000	-0,2989	2,9389
pleasurable-dissatisfactory	0,966	10	0,357	4,2727	0,39273	-0,5131	1,2986

Full List of One Sample *t*-Test Results of the Water Bottles in Component 3 (Continued)

Full list of one sample *t*-test results of B5

One-Sample Test							
Test Value = 3.63						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
accustomed-eccentrical	1,111	13	0,287	4,2143	0,58429	-0,5521	1,7207
beautiful-ugly	0,410	10	0,690	3,9091	0,27909	-1,2367	1,7949
elaborated-sloppy	-1,409	19	0,175	3,1000	-0,53000	-1,3175	0,2575
fragmented-whole	-1,422	6	0,205	2,7143	-0,91571	-2,4920	0,6605
functional-functionless	-0,260	7	0,802	3,5000	-0,13000	-1,3123	1,0523
old-new	1,637	4	0,177	5,0000	1,37000	-0,9529	3,6929
pleasurable-dissatisfactory	-0,468	10	0,650	3,2727	-0,35727	-2,0592	1,3447

Full list of one sample *t*-test results of B6

One-Sample Test							
Test Value = 3.62						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
accustomed-eccentrical	**-2,527**	**13**	**0,025**	**2,6429**	-0,97714	-1,8125	-0,1418
beautiful-ugly	0,861	10	0,409	4,0909	0,47091	-0,7478	1,6896
elaborated-sloppy	0,534	19	0,600	3,8500	0,23000	-0,6718	1,1318
fragmented-whole	-0,491	6	0,641	3,2857	-0,33429	-1,9985	1,3299
functional-functionless	1,613	7	0,151	4,7500	1,13000	-0,5270	2,7870
old-new	0,196	4	0,854	3,8000	0,18000	-2,3647	2,7247
pleasurable-dissatisfactory	-0,666	10	0,521	3,1818	-0,43818	-1,9045	1,0281

Full list of one sample *t*-test results of B7

One-Sample Test							
Test Value = 3.67						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
accustomed-eccentrical	-0,688	13	0,504	3,2857	-0,38429	-1,5918	0,8232
beautiful-ugly	-1,397	10	0,193	3,0909	-0,57909	-1,5029	0,3447
elaborated-sloppy	0,324	19	0,750	3,8000	0,13000	-0,7100	0,9700
fragmented-whole	0,641	6	0,545	4,1429	0,47286	-1,3323	2,2780
functional-functionless	**-3,453**	**7**	**0,011**	**2,3750**	-1,29500	-2,1817	-0,4083
old-new	0,678	4	0,535	4,4000	0,73000	-2,2603	3,7203
pleasurable-dissatisfactory	0,706	10	0,496	4,0000	0,33000	-0,7108	1,3708

Full list of one sample *t*-test results of B8

One-Sample Test							
Test Value = 3.74						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
accustomed-eccentrical	-1,505	13	0,156	3,0000	-0,74000	-1,8022	0,3222
beautiful-ugly	-1,218	10	0,251	3,2727	-0,46727	-1,3219	0,3873
elaborated-sloppy	0,451	19	0,657	3,9000	0,16000	-0,5823	0,9023
fragmented-whole	0,764	6	0,474	4,2857	0,54571	-1,2021	2,2935
functional-functionless	**-3,640**	**7**	**0,008**	**2,3750**	-1,36500	-2,2517	-0,4783
old-new	1,150	4	0,314	5,0000	1,26000	-1,7814	4,3014
pleasurable-dissatisfactory	-0,970	10	0,355	3,3636	-0,37636	-1,2405	0,4878

X. Full List of One Sample *t*-Test Results of the Water Bottles in Component 4

Full list of one sample *t*-test results of B1

One-Sample Test							
Test Value = 3.92						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
attractive-unattractive	**3,081**	**19**	**0,006**	**5,1500**	1,23000	0,3945	2,0655
childish-mature	**3,042**	**14**	**0,009**	**5,3333**	1,41333	0,4168	2,4098
coarse-gracious	**-2,973**	**5**	**0,031**	**2,6667**	-1,25333	-2,3372	-0,1695
controlled-uncontrolled	-0,485	7	0,643	3,5000	-0,42000	-2,4678	1,6278
non slippery-slippery	1,887	11	0,086	4,6667	0,74667	-0,1242	1,6176
plain-ornate	**-5,269**	**7**	**0,001**	**1,7500**	-2,17000	-3,1439	-1,1961
rough-smooth	**10,590**	**20**	**0,000**	**6,0476**	2,12762	1,7085	2,5467
simple-complex	**-7,604**	**15**	**0,000**	**1,8125**	-2,10750	-2,6983	-1,5167
steady-unsteady	**-3,133**	**6**	**0,020**	**2,2857**	-1,63429	-2,9107	-0,3579
vivid-pale	**4,653**	**8**	**0,002**	**5,8889**	1,96889	0,9932	2,9446

Full list of one sample *t*-test results of B2

One-Sample Test							
Test Value = 3.83						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
attractive-unattractive	-1,502	19	0,149	3,0000	-0,83000	-1,9864	0,3264
childish-mature	**-11,539**	**14**	**0,000**	**1,7333**	-2,09667	-2,4864	-1,7070
coarse-gracious	**4,356**	**5**	**0,007**	**5,6667**	1,83667	0,7528	2,9205
controlled-uncontrolled	1,170	7	0,280	4,6250	0,79500	-0,8123	2,4023
non slippery-slippery	**-2,422**	**11**	**0,034**	**2,7500**	-1,08000	-2,0615	-0,0985
plain-ornate	1,599	7	0,154	5,0000	1,17000	-0,5607	2,9007
rough-smooth	**-4,244**	**20**	**0,000**	**2,3810**	-1,44905	-2,1612	-0,7369
simple-complex	0,422	15	0,679	4,0625	0,23250	-0,9425	1,4075
steady-unsteady	**13,569**	**6**	**0,000**	**6,5714**	2,74143	2,2471	3,2358
vivid-pale	-1,597	8	0,149	2,4444	-1,38556	-3,3867	0,6156

Full list of one sample *t*-test results of B3

One-Sample Test							
Test Value = 3.67						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
attractive-unattractive	**-4,811**	**19**	**0,000**	**2,6000**	-1,07000	-1,5355	-0,6045
childish-mature	0,506	14	0,621	3,8667	0,19667	-0,6371	1,0304
coarse-gracious	-0,838	5	0,440	3,1667	-0,50333	-2,0481	1,0414
controlled-uncontrolled	0,087	7	0,933	3,7500	0,08000	-2,0978	2,2578
non slippery-slippery	0,808	11	0,436	4,0000	0,33000	-0,5685	1,2285
plain-ornate	1,932	7	0,095	4,7500	1,08000	-0,2419	2,4019
rough-smooth	1,703	20	0,104	4,1905	0,52048	-0,1171	1,1581
simple-complex	1,721	15	0,106	4,3125	0,64250	-0,1531	1,4381
steady-unsteady	-0,634	6	0,549	3,2857	-0,38429	-1,8673	1,0988
vivid-pale	-1,450	8	0,185	2,8889	-0,78111	-2,0232	0,4610

Full List of One Sample *t*-Test Results of the Water Bottles in Component 4 (Continued)

Full list of one sample *t*-test results of B4

One-Sample Test							
Test Value = 3.95						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
attractive-unattractive	1,648	19	0,116	4,6500	0,70000	-0,1890	1,5890
childish-mature	1,021	14	0,324	4,4667	0,51667	-0,5682	1,6016
coarse-gracious	**-5,803**	**5**	**0,002**	**2,1667**	-1,78333	-2,5733	-0,9933
controlled-uncontrolled	-0,905	7	0,396	3,2500	-0,70000	-2,5289	1,1289
non slippery-slippery	-0,069	11	0,946	3,9167	-0,03333	-1,0985	1,0319
plain-ornate	0,076	7	0,941	4,0000	0,05000	-1,4980	1,5980
rough-smooth	1,297	20	0,209	4,4286	0,47857	-0,2908	1,2480
simple-complex	0,678	15	0,508	4,2500	0,30000	-0,6432	1,2432
steady-unsteady	-0,527	6	0,617	3,5714	-0,37857	-2,1380	1,3808
vivid-pale	0,810	8	0,441	4,5556	0,60556	-1,1180	2,3291

Full list of one sample *t*-test results of B5

One-Sample Test							
Test Value = 3.80						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
attractive-unattractive	0,227	19	0,823	3,9000	0,10000	-0,8224	1,0224
childish-mature	-1,673	14	0,116	3,0000	-0,80000	-1,8254	0,2254
coarse-gracious	0,702	5	0,514	4,3333	0,53333	-1,4206	2,4873
controlled-uncontrolled	0,873	7	0,412	4,5000	0,70000	-1,1959	2,5959
non slippery-slippery	-1,132	11	0,282	3,0833	-0,71667	-2,1102	0,6769
plain-ornate	1,590	7	0,156	5,1250	1,32500	-0,6452	3,2952
rough-smooth	-0,092	20	0,928	3,7619	-0,03810	-0,9006	0,8244
simple-complex	1,955	15	0,069	4,6875	0,88750	-0,0799	1,8549
steady-unsteady	-1,488	6	0,187	2,8571	-0,94286	-2,4930	0,6073
vivid-pale	-1,652	8	0,137	2,7778	-1,02222	-2,4488	0,4044

Full list of one sample *t*-test results of B6

One-Sample Test							
Test Value = 4.12						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
attractive-unattractive	1,853	19	0,080	4,8000	0,68000	-0,0883	1,4483
childish-mature	-1,088	14	0,295	3,4667	-0,65333	-1,9413	0,6347
coarse-gracious	-0,344	5	0,745	3,8333	-0,28667	-2,4288	1,8555
controlled-uncontrolled	-1,343	7	0,221	3,2500	-0,87000	-2,4018	0,6618
non slippery-slippery	**3,051**	**11**	**0,011**	**5,5000**	1,38000	0,3846	2,3754
plain-ornate	0,512	7	0,624	4,3750	0,25500	-0,9220	1,4320
rough-smooth	**4,501**	**20**	**0,000**	**5,8571**	1,73714	0,9320	2,5423
simple-complex	**-2,444**	**15**	**0,027**	**3,0625**	-1,05750	-1,9798	-0,1352
steady-unsteady	-0,856	6	0,425	3,7143	-0,40571	-1,5651	0,7536
vivid-pale	-1,570	8	0,155	3,2222	-0,89778	-2,2168	0,4212

Full List of One Sample *t*-Test Results of the Water Bottles in Component 4 (Continued)

Full list of one sample *t*-test results of B7

One-Sample Test							
Test Value = 4.15						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
attractive-unattractive	-0,887	19	0,386	3,8000	-0,35000	-1,1761	0,4761
childish-mature	**21,858**	**14**	**0,000**	**6,7333**	2,58333	2,3298	2,8368
coarse-gracious	-0,220	5	0,835	4,0000	-0,15000	-1,9060	1,6060
controlled-uncontrolled	0,452	7	0,665	4,3750	0,22500	-0,9520	1,4020
non slippery-slippery	1,092	11	0,298	4,8333	0,68333	-0,6937	2,0603
plain-ornate	-2,075	7	0,077	2,7500	-1,40000	-2,9957	0,1957
rough-smooth	**2,910**	**20**	**0,009**	**5,4762**	1,32619	0,3755	2,2769
simple-complex	**-6,752**	**15**	**0,000**	**2,0625**	-2,08750	-2,7464	-1,4286
steady-unsteady	**-3,948**	**6**	**0,008**	**2,1429**	-2,00714	-3,2512	-0,7631
vivid-pale	**2,423**	**8**	**0,042**	**5,5556**	1,40556	0,0680	2,7431

Full list of one sample *t*-test results of B8

One-Sample Test							
Test Value = 3.85						95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean	Mean Difference	Lower	Upper
attractive-unattractive	**-3,044**	**19**	**0,007**	**2,8000**	-1,05000	-1,7719	-0,3281
childish-mature	**4,446**	**14**	**0,001**	**5,8000**	1,95000	1,0093	2,8907
coarse-gracious	-0,022	5	0,983	3,8333	-0,01667	-1,9422	1,9089
controlled-uncontrolled	1,055	7	0,327	4,3750	0,52500	-0,6520	1,7020
non slippery-slippery	1,318	11	0,214	4,6667	0,81667	-0,5469	2,1803
plain-ornate	**-2,461**	**7**	**0,043**	**2,6250**	-1,22500	-2,4020	-0,0480
rough-smooth	**4,473**	**20**	**0,000**	**5,8571**	2,00714	1,0711	2,9432
simple-complex	**-3,624**	**15**	**0,002**	**2,3750**	-1,47500	-2,3424	-0,6076
steady-unsteady	**-2,956**	**6**	**0,025**	**2,4286**	-1,42143	-2,5982	-0,2446
vivid-pale	0,260	8	0,802	4,0000	0,15000	-1,1814	1,4814

Y. Common Attitudes For Both Experiments And Their Significant Correlations

Common elicited attitudes for both experiments and their significant correlations

CORRELATIONS (COMPUTER MOUSES)			(WATER BOTTLES) CORRELATIONS		
	directionless-directional	**ambiguous-distinct**	**distinct-ambiguous**	relieving-irritating	big-small
user friendly-difficult to use	handy-impractical	**comfortable-uncomfortable**	**comfortable-uncomfortable**	masculine-feminine	necessary-unnecessary
simple-complex	hidden-open	**coherent-discordant**	**discordant-coherent**	unnecessary-necessary	indoor-outdoor
handy-impractical	functional-functionless	**controlled-uncontrolled**	**controlled-uncontrolled**	coarse-gracious	
hidden-open	symmetric-asymmetric	**plain-ornate**	**plain-ornate**	simple-complex	pale-vivid
extraordinary-common	ambiguous-distinct	**directionless-directional**	**directional-directionless**	excited-calm	silent-loud
controlled-uncontrolled	curved-flat	**user friendly-difficult to use**	**user friendly-difficult to use**	loose-tight	easy-difficult
obtuse-pointed	curved-flat	**rounded-sharp**	**rounded-sharp**	excited-calm	uneven-flat
bad-good	poor quality-high quality	**sloppy-elaborated**	**elaborated-sloppy**	new-old	fragmented-whole
handy-impractical	unproblematic-problematic	**ergonomic-non ergonomic**	**ergonomic-non ergonomic**	artificial-natural	stale-fresh
obtuse-pointed	controlled-uncontrolled	**functional-functionless**	**functional-functionless**	new-old	beautiful-ugly
smooth-rough	slippery-non slippery	**shiny-matte**	**shiny-matte**	loud-silent	serious-entertaining
light-heavy	reassuring-insecure	**gracious-coarse**	**coarse-gracious**	controlled-uncontrolled	
whole-fragmented	shiny-matte	**slippery-non slippery**	**non slippery-slippery**	rough-smooth	complex-simple
good-bad	high quality-poor quality	**healthy-unhealthy**	**healthy-unhealthy**	natural-artificial	fresh-stale
accustomed-eccentrical	thick-thin	**high-low**	**tall-short**	uncomfortable-comfortable	indoor-outdoor
outdated-technological	raspy-tuneful	**loud-silent**	**loud-silent**	shiny-matte	serious-entertaining
sloppy-elaborated	bad-good	**unnecessary-necessary**	**unnecessary-necessary**	discordant-coherent	indoor-outdoor
outdated-technological	classical-modern	**old-new**	**old-new**	sloppy-elaborated	functionless-functional
dirty-clean	open-hidden	**deep-treble**	**deep-treble**	silent-loud	matte-shiny
healthy-unhealthy	good-bad	**high quality-poor quality**	**high quality-poor quality**	expensive-cheap	reliable-unreliable
healthy-unhealthy	clean-dirty	**smooth-rough**	**rough-smooth**	slippery-non slippery	
dynamic-bulky	transparent-opaque	**entertaining-serious**	**entertaining-serious**	matte-shiny	silent-loud
hidden-open	coherent-discordant	**simple-complex**	**simple-complex**	plain-ornate	smooth-rough
bulky-dynamic	long-short	**big-small**	**big-small**	relieving-irritating	flimsy-durable
ornate-plain	asymmetric-symmetric	**soft-hard**	**hard-soft**	long lasting-short lived	tight-loose

CORRELATIONS (COMPUTER MOUSES)			(WATER BOTTLES) CORRELATIONS		
eccentrical- accustomed	transparent- opaque	**particular- standard**	**particular- standard**	dynamic- bulky	protective- vulnerable
clean- dirty	whole- fragmented	**durable- flimsy**	**durable- flimsy**	stable- portable	sweet- bitter
slippery- non slippery	non sticky- sticky	**cold- hot**	**cold- hot**	calm- excited	hard- difficult
insecure- secure	coarse- gracious	**thick- thin**	**thin- thick**	dishonest- honest	
gracious- coarse	particular- standard	**transparent- opaque**	**transparent- opaque**	flimsy- durable	sweer- bittter
ergonomic- non ergonomic	comfortable- uncomfortable	**handy- impractical**	**handy- impractical**	portable- stable	outdoor- indoor
insecure- secure	slow- fast	**heavy- light**	**heavy- light**	healthy- unhealthy	natural- artificial
hidden- open	durable- flimsy	**whole- fragmented**	**fragmented- whole**	elaborated- sloppy	eccentrical- accustomed
small- big	fast- slow	**dynamic- bulky**	**dynamic- inactive**	masculine- feminine	insincere- sincere
user friendly- difficult to use	rounded- sharp	**curved- flat**	**uneven- flat**	rounded- sharp	excited- calm

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PUBLICATIONS

1. Derviş, B., & Börekçi, N. A. (2018). Ürün ve Kullanıcı Etkileşiminde Olumlu Duyusal Deneyimler için Malzeme Seçimi. *Üçüncü Ulusal Tasarım Araştırmaları Konferansı.* Ankara: Orta Doğu Teknik Üniversitesi.

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