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INVESTIGATING THE ROLE OF AESTHETICS FOR INTERACTION DESIGN

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ABSTRACT
Two important aspects when designing products is to focus on comfort and to define the aesthetic and emotional value of the product. The main purpose of this research is to answer the question of how attractiveness perceived through the sensory inputs affects the assessment of comfort as well as to explore associations between comfort and product descriptors. The findings of this research are expected to assist designers in developing successful new products by focusing more on softer factors. A study of twenty three respondents assessing comfort in three phases found that comfort scores increase when the levels of attractiveness increase and vice versa. The findings further indicate that there are strong, significant correlations between scores of comfort and product adjectives commonly used to describe product attributes such as size, weight and surface material. Hence, there is an emotional dimension of comfort which is initiated by the visual input during a human – product interaction and is affected by the attractiveness towards the product. In their endeavor to develop successful and comfortable products designers should focus more on attractiveness.

Keywords: user-experience, comfort, aesthetics, emotional design

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1 INTRODUCTION

Comfort is always taken into account when designing products, in particular those with physical contact with the consumer, e.g. headsets or chairs. When driving a car, when buying a bed, even when flying, comfort is taken into account. An equally important aspect of product design is to define the aesthetic and emotional value of the product. The success of a product is not only dependent on its functionality but also on the emotional value that it creates to its user (Achiche & Ahmed-Kristensen, 2008). The industry aims for comfortable and attractive products in order to stay ahead of competition.
Extensive academic research mostly in the form of comfort studies (Hitchings, 2009), (Kuijt-Evers, 2004), (DeLooze et al., 2003) has explored some of the influential factors of comfort such as postural stress (Kee et al., 2012), levels of pressure (force increase) (Goossens et al. 1998, 2002) and noise (Vink et al. 2001), most of which are physical, physiological or linked to external attributes of the environment in which the interaction between a human and a product takes place. Although researchers have attempted through additional studies to address psychological and emotional factors affecting the comfort experience such as the history of past interactions towards the product (Vink, 2012), the current emotional state of the user when interacting with a product (Pickard 1997) as well as the visual information as being a first impression of comfort (Bronkhorst et al. 2001), the research on the emotional dimension of comfort is underdeveloped. There are three main issues when designing a product to achieve comfort: the exact cause of comfort is unknown, comfort relies to a certain extent on subjectivity and there is a lack of a comfort design process or approach (Vink, 2005). Past research on comfort has been rather mono disciplinary. The most recent comfort models which provide a methodological framework towards defining comfort (DeLooze, 2003) are underdeveloped when it comes to investigate the emotional dimensions of comfort and lack a more generalized approach. Against this background one of the two aims of this research is to investigate how attractiveness affects the assessment of comfort during a human – product experience. The second aim is to explore associations between comfort and product descriptors, that is, commonly used adjectives to describe a product. Essentially, this research responds to the call for a new approach towards comfort and draws inspiration from Vink (2012) who has stressed the need for an improved comfort methodology. The findings of this research are expected to assist designers in developing successful new products by focusing more on softer factors such as the attractiveness. The paper consists of three parts. First it reviews the existing literature relevant to comfort studies and aesthetics. Then the research methodology is presented and data analysis techniques are discussed. In the last section the findings are discussed and summarized. The paper concludes with a discussion of theoretical and managerial implications and directions for further research.

2 LITERATURE REVIEW

2.1 Comfort theory: Comfort and discomfort and the debate in literature

This section will initially introduce comfort definitions. In dictionaries comfort is described as “a subjective state of well-being in relation to an induced environment including mechanical vibration or shock”. Comfort is, however, commonly associated with terms such as, “assistance, relief, support” and is also seen as “a feeling of freedom from worry or disappointment” (The Oxford Dictionary of English, 2005). Slater (1987) defines comfort as a pleasant state of physiological, psychological and physical harmony between a human being and the environment. Richards (1980) states that comfort is the state of a person that involves a sense of subjective well-being in reaction to an environment or a situation. In regards to the subjective nature of comfort Vink (2005) states that “Comfort is a subjective experience. For Passenger 1 on a long distance flight, back discomfort is of great importance. Passenger 2 wants a reduction in noise and Passenger 3 needs more space.” In this paper comfort is defined as (1) a construct of subjectively defined personal nature, (2) it is a reaction to the environment and (3) it is affected by factors of various natures (physical, psychological and physiological). Comfort has been linked to the term “discomfort” since the first attempt to operationally define comfort as “the absence of discomfort” (Hertzberg, 1958). Comfort is not a well-defined concept yielding an on-going debate in the literature. The debate stresses on the difference between comfort and discomfort. Several researchers (Hertzberg, 1958), (Floyd, 1958), (Richards, 1980), (Leuder, 1983), (Bishu et al., 1981) seem to be making a distinction between two different states of comfort. According to Bishu et al. (1981), in particular for seating design, “the goal of the designers is to reach the state of absence of discomfort, where the working individual is oblivious of the fact that he or she is seated.” In his study, Richards (1980) has suggested that the fact that people rate their subjective responses across the entire continuum from discomfort to comfort indicates that comfort is part of a bipolar dimension that can be attributed to characteristics of design. This statement is supported by a number of papers in hand tool evaluation studies in which comfort is measured in terms of discomfort (Fellows, 1991). As discomfort factors are present in hand tool use, comfort may be dominated by discomfort (Kuijt-Evers et al., 2004). In their study, Kuijt-Evers et al. (2004) identified factors having the closest relationship to comfort among 40 descriptors. Clustering the factors explained 53.8 % of the variance. In the use of hand tools it was concluded that the same descriptors relate to both comfort and discomfort. Two studies in the design of seats support the above statement. A comfort study (Jianghong et al., 1994) carried out to evaluate the comfort of a passenger seat for a new type of bus and a comfort study (Wilder et al., 1994) which was carried out to compare two different track seats (with and without suspension) when changing driving postures. It was concluded that comfort and discomfort can be seen as two opposites on a continuous scale. This stems from the fact, that people frequently and naturally distinguish ordered levels of their subjective responses across the entire continuum from strongly positive to strongly negative (Richards, 1980). The same principle underlies the graded scales (Habsburg et al., 1977) which have been used to evaluate seats. Opposing to the theory of seeing comfort and discomfort as two extreme states on a continuous scale ranging from extreme discomfort through a neutral state to extreme comfort, several studies have questioned the intuitive assumption of comfort/ discomfort as a single dimension on a continuous scale. These studies (Kleeman, 1981), (Zhang et al., 1996), argue that comfort and discomfort are affected by distinctly different variables, and assessment of comfort and discomfort should hence be based on different types of criteria. In the study by Zhang et al. (1996), the identification of these variables was the primary goal. Descriptors of feelings of comfort and discomfort were solicited from office workers and validated in a questionnaire study. From this study, 43 descriptors emerged which were grouped into two main factors, which were interpreted as comfort and discomfort. Feelings of discomfort are mainly associated with pain, tiredness, soreness and numbness. These feelings are assumed to be imposed by physical constraints and mediated by physical factors like joint angles, tissue pressure and circulation blockage. Comfort, on the other hand, is associated with feelings of relaxation and well-being (Paul et al., 1997). It was concluded that siting comfort and discomfort were identified as independent entities associated with different factors: discomfort is related to biomechanics and fatigue factors, whereas comfort is related to a sense of well-being and aesthetics. Comfort and discomfort need to be treated as different and complementary entities in ergonomic investigations. To conclude, there was little consensus on whether comfort and discomfort should be regarded as being a bipolar continuum or as composing of two experiential dimensions but the theory of Helander and Zhang (1996) convinced the authors that there was a division or discontinuity between comfort and discomfort scales. However, both comfort and discomfort should be addressed since discomfort seems to be more tangible, hence, easier for the individual to express.

2.2 Underlying factors of comfort: Context and type of activity

Ellegast et al. (2012) aimed to evaluate the effects of four specific dynamic chairs on erector spine and trapezius Electromyograms (EMG), postures/joint angles and Physical Activity Intensity (PAI) compared to those of a conventional standard office chair. All chairs were compared to a reference chair. The characteristic dynamic elements of each specific chair yielded significant differences in measured chair parameters, but these characteristics hardly affected the body dynamics of the subjects sitting on the chairs. The results of the study emphasize that many aspects of workplace design, such as variability of tasks should be considered in order for musculoskeletal disorders to be prevented (Kamp, 2012). In a similar context, Groenesteijn et al. (2012) investigated the effect of office tasks on posture and movements in field settings, and the comfort rating for chair characteristics and correlation with type of task. The tasks concerned computer work, conversation, telephoning and desk work. Positive comfort correlations were found among different types of activities and different types of chairs. Hence, the type of task plays an important role when investigating comfort. It is necessary to define the context and the type of activity when assessing comfort.

2.3 Influencing product factors: neighboring body surface and product form

Franz et al. (2012) describe the design of a neck-/headrest to increase car comfort. Two studies were undertaken to create a new comfortable headrest with neck support. All subjects mentioned that the neck support was a great comfort benefit in calm traffic conditions or during driving on the motorway. The back side of the head, the neck and the shoulder area all need different foam characteristics. This study shows that the neighboring/ contacting surface needs to be investigated when assessing comfort.

In her study Kamp (2012) describes the contour of three different car-seat designs, including a light weight seat, and the recorded corresponding emotion and tactile experience of 21 persons sitting in the seats. The seats were all deliberately covered with white sheets so that the participants are not influenced by the appearance of the seats and focus on the seats' sitting comfort. Before they sat down, they expected to experience a different feeling. Results show that the new light weight car-seat concept rated well on experienced relaxedness (Kamp, 2012). This study shows that individuals estimate comfort based on contour, sporty or luxurious feel and appreciation.

2.4 Influencing physical factors: The user's state, memory, physical loading and sensory impact

Kamp's (2012) study also shows that participants assess the products depending on their current state. Moreover, they have a preconceived notion of comfort based on past experiences with similar products. Hence, the product memory of the individual creates a comfort expectation.

Among the many comfort studies which link discomfort to physical loading, Kee et al. (2012) investigated the relationships between subjective measures of discomfort and objective measures related to the assessment of postural stresses based on literature survey. Kee et al. (2012) proposed that discomfort might be used as a measure for quantifying postural stresses. In a similar context, Zenk et al. (2012) conducted an objective assessment approach which evaluates the concept of "optimal load distribution", based on the identification of a close relationship between the pressure on the seat and the discomfort felt by the person sitting. There is a strong connection between discomfort and physical dimensions. In their study De Korte et al. (2012) investigated the use of different types of non-obtrusive feedback signals in order to change unhealthy behavior of office workers. Two of the feedback systems were two types of vibrations in a computer mouse and the other two were visual signals, a small screen appearing at the corner of the screen and a full screen, transparent signal visible on the computer screen. The 24 participants rated the feedback system which does not interfere with their primary task as the most effective. The feedback system which activates another sense than the one used for the execution of the primary task creates a better sense of comfort. Hence, the impact on the senses should be taken into account when designing comfortable products. Stimulating a different sense can alter the comfort experience. The multidimensionality of comfort is highlighted through the new knowledge these papers are providing. Three dimensions of comfort are highlighted in this section: the contextual, the product and the physical dimension of comfort. It is apparent that the emotional dimension of comfort needs to be further investigated.

2.5 Emotional responses towards a product and assessments of comfort based on visual information

According to Norman there are a number of different ways to define how one responds to a product. An emotional response to a product can be either described as: visceral, behavioral and reflective and these interweave both cognitive and emotional responses (Richards, 1980). Visceral responses refer to the most immediate level of processing, and appealing to the senses before interaction with the product occurs; behavioral responses are related to the experience of using the product and is usually concerned with the product's interaction and reflective responses are about one's thoughts after using and owning a product, hence is often connected to self-image and status. Visceral responses allow users to make quick judgments upon the products and how it is perceived. (Achiche, Ahmed-Kristensen, 2008). In this paper, the focus is upon visceral responses only. The visual input influences our experiences. Visual information plays a major role; it is the first impression of comfort (Vink, 2008). The first ideas of a product are communicated visually (Lugt, 2001). Bronkhorst et al. (2001) showed that 49 experienced office workers evaluated 1 out of 4 office chairs negatively for comfort based on the visual information (a brown traditional chair). Contrary to what was expected, this chair was evaluated positively after actually using it. The aesthetic form of the chair influenced the perception of comfort.

Based on the literature review a gap was found through the need of research on dependencies between the perception of aesthetics and the perception of comfort, i.e. the emotional design and the interaction design.

3 METHODS

3.1 Description of the study

For this study 2 groups containing three similar products from the ear industry were selected, two groups of three external - ear bluetooth headsets. A controlled experiment was carried out twice with three different phases.

- In the first phase (no see and wear) each participant was given all three products and was asked to wear them one at a time. Each participant was allowed to wear and touch the products but not see them.
- In the second phase (see and touch) the users were given again the same products, only this time each participant was allowed to see and touch the products but not wear them.
- In the third phase (see, touch and wear) the participants were allowed to have a full physical interaction with the products by seeing, touching and wearing them.

The participants were then given a questionnaire and asked to grade the products in terms of comfort and attractiveness, as well as, they were asked to describe the products from a list of opposite adjectives during each of the three phases. In the first and third phase the participants were asked to grade the products in terms of real comfort whereas in the second phase (see and touch), they were asked to grade them in terms of attractiveness and expected comfort. For the product description part which came at the end of each phase of the study, the participants were asked to describe the headsets in terms of shape, weight, size and surface material. For this task a list of opposite adjectives was offered to the participants to choose among (bulky – slim, curvy – flat, round – square, light - heavy, big – little, long – short, rough – soft, slippery – sticky, pliant – inflexible, plastic-like – velvety). The overall design of the study is summarized in Table 1.

Table 1. Set – up of the study and the values to be measured

Study phases	Description	Measures	Abbreviations
A	No-see and Wear	Real Comfort, Description of products with a list of opposite adjectives	Real Comfort = Ca
B	See and touch	Expected Comfort, Attractiveness, Description of products with a list of opposite adjectives	Expected Comfort = Cb Attractiveness = A
C	See, touch and wear	Real Comfort, Description of products with a list of opposite adjectives	Real Comfort = Cc

Based on the findings of the literature review and drawing inspiration from Norman's (2004) approach on visceral response it is the author's intention to investigate how the attractiveness during a human – product interaction affects the expectation and experience of comfort. It is hypothesized that:

H_1 - In the case when the attractiveness towards a product is high the levels of comfort are increased, whereas in the case when the attractiveness is low the levels of comfort are reduced. (If Attractiveness (A) is high, then $Ca < Cb$ and $Cb \leq Cc$ and if A is low, then $Ca > Cb$ and $Cb \geq Cc$)

H_2 - There are strong correlations between levels of comfort and the product descriptors.

3.2 Respondent profile and Sampling of products

The target population of this study consisted of 23 participants, both men and women of similar age and social and professional background. (see Table 2) All participants were asked whether they were familiar with the products to - be - tested in advance, in order to avoid bias towards one or more products. In the first phase the researcher placed the products upon the respondents' ears, hence the users were unable to see the products. The participants were not blindfolded, in order to minimize intrusiveness.

Table 2. A demographic profile of the respondents

Gender	n	Age (years)
Male	13	25 - 32
Female	10	23 – 33
Total	23	

In the next phases the participants were given the products in a randomized order, again, to avoid bias. The Bluetooth headsets were all current models during the study's execution time. (see Figure 1). All products were competitor products, that is, they belonged in the same product category (in – ear headsets), which means that they had a similar way of resting in the ear, they consisted of similar parts which inscribed similar ways of use and they belonged in the same price range. This was decided in order to keep the participants as unbiased as possible during their interaction with the products towards other potential influencing comfort factors (poor fit, high pressure levels, higher appreciation due to expensive materials, etc). The products, however, were carefully selected in order to address the issue of diversity in terms of visual response and tactile interaction. Hence, they differentiated in shape, size, surface material, etc.

Figure 1. The groups of in-ear and behind-the-ear bluetooth headsets

3.3 Data Collection and measures

Data for the main study was collected with a questionnaire consisting of two parts. The first part contained 5 – point semantic scaled questions in order to grade the comfort experience and the attractiveness. (see Figure 2). In the second part of the study the participants were asked to describe the products while wearing them. For the list of opposite adjectives a similar 5 – point scale was used. When the respondents were asked to describe the size of the products, the scale ranged from -2 ("Very bulky"), -1 ("Slightly bulky"), 0 ("Neutral"), +1 ("Slightly slim") and +2 ("Very slim").

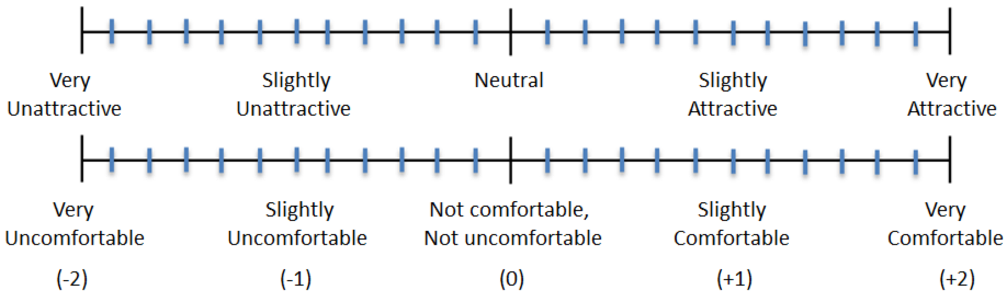

Figure 2. Semantic scales and attributed scores for attractiveness and comfort

4 RESULTS AND DISCUSSION

4.1 Assessment of comfort versus levels of attractiveness

To test the first hypothesis ($H_{1:}$ If Attractiveness (A) is high, then $Ca < Cb$ and $Cb \leq Cc$ and if A is low, then $Ca > Cb$ and $Cb \geq Cc$), the absolute values of comfort for each product in each of the three phases were calculated ($|Ca|$, $|Cb|$, $|Cc|$. The differences $|Cb| - |Ca|$, $|Cc| - |Cb|$ were then plotted against the respective levels of attractiveness. (see Figure 3). With the exception of 6 outliers out of the 69 points in the left graph ((-0,333, 0,167), (1,5, -0,333), (1,-1,167)) and 9 outliers out of the 69 points in the right graph ((-1,5, 1), (-0,333, 0,333), (1, -0,167), (1, -0,5), (1,833, -1,167), the graphs in Figure 3 proved the first hypothesis, since for high levels of attractiveness the respective levels of comfort for each product increased, whereas for low levels of attractiveness the levels of comfort decreased. This means that the expectation of comfort during the second phase when the visual response comes to play was higher when the attractiveness towards the product was respectively high whereas it was lower when the attractiveness was low. In the second diagram the comfort scores in the third phase (see, touch and wear) are either enhanced or even more reduced depending on the attractiveness levels. However there seems to be a randomized increase or decrease. The reason for this could be that in the third phase, where the participants engage themselves in a full physical experience with the products, other influential factors contribute to the assessment of the comfort experience. As seen from the findings of the study of Zhang et al. (1997) where comfort is linked more to emotional factors whereas discomfort is linked more to physical ones, the low scores of comfort in our case could derive not only from low attractiveness but also from physical factors which appear in the third phase.

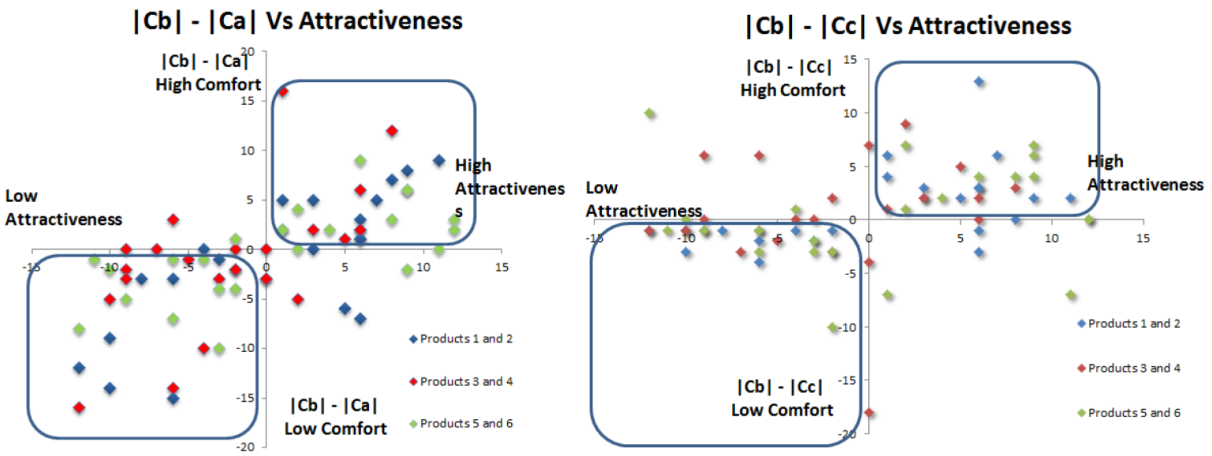

Figure 3. Differences of absolute means of comfort grades versus attractiveness scores

4.2 Dependencies between levels of comfort and product descriptors

To test the second hypothesis (H_2: There are strong correlations between levels of comfort and the product descriptors), a correlational analysis using the Spearman's test took place between levels of comfort for each phase and the participants' responds to the list of descriptors for each product. For the Spearman's correlation coefficient (r) values between 0.40 and 0.69 ($0.40 \leq r \leq 0.69$) indicate a strong positive relationship whereas values above 0.70 ($r \geq 0.70$) indicate a very strong positive relationship. Table 3 shows only the strong and very strong positive relationships observed between comfort scores and product descriptors. The summarization of the coefficients in table 3 show that there is a very strong positive relationship between comfort and the pairs of bulky – slim (Phase A: 0,810, $p < 0,01$, Phase B: 0,821, $p < 0,01$, Phase C: 0,831, $p < 0,01$) and big – little (Phase A: 0,721, $p < 0,01$, Phase B: 0,645, $p < 0,01$, Phase C: 0,706, $p < 0,01$) in all three phases of the experiment. A weaker, yet considerably strong positive correlation is also observed between comfort and the rough – soft pair whereas there is a strong negative correlation between comfort scores and light – heavy in all phases. This translates into the forming of associations between the concept of comfort of products, and words which individuals use to describe them. In this case a slim and small in size headset with low weight made from a rather soft surface material is perceived as comfortable and vice versa. However, it must be made explicit that these associations are being articulated in a context which is inscribed by the properties of the specific products which are in our case a bluetooth in – ear and behind-the-ear headset. In the case of a different type of product, descriptors such as bulky or heavy could be linked to the concept of comfort instead, which did not occur in this study.

4.3 Limitations of the study

The small number of the products used in this study may have created a small bias in terms of creating a memory of past interaction in the participants towards the headsets. Also, more participants should be included in the study to solidify the statistical significance of the results. This current research was limited to one emotional dimension.

Table 3. Cumulative table of coefficients

	Bulky - Slim	Light - Heavy	Big - Little	Rough - Soft
Comfort a (Ca)	,810**	-,548**	,721**	,454**
	,000	,001	,000	,008
	33	33	33	33
Comfort b (Cb)	,821**	-,583**	,645**	,368*
	,000	,000	,000	,035
	33	33	33	33
Comfort c (Cc)	,831**	-,708**	,706**	,689**
	,000	,000	,000	,000
	33	33	33	33

4.4 Conclusion

In this study comfort was assessed in three phases versus the levels of attractiveness. The results of this study highlight the relationship between attractiveness and comfort. The main findings have shown that the comfort experience was amplified by the attractiveness during a human – product interaction. When the levels of attractiveness were low the comfort scores reduced from phase A to phase B and from phase B to phase C. The opposite case occurred for high levels of attractiveness. Additional findings revealed very strong (or strong) correlations between expected and real comfort scores and the bulky – slim, light – heavy, big – little and rough – soft pairs of product descriptors. These findings not only stress the need to focus on the emotional dimension of comfort but they can be seen as guidelines for current product design. Emotional design is a viable strategy for areas where comfort is significant. Consequently designers should focus more on improving the visual response which the products create to the users when striving for comfort. Future work should examine other potential factors that might influence comfort expectation and comfort experience. In particular the relationship between combined physiological and emotional factors and their impact on comfort might offer fruitful avenues for future research.

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