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Using archetypes to create user panels for usability studies: Streamlining focus groups and user studies

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ABSTRACT

Designers at the conceptual phase of products such as headphones, stress the importance of comfort, e.g. executing comfort studies and the need for a reliable user panel. This paper proposes a methodology to issue a reliable user panel to represent large populations and validates the proposed framework to predict comfort factors, such as physical fit. Data of 200 heads was analyzed by forming clusters, 9 archetypal people were identified out of a 200 people's ear database. The archetypes were validated by comparing the archetypes' responses on physical fit against those of 20 participants interacting with 6 headsets. This paper suggests a new method of selecting representative user samples for prototype testing compared to costly and time consuming methods which relied on the analysis of human geometry of large populations.

1. Introduction

Design engineers who are involved in the early conceptual phase of the development of products such as seats, headphones and domestic appliances stress the increasing importance of comfort. Comfort is taken into account in the purchasing decisions of buying a chair, a bed, and when driving a car, or flying. Industry strives to produce products that are comfortable in order to increase the appeal to consumers. The Second European Survey on Working Conditions (Merllié and Paoli, 2002) that took place in 1996, where a sample of 1000 workers from each member state were interviewed, revealed that back pain (30% of the workers) and muscular pains in arms or legs (17% of workers) were amongst the most common work-related health problems. Absenteeism due to work-related health problems affects 23% of workers each year (averaging out at 4 working days lost per worker). These health problems strongly relate to postural musculoskeletal discomfort. Hence, designers need to increase their knowledge on both comfort and discomfort in product design (and workspaces).

The terms *comfort* and *discomfort* are widely used in studies where prototypes are tested for usability. Despite the frequent use of these terms there is an absence of a general notion of comfort or discomfort. There are three main issues when designing a product to achieve comfort: 1) the exact cause of comfort is unknown, 2) comfort relies to a certain extent on subjectivity and, 3) there is a lack of a methodology for considering comfort in the design process (Vink, 2005). Extensive research mainly in the form of comfort studies (Kuijt-Evers, 2004; DeLooze et al., 2003) has explored some of the influential factors of comfort such as postural stress (Kee and Lee, 2012), levels of pressure and force increase (Goossens et al., 2002) and noise (Vink et al., 2001). Most of these factors are physical, physiological or linked to external attributes of the environment in which the interaction between a human and a product takes place. For products that are in a physical contact with the human body, such as chairs and hand tools, researchers have attempted to match product dimensions with people's anthropometry (Mououdi and Choobinesh, 1997; Cho, 1994). However, there is little research for external ear products, such as headphones and headsets with respect to human ear dimensions, partially due to the limited data sets available. In terms of methods to benchmark human dimensions against product dimensions, research is scarce regarding the evaluation of the ergonomic functionality of products. This translates into two issues: primarily current comfort studies either give no justification for the selection of the number of users to include in the comfort studies, or select small samples of users for prototype benchmarking (Parcells et al., 1999; Gouvalli et al., 2006) which are not representative of the

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population as a whole; and secondly there is a lack of methodology to define product dimensions and predict good fit. Essentially, the research presented in this paper, responds to the call for a new approach towards comfort and draws inspiration from Vink and Hellbeek (2012) who has stressed the need for an improved comfort methodology.

Given this background, the main aim of this research is to propose a methodology to develop a reliable user panel for the execution of comfort studies in the industry of external ear-worn products, by using archetypes to represent large clusters of anthropometric data. The subaims were to investigate and generate the proposed methodology through a second usability study comparing archetypes' responses to a number of participants' responses.

This paper consists of four main parts: 1) The paper first reviews the existing literature on definitions of comfort and the studies attempting to link comfort to anthropometry; 2) Then it presents, in detail, the main stages of the archetype methodology, i.e. the process to select participants and the cluster analysis to generate the archetypes; 3) The framework of the ARCH method and the results of the validation of the archetypes are presented in the findings section; and 4) The paper concludes with a discussion of the theoretical and industrial implications of the archetypes and the archetypes methodology (ARCH), as well as, the limitations and the contributions of the methodology.

2. Literature review

2.1. The concept of comfort

This section will 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 a passenger on a long distance flight, back discomfort is of great importance whereas another passenger wants a reduction in noise or more space. In this paper, comfort is defined as (1) a construct of subjectively defined by one's personal nature, (2) as a reaction to the environment and (3) is affected by factors of various natures (physical, psychological and physiological) (Vink, 2005). The focus of this paper is on the physical dimension of comfort.

2.2. A debate in the literature: comfort versus discomfort

2.2.1. Comfort and discomfort as points in a continuum scale

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 the difference between comfort and discomfort. Several researchers (Hertzberg, 1958; Richards, 1980; 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 (Chao et al., 2000; Fellows and Freivalds, 1991). For hand tools, comfort is primarily determined by functionality and the physical interaction between the user and the product. As discomfort factors are present in hand tool use, the perception of comfort may be dominated by that of 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, such as a good fit in the hand, functional, easy to use, reliable, etc. These factors were clustered. The statistical analysis distinguished 6 comfort factors as significant: (1) Functionality; (2) Posture and muscles; (3) Irritation and pain of hand and fingers; (4) Irritation of hand surface; (5) Handle characteristics; And (6) aesthetics. These factors explain 53.8% of the variance. In the use of hand tools the same descriptors relate to both comfort and discomfort.

Two studies in the design of seats also support the use of the same descriptors for both comfort and discomfort (Jianghong and Long, 1994): for the passenger seat for a new type of bus and (Wilder et al., 1994) 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 and Middendorf, 1977) that have been used to evaluate seats, in which issues of functionality and usability are raised.

2.2.2. A division of discontinuity between comfort and discomfort

Opposing 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 understanding 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 be based on different types of criteria. In the study by Zhang et al. (1996), the identification of these variables was the primary goal. A total of 104 respondents provided descriptors of the feelings they experienced when they felt comfortable (e.g. agreeable, at ease, calm) or uncomfortable (e.g. fatigue, cramped, restless) in a seated workplace. 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. Comfort, on the other hand, is associated with feelings of relaxation and well-being (Paul, 1997). The theory of Zhang and Helander (1996) described in this paragraph convinced the authors of this paper that there was a division or discontinuity between comfort and discomfort scales, that is, sitting comfort and discomfort were 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. It can be argued that comfort and discomfort need to be treated as different and complementary entities in ergonomic investigations.