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The influence of age in usability testing

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ABSTRACT

The effects of age in usability testing were examined in an experiment. Sixty users from two age groups (M = 23.0 yrs, M = 58.1 yrs) operated two technical devices (keyboard-based and touchscreen-based smartphones). In addition to various performance measures (e.g. task completion time, task completion rate), several subjective measures were taken (e.g. perceived usability, affect, and workload). The results showed better performance scores for younger adults than older adults for task completion time. For older adult users there was a mismatch between usability ratings and task completion time but not between usability ratings and task completion rate. Age-related differences in the importance of speed and accuracy in task completion point to the need to consider more strongly the factor user age in usability research and practice.

1. Introduction

For a number of years, pervasiveness of technology and an ageing population have represented two important trends in industrialised countries. The fact that the two trends coincide poses several interesting challenges for the science of ergonomics. The increasing omnipresence of technology, often parallelled by high levels of automation, may result in usability problems for all users but will pose a particular challenge to older adults (Rogers et al., 2005). The significance of older adults as a specific user group is on the increase due to demographic changes and the growing importance of technology in society. Against this background, the present article aims to examine issues related to the design of interactive consumer products for older adult users, with a special emphasis being placed on the implications for usability testing as an important method in product design.

1.1. Older adult users and interactive technology

Ergonomics has typically aimed to design technical systems for a broad population of users but, at the same time, it acknowledged the existence of special user groups and the necessity to consider their special needs (Kroemer, 2006). Older adult users are one of these special user groups. In industrialised countries, this group is a substantial part of society already and is expected to increase further in size due to demographic changes.

The terminology of what an older adult user constitutes is quite diverse. For example, Kroemer (2006) stated that in the US "[…] a 'middle-aged' person becomes an 'older' at 40 or 45 years of age, then 'elderly' at about 65 years, 'old' at 75 years, and 'very old' (or 'old–old') if one lives beyond 85 years" (p.128). However, this terminology is not used consistently in the literature and there may be disagreement with regard to the threshold above which a person is considered to be 'old'.

More important than the definitions of terms surrounding advanced chronological age are the many changes that are associated with the process of ageing. When age-related issues are discussed, a large number of functional impairments have been mentioned, including poorer eyesight, deteriorating hearing, degradations in manual skills, and decline in memory performance (e.g. Kroemer et al., 2001; Matthews et al., 2000).

These numerous age-related changes at the cognitive, perceptual and motor level are highly relevant when interactive technology is being used. For example, for the use of computers and the web, cognitive capabilities or "fluid abilities" are of particular importance (Czaja and Lee, 2007; Garfein et al., 1988), including short term memory span, information processing speed, spatial abilities, and abstract reasoning (Hanson, 2009). Since these 'fluid abilities' are important for the adaptation to novel situations, including the adoption and use of new technology, this may result in age-related impairments (Pak et al., 2009; Hanson, 2009). In

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addition, abilities such as spatial thinking or memorization are crucial in building correct mental models of interfaces (Brunsman-Johnson et al., 2015). These mental models are essential for using an interface like a website (Pak et al., 2006). As cognitive abilities decline with age, this seems to have an influence on the performance of older adult users when using interactive technology. Deteriorations in perceptual abilities can be a further reason for problems in using certain technological products. Poor visual scanning capabilities or a reduction in acuity, colour perception and contrast discrimination may lead to difficulties in perceiving information and reading text (Armbrüster, 2007; Brunsman-Johnson et al., 2015). For motor skills, there is evidence that older adult users show poorer performance than younger users in the form of lower peak velocities of movements, more non-productive sub-movements, and particular difficulties when using fine motor skills (Jacko et al., 2000; Keates and Trewin, 2005). Furthermore, reaction time slows down with increasing age (Stelmach et al., 1987) and the speed-accuracy trade-off changes towards accuracy in older adult users (Welford, 1976).

In addition to various decrements in functional abilities, attitudes towards technology are related to the age of users as well. Older adult users have often less positive attitudes towards new technology compared to younger users (Dyck and Smither, 1994; Chua et al., 1999). These positive attitudes were found to be linked to computer experience and to influence the frequency with which technology is used (e.g. Elias et al., 2012; Chua et al., 1999). A number of concepts were proposed to describe different facets of user attitude towards technology including technophobia (e.g. Rosen and Weil, 1995), computer anxiety (e.g. Heinssen et al., 1987), computer playfulness (Webster and Martocchio, 1992), and technology commitment (Neyer et al., 2012). One may presume that these facets of user attitudes towards technology are also influenced by a process of technological socialisation (i.e. the way the user has been introduced to technological changes). Users born after the advent of the internet and its main applications such as email have grown up with computerised technology and may differ from those who have learnt about such technology when they were already adults. This difference in technological socialisation was described by the terms 'digital natives' and 'digital immigrants' (Prensky, 2001). Having been immersed in technology all their lives may influence the ease with which users operate such technology. The idea of a technological generation gap has been discussed in various domains such as ergonomics (e.g. Kolikant, 2010), educational science (e.g. Bennett, et al., 2008) and sociology (e.g. Prensky, 2001).

As a result of the recognised need to compensate for decrements in the functional abilities of older adult users, guidelines have been developed to address these issues (e.g. AgeLight, 2001; Petrie et al., 2013; Zaphiris et al., 2007). These guidelines also include the needs of other special user groups, such as blind, oversized or wheelchair-based users. The guidelines contain very specific rules to be followed during product design. For example, for older adult users too small font sizes and information overload on webpages need to be avoided and instructions of how to use the website should be provided (Nahm et al., 2004). Other work has also successfully explored the utility of adaptive training devices to support the older adult users (Bruder et al., 2014).

Attitudes and functional limitations of older adult users are especially important when it comes to the adoption and use of new technology such as touchscreen devices. Touchscreen interfaces have become increasingly popular due to the flexibility in design and convenience in usage (Taveira and Choi, 2009). While a considerable amount of research has addressed issues such as key size and spacing in touchscreen design using typical user populations like younger adults (e.g. Schedlbauer, 2007; Scott and Conzola, 1997; Colle and Hiszem, 2004), comparatively little is known about the usage of touchscreen devices by older adult users. Research has shown that the use of touchscreen devices for text entry purposes may lead to decreased performance compared to the use of traditional keyboards (Plaisant and Sears, 1992). Although their finding is based on data from younger adult users, Wright et al. (2000) reported similar results for older adults when comparing a touchscreen-based handheld device with a keyboard-operated device. For the design of touchscreen interfaces, research has also revealed that the size of buttons and other interactive features play an important role for performance and user satisfaction (Lee and Zhai, 2009; Jin et al., 2007). Fezzani et al. (2010) compared the influence of target size in touchscreen interaction for younger and older adult users and found that reduced button size affected older adult users more strongly than younger ones in the form of greater difficulties with accurate pointing, increased time on task, and higher mental workload. These age-related effects were also reflected in different recommendations for minimal button size for younger and older adults (e.g. 10 mm vs. 11.5 mm; Lee and Zhai, 2009; Jin et al., 2007). Interestingly, research revealed that both, younger and older adult users preferred touchscreen keypads to physical keypads for numeric data entry tasks since, due to the virtual keypad being situated on the screen, it required less effort for users to divide their attention between the input and the display function of the device (Chung et al., 2010). On the other hand, physical keys have the advantage of giving direct tactile feedback to the user whereas feedback provided by touchscreens is usually limited to the visual modality, which may result in lower performance (Caprani et al., 2012). Overall, the empirical work reviewed points to the need to consider the differential effects that the design of interactive devices may have for user groups of different ages.

1.2. The factor age in usability testing

In consumer ergonomics, an important aspect of product development is to examine the usability of a product by using usability evaluation methods (e.g. Nielsen, 1993). A widely used and very effective usability evaluation method is the usability test. It aims to evaluate the product by setting up a realistic task scenario for product usage involving prospective users. Despite the abundant literature on developmental changes in older adults, little is known about how such age-related changes affect the outcomes of usability tests. This applies to measures typically taken in usability tests (e.g. performance, perceived usability) but also to measures not that widely used (e.g. affect and workload).

In usability testing, performance measures are divided into indicators of effectiveness and efficiency (Jordan, 1998). Effectiveness refers to the degree to which a task was successfully carried out (e.g. task completion rate) whereas efficiency is concerned with the ease with which the task is carried out (e.g. task completion time, error rate). While the use of measures of perceived usability is standard practice in usability tests, affect have only more recently been considered to be a relevant aspect of usability with fun and pleasure gaining in importance for product usage. Subjective workload is rarely used in usability testing, which is surprising given that already in the 1990ies it has been argued that a measure of workload should be taken (Jordan, 1998) and given that measuring perceived workload is standard practice in work ergonomics (e.g. Wickens and Hollands, 2000). The rare use of affect and workload as outcome measures does not only apply to the testing of older adult users but to usability testing in general.

Experimental research generally showed that during the use of artefacts user performance was generally lower for older adult users than for younger ones (e.g. Armbrüster et al., 2007;