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The impact of age on website usability

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ABSTRACT

As the general and working populations age in most developed nations, the study of website usability for older adults is becoming increasingly relevant. Website usability is concerned with both utilitarian (i.e. functional) and hedonic (i.e. pleasure-related) aspects. A new website usability model is proposed that considers the effects of age on website usability through cognitive antecedents that are most relevant to age-related effects. Specifically, spatial ability is the declining cognitive skill of particular interest in this research. A laboratory experiment was conducted where younger and older participants interacted with an experimental website. The results suggest that age has a pronounced impact on performance as a mediated effect through declining levels spatial ability and mental model accuracy as well as through a direct effect suggesting the presence of other objective and subjective changes associated with aging that could impact performance. Perceived disorientation was also examined within the proposed website usability model, revealing both expected and surprising findings.

1. Introduction

The population of most of the world's developed nations are experiencing an increase in average age (OECD, 2006). A similar trend has been observed among users of computers and the Internet with older adults now making up the fastest growing consumer segment of Internet users (Chevalier & Rossetti, 2010; Stevens, 2010). As older adults remain in the workforce longer (Mitzner et al., 2010), many are using computers and the Internet on a daily basis to do their jobs (Nord, McCubbins, & Nord, 2006). Thus, as the Internet is becoming an increasingly integral part of the lives of older adults, the study of Internet usability by older adults is becoming an increasingly relevant field of study.

Usability has been recognized as an important aspect in the study of online behaviors in Information Systems (IS) and Human Computer Interaction (HCI) literature (Venkatesh & Agarwal, 2006). For individuals, usability has been associated with important outcomes such as error reduction and positive attitudes (Venkatesh & Agarwal, 2006), and has been shown to increase users' intentions to use computers as well as subsequent usage behavior (Legris, Ingham, & Collerette, 2003; McCloskey, 2006; Venkatesh, Morris, Davis, & Davis, 2003). Usability also has many important impacts for organizations such as improved job performance, higher productivity and reduced costs (DeLone & McLean, 2003).

To date, a considerable amount of effort has been dedicated to exploring website usability issues for older adults and a number of guidelines have been developed (Morrell et al., 2003; Zaphiris, Kurniqwan, & Ghiawadawala, 2007). While some of these guidelines are very specific (i.e. font size, typeface, colors, etc.), the recommendations for other aspects, such as navigation systems, site topologies, and accommodation of changes in cognitive abilities, are much vaguer. Further, many of these guidelines are based on extrapolations from the study of older users using offline applications, as well as general research on aging, as opposed to empirical studies using websites. In addition, most of the guidelines are focused on functional or utilitarian (functional) aspects of website usability and fail to consider a holistic approach that incorporates hedonic (pleasure-related) aspects. This lack of empirical testing creates many opportunities for future research in the area of website usability for older users. To help fill this gap, we seek to answer the following research question: How does age impact website usability? More specifically, how do declining cognitive skills associated with aging impact website usability? In this study, spatial ability is the declining cognitive skill of particular interest.

The remainder of this paper proceeds as follows: the theoretical background for the research is presented; the research model and hypothesis development are discussed; the research methodology is described; the results of the experiment are presented; and finally, the results are discussed and conclusions drawn.

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2. Theoretical background and research model

2.1. Usability

Although usability is a key concept of HCI research (Hornbaek, 2006), its application in the IS literature has been limited to date (Venkatesh & Ramesh, 2006). More recently, usability is gaining traction in IS as researchers realize its potential to bring new perspectives to IS research (Tung, Xu, & Tan, 2009). For example, in a study of websites Venkatesh and Ramesh (2006) found that the usability theoretical lens outperformed the popular Technology Acceptance Model (TAM) in terms of richness and variance explained in a website study.

Although usability has been defined in a variety of ways in numerous contexts (Tung et al., 2009), the definition developed by the International Standards Organization (ISO) is most often adopted. The ISO defines usability as the "effectiveness, efficiency, and satisfaction with which specified users can achieve goals in particular environments" (ISO, 1998, p. 2). In practice, effectiveness and efficiency are often referred to collectively as performance (Coursaris & Kim, 2011). These definitions have previously been applied in IS research when examining technology artifacts and experiences through an HCI or usability lens (Agarwal & Venkatesh, 2002; Venkatesh & Agarwal, 2006). As such, we employ this popular definition in this research: *usability is the performance achieved and satisfaction experienced by system users*.

Usability is a multifaceted concept in that it considers both the utilitarian and hedonic dimensions of a system. Utilitarian dimensions are concerned with function, are goal directed and performance based (Childers, Carr, Peck, & Carson, 2001; Kim, Malhotra, & Narasimhan, 2005). Utilitarian dimensions may be measured through perceived assessments of the system (e.g. perceived usefulness) or objective measures resulting from system use (e.g. task timing). Hedonic dimensions, on the other hand, are concerned with entertainment, enjoyment, and fun (Davis, Bagozzi, & Warshaw, 1992; Kim et al., 2005), and are measured solely through perceived scales (e.g. perceived satisfaction). Hedonic dimensions are more subjective and personal than utilitarian dimensions (Babin, Darden, & Griffin, 1994), referring to a personal assessment of self and evoked through the experience. Although a system as a whole may be categorized as utilitarian (e.g. a productivity application) or hedonic (e.g. a game) in nature, the use of any system will result in both utilitarian and hedonic assessments of usability.

In the ISO definition of usability provided above, utilitarian and hedonic aspects are considered through performance and satisfaction respectively. Hence, in order to have a complete picture of the usability of a website, both utilitarian and perceived hedonic assessments should be considered (Agarwal & Venkatesh, 2002; Hornbaek, 2006). Historically, usability evaluation has primarily concerned itself with performance-based measures of usability (Hornbaek, 2006; Otter & Johnson, 2000). More recently, however, researchers have emphasized the importance of bringing more focus to the hedonic considerations (O'Brien and Toms, 2008). Both utilitarian and hedonic benefits are important drivers of technology use (Venkatesh, Thong, & Xu, 2012) and the effect of hedonic dimensions should not be underestimated (Zhang & Li, 2005).

2.2. Usability for older adults

Age, as defined by a person's chronological or calendar age, is a frequently studied individual difference in many disciplines, including IS. Although the study of age seems a logical and straightforward topic on the surface, it is in fact quite complex. Aging is not a homogeneous process, and thus individuals at the same chronological age may differ in any number of ways. Despite this fact, extant research in IS and many other disciplines use chronological age (Carstensen & Turk-Charles, 1994). Some researchers have suggested that this is an oversimplification and, therefore, a limitation of the study of age differences (Morris & Venkatesh, 2000). Kooij, deLange, Jansen, and Dikkers (2008) discuss five conceptualizations of age that take a variety of factors into consideration: chronological or calendar age; functional or performance-based age; subjective or psychosocial age; organizational age; and the life span concept of age. In the present research, chronological age is used in the main research model for consistency with existing literature. Other conceptualizations, however, may be relevant in the context of website use and therefore were collected to enable exploratory analysis of the findings. Specifically, there is some evidence to suggest that functional age (related to health status) may impact a user's performance, and subjective age (how old someone feels) may influence feelings about a website. Therefore these two conceptualizations were collected for post hoc analysis in addition to the collection chronological age for inclusion in the research model.

A long line of research exists that examines changes among individuals based on chronological age (Morris & Venkatesh, 2000). Extant literature shows that such changes can be both subjective and objective in nature (Mroczek & Kolarz, 1998). Subjective changes are typically psychosocial in nature and refer to systemic changes in personality, needs, expectations, behavior and perspectives (Rhodes, 1983). For example, researchers have suggested that subjective well-being may improve with age (Carstensen, 1995; Carstensen & Turk-Charles, 1994). Older people see the future as being more bounded, which may cause them to gear their lives toward maximizing positive and minimizing negative affect (Mroczek & Kolarz, 1998). Gibson and Klein (1970) indicate the positive correlation between age and overall life satisfaction can be due to changing needs, a mellowing process, and changing cognitive structures associated with age. These changes in personality, needs, expectations, behavior and perspectives may impact perceptions of computer experiences and interface usability.

From an objective point of view, scientists have reported various physical and cognitive changes associated with the natural biological aging process. Such changes have implications for the usability of computer interfaces. For example, physical changes associated with aging include declines in vision, hearing, and psychomotor coordination (Höök, Dahlbäck, & Sjölinder, 1996). Thus, interfaces will be more usable for older users if they make use of features like larger fonts, sounds within certain frequency ranges, and layouts that require less precise mouse movement. Similarly, cognitive changes such as reduced attention span, declines in memory, and changes in spatial abilities create a need for interfaces that have fewer distractions, provide memory cues, and are simple to learn and understand (Höök et al., 1996).

Spatial ability is one aspect of cognitive ability that is known to decline with age (Salthouse, 1982). It refers to an individual's ability to conceptualize relationships between objects in space as well as awareness of location within a space relative to other objects (Sjolinder, 2006). Spatial ability has been examined in a number of studies and has been found to impact the performance of computer tasks, including website navigation (Benyon & Murray, 1993; Egan & Gomez, 1985; Höök et al., 1996; Vicente & Williges, 1988). Since spatial ability is resistant to training (Salthouse, 1982), it is an especially important consideration in web usability for older users.

Spatial abilities are believed to advantage website navigation performance by enabling users to construct a proper mental representation, or mental model, of the system's structure (Mayer, 1986; Nielsen, 1995; Sein, Olfman, Bostrom, & Davis, 1993; Ziefle & Bay, 2006). This mental model of the system assists individuals in understanding, explaining, or predicting how the system works (Slone, 2002). In a website context, mental model refers to the