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Understanding Web Site Satisfaction for Older Adults

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ABSTRACT

As older adults increasingly make use of the Internet, the study of web site usability for older adults is becoming increasingly relevant. Web site usability is concerned with both utilitarian (i.e. functional) and hedonic (i.e. pleasure-related) aspects. This study explores the impact of age on select utilitarian (mental model accuracy and performance) and hedonic (disorientation and engagement) measures of web site usability, and the subsequent impact of these utilitarian and hedonic measures on user satisfaction. An experiment was conducted with 50 younger and 47 older participants. The results suggest that age has a more pronounced impact on utilitarian constructs than hedonic ones. Specifically, older adults were less able to create an accurate mental model of the web site and in turn had poorer performance within the web site. In terms of impact on user satisfaction, the contribution of hedonic constructs was significant while the impact of utilitarian constructs was not.

Keywords

usability, older adults, hedonic, utilitarian, mental model.

INTRODUCTION

The population of most of the world's developed nations are experiencing an increase in average age and older adults now make up the fastest growing consumer segment of Internet users (Chevalier & Rossetti, 2010). To date, a considerable amount of effort has been dedicated to exploring web usability issues for older adults and a number of guidelines have been developed. Nonetheless, a number of gaps in the literature remain, as described in Wagner, Hassanein, & Head (2010). To address some of these gaps, we seek to answer the following research questions within the context of understanding older adult experiences with websites: 1) What utilitarian and hedonic usability factors influence user satisfaction? 2) What relationships exist between utilitarian and hedonic usability antecedents to satisfaction? 3) How does age influence the hedonic and utilitarian usability antecedents to satisfaction? 4) How can mental model accuracy be measured and what role does it play in influencing the user experience? 5) How do younger and older adults differ in terms of hedonic and utilitarian usability antecedents of satisfaction?

THEORY

This study applies the popular ISO definition of usability: "the effectiveness, efficiency, and satisfaction with which specified users can achieve goals in particular environments" (ISO, 1998, p. 2). Further, effectiveness and efficiency are referred to collectively as performance. Usability has been recognized as an important aspect in the study online behaviours in IS and HCI literature (Venkatesh & Agarwal, 2006) and is particularly important in the context of older users since they tend to be more severely impacted by usability problems than younger users (Pernice & Nielsen, 2005). Usability is a multifaceted concept in that it considers both utilitarian (performance) and hedonic (satisfaction) aspects. In order to have a full picture of the usability of a web site, both performance and subjective assessments in the form of user perceptions should be considered (Agarwal & Venkatesh, 2002).

The interface usability concerns of older computer users are distinct from those of younger ones as a result of the physical and cognitive changes associated with the natural aging process, which become more noticeable at roughly 45 years of age (Hawthorn, 2000). Each of these changes has implications for the usability of computer interfaces. For example, physical changes associated with aging include declines in vision, hearing, and psychomotor coordination, and cognitive changes include reduced attention span, declines in memory, and changes in spatial abilities (Hawthorn, 2000). In particular, spatial ability has shown to impact computer performance in offline and online contexts. Spatial ability is known to decline with age and is resistant to training (Salthouse, 1982), making it an especially important consideration in web usability for older users.

Spatial abilities are believed to support web site navigation by enabling users to create a mental representation of the system's structure (Nielsen, 1995). Users who are unable to construct a mental representation are more likely to feel lost, or disoriented, within a web site. As a result of the decline in spatial abilities with age, disorientation has been found to be a more severe issue for older users (Lin, 2003a).

RESEARCH MODEL

This study explores the web site use of older adults through the lens of usability theory. As such, we explore the performance and satisfaction experienced by older adults during web use as they are influenced by some utilitarian and hedonic factors. Age is, in turn, explored as an influence on these utilitarian and hedonic factors.

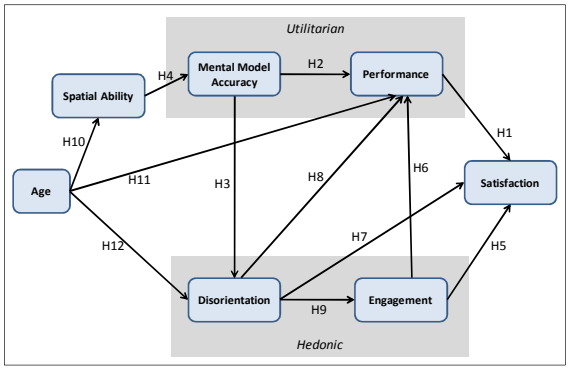

Figure 1. Research Model

Due to space limitations, the theoretical justification for each of the hypotheses cannot be provided in detail here. Only some key, but limited, arguments and references are provided.

Satisfaction

In this research, satisfaction is defined as web site user satisfaction: "the attitude toward the web site by a hands-on user of the web site" (Muylle, Moenaert, & Despontin, 2004). As Figure 1 shows, the research model explores two paths between age and satisfaction: a utilitarian path and a hedonic path, each discussed separately below.

Utilitarian Path

Typically, either satisfaction or performance is the main focus of a usability study. This study also explores the relationship between the two, as others have done in the past (for example Pernice & Nielsen, 2005), finding that performance has a positive impact on user satisfaction. Therefore it is hypothesized that:
H1: Higher levels of user performance within a web site will lead to higher levels of user satisfaction with the site.

In a web context, a mental model can be conceptualized as an understanding of the structure of the web site, or how the nodes within the hierarchy of the site relate to one another (Otter & Johnson, 2000). The accuracy of the mental model that a user develops has been found to impact their performance during navigation (Ziefle & Bay, 2006), thus it is hypothesized that:
H2: Higher levels of mental model accuracy will lead to higher levels of user performance within a web site.

Disorientation occurs when the user has an inaccurate mental model of the system (Woods, 1984). Users who have a more accurate mental model are less likely to become confused or lost (Otter & Johnson, 2000). Thus it is hypothesized that:
H3: Higher levels of mental model accuracy will lead to lower levels of disorientation while using a web site.

Spatial abilities are cognitive characteristics measuring the ability to conceptualize the relationships between objects in space, and the awareness of location within a space relative to other objects (Sjolinder, 2006). These abilities have obvious relevance for web use, assisting in understanding the relationships between pages in a web site, and which page is currently being viewed in relation to the other pages (Ziefle & Bay, 2006). Studies have shown that individuals with low spatial ability were more likely to report being disoriented because they could not understand the system structure (Ziefle & Bay, 2006), which implies that their mental model was poor. Therefore it is hypothesized that:
H4: Higher levels of spatial ability will lead to higher levels of mental model accuracy.

Hedonic Path

Engagement is a state of playfulness, which occurs when an individual experiences perceptions of pleasure, involvement, and curiosity (Webster & Ho, 1997). Although studies explicitly examining engagement and satisfaction could not be located, a number of studies examining engagement-related constructs indicate that a positive relationship with satisfaction is likely. Thus it is hypothesized that:
H5: Higher levels of user engagement with a web site will lead to higher levels of user satisfaction with the site.

Webster & Ahuja (2006) hypothesized and confirmed that higher levels of engagement improve user performance; the same result is expected in this study. Thus it is hypothesized that:
H6: Higher levels of user engagement with a web site will lead to higher levels of user performance within the site.

Disorientation in hypertext is generally conceptualized as not knowing where to go next, knowing where to go but not how to get there, or being unaware of location within the structure (Webster & Ahuja, 2006). Although the relationship between disorientation and satisfaction has not yet been studied in experimental research, perceived disorientation is a conceptually similar yet distinct construct to perceived ease of use (PEOU) in that if a web site is easy to use, a user is less likely to feel lost (Ahuja & Webster, 2001). A review by Roca, Chiu, & Martinez (2006) found several studies where PEOU has a positive impact on satisfaction. Thus, it is hypothesized that:
H7: Higher levels of disorientation while using a web site will lead to decreased user satisfaction with a site.

Objective measures of disorientation examine apparent inefficiencies in user navigation, thus less efficient navigation results in poorer performance. Some studies have found that the relationship between perceived disorientation and performance is stronger than the

relationship between objective measures of disorientation and performance (Otter & Johnson, 2000). Thus it is hypothesized that:
H8: Higher levels of disorientation while using a web site will lead to decreased user performance with the site.

Disorientation is expected to influence engagement such that users who feel more disorientation will be less engaged with the web site, as was found in Webster & Ahuja (2006). Thus, it is hypothesized that:
H9: Higher levels of disorientation while using a web site will lead to decreased user engagement with the site.

The Impact of Age

Individuals experience a number of changes as a result of the aging process. These changes are expected to influence both the utilitarian and hedonic indicators of user satisfaction in this research. First, spatial ability, whose importance in relation to computer and Internet use has been widely studied, is known to decline with age (Salthouse, 1982) thus it is hypothesized:

H10: Older adults will exhibit lower levels of spatial ability than younger adults.

As summarized in Wagner, Hassanein, & Head (2010), a large portion of the literature concerning computer use by older adults focuses on performance evaluation, and there is consistent evidence that performance declines as age increases, including in a web site context (see Wagner et al., 2010 for details). Thus it is hypothesized that:
H11: Older adults will have lower levels of user performance within a web site than younger adults.

Lastly, older users have more difficulty learning the spatial structure of new environments, and thus tend to become disoriented (Lin, 2003a). Several studies have found disorientation to be more severe for older users than younger ones, thus it is hypothesized that:
H12: Older adults will perceive higher levels of disorientation while using the web site than younger adults.

METHODOLOGY

In order to test the theoretical model, a laboratory experiment was conducted. Since exploring the differences between older and younger users is a primary concern of this study, participants across a wide age range were recruited for the experiment. Specifically, half of the participants were between the ages of 18-35 and the other half were over 55. A total of 101 participants were recruited: 51 older, 50 younger; 60 female, 41 male equally distributed between the age groups. Of all of the demographic items collected, very few differed between the age groups.

Measurement of the participants' mental model accuracy required that participants had not seen the experimental web site before. Thus, a new web site was designed and built for this experiment. The content chosen for the experimental web sites was healthy living information since it is believed that this topic should have fairly equal appeal to the older and younger participants. Upon arriving at the experiment, participants completed a demographic questionnaire and two paper-based assessments of spatial ability. Then, participants were provided with a laptop and instructed to explore the web site for five minutes. Once the participants were done browsing, they were asked to complete six tasks within the web site followed by the MMA exercise. Here they were provided with a large magnetic white-board and a set of 39 small cards with magnets on them. Each card had the label from one of the pages in the web site on it. The participants were instructed to arrange the cards on the board in order to recreate the hierarchy of the web site as they understood it. A similar methodology has been used in previous studies (Otter & Johnson, 2000). Participants were allowed up to fifteen minutes to complete the exercise. Last, participants were asked to complete the post-experiment questionnaire. This questionnaire collected their responses concerning the perceived constructs in the research model (disorientation, engagement, and satisfaction) and two open ended questions.

The constructs in the research model are both formative and reflective in nature. Spatial ability and performance are modeled as formative. Spatial ability is indicated by the participant's scores on VZ-2: Paper Folding and S-1: Card Rotations from Ekstrom et al.'s (1976) Kit of Factor-Referenced Cognitive Tests. Performance is indicated by the number of tasks completed correctly and the total time taken to complete all of the tasks. Disorientation, engagement, and satisfaction are modeled as reflective constructs and measured using previously validated scales from Ahuja & Webster (2001), Webster & Ho (1997), and Bhattacherjee (2001) respectively.

RESULTS

Prior to running the PLS analysis, the appropriate validity tests were conducted on the reflective and formative constructs and all were found to be within recommended thresholds. The results of the PLS analysis are shown in Figure 2. Nine out of twelve of the paths in the model are significant (at least $p<0.05$) indicating that the model is reliable overall. The variance explanation of the endogenous variable Satisfaction is substantial at $R2 = 0.765$.

Although the path from age to disorientation was statistically significant, the sign was in the opposite direction to that hypothesized. Investigating further, the highest level of disorientation was reported by the youngest participants. The responses to the open-ended questions indicate that this may be a result of the simplicity of the experimental site design: the youngest, most experienced users were missing navigation items not included such as bread crumbs and a search function.

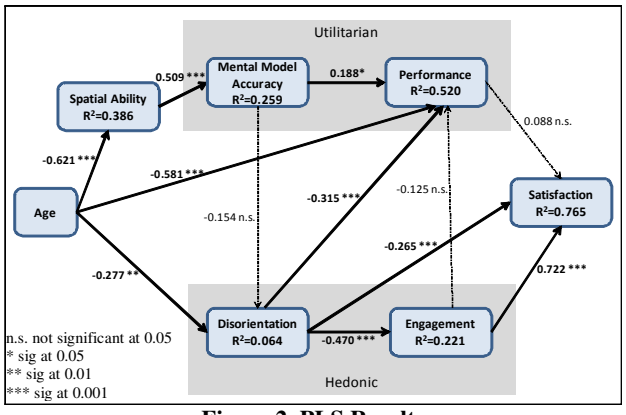

Figure 2. PLS Results

One-way ANOVA analyses were run in order to test for significant mean differences between the age groups on each of the model constructs. The results indicate that older adults have lower levels of spatial ability, less mental model accuracy, and lower levels of user performance, as expected. As mentioned earlier, older adults reported less disorientation than younger. And finally, the difference in user satisfaction between age groups was not significant.

CONCLUSIONS & CONTRIBUTIONS

Each of the research questions is addressed in this section.

What utilitarian and hedonic usability factors influence user satisfaction? This study examined two utilitarian (MMA and performance) and two hedonic (disorientation and engagement) antecedents of satisfaction. The results indicate that hedonic factors had more of an impact on user satisfaction than utilitarian factors. While performance did not have a significant impact on satisfaction (H1 not supported), disorientation and engagement did both have a significant impact (H5 and H7 supported). Specifically, the less disorientated and more engaged a user was, the more satisfied.

What relationships exist between utilitarian and hedonic usability antecedents to satisfaction? Of the three relationships hypothesized between the utilitarian and hedonic constructs, only one was found to be significant. Specifically, disorientation was found to have a negative impact on user performance (H8 supported). Although MMA was expected to impact disorientation, this was not found to be the case (H3 not supported). This is the result of the unexpected findings within the disorientation construct, as discussed. Also, the influence of engagement on performance was found to be insignificant (H6 not supported).

How does age influence the hedonic and utilitarian usability antecedents to satisfaction? Age had a significant influence on both the hedonic and utilitarian constructs in the model. On the utilitarian side, as age increased, spatial ability decreased (H10 supported). Spatial ability subsequently was an important determinant in participants' ability to form an accurate mental model (H4 supported). Age also had a significant impact on performance directly (H11 supported). This direct effect of age might encompass factors such as changes in manual dexterity, memory, etc. On the hedonic side, the influence of age was unexpected. Where it was hypothesized that increased age would result in increased disorientation, the opposite was found (H12 not supported). Investigation of the responses to the open-ended questions shows that the most disoriented of the younger group made a number of comments concerning the lack of visual interest and support of navigation items such as a search function. This implies that designing a simple web site may in fact disadvantage younger adults. Also, it is possible that older adults under reported their disorientation, since older participants have a tendency to focus on the positive aspects of their experience and report feelings more positive than observed by the experimenter (Sayers, 2004).

How can mental model accuracy be measured and what role does it play in influencing the user experience? Here the MMA of the participants was assessed by having them recreate the hierarchy of the web site as they understood it using a set of cards. Although creating a mental model representation in this fashion is not a new concept, the scoring method implemented here is novel in a usability experiment context. Each participant's hierarchy was compared to the correct hierarchy using a tree distance algorithm resulting in a score for the exercise. This scoring method was more sophisticated than that used in previous mental model studies, which only allotted one point for each node connected to the correct parent node, and performed well on the utilitarian side of the PLS model, being positively influenced by spatial ability (H4 supported) and having a positive influence on performance (H2 supported). MMA did not, however, impact disorientation on the hedonic side as expected (H3 not supported). This is related to the discussion of disorientation above since older participants did have less accurate mental models, but reported lower perceived disorientation than younger participants. Thus, MMA assisted participants in performing from a utilitarian perspective, but did not have any influence on their hedonic perceptions.

How do younger and older adults differ in terms of hedonic and utilitarian usability antecedents of satisfaction? Comparing the mean scores of older and younger participants on the utilitarian (MMA and performance) and hedonic (disorientation and engagement) antecedents of satisfaction examined in this study provides some interesting insights. The utilitarian constructs performed as expected with older adults having less accurate metal models (and associated lower levels of spatial ability) and poorer performance ($p<0.001$). The hedonic measures, however, were much less straight forward. As discussed above, the findings for disorientation were unexpected with older adults reporting less disorientation than younger adults ($p<0.029$). The exploration of age differences in engagement and

satisfaction were exploratory since previous research has not examined these relationships. Although no statistical difference was found between the satisfaction of older and younger adults, older adults were found to be more engaged ($p<0.002$). Older adults were also more familiar with the topic ($p<0.05$), supporting the notion that engagement is triggered when the subject matter is personally interesting (O'Brien & Toms, 2008). Whether or not there is a separate age effect on engagement is uncertain and merits further exploration.

From a theoretical perspective, this study contributes to several areas of literature. First, usability literature is expanded by exploring some novel indicators of satisfaction. Also, literature concerning web site usability for older adults is extended by examining the impact of age on utilitarian and hedonic antecedents of satisfaction. Finally, this study presents a new methodology for examining the mental model accuracy of web site users.

From a practical perspective, the findings around MMA are interesting, particularly for utilitarian web sites: encouraging users to develop accurate mental models will help them to improve performance. Also, the results illustrate some of the intricacies of designing for older adults. Developers should provide the navigation cues that experienced users have come to expect, while bearing in mind the simplicity that older users prefer.

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