COMPARING OLDER AND YOUNGER ADULTS' TRAVERSAL TIME IN EXPANDABLE AND NON-EXPANDABLE HIERARCHICAL STRUCTURES

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The present study investigates time and click error differences when older and younger computer users traversed expandable and non-expandable online hierarchical information structures to reach a target. The results show that older users were slower but did not make more errors than their younger counterparts, suggesting more cautious decision making. The study did not show superiority of either hierarchy in terms of traversal time but the expandable hierarchy resulted in fewer errors to get to the target. Although older users significantly rated their computer and Internet experience lower than younger participants, experience did not alter the significance of age and hierarchy differences.

INTRODUCTION

Forecasts project that by the year 2030 people aged 65+ will represent 20% of the people living in the U.S. (U.S. Census Bureau, 2000). Although older adults are still underrepresented as computer users, more and more are beginning to incorporate computers as part of their lives (Kurniawan et al., 2001). As some researchers have noted, computers and information technology can potentially play a role in helping the elderly maintain independence and high quality of life (Czaja, 1997).

However, numerous studies have pointed out that older adults have some disadvantages in fully utilizing online information as an information resource. For example, older people have more trouble finding information in a Web site than younger people (Mead et al., 1997). There is little research focused on accommodating the needs of older adults in using online information, even though previous research has shown that problems with usability might lead to poor performance or even abandonment (Czaja, 2000).

Various attempts have been made to help people use online information faster and easier, ranging from organizing the information in a structured fashion (e.g. in a linear or hierarchical structure) to developing navigational aids (e.g. bookmarks, compasses, geographical browsers).

The general purpose of this research is to compare the time required by older and younger adults to traverse a hierarchical structure. The hierarchical structure was chosen in the present study because McDonald and Stevenson (1998) found that organizing links in a hierarchical structure improves information retrieval performance, especially in non-knowledgeable subjects. Two primary hierarchical structures: expandable and non-expandable or sequential (Hochheiser & Shneiderman, 2000) were tested in the current study. These two structures are presented in Figure 1 and 2.

Studies have shown the advantages and disadvantages of providing expandable and non-expandable structures (Hochheiser & Shneiderman, 2000; Zaphiris, Shneiderman & Norman, 2001). Because there are advantages and disadvantages of providing expandable and non-expandable hierarchical structures, there is a need to study whether one structure is superior to the other in terms of traverse time for each age group. The present study aims to answer two research questions:

1. Do older adults traverse through a hierarchical structure at the same speed as younger adults?
2. Do different hierarchical structures affect traversal time?

Various studies suggest that users' Internet and/or computer abilities might affect the success of computer or Internet-related tasks. Therefore, a measure of users' Internet and computer abilities was also included in this study.

METHODS

Participants

Participants consisted of 24 older adults (M=67.5, S.D.=6.5 years) and 24 younger adults (M=26.8, S.D.=5.18 years), who lived independently in the community (non-institutionalized). The number of participants for each group was chosen to ensure enough statistical power for the analysis (Cohen, 1988). Participants were recruited from area senior centers, senior church groups, community organizations, and a university campus. The sample consisted of a variety of ethnic groups, gender, and education levels. Due to the nature of the study, a certain level of computer and mouse operation knowledge was required; thus, the exclusion criteria were quite stringent in the practical terms. Participants were screened through interviews on computer usage, particularly familiarity with using a mouse and browsing the internet.

Participants were also screened out for poor vision, illiteracy and poor health conditions. Only participants with Snellen (vision) scale of 20/30 or better were included. Asking

participants to fill out their own demographics questionnaire

Figure 1: The expandable hierarchical structure

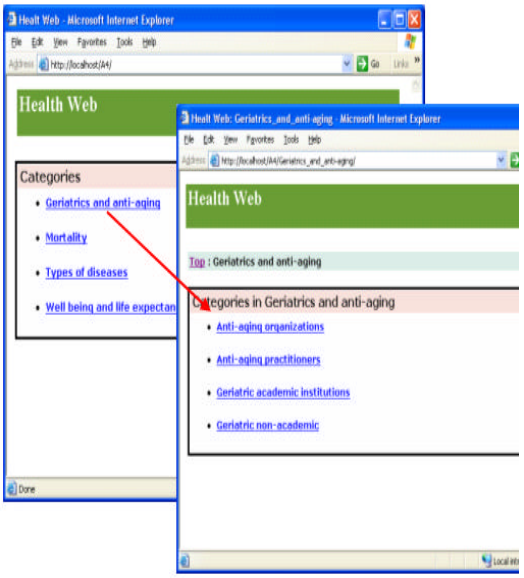

Figure 2: The non-expandable hierarchical structure

screened out functional illiteracy. Health status was a self-rated measure from very bad to very good. Participants who filled in their health condition as bad or very bad were not included in the study.

Stimulus and Apparatus

Demographics and Internet experience data were collected using paper and pencil questionnaire. The Internet experience questionnaire was adapted from the user demographics section of the WWW User Survey fielded by the GVU Center of the Georgia Institute of Technology (http://www.gvu.gatech.edu). Two sets of information, each containing 64 pages of health and medical-related information for older adults, were designed and presented to participants using a standard web browser. Two sets of stimuli were necessary to minimize familiarity because participants had to traverse the hierarchy multiple times. The pages were hosted locally to maintain a consistent page loading time throughout the study and across all participants.

One of the domains of interest to older adults is health information (White, et al., 1999). Therefore, to stimulate participants' interest, the present study used the domain of health information. The test stimuli were taken from Health:Aging and Health:Senior Health directories of http://www.dmoz.org. These sites were categorized by supposed experts in the relevant areas. The stimulus layout was designed to maximize users' performance based on previous studies, such as by putting spacing between categories and by organizing information in columns (Parkinson, et al., 1985).

The tests was conducted with Pentium II-class personal computers operating with Windows 98, SVGA monitors (1280x1024 resolution, .22mm dot pitch @ 85 Hz) and recorded using server log capable of recording time and location stamp of mouse click, and the result of the clicks (i.e. what page is loaded as the result of clicking a hyperlink). To verify that the server's log recorded the correct time and duration, Lotus Screen Cam® software was used to observe the first few participants.

Procedure

For each set of the stimuli, each participant was asked to perform 18 tasks for the expandable mode (9 tasks in each set of stimulus material) and 18 in the non-expandable mode. In total, each participant performed 72 navigation tasks. The experiment was designed to allow breaks at the end of every task to minimize fatigue and boredom. At the beginning of each trial, subjects were given the information found at the target node and asked to find it by choosing among the categories.

ANALYSIS AND RESULTS

Computer and Internet Experience

This measure was a self-assessment of participants' experience using a computer or the Web as listed in Table 1. The ratings were converted to numerical ratings of 1-5 (5 being the highest). These seven items have a high reliability with α=0.91. Most of these general Internet-related experience measures are also significantly correlated to participants' formal education (only the correlation with comfort in computer use has a marginal p=0.05).

Traversal Time

Traversal time in the present study is defined as the total time needed to arrive at the correct target. Figure 3 shows traversal time by age group.

Figure 3: Traversal time by age group.

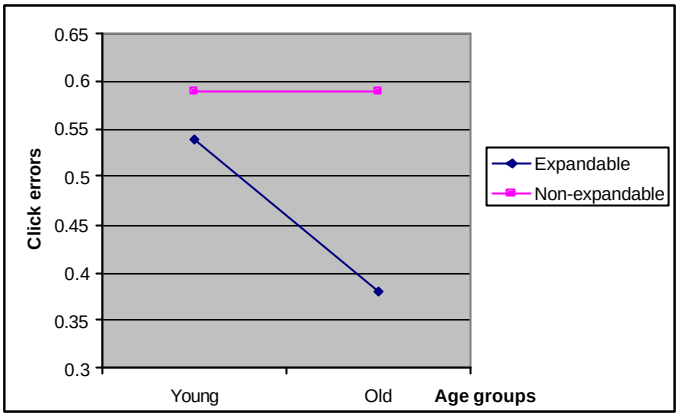

Figure 4: Click errors by age group.

Table 1: Computer and Internet experience.

Items	Young*	Old*	p
Frequency of computer use	3.6(1.18)	2.6(0.90)	0.006
Duration of computer use	3.4(1.21)	2.3(0.86)	0.007
Duration of web browsing	2.9(1.10)	1.5(0.51)	0.000
Web use expertise	3.8(0.92)	2.0(1.00)	0.000
Comfort in computer use	4.5(0.88)	3.0(1.30)	0.000
Comfort in Internet use	4.5(0.93)	2.7(1.01)	0.000
Satisfaction with Internet skill	4.4(0.49)	2.7(0.87)	0.000

* Mean(Standard Deviation)

The ANOVA analyses showed a significant age-difference {F(1,92) = 23.574, p = 0.000} but no significant difference between structures {F(1,92) = 0.918, p = 0.341} was apparent. The age x structure interaction was not significant {F(1,92) = 0.532, p = 0.468}. To investigate whether the significant effects were due to variance in Internet experience between age groups, a set of ANCOVA analyses were conducted to factor out Internet experience. The analyses showed that the results still held: the age-difference was still significant {F(1,83) = 12.981, p = 0.001}, while the structure-difference and the age-structure interaction were still not significant {$F_{structure}$(1,83) = 0.992, p = 0.322; $F_{interaction}$(1,83) = 0.579, p = 0.449}.

Click Errors

To investigate the potential for a speed-accuracy trade-off, click errors were measured. Click error is defined as deviation from optimal number of clicks to arrive at a target page, calculated as: [(observed number of clicks – optimal number of clicks)/optimal number of clicks]. Figure 4 depicts click errors by age groups.

The ANOVA analyses showed a significant structure-difference {F(1,95) = 4.202, p = 0.043} but did not reveal a significant age-difference {F(1,95) = 0.828, p = 0.365}. The age-structure interaction was not significant either {F(1,95) = 0.286, p = 0.594}. Factoring out Internet experience did not alter the significance of the mean differences although the structure-difference became marginally significant at p=0.05.

DISCUSSION

Previous studies indicated that older adults in general have lower Web and computer experience (e.g. Henderson, et al., 1995). The computer and Internet experience measures used in the present study had been tested with a large number of respondents (more than 100,000 over the course of 5 years), and have a high reliability. Indeed, in the present study, the reliability of these five measures was quite high. In all seven measures of computer and Internet experience, older participants rated their general Internet-related experience significantly lower than younger participants. This result is in agreement with previous research on age-differences in Internet experience (e.g. Kurniawan, Allaire & Ellis, 1999). The lower experience levels, however, were not very useful in describing the age-related variation in traversal time and errors. This may be due to limitations in our sample and analysis methods, or could be due to the effect of unspecified mediating variables.

Older users took a longer time to traverse the hierarchy. The traversal time differences between older and younger users were quite large (ranging from a factor of 1.37 to a factor of 1.49). These observations are in line with previous findings, both in the general cognitive aging literature as well as previous studies of web usage (Bailey, 2001).

Neither the structure effect, nor the age x structure interaction, was significant in traversal time, meaning that across all users, the time required to traverse the expandable and non-expandable hierarchies was about the same. This finding was in contrast to the findings by Zaphiris,

Shneiderman and Norman (2001), which showed that more time was needed to traverse an expandable hierarchy. One potential reason for the findings is the effects of concomitant factors such as task complexity and screen format, which was not measured in the present study and creates opportunity for further study.

Older adults did not make more errors than their younger counterparts. We also found that the expandable hierarchy resulted in a more optimal path to the target. This could be due to the increased amount of contextual information available during search. More research is required to confirm and explain this finding. The result suggested that if getting to the target page in as few clicks as possible was the main aim of the online information design then it would be better to arrange the information in an expandable hierarchical structure. The findings that there was a difference in speed but not in accuracy between older and younger age groups was in line with findings from previous research (Ellis, Kogan & Rowan, 1999).

Given that there were no significant age-differences in click errors, the traversal time may be interpreted in terms of differences in search and processing time. A more complete picture is required to fully understand the behavioral basis of this effect. That is, older adults might take longer to search, decide, or select an option, or any possible combination therein.

CONCLUSIONS

The interface design community has made many significant strides since the early days of web-design. The search for better features and optimal designs will doubtlessly continue. While this study cast some doubt on the superiority of expandable hierarchies in terms of traversal time, we have garnered some evidence for lower error rates. In terms of specifically accommodating older users, neither interface excelled. The lack of an interaction showed that older adults remain at a disadvantage regardless of the screen design alternatives examined here.

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