An analysis of information-seeking behavior on the Web in novice older adults

N. Sato, N. Nakamichi, M. Sakai, and H. Uwano

***Abstract*—The purpose of this study was to investigate the factors that influence navigation performance of a Web site in novice older adults, using quantitative and qualitative methods. Eighteen older females (aged 60-72) and eighteen younger females (aged 30-41) who had no experience on the Internet performed three Web navigation tasks on a computer. Their navigation performance was evaluated by total number of pages visited, total number of irrelevant pages visited, and time of task completion. In addition, verbal reports of the participants during tasks were recorded to explore their cognitive processes. The results suggest that older adults took more time to find the targeted Web pages, because, as compared with younger adults, they had more difficulty in finding appropriate links due to character size, inappropriate link name, and high clutter of a Web page.**

I. Introduction

Growth of technology has had enormous impact on our daily lives. Nowadays, it is hard to live in comfort without relying on technology in general and computers in particular [1], in fields such as work, education, healthcare, communication, and entertainment [2].

In many potential uses of computer, the Internet is rapidly becoming one of the most beneficial tools, because it provides information in an efficient manner. In Japan, 68.5% of the population was using the Internet in 2006, as compared with 44.0% in 2002 [3]. Of Internet applications, a common use of the Internet is navigation of the World Wide Web (WWW) [4]. Previous research has shown that the WWW has the potential to improve quality of life in older adults. Cody et al. reported that older adults who learned how to access the Internet had more positive attitudes toward aging, high levels of perceived social support, and higher levels of connectivity [5]. White et al. showed that older adults tended to feel decreased loneliness after receiving training in use of the Internet [6, 7]. More recently, Fokkema et al. suggested that use of the Internet alleviates loneliness and increases self-confidence in older adults [8]. Thus, the Internet would empower older adults if it becomes widely used as an information retrieval/ acquisition or communication tool.

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N. Sato is with the School of Science and Engineering, Kinki University, Osaka, Japan (Phone: +81-6-6721-2332; Fax: +81-6-6727-2024; E-mail: nsatoh@ mech.kindai.ac.jp).

N. Nakamichi is with the Faculty of Mathematical Sciences and Information Engineering, Nanzan University, Aichi, Japan (nakamiti@it.nanzan-u.ac.jp)

M. Sakai is with SRA Key Technology Laboratory, Inc, Tokyo, Japan (sakai@sra.co.jp)

H. Uwano is with the Graduate School of Information Science, Nara Institute of Science and Technology, Nara, Japan (hideta-u@is.naist.jp)

Despite the increased use of the WWW, accessibility to the WWW in older adults is still highly limited. In Japan, adults aged 65 and over constituted about 20.8% of the population in 2006 [9], and they constitute the fastest growing section of the population. However, a survey on Internet use found that only about 5.5% of the Internet user population is aged 65 and over. As for gender differences, about 59.5% of Internet users aged 65 and over are men and the remaining 40.5% are women [10]. Thus, a digital divide exists in terms of age and gender.

To facilitate access to the WWW and provide older adults with equal opportunity to receive benefits through the WWW, we must clarify the navigation problems encountered by older adults as they seek information on a WWW site (i.e., a Web site).

The purpose of this study was to compare the WWW navigation performance of older and younger adults. To date, a number of studies have examined the effects of aging on WWW navigation performance and have provided useful guidelines on designing Web sites for older adults. Most of those studies, however, mainly evaluated navigation performance by quantitative data. Relatively little attention has been given to qualitative evaluation in the area of ergonomics. Previous research addressed the need to employ a combination of qualitative and quantitative methods to investigate problems in this area [11]. Therefore, in addition to quantitative method, as a qualitative method, verbal protocol analysis, which has been used to evaluate usability of a Web site [12] or cognitive searching strategies on navigation tasks [13], was employed for examining physical and cognitive factors of Web sites that may influence navigation performance of older adults.

II. Methods

A. Participants

Eighteen older females (aged 60-72) and eighteen younger females (aged 30-41) participated in this study. None of the participants had any experience with the Internet. They reported having sufficient sight and hearing abilities and no physical discomfort in the upper body regions. Before enrollment in the study, all participants provided written informed consent.

B. Experimental tasks

Three Web navigation tasks were conducted on existing Web browsers. Participants were asked to locate the Web pages for: 1) the duty roster of orthopedists on the Web site of a hospital (Task1; T1), 2) treatment of hypertension on the Web site of a TV program for health information (Task

2; T2), and 3) a recipe of Japanese food on a cooking Web site (Task 3; T3).

C. Measures

Navigation performance

Participants' movements on the screen during tasks were logged by WebTracer [14] and were also recorded on videotape through a scan converter. Navigation performance was evaluated by the total number of pages visited, total number of irrelevant pages visited, and time of task completion, all of which were obtained from log file data of WebTracer and records on videotape.

Verbal protocol data

Participants' verbal reports were recorded by a digital voice recorder. Participants were asked to perform the navigation task and verbalize their thoughts (e.g., what they were attempting to do, what problems they were encountering and other task-related thoughts) concurrently. To identify problems participants faced, the complaints they registered and other behaviors while completing navigation tasks, data from verbal reports were transcribed and categorized into several groups by using codes that we developed. Table 1 shows an example of the verbal reports and the categories for analyzing data.

Table 1 Examples of coding for verbal reports

Participants' verbal reports	Code
"The character size of this screen is too small."	SC
"…the screen is too crowded!"	SL
"I don't know what this word means."	LN
"This is the wrong page. How can I go back to the top page?"	NE
"I can't click the mouse button well"	MC

(Example of codes; SC = Screen character, SL = Screen Layout, LN = Link Name, NE = Navigation Error, MC = Mouse Control).

Computer anxiety

To examine whether participants' attitudes toward computers influenced Web navigation performance, computer anxiety was measured with Aikyodai's Computer Anxiety scale (ACAS) [15]. ACAS comprises 21 items that measure three components of computer anxiety, each consisting of 7 items: 1) anxiety toward computer operation, 2) computer interest, and 3) anxiety toward social influence of computer technologies. Participants were asked to respond to each of the items using a 5-point Likert scale (1 = "strongly disagree", 5 = "strongly agree").

D. Experimental procedure

Participants completed two sessions, on different days. In the first session, participants trained on how to use a mouse and how to perform a navigation task (approximately 30 min, and this time was extended if either the participant or experimenter felt it necessary). The second session was conducted for collecting data. Participants were allowed to practice a navigation task for 20 min before data were collected. After completing practice, the participants performed three navigation tasks with a 10 min. resting period between tasks, with all participants performing the tasks in the same order. At the end of this session, participants responded to the ACAS.

III. Results

A. Navigation performance

Table 2 shows the results of navigation performance for each task. No significant differences were found between younger and older participants in total number of pages visited and total number of irrelevant pages visited in each task. Time of task completion was significantly longer in older participants than in younger participants ($p<0.01$). This suggests that, as compared with younger participants, older participants spent more time on each page to search a link for moving to another page.

B. Verbal protocol data

The results of analysis on verbal protocol data indicate that older adults had more difficulty in finding appropriate links than did younger adults, because of small character size, unfamiliar names of links which did not provide a hint of the pages they link to, high density of page layout, and high clutter on a page. Some older participants also mentioned that they had difficulty in pointing and clicking a small button or link. Some younger participants were embarrassed that they took significant time to find a link or made a navigation error.

C. Computer anxiety

Table 3 shows the scores of computer anxiety for each age group. No significant differences are found in total scores, scores of computer interest, and scores of anxiety toward social influence of computer technologies. Scores on anxiety toward computer operation were significantly higher in younger adults than in older adults ($p<0.01$).

IV. DISCUSSIONS

This study was conducted to determine the factors that influence WWW navigation performance in novice older adults by both quantitative and qualitative evaluation.

As for navigation performance, time for task completion in older participants was significantly longer than that in younger participants, although no significant differences were found in total number of pages visited, and total number of irrelevant pages visited. These findings suggest that mean duration on a page before choosing where to click was longer in older participants than that in younger participants.

Previous research suggests that small character size [16], inappropriate link name [17], and high clutter [4, 12] of a Web page affect navigation performance. Smith et al. reported that cursor control tasks with a mouse are more difficult for older adults [18]. In this study, these factors could have led to poor navigation performance.

Attitude toward computers or technologies did not have any observable influence on Web navigation performance. Interestingly, younger participants were more anxious about operating computers. Their generation has become accustomed to using computers efficiently in daily lives, regardless of whether they are willing or unwilling to use

Table 2 Values of navigation performance (mean ± S.E)

		Younger adults	Older adults
Total number of pages visited	T1	3.67 ± 0.50	4.89 ± 1.33
	T2	7.44 ± 1.48	5.61 ± 0.70
	T3	5.83 ± 0.88	7.31 ± 0.83
Total number of irrelevant pages visited	T1	1.17 ± 0.33	1.83 ± 0.88
	T2	1.83 ± 0.94	1.89 ± 0.57
	T3	2.17 ± 0.45	2.44 ± 0.64
Time of task completion (sec)	T1	81.33 ± 15.26	164.44 ± 28.51
	T2	164.17 ± 37.91	424.33 ± 58.65
	T3	159.28 ± 24.83	333.19 ± 39.37

Table 3 Scores of computer anxiety (mean ± S.E)

	Younger adults	Older adults
Anxiety toward computer operation	23.61 ±1.19	19.33 ± 0.93
Computer interest	19.39 ± 1.01	20.17 ± 1.16
Anxiety toward social influence of computer technologies	20.28 ± 1.04	18.89 ± 1.67
Total	63.28 ± 2.22	58.39 ± 2.81

computers. Therefore, selection bias might be at work; a group of younger adults that lack Internet experience would probably include many who are anxious about computer use. Meanwhile, older adults generally have fewer opportunities to use computers, and therefore many would be novices because of lack of opportunity rather than because of computer anxiety.

This study clarified that some physical and cognitive factors could influence usability of Web site in novice older adults. Of those, relatively much research has been done about appropriate character size of Web sites for older adults. Further study is needed to examine systemically how link name or clutter on Web sites influences navigation performance in older adults, in order to minimize these problems.

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