

Study of User Interface for Browsing Web Contents That Considers the Cognitive Features of Older Users

Masahiro Watanabe, Shunichi Yonemura, Ryo Hashimoto, and Yoko Asano

Cyber Solutions Laboratories, Nippon Telegraph and Telephone Corporation,
1-1 Hikarinooka, Yokosuka, Kanagawa, 239-0847, Japan
{watanabe.masahiro, yonemura.syunichi, hashimoto.ryo,
asano.yoko}@lab.ntt.co.jp

Abstract. Web accessibility for old users has become a serious issue, especially in Japan. The problems involve cognitive as well as physical characteristics. Cognitive problems are well-handled by the metaphor approach, especially for older users when Web browsing. In order to investigate the impact of his approach, we conducted experiments with 11 old subjects and 10 young subjects. They were asked to search for a target in a Web site via the book metaphor interface and with a common Web browser interface. Although there were no differences in the task success rates or the task completion time between the two interfaces, there was a difference in the browsing time per Web page. The results of a questionnaire show that many old users prefer the metaphor interface. With the book interface, they selected the strategy of look and click because it lessens the demands placed on working memory.

Keywords: older user, Web, accessibility, usability, book metaphor.

1 Introduction

The rapid penetration of the Internet has made Web sites one of the most important ways of passing and acquiring information today. The relative newness of Web site design principles has created serious usability issues, particularly for people with disabilities and older users; this is especially true in Japan because it has already become an aged society. It is important to focus not only on the physical issues of the elderly but also on their cognitive issues. A lot of research is targeting Web accessibility, the ability to access information [1 - 3] and there are some guidelines for Web design [4, 5]. These studies and guidelines mainly focus on physical issues, and few Web design methods that are appropriate for the cognitive issues of older users have been published.

Many laboratories have executed psychological studies on the cognitive issues of the elderly under strictly controlled conditions. Study issues include attention and working memory, and results have shown the negative effects of aging. Although field work with existing Web sites is important, these studies did not address the usability of Web content for older users.

Some Web designs cause various troubles for old users in browsing Web sites, for example they have trouble in scrolling a Web page. These troubles are caused by the

cognitive weaknesses of users, and have no known direct cause. We focused on the dialog principles of ISO 9241-110 [6], and found that self-descriptiveness is a critical dialogue principle for older users [7]. In order to satisfy the principle and to reduce the impact of the cognitive issues of older users, we think that the metaphor approach is very attractive. This is because the metaphor represents something they are familiar with in daily life and so places no unusual demands on their working memory. We focused on the book metaphor as a Web site interface and investigated its usability for older users.

2 Experiments

Eleven older users (65 - 74 years old; 6 females) and 10 young users (20 - 33 years old; 5 females), who had experience of PC operation for 3 months - 15 years and use the PC less than 4 times a week, participated in the experiments. They were requested to access a Web site managed by our research group and accomplish search tasks using two interfaces: a common Web browser (Fig. 1: browser interface), and the book metaphor interface (Fig. 2: metaphor interface). In order to investigate the impact of the metaphor, we made a Web site that looked like book, see Fig. 2, mainly by changing the style sheets of the Web page. Both interfaces displayed the same information.

The subjects were instructed to accomplish 4 search tasks as shown below and not to use keyword search. We made 2 simple tasks (1-1 and 1-2) and 2 complicated tasks (2-1 and 2-2). The site consists of many pages that are categorized. In the complicated task, the subjects had to locate the keyword in one category while holding the other keyword in memory, and then to locate the second keyword in another category. This task places more loads on the subject's working memory. The experiment with the complicated task followed that with the simple task. In both tasks, the assigned task order, 1-1 or 1-2 (2-1 or 2-2), was randomized between subjects.

- Task 1-1: Find out via the Internet the conference attended by 102 people in the event "NTT Group Collection 2007."
- Task 1-2: Find out via the Internet the favorite football team of Mr. A (displayed on the page "Key person for universal design"). We used the real name of Mr. A in the experiment.
- Task 2-1: Find out via the Internet the telephone number of the NTT-West information equipment division that made the telephone terminal, "IP Telephone UD."
- Task 2-2: Find out via the Internet the name of 4 NTT DoCoMo staff members who created a mobile phone with 2 displays as part of a universal design activity.

We observed each subject while performing the tasks and interviewed each. The subjects were requested to select their preferred interface. The Web pages were generated within Internet Explorer 6 running on Windows XP, and presented on a liquid crystal display (21.3 inches, UXGA). The window of the browser was fixed at full screen mode.

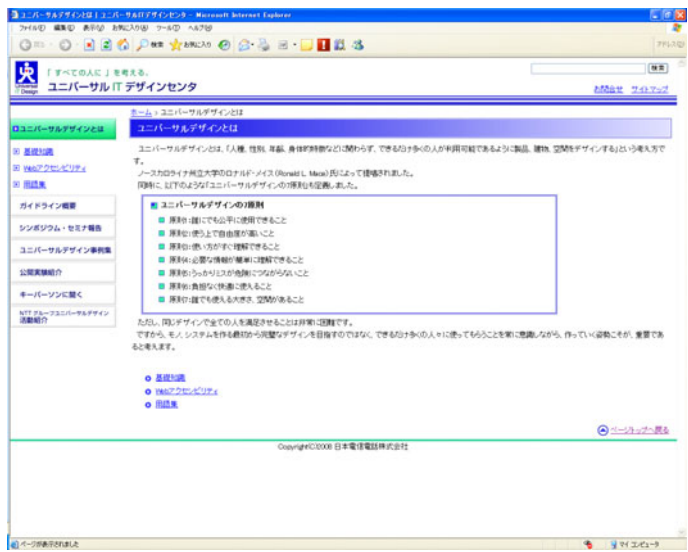


Fig. 1. Web page presentation via existing Web browser (browser interface)

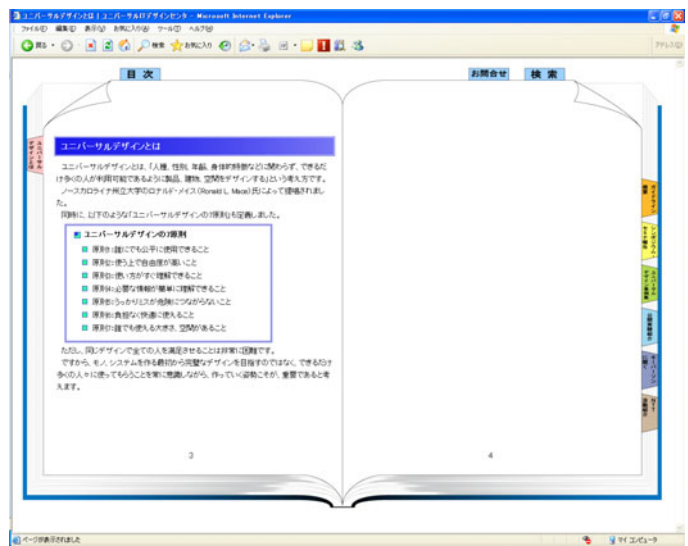


Fig. 2. Web page presentation via book metaphor (metaphor interface)

In the metaphor interface, all Web pages in the site are linked each other in one line like a real book. As shown in Fig. 2, the right and left upper corners of the book are everted and links are provided by using image maps. The image map at right upper corner links to the next page and that at left upper corner links to the previous page. Animated page turning was not used.

To provide the same navigation methods in both interfaces, we designed the 7 tabs in the metaphor interface (Fig. 2) to match the left side navigation menus in the browser interface (Fig. 1). The same information is provided in both interfaces and the sentences provided the same links. The subjects were instructed to accomplish the tasks as quickly as possible and we timed the task completion time. If the subject found the right answer within 15 minutes the trial was deemed a success, otherwise, a failure. Even if the page holding the answer was displayed, the subject had to provide the right answer. Trials were terminated if

1. Subject gave an answer.
2. Subject gave up.
3. Fifteen minutes passed.

The subjects were asked to say “I found the target.” or “I give up” to the experimenter and we stopped timing at these declarations. This means that the task completion time is the whole time of Web operation regardless of success or failure. Right before the first task in the metaphor interface, the subjects were asked to practice by freely operating the book interface for 2 minutes. After completion of all tasks, we determined the preferred interface from interviews and six questions.

3 Results

3.1 Task Success Rate

Fig. 3 shows the success rates for each subject, each task, and each interface. Task 1 (task 1-1 or 1-2) was comparatively easy, while task2 (task 2-1 or 2-2) was comparatively difficult. In all conditions, older subjects had lower success rates than the young subjects. There were no significant differences with regard to success rates between browser and metaphor interfaces.

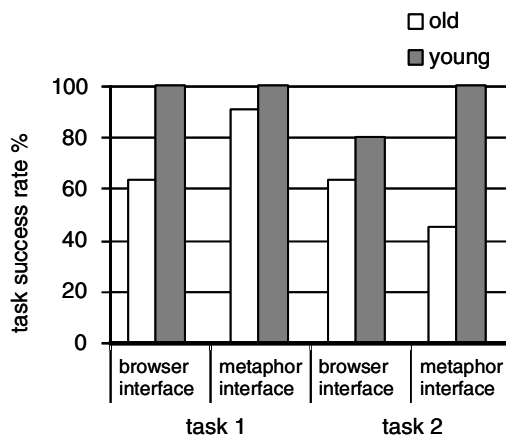


Fig. 3. Task success rate

3.2 Task Completion Time Periods

Fig. 4 shows the mean task completion times. Vertical bars show the standard deviations. The times are for the subjects who performed the task successfully. The data of subjects who failed the task was not used.

The old and young subjects demonstrated the same completion times for task 1 regardless of the interface. In task 2, although there was no difference in the time taken by old and young subjects in the metaphor interface, the old subjects took longer than the young subjects in the browser interface (Kruskal-Wallis test, $p < 0.01$). ANOVA showed that the young subjects took longer for task 1 than for task 2 of ($F = 5.34$, $p < 0.05$) in both interfaces, although the old subjects showed no such difference according to the Kruskal-Wallis test.

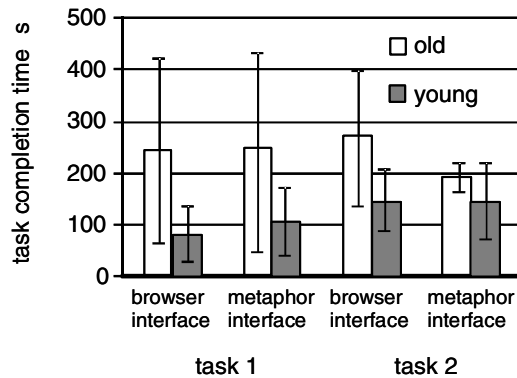


Fig. 4. Task completion time

3.3 Browsing Time per Web Page

Fig. 5 shows the browsing time per Web page. Vertical bars show the standard deviations. The browsing time per page indicates the ease with which a page can be processed. In order to investigate the subjects' search strategies, the data is taken from both successful and failed trials.

In task 1, the per page browsing time of old subjects in the metaphor interface was shorter than that in the browser interface (Kruskal-Wallis test, $p < 0.05$), although the young subjects showed no such difference. In task 2, the old subjects showed no difference in per page browsing time, while the young subjects showed shorter per browsing times in the metaphor interface than in the browser interface (Kruskal-Wallis test, $p < 0.01$).

In task 1, there was no difference between the per page browsing times of old and young subjects, but the old subjects showed longer times than the young subjects in task 2 (Kruskal-Wallis test, $p < 0.05$).

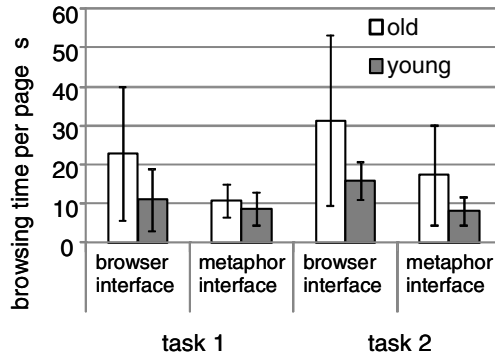


Fig. 5. The browsing time period per page

3.4 Replies to Questions and Interviews

Fig. 6 shows the subject's replies to 6 questions. The metaphor interface was preferred by old subjects in 77 % of the questions and by the young in 62 % of the questions. Over 90 % of the older users and over 60 % of the young users preferred the metaphor interface in at least one question. In interviews, some older users noted that they preferred the metaphor interface because "It is easy to learn how to use it. It is used as a book." Another said, "It looks like it contains a small amount of information." Another reply was "It does not use Web page scrolling." These answers imply that the metaphor interface does not overload the cognitive abilities and well-suits older users. We gathered from the subjects their reasons for making the choices shown in Fig.6. The major opinions are shown in Table 1.

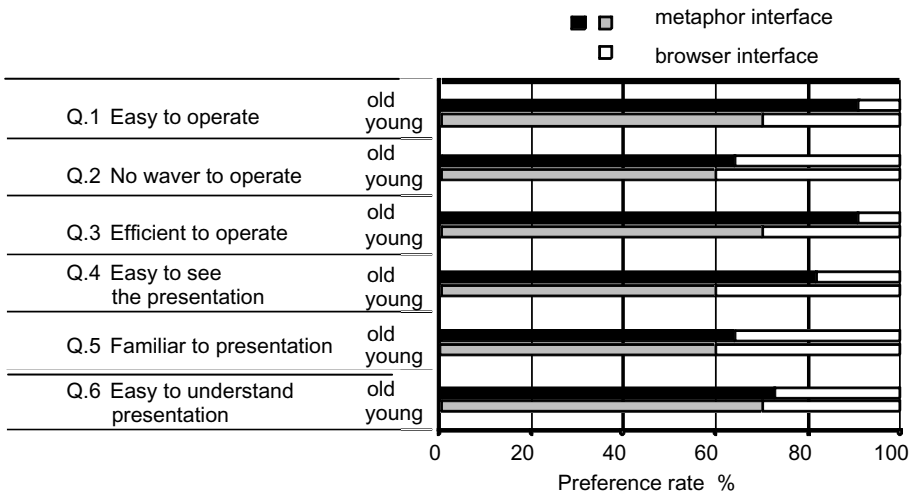


Fig. 6. Preference rates

Table 1. Major reason for preferences

Selected interface	subjects	Major reasons why they chose the interface
Select metaphor interface	old	● It is similar to a book. Because I understand how to use it, I do not have to click several places. ● Page turning. If I cannot find the way to the target, all I have to do is to turn over the page. I can search sequentially. To turn over is easier than scrolling a page. ● Each page contains a well defined amount of information.
	young	● I can use it like a book. ● It has a list of content, book marks, and tabs. ● It contains very simple information
Select browser interface	old	● I often use it. I am not familiar with the book metaphor. ● The electric book is not suitable for searches. I have an image of reading a book. ● It is easy to search using keywords.
	young	● I often use it. ● It is easy to understand because there is much information on each page. ● There is a clue in a page to find the target.

4 Discussion

There was no difference in the success rates between the browser and metaphor interfaces. The success rates in the metaphor interface were high even though the book metaphor was novel to all subjects. With the metaphor interface, the old subjects basically matched the performance of the young. A key indicator of the characteristics of the metaphor interface is the average time spent per page. The metaphor interface encouraged the strategy of rapid page jumps, the subject did not give up the task and continued the search.

The replies to the six questions clearly indicated that the elderly preferred the metaphor interface. A previous study showed that object familiarity reduces the load on the working memory of old people [8]. This is confirmed by the subjects who replied that the metaphor interface was “easy to understand how to use”. The metaphor interface is familiar to even novice users. All subjects had experience in reading books and could put their experience to use in browsing Web pages in the metaphor interface.

Most of the older users preferred the book metaphor. The result shows that a metaphor has a possibility to ease cognitive load of older users although there were no differences in the success rates and the performing task time period. The metaphor enhances operating Web pages, saves working memory’s load and provides some sense of ease.

The metaphor interface was more popular with the old subjects than the young. The former expressed the opinion that it was easier to mentally process a block of information that had clearly defined limits, the page had borders. That is, they could see all the information on the page without additional operations like page scrolling.

While the elderly are trying to comprehend a block of text, it is counterproductive to force them to perform additional operations.

As described above, our comparison of browser and metaphor interfaces in the field of human-machine interface and information structure has shown the possibility of the latter reducing the load placed on the working memory of elderly users. It indicates the metaphor interface is one of the most suitable interfaces for older users. In order to apply this finding to practical Web design, further study is needed.

5 Conclusions

In this study, we focused on accessing the Web via the metaphor interface as a way of reducing the cognitive loads placed on the working memory of older users. A comparison of metaphor and browser interfaces showed that there was no difference in task success rate or in task completion time. Even though all subjects were experiencing the metaphor interface for the first time, their performance was not significantly degraded. It indicates that the metaphor interface is suitable for novice users. The browsing time period per page in the metaphor interface is shorter than that in the browser interface. It indicates that the interfaces yield different search strategies. Most of the older subjects preferred to book metaphor which suggests that the metaphor interface placed less loads on working memory. Future works include investigating which feature of the metaphor impacts the cognitive issue of older users and Web design methods including system design.

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