Auditory and Visual Guidance for Reducing Cognitive Load

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Abstract. Auditory and visual guidance are often used as means to make IT equipment easier to use and decrease cognitive load. However, the effective use of the guidance is not yet clarified. Accordingly, there is a case that the guidance disturbs user operation because of inappropriate use of guidance. This paper discusses the effective use of auditory and visual guidance to reduce user's cognitive loads through experiments with simulated ATM systems.

Keywords: Auditory and visual guidance, cognitive load, usability.

1 Introduction

The operation of today's IT equipment is complex due to their multifunctional nature. Therefore, many users including the elderly have difficulty using the equipment. The IT equipment must give better assistance to the elderly users. If the functions are not decreased, it is necessary to examine how cognitive characteristics (attention and memory etc.) influence operation. Then, it is important to consider about adequate attentions for decreasing the cognitive loads of users.

Voice guidance (auditory guidance) is often used as a means to improve cognition. In case of ATMs (Automatic Teller Machines), when a user does not perform the next step after a certain period of time, voice guidance that serves as prevention against operational mistakes is given from the ATM. The guidance may be repeated at a set time. However, there are times when a user did not forget the operation but are still thinking. Then the user tends to make an operational mistake when disturbed by the voice guidance [1].

Moreover, the voice guidance is sometimes not synchronized to the screen massages displayed at that time. Usually the IT equipment is made easier to use by adding visual guidance that synchronizes with the auditory guidance and induces the user to glance at the pertinent display on the screen.

This study examined the method and the effect of auditory and visual guidance using an ATM system that the elderly users find difficult to use.

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2 Guidance and Cognitive Function

It is said that the auditory guidance is effective at aiding operation. However, it has not been discussed what kind of effect auditory guidance gives to cognitive load reduction. Therefore, in this study, the effect of the auditory and visual guidance was organized based on PDS model [2]. The result is shown in the model of Fig. 1.

The user follows the P (plan), D (do), and S (see) model for each step when operating systematic equipment like the ATM, and the PDS model is repeated until all steps are completed.

It is thought that the cognitive function appeals to the PDS at perception, understanding, and judgment level, and guidance respectively promotes visual guidance, understanding and search.

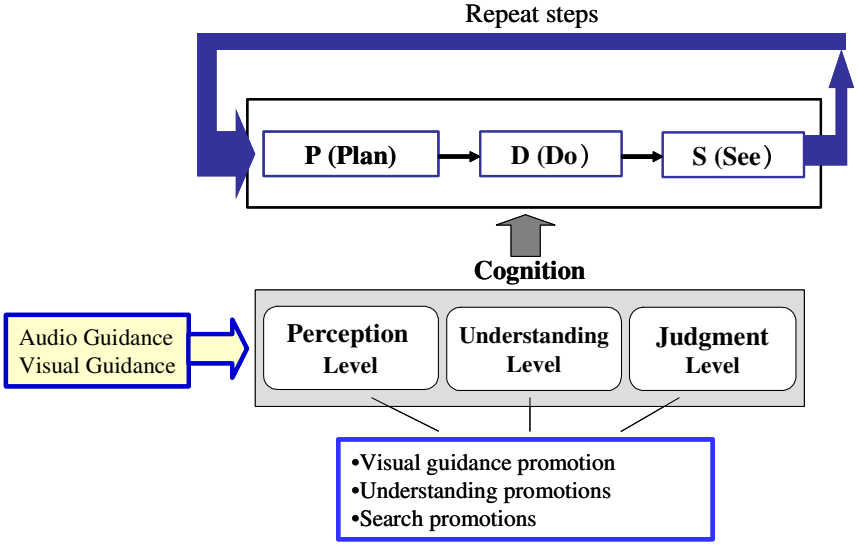

Fig. 1. Guidance and Cognitive Functions

3 Experiment

The effectiveness of guidance for the elderly and middle-aged was compared with four speed levels.

3.1 Experimental System

In this study, an ATM that presented on the screen a load of information including detailed explanation of operation and input steps was used. Not only auditory guidance but visual guidance that induces user's glance to the pertinent display on screen at the same time as the presenting auditory guidance was also shown. It was thought that the visual guidance provided better comprehension of the required information and made looking up desired items easier during searches.

When the screen is switched on, auditory guidance is presented only once and the same content as the auditory guidance is displayed on the screen. There is a case where the understanding level drops when the content of the display and voice guidance are different [3]. There is another case where the presentation timing of the voice guidance disturbs the operation [4].

In the experimental system, auditory guidance was assumed to read out all information related to the operation required on the screen as well as available choices. At that time, the pertinent word corresponding to the reading voice was enclosed with a red frame as a visual guide. The speed of the auditory and visual guidance was set at four levels (A, B, C and D) as shown in Table 1[5]. “A” represented standard speed, and “B” (1.5 times faster), “C” (2 times faster), and “D” (0.8 times slower) were prepared.

The control condition without auditory and visual guidance was defined as “no guidance". "Mora" (beat) is a unit of voice speed, and it is a phonology concept of displaying a time unit. One “Mora” equals one syllabic sound. Larger numbered “Mora” indicates faster voice speed.

3.2 Experimental Participants

The experimental participants were a group of six elderly users (three males and three females, age between 66 and 78), and a group of six middle-aged users (three males and three females, age between 50 and 53). They had negative feelings operating ATMs.

Table 1. System types with the Guidance Speed

System	Guidance Speed (Mora /second)
No guidance	—
A	6
B	9
C	12
D	5

3.3 Experimental Equipment

As an intended system, the ATM simulator was set up with a personal computer and a touch display. A video camera, tiepin-type small microphone, and recording equipments, etc., were prepared as recording tools.

Moreover, the experimental participants were asked to wear an eye camera to measure the point of their gaze.

3.4 Experimental Procedures

Each experiment was conducted by the individual participates. At first, an explanation of the experiment objectives, the use of the equipment, and preliminary questionnaires concerning the use of ATM were conducted prior to performing the tasks. A follow-up

survey was given after the tasks had been completed, and additional interviews were conducted. The experimental task was "money transfer". The operational orders were counterbalanced.

4 Results and Considerations

4.1 Use of Guidance

The use of guidance while operating the ATM was counted from user's glance analysis. The elderly users used the guidance more than the middle-aged users. Each group datum was analyzed using the Chi-Square Test for the comparison of systems (Fig. 2). As a result, the elderly users were found to show no significant difference in the frequency of use, while the middle-aged users showed a significant difference ($\chi^2_{(3)}$=18.211,p<.01). It was found that the middle-aged users use the guidance of the "C" system more than the "A" system or "D" system. Therefore, the middle-aged users use the guidance of fast speed. The elderly users tend to use the less fast speed of the "B" system.

4.2 Operation Time

The bank selection step was studied to evaluate the influence of search promotion. Each group datum was analyzed by variance (Fig. 3). According to the analysis, both the elderly users and middle-aged users showed significant difference ($F_{(4,20)}$=2.52,p<.10; $F_{(4,20)}$=5.74,p<.01). Results of the multiple comparisons using LSD indicate the operation time required for "no guidance" was more than the 4-level speed guidance.

The confirmation step (confirmation of all selected items) was studied to evaluate the influence of understanding promotion. Each group datum was analyzed by variance. As a result, the middle-aged users showed no significant difference while significant difference ($F_{(4,20)}$=3.79, p<.01) was found in elderly users. Results of the multiple comparisons using LSD indicate the operation time required for "no guidance" was more than the 4-level speed guidance. This is the same as the bank selection step.

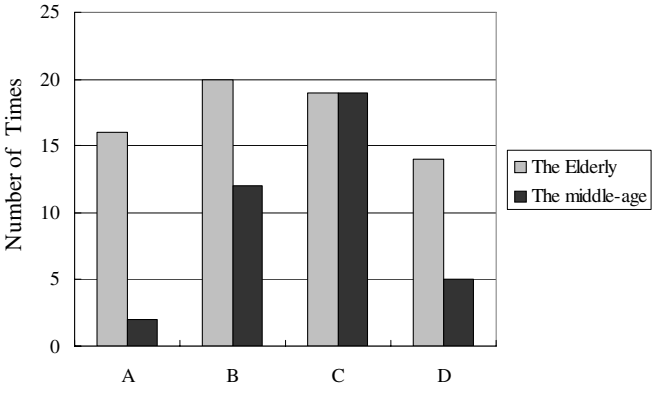

Fig. 2. Use of Guidance

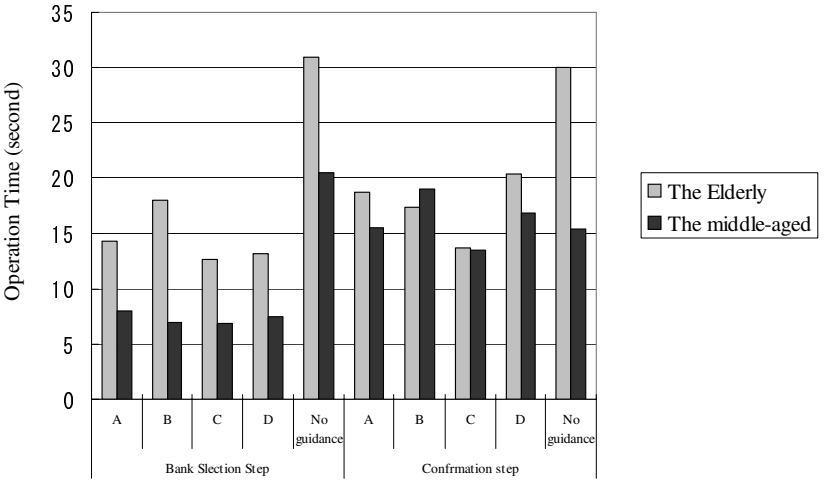

Fig. 3. Operation Time

Therefore, it can be said that the search and understanding were promoted (assisted) by the guidance.

4.3 Operational Errors

The datum of each group was analyzed using the Chi-Square Test (Fig. 4). According to the analysis, both the elderly users and middle-aged users exhibited no significant difference. Although there is no significant difference, the errors decreased with the 4-level speed guidance in the middle-aged users. The elderly users' errors were small with the above-mentioned "B" system.

Therefore, it can be said that the errors decreased with guidance.

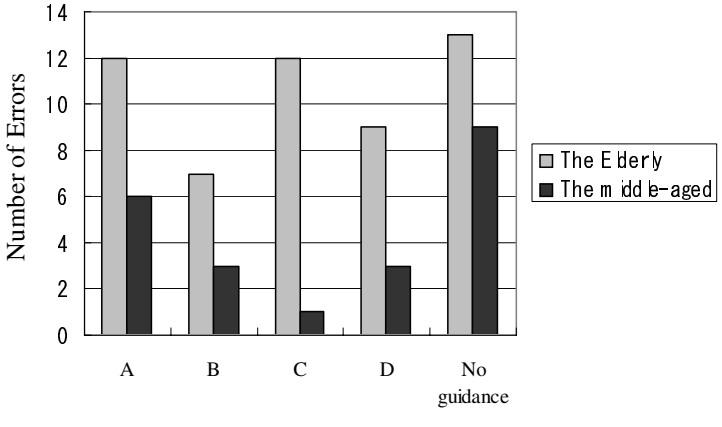

Fig. 4. Operation Errors

4.4 Psychological Evaluation of the Guidance

After each system operation was finished, a survey using six evaluation scores (for example: very good; 6 → very bad; 1) was conducted. The datum of each group was analyzed by variance (Fig.5). For questions regarding "Calmness" and "Relaxation", the elderly users and middle-aged users showed significant difference.

According to analysis of calmness, significant difference ($F_{(4,20)}$=2.78,p<.10; $F_{(4,20)}$=3.95,p<.05) were found with the elderly users and middle-aged users. The results of multiple comparisons using LSD indicate the elderly users and middle-aged users rated the "C" system lower than "no guidance" and "A", "B" and "D" systems.

Analysis of relaxation also shows a significant difference ($F_{(4,20)}$=2.35,p<.10; $F_{(4,20)}$=8.08,p<.01) with the elderly users and middle-aged users. The results of multiple comparisons using LSD indicate the elderly users and middle-aged users rated the "C" system lower than "no guidance" and "A", "B" and "D" systems.

This clarifies that the guidance psychologically influences the users and when the guidance is too fast, they felt uneasy.

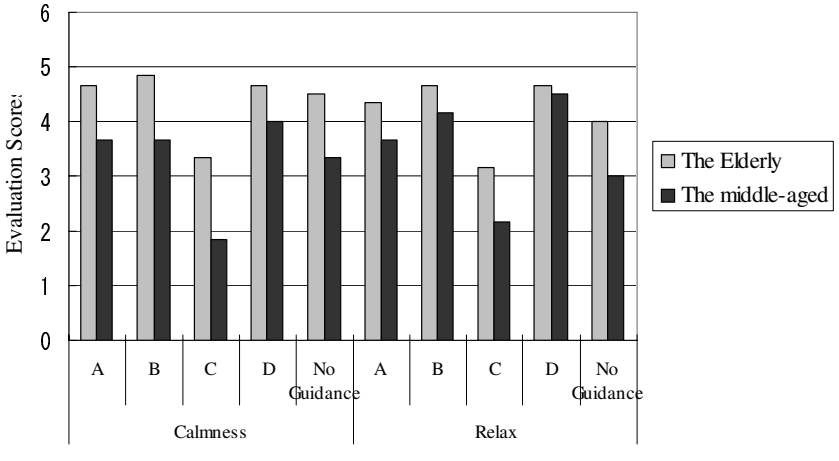

Fig. 5. Guidance Evaluation

5 Conclusion

In this paper, the auditory and visual guidance were examined. It was clarified that the auditory and visual guidance are effective at the confirmation step and search step. When user search or confirm, it was shown that operation times were shortened with the presence of auditory and visual guidance. However, when the guidance speed was too fast for the users, they felt uneasy. In future studies, it is necessary to examine the guidelines for an effective auditory and visual guidance.

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