Strategy of Visual Search of Targets on Screen Through Eye Movement of Elderly Person

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Abstract. It is important that the operation characteristic of the elderly have to clear for designing information equipment that was deeply considered about influences of aging. Visual search tasks were imposed on the elderly in this study and found strategy for searching target by analyzing their eye movements that gazing time, gazing position and locus in the search task. Experimental parameters of stimulus were the number of character strings, the letter types, and the number of stimulus represented on screen. Results showed that mean gazing times become long in accordance with the number of characters. When alphabetic letters was reproduced on screen, the elderly hesitated to search a target stimulus. By analysis of gazing position and locus of eye movement, the strategy of visual search of the elderly was categorized three patterns.

Keywords: Elderly person, Information equipment, Eye movement, Visual search.

1 Introduction

Information instruments that has rapidly complicated the function in recent years cannot necessarily say an easy-to-use one for the elderly. It is enumerated that consideration-and-attention to them is insufficient in the design of information Instruments as one of the reasons. To design Information Instruments, a variety of design models are applied. However, there is little model by whom the design of an easy-to-use information devices to them can be examined. For example, a human information processing (HIP) model proposed by Card et al. which is useful for design of information-processing equipment is the simplified model which divides the information processing system of human being into three subsystems that are perception, cognition, and movement system [1]. However it is hard to use the model in consideration of effect of aging for process stage by each subsystem. Moreover, the proposal of the information processing model who considered eye movement of the elderly that is closely related to perception is not found. Therefore, it is difficult to

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make the best use of their information processing characteristic for the design of the equipments.

At first this study analyzes eye movement of the elderly in operation of information equipments to suggest the information processing model that can explain the influence of aging in the information processing. Their eye movement characteristics are examined by using visual search task in this research to know basic information processing characteristics of the elderly.

2 Experiment Method and Conditions

2.1 Visual Search Task

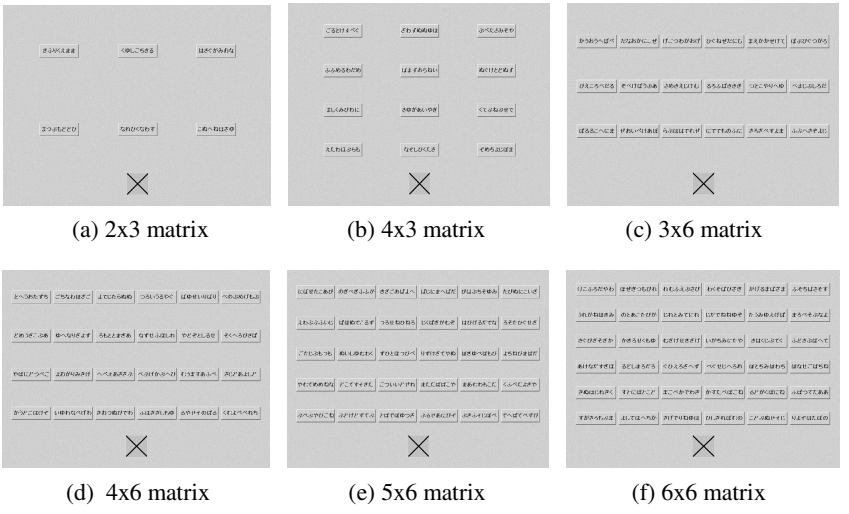
The character string represented on LCD screen was observed by both eyes, and it was assumed the task of looking for the target stimulation from among two or more stimulation [2], [3]. The character string, the start button, and the home position that was the target stimulation to an initial screen were displayed. The subjects memorize the character string that is the target stimulation. Afterwards, the target stimulation and the start button disappeared when pushing the button to start, and the target stimulation was presented with two or more obstruction stimulation one second later.

The target stimulation and the obstruction stimulation went out of the screen when stimulation was selected, and the following target stimulation and the start button were represented. The home position was always presented. The next target stimulation was presented without looking for the same stimulation again when stimulation other than the target were selected. Moreover, the subjects put the finger of his/her dominant arm on the home position except touching the selection button of the character string on the screen. If time from leaving of the finger from the home position to pushing stimulation was too long, the obtained data was invalid because it was considered that he/she had searched the target for the period. Level of horizontal illumination of screen was approximately 500 lx.

2.2 Stimulus

There were three kinds of numbers of characters of character strings of stimulation, that is, 3, 5, and seven characters. Four kinds of character of stimulation is hiragana, katakana, alphabet that was a meaningless spelling and the numeral. There were six kinds of numbers of obstruction stimulation of 5, 11, 17, 23, 29, and 35 pieces. The target stimulation was 1 piece. The color of the character was assumed that the color of the black and the background was grays, and presented on the screen button. A typical layout of buttons displayed is shown in figure 1.

Target stimulation that was searched by one session was changed for different ten types. The subject carried out 72 sessions in all because he or she searched for all of the combination of three characters, four types of character and six character numbers. So the task of looking for the target stimulation as many as 720 times was imposed on the subjects. The order of the session was assumed to be random in each test.



(a) 2x3 matrix (b) 4x3 matrix (c) 3x6 matrix

(d) 4x6 matrix (e) 5x6 matrix (f) 6x6 matrix

Fig. 1. Typical screen of visual search task on pointing the same character with the target character (seven characters, hiragana)

2.3 Experimental Devices

The eye movement was measured by using the experimental system composed by goggle and camera. Resolution on the touch panel display (Touch panel systems) used to experiment was 1280×1024 dots, and the size was 17 inches. Measuring device of both eyes' movement (Takei equipment) was used for the measurement of the eye movement. The subject whose head was fixed with the jaw stand had the glance when he/she sat on a chair, and it looked straight up ahead come to the center of the screen. The viewing distance from the subject and the presentation stimulation was about 35cm. It took a picture of eye movement with a camera attached on the goggle that the subject had wear, and it recorded with the VCR (EV-S2200, SONY company). The sample rate of the images was 16(msec).

2.4 Subjects

Ten senior people of 65 years or more (7 males and 3 females) participated in the experiment and undertook the reward as the subjects. They had normal eyesight or anormal corrected eyesight. In the one's dominant arm, nine people were right-handed, and one person was left-handed. We understood that feeling of the elderly is comparatively little in difficulty of the search for daily life since questionnaire survey was conducted for concerning the easiness to use an Information Instrument.

2.5 Searching Time

Search time was the period from the presentation of the target stimulation and the obstruction stimulation on the screen to parting of the finger put on the home position, and hand movement time was the time to pushing stimulation separating the finger

from the home position. The frequency in which the obstruction stimulation was selected was measured, and the error rate was calculated.

2.6 Analysis of Eye Movement

Statistical analysis on eye movement data obtained by both eyes' movement measurement device was carried out by special software that is being offered by Takei company. We can indicate three factors influences in visual search that are gazing time, gazing position and locus of eye movement. The definition of the gaze point is needed to analyze the eye movement. The gazing location is defined by setting the reference value separating the gazing time and saccades of the glance.

When the character is presented, eye movement of 5(deg/sec) above might be defined as saccades. However, it was difficult for this task to separate eye movement in 5(deg/sec) because it was high-speed. Then we decided to separate it by 10(deg/sec).

3 Results and Discussions

3.1 Average Gazing Time

It is said that the gazing time will account for 90 percentages at all eye-movement time only though saccades account for 10 percentages because it is very high-speed [2]. Therefore, we thought that huge influence is exerted on the search of the gazing time. Then, the average gazing time in visual search of the elderly was analyzed. And, the differences were compared between the number of characters and each character types according to the presentation number of stimulation of the screen. Figure 2 shows the typical gazing time.

It is understood that the average gazing time was often becoming long when the number of characters becomes seven characters even if which graph is seen. However, the average gazing time was not proportional to the number of stimulus characters. It is guessed that it is because only the first three or four characters was remembered even if the stimulus is composed with five or seven characters. However, we can guess that the hesitation is caused in collation because the character string becomes complex when being seven characters, and the gazing time became long a little for three characters and five characters.

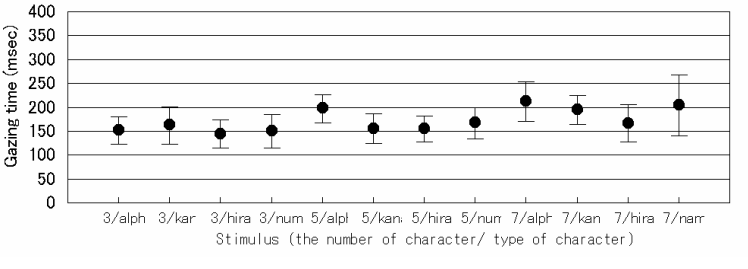


Fig. 2. Relationship between targets and average gazing time in 6x6 matrix

The average gazing time became long, too, according to the number of characters at the time of five characters for the alphabet. It is guessed that the tendency to this character type depends on the experience of the subjects. Moreover, the changes were not seen at the average gazing time though the number of stimulation increased.

3.2 Gazing Location and Locus of Eye Movement

We used the video images and software of statistics program in eye movement for analyzing the gazing position and movement locus. We found there were three patterns in the gazing position and eye movement locus of the elderly.

Pattern 1: The subjects horizontally collate the character from the edge of the row of the array as shown in Figure 3(a). And, when collation is finished, they sequentially collate it from the first edge side again.

Pattern 2: The subjects sequentially collate the target character from the edge of the row. They take a strategy that sequentially collate from the same edge side when the collation is finished. Figure 3(b) shows the strategy.

Pattern 3: The subjects collate a target from the stimulation that exists near the position in which the eye gazed when the screen is displayed. Then, they collate at random the stimulation that not collated still (Figure 3(c)).

We classified it into other patterns excluding these three patterns. For instance, the glance is in the target stimulation by chance when stimulation is presented on screen, and the target might be found at once. At this time, we judged that the strategy did not work either.

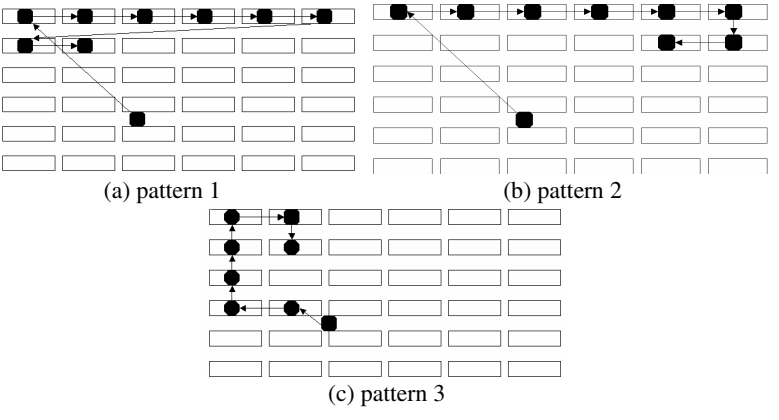


Fig. 3. Three patterns of searching strategy

Table 1 shows the relations between the number of stimulation presented and these three patterns. The number of presentation stimulation indicated 12 pieces or more in Table 1 because it was able hardly to read a remarkable pattern at the time of 6 pieces in number of presentation stimulation.

Table 1. Relationships between the number of stimulation presented and these three patterns

stimulus	character	Rate of pattern (%)			
		Pattern1	**Pattern 2**	**Pattern 3**	others
12	3	1.4	15.0	73.6	10.0
	5	4.3	19.3	66.4	10.0
	7	3.8	8.1	77.5	10.6
18	3	8.6	48.6	30.7	12.1
	5	6.2	58.5	21.5	13.8
	7	4.0	44.7	46.0	5.3
24	3	6.0	45.3	32.7	16.0
	5	5.4	53.1	26.2	15.3
	7	4.3	36.9	46.9	11.9
30	3	6.0	46.7	34.0	13.3
	5	10.0	56.9	23.1	10.0
	7	1.9	43.1	51.2	3.8
36	3	3.3	41.4	49.3	6.0
	5	5.4	43.8	40.0	10.8
	7	6.0	25.3	60.7	8.0

We understood that there were a lot of patterns 3 at the time of 12 pieces in number of presentation stimulation. It is guessed that this is because the collation that reduces the leakage of the search by pattern 3 can be done for the number of stimulation and the stimulation position shown in Figure 1(b). It was clarified that pattern 2 increased as the presentation stimulation increased. This is guessed that pattern 2 increased because there is a possibility that the leakage occurs in collation by pattern 3 for the number of stimulation and the stimulation position shown in Figure 1(c) ~ (e).

When quite a lot of numbers of presentation stimulation become, it has been understood that pattern 3 increases as shown in Figure 1(f). The following is considered as this reason.

It is necessary to collate target characters politely to search for it sequentially by using pattern 2 one by one. However, we think that the elderly adopted the pattern 3 to keep the strategy at a distance because it is troublesome that the elderly accomplishes the strategy of pattern 2. Moreover, it has been understood that pattern 3 increases at seven characters. Because it is necessary to collate this politely by one character when the character increases, it is guessed that the elderly kept at a distance pattern 2. It seems that it is because the elderly wanted to avoid the saccades of a long distance as a reason why the strategy of pattern 2 and pattern 3 is often taken.

We can guess the reason why pattern 1 is not so used as follows. The elderly memorizes only the first three characters or four characters at five and seven characters in the number of the target characters. So, the character string of the presentation stimulation need not be collated from the left with the right. Therefore, it is guessed they can search enough in the strategy of pattern 2 though pattern 1 was not adopted.

4 Conclusion

We measured eye movement of the elderly in visual search task to obtain initial data to construct the information machine design model for them, and analyzed the characteristic of the gazing time, the gazing position, and the locus of eye movement. The results showed that there was the tendency that average gazing time becomes long when the number of alphabets stimulation increased. Moreover, other tendency that the average gazing time becomes long when the character increased was seen in any character types.

In addition, the tendency was revealed that the gazing position and the locus of eye movement were changed by differences of the number of stimulation. Therefore the visual search becomes difficult for the elderly when the character increases, the character type is not accustomed or the number of stimulus increases. Finally, it was clarified that the elderly properly used the strategy of three patterns when searching the target on screen. Finally, we can propose that the presentation character strings of one screen were 12 pieces or less, and when seven characters or less were suitable for the elderly through the search time and the characteristic of eye movement.

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