YOUNG LEARNERS' RECOGNITION OF THE WINDOWS FOLDER ICONS BY SCHOOL AGE IN VDT WORK

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Introduction

Recently, the use of VDT for learning has widely spread in schools. VDT is essential to all computer work, and it is obvious that such a learning style requires mental labor that is different from physical labor. Therefore, a fundamental experiment to relate the placement method of icons to make it easy to search, namely, the ideal method for making an appropriate screen design in VDT work is necessary. in this experiment, the presentation number and placement method of icons paid attention to characteristics of ocular movement needed for visual cognition of icons during the search time of young learners.

This study focuses on the difference of visual cognition of elementary school children, junior and senior high school students, university students in particular.We examined the relationship between the placement method of icons on a desktop screen and the relation of eye movement based on an experiment to improve the operability of VDT work. in this experiment, characteristics of the influence of the presentation number and the placement method of icons had on search time and ocular movement when users searched for an icon focused more on the presentation position of the icon and the degree of difficulty of the search number.

Experiments

1.1 Subjects

The subjects were 60 university students (29 men and 31 women) and 65 senior high school students (34 boys and 31 girls who were eleventh graders) and 37 junior high school students (19 boys and 18 girls who were ninth graders) and 87 elementary school students (32 boys and 34 girls who were sixth graders, 11 boys and 10 girls who were fifth graders) who were used to VDT work because they use computers routinely. An ocular movement experimental device (EMR-AT VOXER) was used in this experiment (the product made by Nac technology, JAPAN); this device limited subjects to people with unassisted vision or those wearing soft contact lenses. Correct eye mark data were not provided when a subject wore glasses or a hard lens.

1.2 Experimental Devices

In this experiment, the measuring device used is a non-contact eye mark recorder EMR-AT VOXER as an ocular movement experiment. This model attaches nothing to the subjects and it's the completely non-contact and unconstrained type by setting an eye camera in a remote place. In addition, we covered and limited the computer screen and its surroundings with white paper so that nothing except the screen was in the field of vision of the subject.

The background of the presentation screen was plain, and the background color was blue. In addition, the icons to be used in the search were folder icons (yellow) of the default and added numbers (white) under the icon in the position of the folder name. The reason is that it is the most generally default folder icon pattern in Windows, and we wanted to avoid influencing the search speed by the design of icons. The number of the placement of an icon was set in

fourpatterns of 52 .78 .104 .208s in consideration of the condition of the PC screen. For the presentation method, we made vertical direction/numerical order, vertical direction/random, a horizontal direction/ numerical order, four patterns of a horizontal direction/random about the number of each placement pattern. On the pattern of 208/random, vertical direction/a horizontal direction repeats to fiil the screen and becomes one pattern. Therefore, the presentation screen has 15 cases in total. As an example, we show a screen on which 52 icons are displayed in vertically (See Figure 1.).

1.3 Presentation Condition

The numbers that the subjects searched were five arbitrary numbers about 15 cases of presentation screens each. in order to choose the numbers, we considered to make them dispersed on a screen, however, there is no regularity in particular. In addition, we selected five common numbers on searching for all the subjects in every case of the presentation screen so that discrimination time was not influenced by the choice of a search number. Experiment procedure is as follows. The subject sits down on a chair that is placed before the display screen and we adjusted the position and the height of the chair to the FACE camera. The personal calibration is performed, that is a fine adjustment to cut noise such as near-infrared light or an eyelash. S/he does an experiment to test that the movement of the eyeball can be measured normally.

The subject is instructed to look for an icon with a folder name of the number that was appointed from the presentation screen, and s/he is directed to stop a stopvvatch when s/he finds it. Before the search time starts, the computer screen is covered with white paper, and after the procedure is explained, the paper is removed and the measurement starts. The subject herself/himself measures the starting time and the time taken to look for a folder with the stopwatch.

The presentation screen of 15 patterns in total make the placement pattern with a turn of vertical numerical order, horizontal numerical order, vertical random, horizontal random, with a turn of 52. 78. 104. 208s more. On each presentation screen, subjects search for five icons and so will search for 75 icons in total. The time interval before searching the next icon was assumed to be 20 seconds after discovering one icon, and it was 30 seconds after changing to the next presentation screen.

1.4 Results

1.4.1 Comparing of Search Time

Figure 2 shows the number of the presentation icons and relations of search time in every presentation method. The searching time when icons were posted in numerical order is faster than when they were posted at random, and the difference became bigger as the number of icon increased. (See Figure 2.)

1.4.2 Numerical Order Placement and Random Placement

The searching time when icons were posted in numerical order is faster than when they were posted at random, and the difference became bigger as the number of icon increased.

The younger subjects are slower to search for icons than the older subjects, especially when the icons are posted at random. From this result, we can assume that the same tendency would be recognized with vertical direction placement/horizontal direction placement.

1.4.3 Vertical Direction Placement and Horizontal Direction Placement

The searching times of the horizontal direction placement are totally faster than those of the vertical direction placement. And having the icons arranged in numerical order, the tendency of horizontal direction placement and that of vertical direction placement can be said to be approximately similar.

1.5 Analysis by ANOVA

We performed a dual source placement analysis of variance with repetition about the numerical order placement and random placement, lengthwise direction placement and cross direction placement, 52 presentation icons. 78.104. 208s to clarify the influence of each factor on the search time. Regarding the numerical order placement and random placement, a significant difference was

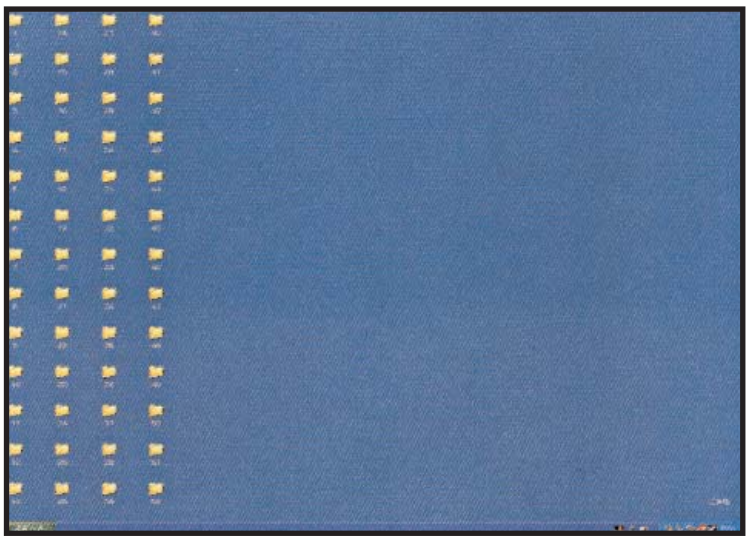

Fig. 1. Experimental Screen Pattern (52 icons, vertical direction)

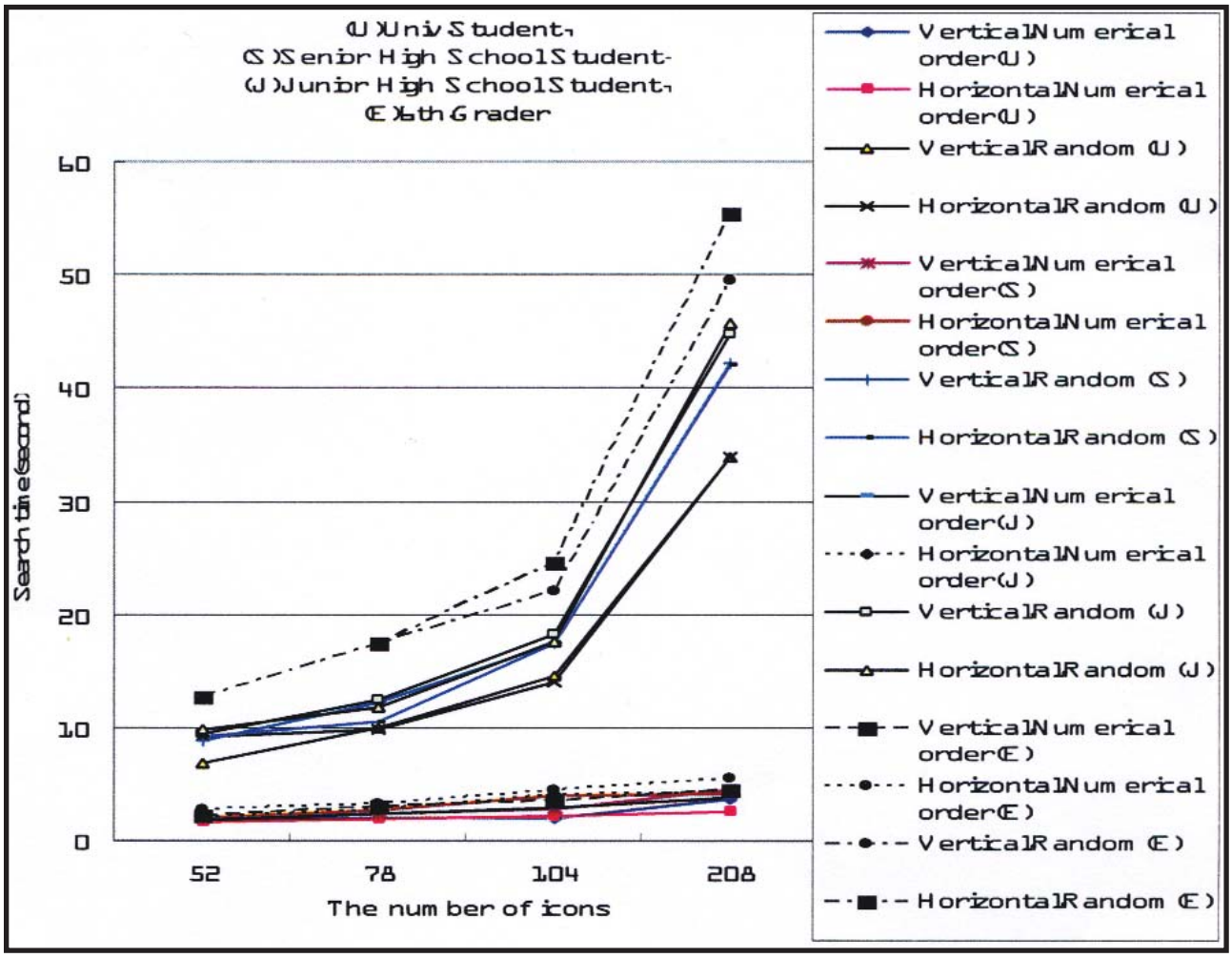

Fig. 2. The Number of Icons and Searching Time

recognized in all presentation conditions (52 icons/vertical direction, 52/horizontal direction, 78/vertical direction, 78/horizontal direction, 104/vertical direction, 104/horizontal direction, 208) (P <0.01). Furthermore, regarding 52 presentation icons. 78.104 .208s, a significant difference was recognized in ali presentation conditions (length/numerical order, the side/numerical order, length/random, the side/ random) (P< 0.01).

In addition, regarding vertical direction placement and horizontal direction placement, a significant difference was recognized in both random placement and numerical order placement in the case of 52 presentation icons together (P <0.05). However, a significant difference in vertical direction placement and horizontal direction placement was not recognized in other presentation conditions (78/ numerical order, 78/random, 104/numerical order, 104/random, 208/numerical order).

1.6 Comparison of Ocular Movement

For comparison of ocular movements, at the time of the icon search, common to all the subjects, the following tendencies were recognized. We didn't count the cases that we couldn't get a movement of the viewpoint when the subject found the icon immediately.

- A viewpoint at the time of a search stops on one folder icon and jumps to other folder icons from that folder icon. Furthermore, after stopping, it jumps to other folder icons. This repeats.
- The position of a viewpoint at the beginning of a search is often located in the upper left or the center of the screen when the icons were placed in order, and in the upper left of the screen when the icons were placed in random order although there was some difference according to the subjects.
- As new results of the research in this study, we found that there were some basic types of movement order of viewpoints between icons. Therefore, I show a type of viewpoint movement at the time of a representative icon search for Figure 3-5.

We named these three viewpoint movements. Fig.3 is horizontal S character Fig.4 is vertical S character. Fig.5 is mixture (of vertical and horizontal walk).

1.7 Presentation Position and Degree of the Difficulty of Search Number

These experiments made the subjects search five folder icons on one presentation screen. The Table 1 shows the folder numbers that each subjects searched fastest and slowest.

When the search number is one digit, this result shows that it is very likely that the search time becomes fastest. In this experiment, seven searches included one digit number. We divided the screen into 4 parts (left upper, right upper, left bottom,right bottom) , and displayed a position of the slowest with ● and the numerical value, and the fastest with○and the numerical value (Table 2). We displayed the search time in two places by □ or▲ when they were the same and when the icons were located on the lines.

2. Discussion

2.1 Search Time

We found in this experiment that the more difficult a search is, the more time it requires. As was shown in the result 1.4.1, there is a remarkable difference in the icon search time between posted in numerical order and posted in random order. The search time was 3.7-5.9 times faster in the case of 52 icons that were posted in numerical order; 5.1-5.4 times faster in the case of 78 icons, likewise; 6.8-7.2 times faster in the case of 104 icons, likewise; 9.3-13.8 times faster in the case of 208 icons, likewise. it can be said that the difference in search time by numerical order placement and random placement grows in proportion to an increase of the number of icons. in this point, significant difference is recognized in the two-way analysis of variance (P<0.01). in other words, search time is assumed to become very fast, when icons are posted in numerical order rather than when icons are posted at random, and it is considered that the influence grows as the number of the icons shown increases. And, search time becomes longer with increase of the number of the icons whatever direction the icons are posted,

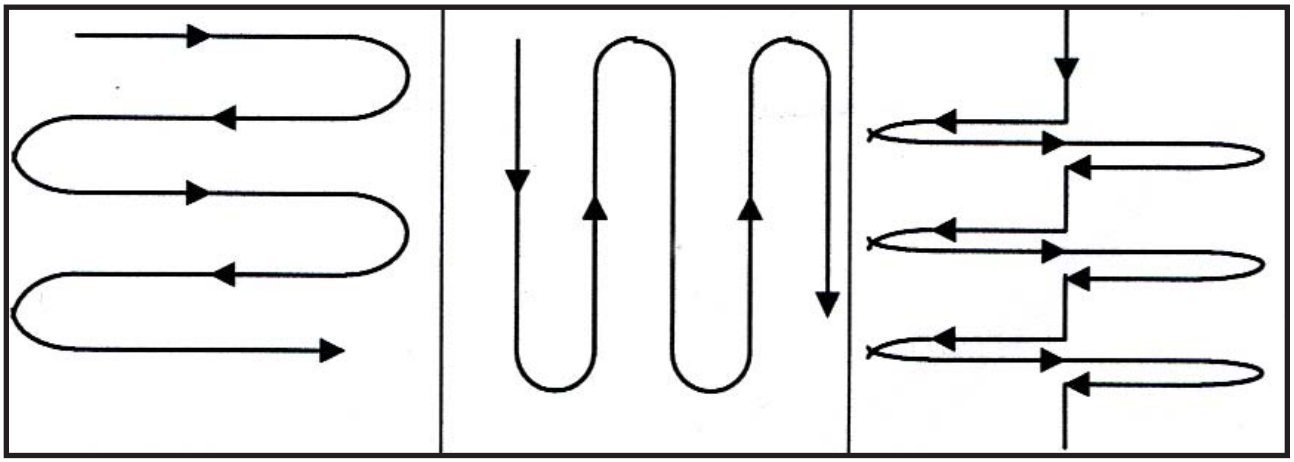

Fig. 3. Horizantal S Character Type

Fig. 4. Vertical S Character Type

Fig. 5. Mixture Type

screen condition			fastest		latest	
			numerical value	subjects	numerical value	subjects
52	Vertical	numerical order	4	12	24	8
		random	17	12	49	7
	Horizontal	numerical order	52	8	18	8
		random	46	9	18	4
78	Vertical	numerical order	2	12	77□38	5
		random	44	10	37	5
	Horizontal	numerical order	9□76	8	53	6
		random	9	6	38□54	2
104	Vertical	numerical order	98	8	67	5
		random	42	9	53	7
	Horizontal	numerical order	20□88	4	80	6
		random	66	6	25	8
208	Vertical	numerical order	124	7	173	6
	Horizontal	numerical order	7	8	191	5
		random	141	6	141	5

Table. 1. The folder number that the subject searched in evrey subject the fastest and the latest

vertical, horizontal, numerical order, or random placement. And the influence on search time is remarkable when the number of the icons posted at random increases. On the other hand, the influence on search time is small when the number of the icons posted in numencal order increases. Furthermore, it resembles random placement, and numerical order placement with significant difference, which is recognized in two-way analysis of variance with repetition in this point ($P<0.01$). Thus, search time becomes longer as the number of the icons shown increases. It is considered the influence becomes greater when they are posted at random than posted in numerical order. Search time is comparable when icons were posted in a horizontal direction and when posted in a vertical direction. As shown in 4.3, search time when icons are posted in numerical order, the search time in horizontal direction placement is faster than in vertical direction placement, except in the case of 104 icons. It is 1.2 times faster in the case of 52 icons; 1.1 times faster in the case of 78 icons; 1.5 times faster in the case of 208 icons. Incidentally, it is 0.96 times faster in the case of 104 icons and we assume that vertical direction placement and horizontal direction placement do not have the most differences.

In other words, when icons were posted in numerical order, search time is faster when icons were posted in horizontal direction than when icons were posted in vertical direction. Moreover, the search time when icons were arranged at random, vertical direction placement becomes 1.3 times faster, in the case of 52 icons. However, regarding vertical direction placement and horizontal direction placement, a significant difference was recognized only in the case of 52 icons as a result of two-way analysis of variance with repetition. Precise examination about this cause of the experiment results will be needed in the future.

3. Conclusion

This study clarified the following characteristics on icon search, which will help to design coursewares in e-Learning for young learners.

(1) The originality of this study is that we examined the differences of visual cognition of school students in various grades for the first time in the world.
(2) Search time becomes dramatically faster when the icons are posted in numerical order than when they are posted at random. And the larger the number of icon becomes, the more it influences a search time.
(3) When icons are posted at random, younger learners tend to take longer time to search for an icon than elder learners.
(4) There was not much difference in search time between icons posted in a horizontal direction and in a vertical direction.
(5) The movement of a viewpoint in the icon search can be classified into 3 types. The subjects combined them and used them together when they searched for an icon.
(6) The search time is fast when the icon name is one digit figure, and it is not affected by the presentation condition.
(7) On the computer screen, there are arrangements of icons that are difficult to search and those that are easy; a search is faster when icons are posted in the upper part of the screen. No difference in the degree of difficulty was identified between the left side and the right side of the screen.

4. References

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52/vertical□numerical order	52	○4					
52/vertical□random			●49			○17	
52/horizontal□numerical order			●18				
52/horizontal□random							
78/vertical□numerical order	78	○2					
78/vertical□random			●37			○44	
78/horizontal□numerical order						□9	
78/horizontal□random						○9	▲38
104/vertical□numerical order	104					□98	●67
104/vertical□random		○42					
104/horizontal□numerical order		□20					
104/horizontal□random						○66	
208/vertical□numerical order	208					□124	●173
208/vertical□numerical order		○7					
208/vertical□random				Left upper	Right upper	○141	●141
52/vertical□numerical order	52		●24	Left lower	Right lower		
52/vertical□random							
52/horizontal□numerical order		○52					
52/horizontal□random		○46	●18				
78/vertical□numerical order	78		▲38				▲77
78/vertical□random							
78/horizontal□numerical order			●53			□76	
78/horizontal□random			▲54				▲38
104/vertical□numerical order	104					□98	
104/vertical□random							●53
104/horizontal□numerical order		□88					●80
104/horizontal□random			●25				
208/vertical□numerical order	208					□124	
208/vertical□numerical order							●191
208/vertical□random							

Table. 2. Distribution map of searched numerical value