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Relation between impression of touch panels' coloration and operation

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***Abstract*:** The relationships between the color used in designs of a touch panel and operations on electronic devices are discussed. Experiments that investigate the effect of color in designs of touch panel interfaces on the operation and on impressions of users have been conducted. Subjects tried mental arithmetic tests on twelve screens which are used different color images. The following points: "time which passed during a task," "number of correct answers," "number of incorrect answers" and "number of timeouts" were measured and counted. After the tasks were administered, the subjects answered questionnaires about their impression of the displays' color design. The average numbers of correct answers was higher when using "cool-casual" than when using the other coloration. Furthermore, there was a positive correlation between the number of correct answers and preference for the displays' coloration. There are strong relationships between the coloration of interface and the speed and accuracy of operation. The results of the study lead us to expect that both the usability and accuracy of operations will be improved by considering the color designs of the touch panel interface.

Keywords: coloration, color design, touch panel, evaluation of impression of screens

I. INTRODUCTION

The use devices with touch panel interfaces such as ATM consoles, smart phones, and ticket vending machines has become increasingly widespread. Because these devices have no mechanical buttons, users need to understand how to operate them from the visual information displayed on the screen. Therefore, the users who have no experience using such interfaces cannot use them with a high degree of accuracy. Hence, it can be said that graphic design of the screen plays an important role in the usability of the electric devices.

We focus on the users' impressions of the coloration of touch panel devices. In particular, the relationship between the users' impressions and the operation are discussed. Experiments have been carried out to investigate the effects of the whole image of interface color on accurate and speed of operations. Moreover, the relation between impressions of touch panel and operation are analyzed on the basis of result of the experiment.

II. COROLATION AND OPERATION

Coloration, i.e. color scheme, is an important factor of design, and there are many laws of color harmony [1][2][3]. The authors focus on the effect of interface's colors on operators of an electronic device, and they already have conducted experiments which show that the accuracy and speed of operation change with the color of the buttons in the control panels. We found that the blue buttons were better than red ones in regard to accurateness and speed of operation[4]. The effects of images of combinations of the buttons in the control panels were also investigated, and we found that a "formal" image combination was better than the other ones.

Of course, the interfaces of electronic devices do not only consist of buttons, and operators look at all items on the screen even if they seem to be merely for decoration. Furthermore, ATM and multi-media information terminals usually have a coloration that is consistent with the corporate color. If the operations change with the coloration, the designers should consider the color design of the control panels.

III. EXPERIMENT

Experiments were done to investigate the relationship between operation and color image of the control panel. Subjects tried mental arithmetic tests (single-digit ones). The twelve interfaces were prepared. Each interface has a different color image. The twelve major patterns of coloration from the mixed image scale [5] were used. The Mixed Image Scale is an image map, which has two axes, "soft-hard" and "cool-warm," and colorations with words conveying the subjects' impression were arranged on the frame of reference. Using this image scale enables us to link coloration with impressions. We used twelve major descriptive phrases "casual," "cool-casual," "romantic," "modern," "elegant," "classic and dandy," "formal," "clear," "natural," "chic," "gorgeous," and "wild" in the experiments. The time that passed during a task, the correct and incorrect answers as well as the number of timeouts were measured or counted. After the tasks were completed, the subjects answered questionnaires about the color design of the screen by using the visual analogue scale (VAS) method [6].

1. Tasks in experiment

A snapshot of a screen of the computer program used in the experiments is shown in Fig. 1. One correct answer and two wrong answers are displayed under a problem. Subjects had to select the correct answer from three alternatives and touch one of three push panels. If a subject did not touch a panel in 1.5 sec., they were transferred to the next problem. Thirty different problems were given for a condition. The bottom of the program windows were decorated with different color patterns that varied with the condition of the experiments. The colors used in each condition are shown in Table 1. The background color of the window was pale gray (N8), and the background color of the push panels was white (N9.5). The characters' color in the window was dark gray (N3). These colors were decided by considering the visibility of the characters in the window. First, the subject practiced on a screen that had no colored decoration. They then tried tasks displayed on screens with the twelve conditions shown in Table 1. A two-minute break was given between each condition. During the break, the subject wore an eye mask to rest his/her eyes. The order of condition was changed for each subject to reduce the effects of order.

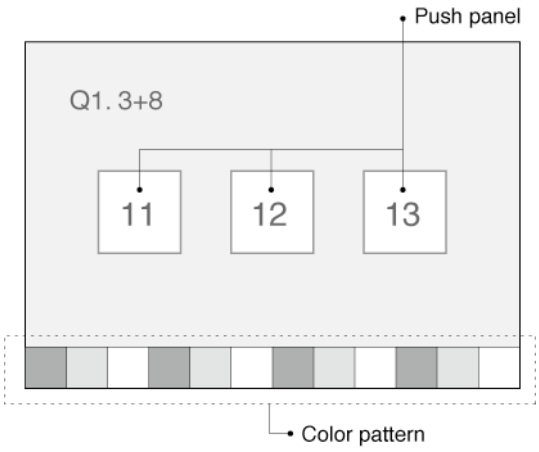

Fig. 1. Snapshot of screen displayed in computer program

Table 1. Color patterns used for experiment

Conditions	Color paterns used for experiment				
Condition 1 casual	5R5/12	5PB4/10	10Y8/12		
Condition 2 cool-casual	6Y8/10	5B7/6	5PB6/8		
Condition 3 romantic	7.5R8/4	7.5Y9/6	2.5G8.5/2		
Condition 4 modern	6.25PB5.6/6	5B8/4	5B3/2		
Condition 5 elegant	10PB8/4	2.5RP8/4	2.5P6/6		
Condition 6 classic & dandy	10GY3/2	2.5Y6/8	2.5Y3/2		
Condition 7 fomal	5B4/4	7.5PB8/2	5PB2/2		
Condition 8 clear	10BG9/2	10Y9/0.5	10BG7/4		
Condition 9 natural	3RP8/4	5Y9.2/1	5P8/4		
Condition 10 chic	5PB6/4	5P6/2	5P7.5/0.5	5PB8/1	
Condition 11 gorgeous	5P2/1	3R4/12	5RP8/4	7R9.2/1	2.5P4/10
Condition 12 wild	N1	8YR5/8	10YR4/4		

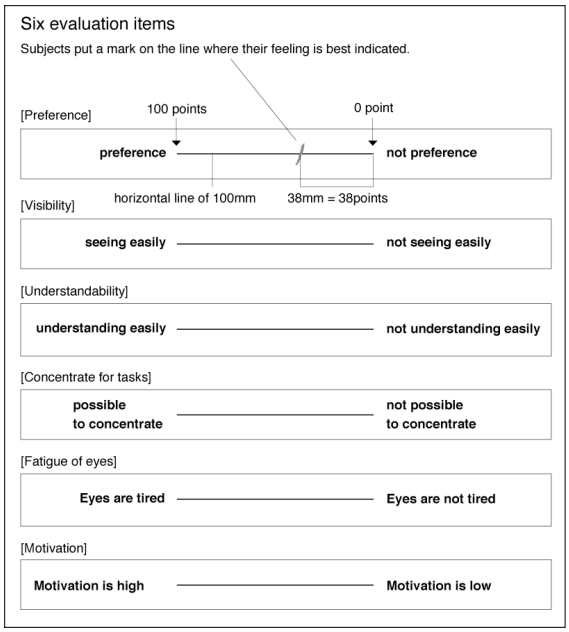

Fig. 2. Questionnaire sheet

The subjects were 24 mentally and physically healthy university students who were 22~25 years old.

2. Evaluation of screens

After the tasks, the subjects evaluated each screen, and the items which were evaluated were "preference," "visibility," "understandability," "enables concentration," "fatigue of eyes," and "motivation." The subjects used the visual analogue scale (VAS) method. An example of a questionnaire sheet used in the method is shown in Fig.2.

The VAS method is usually used in field of medicine to analyze a subject's statement regarding their psychological state. A horizontal straight line of 100 mm is drawn. Words that shows the item being evaluated and as well as its opposite are arranged on the right and left of the line. The subjects put a mark on the line where their feelings are most accurately expressed. In this process, the subjects evaluated each screen by marking a position on along a 100 mm line between two endpoints corresponding to a ward for each impression and the word's antonym. The ratio between the length of the negative item and the mark and length on the 100 mm show the value of the evaluation.

Six evaluation items in the questionnaire were shown at random for each subject, and the positions of the word and its antonym are also swapped at random. This was done to reduce order effects.

IV. RESULTS AND DISCUSSION

A graph of "measurement time" i.e., the average of time which passed during a task under each condition. There are significant differences between measurement times under condition 5, 6, 8, and 12 ($P<0.01$, Tukeys' multiple comparison test). A task took longest to complete under condition 12.

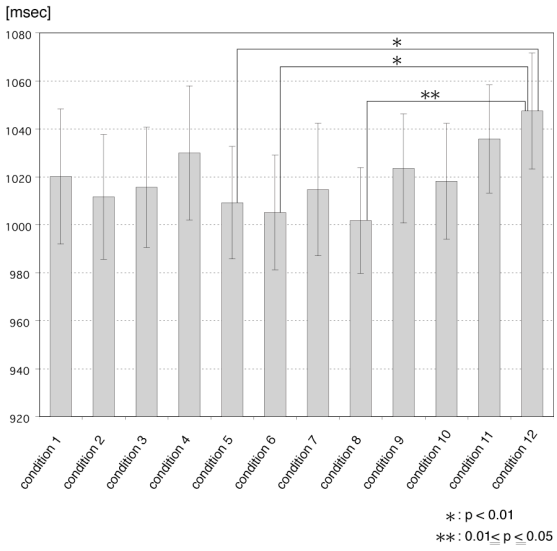

Fig. 3. Average time passed during tasks

The number of correct answers under condition 2 was better than the number of correct answers under the other conditions, but there is not significant difference between the number of correct answers under the each condition. As a shown in Fig. 3 and Fig. 4, the measured time and number of correct answers were not necessarily connected. However under condition 2, the graphs show better results in both the time and the number of correct answers than under the other ones.

Averages of evaluation of "preference" on each screens used in the experiments are shown in Figure 5. The preference under condition 2 and 9 are better than the preference under the other conditions.

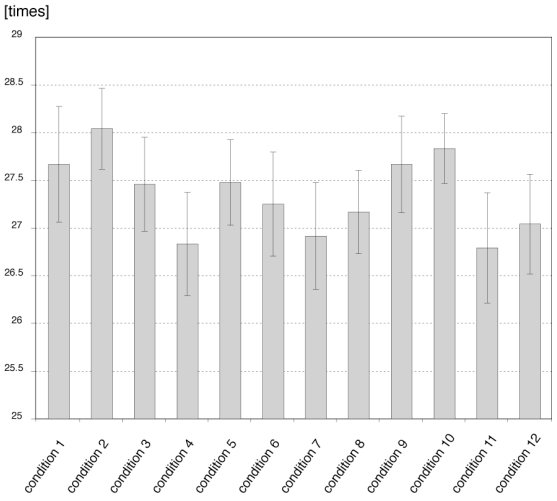

Fig. 4. Average number of correct answers

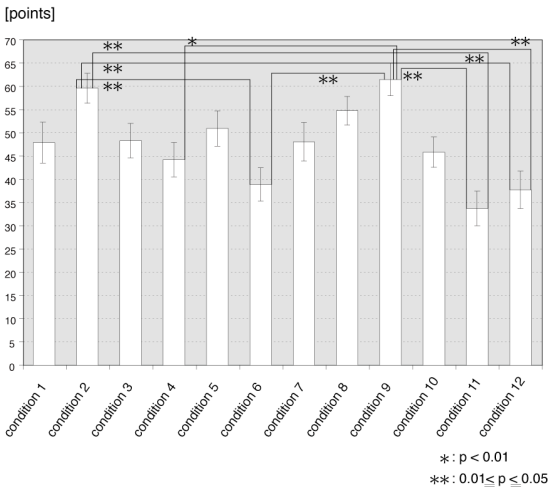

Fig. 5. Average of evaluation of "preference"

The correlations between results of operations and impressions of screens are shown in Table 2. There was positive correlation between number of correct answers and the preference. There was also positive correlation between the number of correct answers and the motivation. In addition, there was a negative correlation between the number of incorrect answers and preference of coloration, and the number of incorrect answers and the motivation.

V. CONCLUSION

We focused on the coloration and operation of a touch panel interface on electronic devices. Experiments were conducted to investigate relations between coloration and operation of touch panel screen.

The results of the experiments show that "cool-casual" is better than the other color images for the touch panels design in terms of speed and accuracy of operation. In addition, "classic & dandy" and "clear" are good for fast operation, but not good for accuracy.

On the other side, "gorgeous" and "wild" are not good for the panels in which accuracy of operations is important. Accordingly, we expect that the color images that are good for speed and accuracy of operation consist of a low-contrast bluish coloration as shown in Fig. 6 (A). Furthermore as shown in Fig. 6(B), the color images that do not improve speed and accuracy of operation consist of a high-contrast coloration, i.e., warmth and hardness.

Table 2. The result of no correlation authorization of data of the experiment

Data compared	Correlation coefficient r	p value
Number of correct answers preference	0.65	0.0234
Number of incorrect answers preference	- 0.61	0.0335
Number of incorrect answers motivation	0.59	0.0438
Number of correct answers motivation	- 0.66	0.0193
Preference fatigue of eyes	0.68	0.01576
Preference understandability	0.79	0.0022
Preference visibility	0.83	0.0008
Preference concentrate for tasks	0.75	0.0045

The result of this study are expected to be used to evaluate screens of electronic devices as well as the supporting system of interface designs. We plan to develop systems that are based on the results in which the choice of color improves the speed and accuracy of use.

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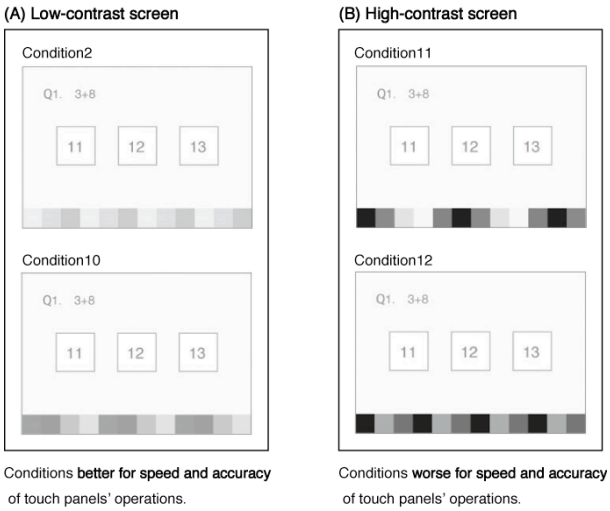

Fig. 6. Comparison between result of experiment and contrast of color images