

Analysis on the Influence of Long Endurance on the Operation Performance of Electronic Map Color Matching Scheme

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ABSTRACT

In order to study the influence of long flight time on the operation performance of personnel under the electronic map color scheme and obtain the electronic map color scheme suitable for long flight time, this study designed an ergonomic experiment simulating the operation of electronic map by personnel under the environment of 60 days of long flight time, and studied the operation performance of four electronic map color schemes: color matching, sunlight color matching, yellow light source color matching and gray color matching. The results show that the long endurance has a significant impact on the operation performance of different color schemes, and the color scheme of yellow light source has good operation performance and is more applicable under the condition of long endurance.

Keywords: Long endurance, Electronic map, Personnel performance

INTRODUCTION

As one of the information coding elements, color plays the largest role in visual guidance (Li Jing, 2015), so the rationality of electronic map color matching has an important impact on whether operators can quickly find key targets and identify target characteristics. Previous studies have shown that the color attribute of the interface will affect the cognitive ability of operators (Kuzinas and Arvydas, 2013). Through the study of image panel toolbars with different colors, many scholars have explored the impact of different colors or color combinations on the visual search process and direct operation behavior. The research shows that color has a significant impact on accuracy and speed (Michalski, R. 2014).

Wang Xinyue et al., Studied the color coding of the interface of complex systems. Through the comparative experiments of different cognitive tasks, and used the color difference formula to evaluate the cognitive performance. The results showed that the color difference between the target colors of

the display and control interface should be between $15\Delta_{E_{00}}$ and $50\Delta_{E_{00}}$ or greater than $60\Delta_{E_{00}}$ (Xinyue Wang, 2018).

For the study of different color matching schemes, some scholars have studied the impact of different electronic color matching schemes on personnel operation performance in the laboratory fluorescent lamp environment (Bei Zhang, 2019). Based on the above research foundation, this study studies the impact of ship long voyage on the operation performance of different color matching schemes from the characteristics of ship long voyage tasks, in order to find a color matching scheme more suitable for ship long voyage operation conditions.

EXPERIMENT ON COLOR MATCHING SCHEME OF SHIP DURING LONG VOYAGE

Experimental Method

Six male participants were selected to compare the interpretation performance of four different electronic map color schemes by using their search reaction time and accuracy under the simulated ship background.

Experimental Tasks

The test materials are electronic maps with different color schemes (4 kinds of electronic map backgrounds), and the electronic map is displayed in full screen.

There are four targets marked with different colors on the electronic map. The targets are composed of military logo and batch number. There are four types of military logo. The batch number is composed of seven digits, the first three digits are 000, and the last four digits are 1001 to 1020.

The task of the participants is to search the icons of lot 0001001–0001010 in the interface as soon as possible and click them in turn (after clicking correctly, a black border will be added to the color target to indicate that it has been clicked).





In the electronic map, the number of four color targets is 5, and the positions of different targets are random. But ensure that there is no overlapping area for each two goals.

Experimental Variables and Design

Independent variable: four electronic map color schemes, including existing scheme, sunlight color scheme, yellow light source color scheme and gray scheme. See Table 1 for the illustrations of the four color schemes.

Dependent variables: search response time and accuracy of participants every 12 days.

Table 1. Four color matching schemes in the test.

1 (Grey scheme)	2 (Sunlight color scheme)	3 (Original scheme)	4 (Color scheme of yellow light source)
			

Experimental Process

Before starting the experiment, first adjust the sitting position, adjust the seat height, and keep the participants' eye height of about 105cm, the sight distance of 60cm, and the distance from the body to the table.

Number of subjects in the experiment: the form of times + personal number, such as 8-001.

Lighting environment only select fluorescent environment.

Then, under the guidance of testers, practice the test according to the test requirements, and enter the formal test after getting familiar with the test requirements.

During the test, the participants used the mouse to operate. First, the instructions are displayed in the middle of the screen. After the participants press the Enter key, the white gaze "+" appears in the center of the screen for 300ms, and then the navigation map is displayed in full screen. The participants are required to find out the target of batch number 0001001-0001010 on the screen as soon as possible under the correct premise, and click it with the mouse.

Each test task has 40 seconds to complete. If the task is not completed after 40 seconds, the next task will be automatically entered.

In the test, under the background of each electronic map, participants need to complete a total of 8 judgment reactions, and each participant has completed a total of 32 judgments (4*8).

In the program, after 8 consecutive operation tasks are completed under each electronic map color scheme, 8 tasks under the next group of electronic map schemes are presented, and the order of different electronic map schemes is completely random.

Experimental Device and Environment

The test was carried out in the simulated environment of the test ship. The flat panel LCD was used to control the experimental process and record the experimental data of the participants. The size of the display was 20.1 inches, the resolution was 1600*1200, and the refresh frequency was 60Hz.

During the experiment, strictly control the amount of interference, the illumination is 300lx, the color temperature is 4000K, and keep it constant during the experiment.

Participants

Six men, aged 29 ± 2 , with visual acuity or corrected visual acuity above 5.0, are selected for this experiment. They are all right-handed, without color blindness or color weakness and other visual disorders of color discrimination. They have ship knowledge background and are not the designers and developers of this experiment.

ANALYSIS OF EXPERIMENTAL DATA

Raw Data

The original data of the task completion time of clicking on the new target in the job performance are put forward with outliers, sorted and counted, and the data of seven time points (dates: 9.30, 10.12, 10.27, 11.8, 11.23, 11.23, 12.5, 12.17) of four color schemes are obtained, as shown in Table 2 and Figure 1.

Table 2. Statistics of task completion time (unit: ms).

Scheme\Date	9.30	10.12	10.27	11.8	11.23	12.5	12.17
1	4567.41	3418.09	3306.94	2910.72	3110.75	2978.28	2681.38
2	4961.00	5049.94	5024.13	5187.44	7049.94	4000.75	3627.48
3	4440.53	4266.81	6099.38	4810.09	4621.44	5250.56	5337.94
4	3297.28	2920.94	2574.53	2501.34	2651.88	1934.34	2486.97

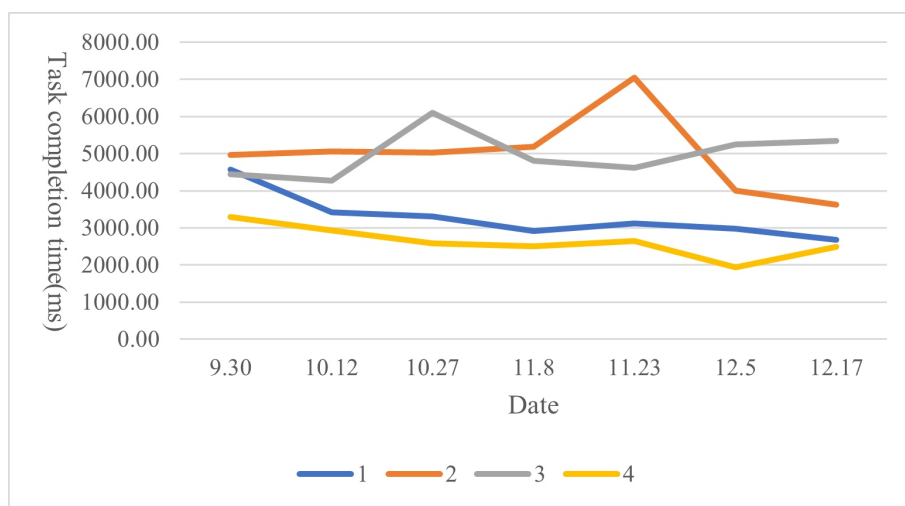


Figure 1: Comparison of completion time data.

Significance Analysis

The significance analysis of the completion time of different color schemes on different dates shows that different color schemes have a significant impact on the task completion time of clicking on the new target ($f = 18.34$, $p = 0.000 < 0.05$), and the long endurance has a significant impact on the task completion time of clicking on the new target ($f = 17.87$, $p = 0.006 < 0.05$).

Compared with the completion time of clicking the new target under the laboratory fluorescent lamp environment, the data are shown in Table 3 and Figure 2.

Table 3. Comparison of completion time of clicking new targets under different experimental conditions (unit: ms).

Scheme \ Experimental environment	Long sailing hours	Laboratory fluorescent lamp
1	3281.94	1299.58
2	4985.81	1451.16
3	4975.25	1573.24
4	2623.90	1333.68

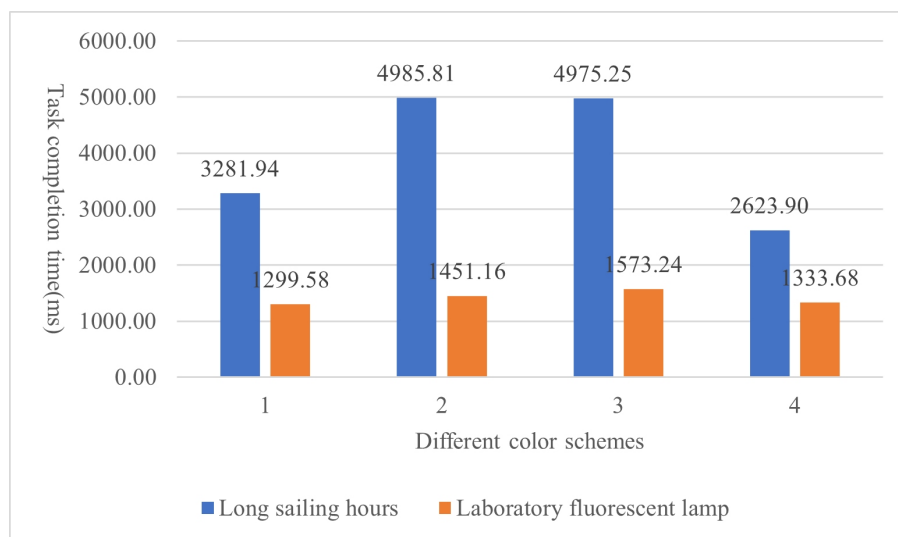


Figure 2: Comparison of completion time of clicking new target under different experimental conditions.

From the data comparison, it can be seen that the task completion time of clicking on the new target under the condition of long voyage is greater than that under the fluorescent lamp in the laboratory, and there is a significant difference ($f = 17.87$, $p = 0.006 < 0.05$).

CONCLUSION

Under the background of long voyage, the long voyage of the ship has a significant impact on the task completion time of the operator when clicking on the new target, and the yellow light source color scheme has better operation performance under the condition of long voyage, so the yellow light source color scheme is more recommended under the background of long voyage.

In addition, the completion time of clicking on the new target under the condition of long voyage is greater than that under the fluorescent lamp in the laboratory, and there is a significant difference.

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