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Study on the influence of dynamic ICONS on car central control screen on safe driving

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Abstract: Through eye movement experiments, to test the driver's influence on the search and recognition of icons on the center screen interface while driving. The experiment set different target information, aimed at the time of the first entry of the target information and the duration of observation. Through the analysis of the eye movement data of target icon positioning, it is found that the influence of different icon forms on the first entry time and fixation duration of target icon positioning is significant, indicating that the display form of an icon has a certain influence on information search and recognition.

1. Quotes

In recent years, with the continuous development of the car, the functionality of the central control screen has become more and more prominent, and the connection between the large central control screen and intelligent icons has become increasingly close. Dynamic icons of various styles and complex functions in one interface, such a design approach offers a lot of functional convenience to the driver in terms of control, but it also poses many safety risks to drivers during driving. As a result, the ability of drivers to quickly identify and accurately select icons during driving can effectively reduce the risks to driving safety. Combining complex functions with safe driving and helping drivers to recognise them quickly and efficiently is an important factor in the intelligent centre console interface and safe driving.

Eye-tracking is often used to test the effectiveness of a user's interaction with an interface. Compared to other traditional research methods, eye-tracking enables more in-depth testing of user habits and potential pain points. In the past, researchers have analyzed typical usability in terms of time to complete a task, percentage of task completion, type of error, number of errors, and level of satisfaction [1, 2].

However, it is difficult for these indicators to answer the inherent differences between different operation indicators of different interfaces, and the use of eye-tracking technology to record the user's eye movement can solve this problem. Eye movement mode shows the spatial position of the user's attention on the screen and the shift in attention, so the use of eye tracking technology can be used in the user interface analysis, usability testing, user behavior analysis and other internal reasons [2, 3]. Using eye-tracking technology for user interaction with the car's central information interface allows for more intuitive test data, contributes to a virtuous upgrade of the interface design, and enhances the driver's driving experience.

Through the eye movement recognition experiment of the car central control icon, the eye movement data is analyzed, to obtain the eye movement index that the dynamic icon is quickly and effectively recognized on the car central control screen and has an impact on safe driving. Observe the changes during the experiment and be able to reflect in detail on the specific dynamics of eye movements, thereby obtaining the potential cognitive processing activity of the subject during the test. During driving, some interaction between the driver and the car takes place. The survey found two main types of driver interaction with the car while driving. One is that the driver obtains driving information about the vehicle and its surroundings through his vision. The second is that the driver controls the car through the car's central control system[4]. And the car's central control system plays an important role. The driver follows the information prompts on the central control screen, quickly locates targets, and drives accordingly. When the visual information is not clear or untimely, it distracts the driver and can lead to a traffic accident.

In the current research findings, studies on the design of iconographic forms for automotive central control interfaces have focused on the theoretical level. Currently, researchers have focused on human perceptual perceptions and judgments of icons, no quantitative analytical model has been developed, no quantitative study of the icon's movement behaviour has been carried out, and no in-depth exploration of the icon's form and the user's experience has been undertaken.

Early researchers have found that dynamic icons can help users better understand current system tasks[5]. Gong Yong et al. [6] testing the effect of color quantity and color consistency on the visual search efficiency of icons through eye-movement experiments found that the number of colors affects the efficiency of the icon search and that using different colors improves the visualisation of the icons. Wang Xianyu et al. [7] summarise the factors influencing icon search performance from the perspective of the search subject - the human being, and conclude that visual search becomes more difficult as the type and number of icons increase. According to the mechanism of influence of different icon search performance factors, it is also increasingly important to develop icon design specifications that are conducive to visual search. Qiu Qianqian[8]from the perspective of the interface icon concept, the complexity of icon cognition, and the actual use of icons facing time pressure, explore the impact of time pressure on icon understanding. The experiment found that time pressure can affect the user's understanding of the interactive interface icons, the user's response time is longer under high time loads, and the accuracy rate is also lower.

2. Test method

2.1 Purpose

The eye contrast experiment was designed through the control screen interface icon in the car, recording the eye data of the subjects' visual search for different types of icons during the simulated experiment. In this thesis, we analyze the recognition efficiency of different icon types in safe driving based on subjects' eye-tracking data and suggest targeted refinements to improve safe driving efficiency.

2.2 Subjects

The participants are university students, 20 in total, aged 20–26 years old, with visual acuity or corrected visual acuity of at least 1. 0 and without color blindness. All participants were free of behavioral deficits, had driving experience, were right-handed, and met the conditions for the eye-movement experiment.

2.3 Selection of experimental materials

The experimental materials were created using Adobe Photoshop software. The experimental materials are all divided into four quadrants on the screen: quadrant one, quadrant two, quadrant three and quadrant four. Each quadrant displays text contrast, gray contrast, background contrast, and abstract and concrete contrast. In the design of the material, to prevent interference on the experimental data due to the iconic shape and the color of the icon, all icons in this experiment are the same color and avoid choosing complex shapes. In order to avoid emotional effects and influence the familiarity of icons on the selection of operating time thresholds for the icons being tested, these icons are graphics commonly used in everyday life. [9]The experimental scenario was daytime, with clear light and a quiet environment.

2.4 Selection of experimental equipment and eye movement indicators

The experimental equipment gathers eye-motion data for the Tobii Type 4 eye animator and the 15-inch display with a screen resolution of 1366 x 768. Record the subject's personal information, such as name, gender, age, etc. The experiment will study the identification process of four different materials using eye-movement devices and analyze the reliability of materials effectively identified in experiments. The validity of the icons is tested by data such as the time of the first look, the duration of the look, and the accuracy of the search.

2.5 Experimental procedure

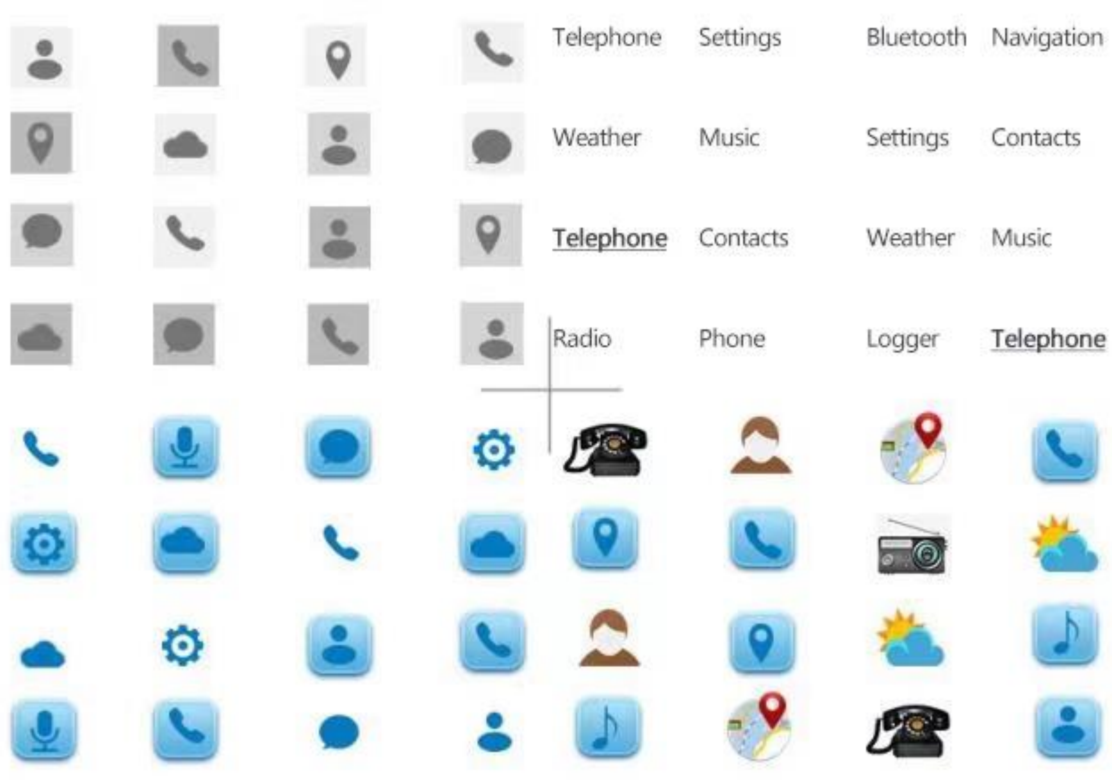

Figure 1: Experimental material interface

During the driving process, drivers often need to interact with the control interface based on the road situation and their own needs, using blind eye observation to position the target task. The brain generates learning mechanisms during the experiment, so the icons for the three groups of experiments were arranged in random order. The independent variable in this experiment was the design form of the icons, and the dependent variable was the reaction time of the subject's eye movements and their recognition efficiency.

The experimental test is divided into two parts. The first part is the learning phase, where the experimenter needs to go through the process of this experiment and what to expect from the subjects before the formal testing. Without compromising the experimental data, allow subjects to become familiar with the apparatus and the experiment. The second phase is the testing phase, subjects follow the prompts to search for icons on the experimental interface and click to complete the search task, see Figure 1 for material presentation. The final eye movement data was imported into SPSS for analysis of the study.

At the end of the experiment, the subjects were interviewed about their feelings during the experiment, and a questionnaire was filled out to obtain their subjective feelings during the experiment and their psychological changes during the experiment.

3. Experimental results and analysis

3.1 Analysis of targeting time for different forms of target information

The target localization time for this experiment was analyzed in two parts: first entry time and gaze duration. The first entry time is the time taken by the subject from the beginning of the experiment to the first gaze point into the target information area. The reasonableness of the target information form cue can be seen based on the first entry time. If the first entry time is short, it indicates that this type of target form is more appealing. The duration of observation is the sum of the observation time of all observation points within the target information area of the test, i. e. the total length of time for observation of target information. The SPSS statistical analysis software was used to analyze the first entry time and duration of observation in each of the four quadrants, and the results are as follows.

Table 1: One-way ANOVA for time to first entry of target information in the first quadrant.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4. 950	19	0. 261	0. 000	0. 000
Within Groups	0. 000	0	0. 000	-	-
Total	4. 950	19	-	-	-

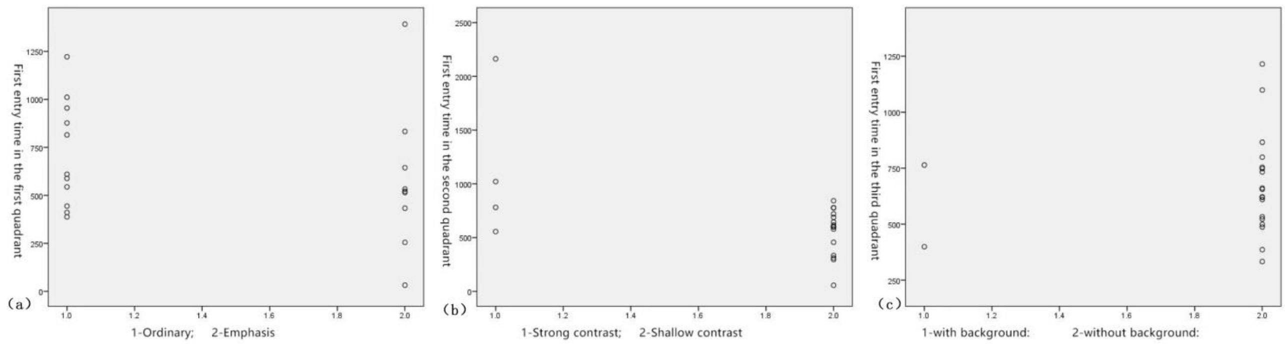

Figure 2: Each quadrant enters the time scatter chart for the first time.

From Table 1, it can be seen that the corresponding probability p is 0, 000, less than a significant level of 0. 05. Therefore, it can be considered that different information types in the first quadrant have a significant impact on the first entry time. Found from Figure 2(a) scattering diagram and average comparison of time for first entry of ordinary text types and emphasis text types (the average first entry time of the ordinary text type is 715 ms, and the average first entry time of emphasis text type is 573. 11 ms), it can be found that the entry time of emphasis text type is shorter, indicating that the recognition efficiency of this type is higher.

Table 2 One-way ANOVA for time to first entry of target information in the second quadrant.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3. 200	17	0. 188	0. 000	0. 000
Within Groups	0. 000	2	0. 000	-	-
Total	3. 200	19			

From Table 2, the corresponding probability p is 0. 000, which is less than the significance level of 0. 05. Therefore, it can be assumed that the different message types in the second quadrant have a significant effect on the first entry time. The scatter plot in Figure 2(b), the average contrast of the first entry time is a strong background contrast and a shallow background contrast (the strong background contrast is 1130. 25ms, and the shallow background contrast is 555. 94ms), it is found that the entry time for the shallow background contrast type is shorter, indicating that this type is more efficient in recognition.

Table 3 One-way ANOVA for time to first entry of target information in the third quadrant.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1. 800	19	0. 95	0. 000	0. 000
Within Groups	0. 000	0	0. 000	-	-
Total	1. 800	19			

From Table 3, the corresponding probability p is 0. 000, which is less than the significance level of 0. 05. Therefore, it can be assumed that the different message types in the third quadrant have a significant effect on the first entry time. From the scatter plot in Figure 2(c) and the average contrast of the first entry time with background contrast and without the background contrast , it was found that (the first entry time with the background type was 581.5 ms and the first entry time without the background comparison was 674.67 ms), the difference between the mean values of the two times was not significant, but based on the scatter plot analysis and the large sample size of the without the background comparison, the target type without the background was, therefore, more efficiently identified.

Table 4 One-way ANOVA for time to first entry of target information in the fourth quadrant.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4. 500	18	0. 250	0. 500	0. 826
Within Groups	0. 500	1	0. 500	-	-
Total	5. 000	19		-	-

From Table 4, p is greater than the significant level α (0. 05), indicating that the overall variance of first entry times for the two comparison types of abstract and figurative icons tested in the fourth quadrant did not differ significantly and did not have a significant effect on first entry times.

3.2 Analysis of gaze duration for different types of target information between quadrants

Table 5 One-way ANOVA for duration of fixation for different types of information between quadrants

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	98. 000	78	1. 256	0. 628	0. 789
Within Groups	2. 000	1	2. 000	-	-
Total	100. 000	79	-	-	-

Table 5 shows that the corresponding probability p is 0. 789, which is greater than the significance level α (0. 05). Therefore, it can be concluded that the target information form variable between the four quadrants did not have a significant effect on the duration of the subject's gaze.

3.3 Correlation analysis of first entry time and fixation duration for target information types

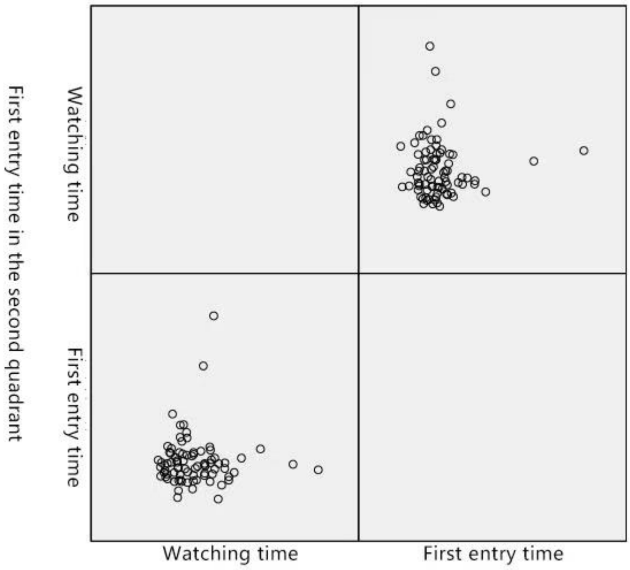

Figure 3 Scatterplot of first entry time and fixation duration for target information types.

Table 6 Matrix of simple relationship counts for factors related to target information type first entry time and fixation duration.

		Fixation time	First entry time
Fixation time	Pearson Correlation	1	0. 015
	Significance (two-tailed)		0. 896
	Number of cases	80	80
First entry time	Pearson Correlation	0. 015	1
	Significance (two-tailed)	0. 896	
	Number of cases	80	80

According to Figure 3 and Table 6, it can be seen that the simple correlation coefficient between gaze duration and first entry time was 0. 015, which corresponds to a p-value of 0. 896, which is greater than the significant level α (0. 05), then indicating that the effect of first entry time and gaze duration for the type of target information was not significant.

4. Conclusion

Most of the studies currently available are theoretical studies on the form of icons in the car's control interface, and there is a lack of quantitative experimental studies.

This experiment combines objective experimentation with subjective evaluation to conduct a relatively comprehensive study of the iconographic and textual forms of the car's central control interface. The analysis of the experimental results leads to the following conclusions.

1) By analyzing the positioning time of four kinds of target information in the four quadrants: text type, icon contrast, icon with or without background and abstract concrete icon, it is found that except for the contrast between abstract and concrete icons in the fourth quadrant, the remaining three different target types all have an impact on the first entry time.

2) Through the analysis of the experimental results, it is found that the first entry time of the emphasis text types、the shallow background contrast and without the background contrast is shorter, and more efficient than contrast recognition.

3) There was no correlation between the first entry time of different target information types and the fixation duration.

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