Effect of character size on accuracy and time on the color E-reader

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Abstract: As a portable mobile device, the e-book reader (e-reader) facilitates text-reading. With the color LCD e-reader employed, this study is aimed to investigate how legibility and visual fatigue are affected by different character sizes. Following the experimental method, 15 participants are required to search out the target words in the pseudo-texts; meanwhile, they are connected to the database through the Internet. The experimental data, such as the search time, accuracy rate, and subjective visual fatigue, are recorded in the database as well as analyzed. It is discovered that the character size exerts an influence on the accuracy rate. 12 pt and 14 pt are suitable for the e-reader on the 9.7" screen. Subject visual fatigue affected by the character size. The results of this study can be used as a reference to design the color LCD e-reader.

Key words: E-reader, legibility, character size.

1. Introduction

As technology advances constantly, the pace of life is ever-increasing. To obtain real-time information, portable mobile devices are utilized by modern people to read texts easily when they are on the move. Through mobile devices, users can read the real-time message, e-mail, and data files, as well as surf the Internet. The text contents and fonts presented on different displays may affect the user's operational performance and satisfaction [1]. The poorly-designed display layouts easily cause fatigue to the user and reduce his/her efficiency in reading texts and browsing pages [2]. On the contrary, the well-designed reading device contributes to the legibility of the text.

The screen size of the e-reader is larger than that of a PDA but smaller than that of a notebook. As a result, it offers its user both portability and reading performance. It is light enough to be carried around; moreover, it consumes very low power and boasts a wide viewing angle. Thus, it can be used in various lighting and mobile environments. In addition, files can be repeatedly read on the same carrier, which brings some advantages, such as reducing the waste of paper [3].

The character size of any e-reader play an important role in the user’s search efficiency. With the color LCD employed as the display medium, this research investigates how the character sizes affect the search efficiency and visual fatigue of those users who read Chinese texts. The relevant trials are conducted and analyzed, with

subjective visual fatigue surveyed as well. The goal is to gain an insight into the current status of the e-reader used for reading Chinese texts as well as its limitations. Also, further analyses and discussions are made so that they may serve as a reference when e-reader products are designed and developed in the future.

Different character sizes on the display exert a significant influence on the user's reading performance. One study was carried out to investigate the text readability on the desktop computer [4]. It was discovered that the character size significantly influenced the recognition rate. As for the effect of different character sizes on reading performance, another study was aimed at the children aged from 9 to 11, comparing 12 pt with 14 pt [5]. It was determined that the sans serif typeface with 14 pt was more appealing, readable, and faster to read. Still another study was concentrated on the mobile device with the pocket-sized screen [1]. It was learned that the character sizes from 8 pt to 12 pt were more suitable for the user.

Concerning the study of Chinese characters, the PDA was used as the experimental tool [6]. It was discovered that the character size whose resolution was below 250 pt and whose character height was 1.0 mm was the most unsuitable for reading purposes. In contrast, the character size whose character height was 3.0 mm performed best in terms of reading speed. Moreover, another study was carried out to compare the reading performances of different typefaces and character sizes on the 15" CRT screen [7]. It was ascertained that, in terms of readability and reading speed, the Ming-style characters with the 14-point character size, double line spacing, and positive polarity performed better than the Li-style characters (Clerical Script) with the 10-point character size, single line spacing, and negative polarity. Still another study was made to compare the recognition rates of different Chinese typefaces [8]. It was determined that the Ming-style typeface performed better than the standard typeface (Regular Script) and that the standard typeface performed better than the Li-style typeface. Still another study was made to compare the performances of different character sizes on the PDA screen with different resolutions [6]. After that, the character size suitable for the small screen was recommended. Sometimes, the smaller character size performed better than the larger one in terms of reading speed. This research focuses on the character size. With the character sizes from 8 pt to 14 pt combined with same screen sizes, an experiment is conducted in this research to compare the legibility in various conditions. And the results can be used as a reference by the designers engaged in designing the Chinese-reading interfaces.

2. Methods

With the e-reader employed as the experimental tool, this research is designed to explore the visual performance and visual fatigue caused by character size. In compliance with the experimental method, the participant is demanded to search out the target words in the pseudo-texts. In this way, the effects on the search time, accuracy rate, and subjective fatigue level can be determined. Previously, the relevant studies mainly counted the number of the correct words located by the participant [3]. The experimental results will be automatically recorded in the system, which will serve as objective information to be analyzed.

With the iPad used as the experimental tool, this research is intended to evaluate how legibility performance and visual fatigue are affected by character size. The new Ming-style font is used in the Chinese text. The following are the screen sizes of the displays on 9.7" (14.78 cm × 14.78 cm). There are four different character sizes: 8 pt (2.26 mm × 2.27 mm), 10 pt (2.70 mm × 2.72 mm), 12 pt (3.15 mm × 3.17 mm), and 14 pt (3.60 mm × 3.63 mm). Consequently, the independent variables consist of four character sizes. In other words, there are 4 trials in total, with 15 participants undertaking the within-subjects trials. Also, the principle of counterbalance is

followed; that is to say, the order in which each participant operates the experimental interface will vary with his/her experimental sequence. The participant will conduct the 4 trials in the predetermined sequence. With the trials completed, the experimental results will be automatically recorded in the system.

During the trial, the participant is required to read the meaningless pseudo-text appearing on the e-reader. Once the target word in the pseudo-text is found, it has to be touched with the participant's fingertip and then it will turn green in color, which means a successful search. But, if the participant misjudges the target word and touches it by mistake, the false one also turns red and is recorded in the system.

There are 15 participants in all. They are all ninth-graders whose ages range from 18 to 24 (M = 19.93). None of them is color-blind or is infected with other eye diseases. Their natural or corrected eyesight is above 0.8. The experimental sequence of each participant will be randomly arranged through permutations and combinations. Also, each participant will be given a reward of NT$200 after the whole set of trials is finished.

3. Result

With the e-reader adopted as the experimental tool, this research is aimed to compare the effects of character size on the search time, accuracy, and subjective visual fatigue.

Character size also has a significant effect on search time $F_{(3,42)} = 4.57$, $p < 0.01$, as is shown in Table1. The mean search time of 8 pt is 308.73s, that of 10 pt is 295.33s, that of 12 pt is 242.67s, and that of 14 pt is 274.47s. After the LSD multiple range test is used to analyze the result (Table 1), it is discovered that 12 pt takes the shortest time, 14 pt ranks second, 10 pt ranks third, and 8 pt takes the longest time.

Table 1 ANOVA result of search time

Source	*df*	SS	MS	*F*	LSD
Within subjects	14	511340.10	36524.29		
Character size (C)	3	37271.27	12423.76	4.57**	8 pt, 10 pt, 14 pt＞12 pt
C × Subject within group	42	1653437.406	9341.454		

Significant at * ≦0.05 ; **≦0.01; ***≦0.001 level.

As is shown in Table 2, accuracy is analyzed through the ANOVA method. Character size exerts a significant effect on the accuracy rate of the searched target words ($F_{(3,42)} = 22.56$, $p < 0.01$). After the LSD multiple range test is used to analyze the result (Table 2), it is discovered that the accuracy rate of 8 pt is 73.6% , that of 10 pt is 85.1%, that of 12 pt is 92.8%, and that of 14 pt is 94.9%. That is to say, 12 pt and 14 pt show the highest accuracy, 10 pt ranks third, and 8 pt has the poorest accuracy.

Table 2 ANOVA result of accuracy

Source	*df*	SS	MS	*F*	LSD
Within subjects	14	1.122	.080		
Character size (C)	3	.419	.140	22.56***	14 pt, 12 pt＞10 pt＞8 pt
C × Subject within group	42	.260	.006		

Significant at * ≦0.05 ; **≦0.01; ***≦0.001 level.

Character size has a significant effect on subjective visual fatigue ($F_{(3,42)} = 11.51$, $p < 0.001$). It is ascertained that the smaller character size causes more subjective visual fatigue. After the LSD multiple range test is used to

analyze the result (Table 3), it is discovered that the mean subjective visual fatigue score of 8 pt is 19.23 points, that of 10 pt is 15.96 points, that of 12 pt is 12.77 points, and that of 14 pt is 10.20 points. The above results indicate that, in terms of subjective visual fatigue, 8 and 10 show the highest visual fatigue, 12 pt and 14 pt gets the lowest level.

Table 3 ANOVA result of subjective visual fatigue

Source	df	SS	MS	*F*	LSD
Within subjects	14	355.803	25.414		
Character size (C)	3	690.172	230.057	11.51***	8 pt, 10 pt＞12 pt, 14 pt
C × Subject within group	42	893.356	19.985		

Significant at * ≦0.05 ; **≦0.01; ***≦0.001 level.

4. Discussion

Character size also has an effect on the user's searching speed. The smallest character size, namely, 8 pt, takes the longest search time. When the character size is increased from 8 pt and 10 pt to 12 pt, its searching speed is improved. However, when the character size reaches 14 pt, it takes a longer time than 12 pt but a shorter time than 10 pt. The result agrees with the conclusion reached by other researchers, who compared the Chinese legibility on the 15″ screen [7].

Character size is the main factor affecting search accuracy. As the character size becomes bigger, the accuracy rate of Chinese text-reading is higher. However, it is discovered by this research that the character size above 12 pt does not enhance accuracy. The conclusion is similar to the findings of other researchers [5]. It was discovered by them that too small a character size led to reading difficulty and the declining accuracy of text recognition. On the contrary, as the character size became bigger, accuracy was improved. Yet, when the character size exceeded a particular value, the accuracy rate of reading did not improve any more. Therefore, when the 8-pt words were read on the 9.7″ screen, there were so many lines that the user might easily jump to a wrong line or skip a certain line, and thus the accuracy rate was significantly lowered.

As for the measurements of subjective visual fatigue, it is discovered by this research that character size are largely responsible for visual fatigue. The small character size causes a higher level of subjective visual fatigue. Also, it is discovered that, when searching the 8 pt words, the participant is most likely to feel tired. Still another study was made to compare the comprehension score for the 10 pt and 14 pt Chinese characters which were read on the 15″ screen [7]. It was discovered that the 14 pt font performed better than the 10 pt font in terms of reading comfort, reading ease, reading fatigue and overall performance. Furthermore, the result was statistically significant.

5. Conclusions

With the e-reader adopted as the experimental tool, this research involves a series of trials. Its goal is to investigate the effect on legibility performance and visual fatigue caused by character size. Following the experimental method, the participant searches out the target words in the pseudo-texts. In this way, the effect of the character size on the search time, accuracy, and subjective visual fatigue can be identified. The main findings are summarized as follows.

Character size is the main factor affecting search time, accuracy and subjective visual fatigue. The larger character size enhances accuracy; therefore, 12 pt performs best in terms of accuracy. However, if character size exceeds 12 pt, accuracy will not be improved. It is discovered by this research that the smaller font, 12 pt or 14 pt is suitable for the e-reader on the 9.7″ screen.

6. References

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