The effects of gender and visual disability factors on the legibility of web pages

Yavuz Erdoğan

Marmara University,

Department of Computer Education and Instructional Technology

Goztepe, Istanbul, TURKEY

e-mail: yavuzerdogan@gmail.com

Servet Bayram

Marmara University,

Department of Computer Education and Instructional Technology

Goztepe, Istanbul, TURKEY

e-mail: sbayram@marmara.edu.tr

Abstract

This study aims to investigate the effects of gender and visual disability on the

legibility of the computer screen. With this aim in mind three different font types were used:

Verdana, Times New Roman and Courier New. Fifteen background-foreground color

combinations were examined; basic colors that are available on most browsers were selected.

Also, four different background-foreground color contrast combinations were chosen (dark

text on dark ground, light text on light ground, light text on dark ground and dark text on light

ground). For the study, a survey method was used to investigate the attitudes of the students

towards the legibility of the computer screen. The sample consisted of 124 students of the

Department of Computer and Instructional Technologies who were capable of visual literacy

and web technologies. Of the124 students, 35.5% were female, and 64.5% were male. Also,

46.8% of the students were visually disabled (visual acuity of the better eye $\leq \pm.05$). In the

current study, visual disability includes myopia, hypermetropia, astigmatism and color

blindness. To compare the attitudes of students according to the variables of gender and visual

disability, Independent Samples t-test was used. The results revealed that visually disabled

students perceived Verdana as more legible than any other font. Also, significant differences

were found for the high-contrast pages. Female and visually disabled students significantly

perceived that the pages designed with dark text on light ground are more legible than other

combinations.

Keywords: Interface Design, Web Design, Legibility, Gender, Visual Disability

Introduction

One of the most important elements when interacting with web pages is interface design because this is the point of contact between the user and the computer (Bernard et al., 2001). Perfect interface design requires good legibility. Legibility of screen displays is very important for efficient communication because all efforts (design, speed, content, etc.) fail when users cannot read the text (Nielsen, 2000).

Legibility depends on many factors such as color combinations, foreground/ background contrast, font, font size and computer pixel size. Fonts, foreground/background color and the contrast between the two may play a crucial role in screen readability (Hill and Scharff, 1997; Arditi, 2005; Milne et al., 2005). However, there is little agreement about legibility among professional designers. For example, experts do not always agree which fonts are more legible or which ones are the most appropriate for web use. Hozl (1997) claims that sans-serif font with uniform line thickness is easier to read. Crawford (2003), however, does not agree with this idea. On the other hand, Horton (1990) warns against serif fonts in smaller font sizes.

Similar to the conflicting views stated above, some professionals recommend a high degree of contrast between the text and the background (Rivlin, 1990; Scharff, Hill & Ahumada, 2000). Nielsen (2000) says that using color with high contrast "between the text and the background is a basic rule that should be followed by all websites." However, Powell (1990) warns against using sharp contrast between the text and background. Furthermore, one of the most difficult tasks for the web designer is being able to select harmoniously matching color combinations because the effective use of color is vital for legibility in web design. Evidence demonstrates that color enhances learning and motivation. However, color can be easily misused so as to be ineffective or even detrimental (Alessi & Trollip, 2001, p. 76). For

these reasons, the right choice of background and foreground colors is important in assuring good legibility.

There are plenty of opinions, preferences, observations and even proposed algorithms related to legibility (Clay, 2002; Richard, 2003; Keith, 2004; Arditi, 2005; Wood et al., 2005), but very few objective studies have been published about the effects of gender and visual disability on legibility (Arditi, 2000; Bernard et al., 2001; Hanson & Richards, 2005). It is certain that websites must be accessible for different segments of the target audience. World Health Organization (WHO) estimates that globally more than 161 million people were visually impaired in 2002. They represent 19% of the world's population. According to WHO, in every region of the world and at all ages, females have a significantly higher risk of being visually impaired than males. Visual impairment is not distributed uniformly throughout the world. The population increase is more prominent in developing countries, and more than 90% of the world's visually disabled people live in developing countries (WHO, 2006).

Of course, one of the most serious accessibility problems given the current state of the web probably relates to visually disabled users since most web pages are highly visual. Vision impairments provide a common source of difficulty for users when browsing on the web (Hanson & Richards, 2005). For example, it is quite common to see combinations of background and foreground colors that make pages virtually unreadable for colorblind users. In one of his studies, Nielsen (1996) found that users without disabilities experience three times higher usability than users who are blind or have low vision. Arditi (2000) made recommendations about typography, color and contrast that are intended to help people with low vision. Certain changes such as font enlargement, font style (sans serif), and enhanced color contrast can increase legibility for users with visual problems (Jacko et al., 2000).

Research literature about the web has examined gender differences since the early 1990s. (Kominski & Newburger, 1999; Jackson & Ervin, 2001; Jazwinski, 2001). A number of studies have noted that females are less likely than men to use the web (Shashaani, 1997; Binner, 2000; Ono & Zavodny, 2003). Many studies have also examined the role of gender on legibility (Bernard et al., 2001; Bernard, Liao & Chaparro, 2001) because men's and women's expectations of and attitudes toward the web differ. For instance, some websites such as those related to shopping and childcare tend to attract mostly female users, so this kind of website should be designed according to females' preferences. In this respect, to take gender-related factors into consideration will increase the legibility of web pages. Considering all these points, the current study hopes to examine the effects of gender and visual disability on the legibility of web pages.

Research Questions

The research questions to be investigated in the study are stated below;

1. Is there any significant difference in the legibility of font types according to gender and visual disability?

2. Is there any significant difference in the legibility of background-foreground color combinations according to gender and visual disability?

3. Is there any significant difference in the legibility of background-foreground color contrast combinations according to gender and visual disability?

Methodology

Method and Sample

In the current study, a survey method was used to investigate the attitudes of students toward the legibility of web pages. The study was conducted in the 2004-2005 academic year.

The study sample consisted of 124 students of the Computer Education and Instructional

Technologies Department at Marmara University, Istanbul. This department aims particularly

to equip the students with computer-based instruction and educational technology. The

students are capable of visual literacy and web-based multimedia applications. Of the sample

group, 35.5% is female (N_{female}=58) whereas 64.5% is male (N_{male}=80). The ages of the

students range from 19 to 23 years. Also, 46.8% of the sample is visually disabled ($N_{visually}$

$_{disabled}$=44). People are considered visually disabled if they are unable to perform a certain

task because of their visual impairment (Chadow, 2001). For example, a person may be able

to read a newspaper if it is printed in large print but not if it is printed in small print. For this

study, visual disability includes myopia, hypermetropia, astigmatism and color blindness,

where visual acuity of the better eye is lower than ±0.05.

Data Collection and Procedure

A website of 45 pages was designed in the study so that students could evaluate the

web pages for legibility. The students were seated approximately 60-70 cm from the screen,

and the ranking time for legibility was limited to only 30 seconds for each page. Each web

page consisted of 150-200 words, and each page featured a different combination of font style

and background-foreground colors. The pages were created using ASP, and a five-point

Likert scale for rating legibility was placed in the bottom-right corner of the page. The

students taking part in the study evaluated the legibility of each page on a 5-point scale as

follows: 1 -- very bad; 2 --bad; 3 -- average; 4 -- good; 5 -- very good.

Pentium IV PC computers with 2.00 GHz processors and 15-inch monitors with a

resolution setting of 1024 x 768 pixels were used in the study, which was performed on a

network simultaneously at four different computer laboratories in the department. The

computer operating system used was Microsoft Windows XP. Each text was formatted as an

HTML web page. The browser used was Microsoft Internet Explorer 6.0. During the study,

first each student was given a username and password, and at the end of the one-hour study,

the points given to each page were collected by a server on an SQL database. To ensure that

the students completed the entire evaluation, the web pages were designed so that the students

were not allowed to see the following page before evaluating the current one. Finally, the

124 student evaluations of the 45 pages were saved as a Microsoft Access data file on the

server.

Three different font types were used in the study. One font type was chosen from each

of the major font families: serif, sans-serif and monotype. The specific fonts are Times New

Roman (serif), Verdana (sans-serif) and Courier New (monotype) as illustrated in Figure 1.

Figure 1. The font types used in the study

Times New Roman
Courier New
Verdana
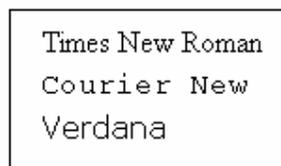
These three font types were used in combination with 15 different background-

foreground color combinations. Therefore, 45 different web pages were designed for the

study. Each web page included 150-200 words of text. The 15 different background-

foreground color combinations chosen for the study were as follows:

      1) red text on blue ground

      2) green text on red ground

      3) yellow text on green ground

      4) blue text on black ground

      5) white text on red ground

      6) red text on white ground

      7) orange text on black ground

8) yellow text on blue ground

9) blue text on yellow ground

10) yellow text on black ground

11) white text on blue ground

12) green text on white ground

13) white text on black ground

14) blue text on white ground

15) black text on white ground.

Some foreground-background color combination samples are illustrated in Figures 2, 3 and 4. The specific colors chosen are ones that do not change depending on the browser. The hexagonal codes for these colors are #006633 (green); #FF0000 (red); #FFFF99 (yellow); #0000FF (blue); #000000 (black); and #FFFFFF (white).

Figure 2. Red text on blue ground with Courier New
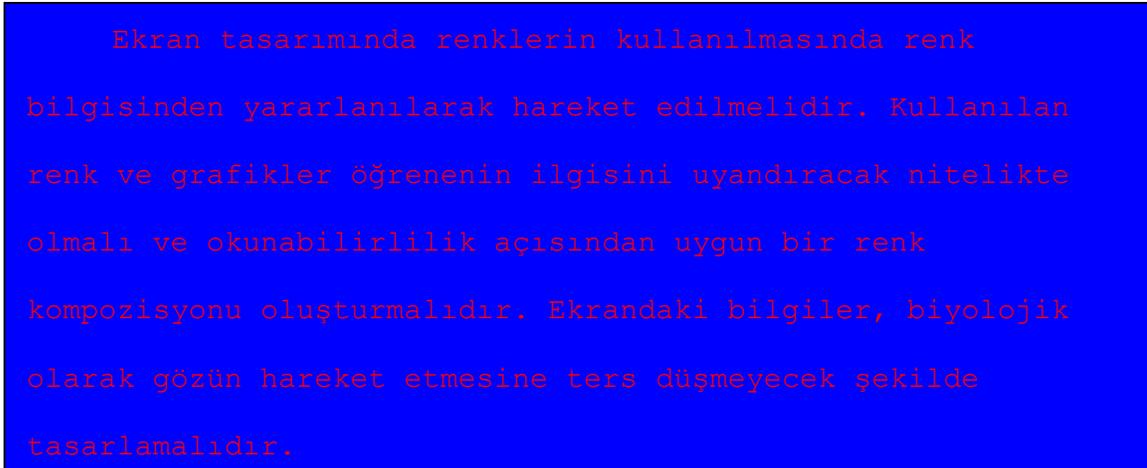
Figure 3. Yellow text on blue ground with Times New Roman
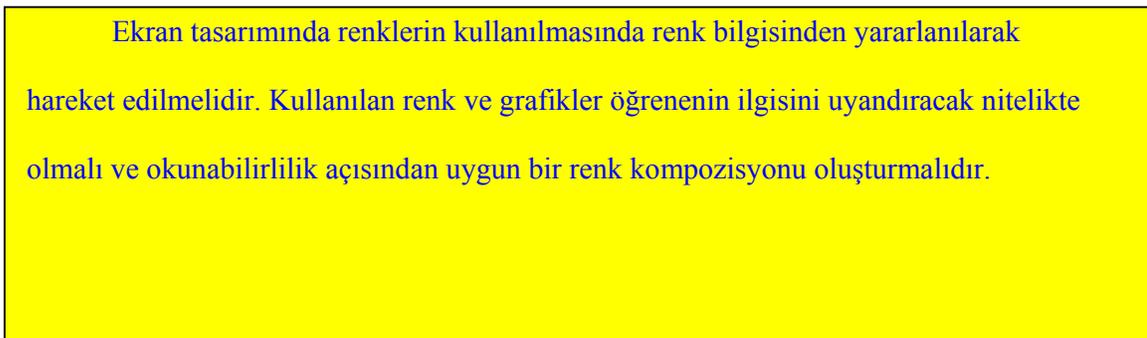
Ekrandaki bilgiler, biyolojik olarak gözün hareket etmesine ters düşmeyecek şekilde

tasarlamalıdır.

Figure 4. Black text on white ground with Verdana

Ekran tasarımında renklerin kullanılmasında renk bilgisinden

yararlanılarak hareket edilmelidir. Kullanılan renk ve grafikler

öğrenenin ilgisini uyandıracak nitelikte olmalı ve okunabilirlilik açısından

uygun bir renk kompozisyonu oluşturmalıdır. Ekrandaki bilgiler, gözün

hareket etmesine ters düşmeyecek şekilde tasarlamalıdır.

Data Analysis and Presentation of the Findings

For the data analysis, first, the descriptive statistics of 124 students are presented.

Then, according to the variables of gender and visual disability, students' attitudes toward the

font types, background-foreground color combinations and background-foreground color

contrast combinations are compared with Independent Samples T Test. For all tests, a

probability value of 0.05 was considered significant. For statistical analysis the software used

was SPSS 13.0.

Figure 5. Comparing the legibility of font types according to gender
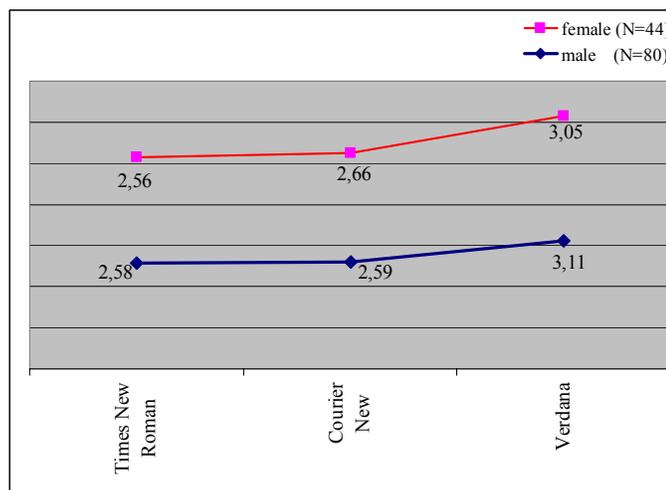
Figure 5 shows the mean ratings of the legibility of font types according to students'

gender. Independent Samples T-Test was conducted to compare the results with respect to the

gender variable. The results reveal that the attitudes of male and female students towards the

legibility of font types do not differ (t=1.08; df=122; p>0.05). However, Verdana was viewed

more favorably by males. Verdana also had the highest preference ranking for both males and

females when the two genders were considered together.

Figure 6. Comparing the legibility of font types according to visual disability
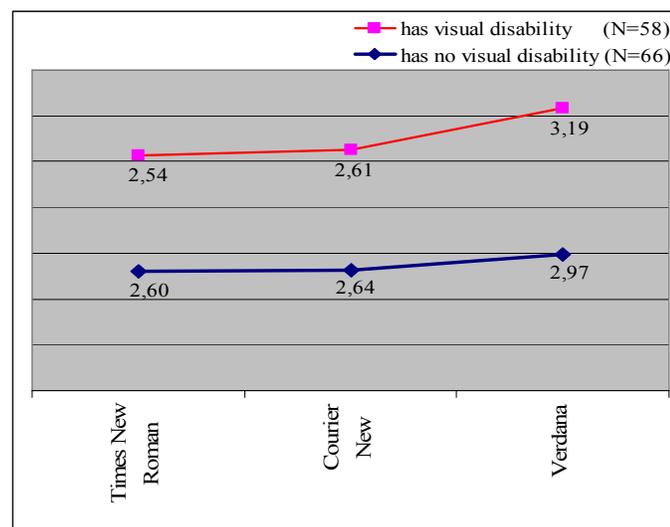
Legibility of font types according to the visual disability variable is presented in Figure

6. According to Independent Samples T Test analysis, visually disabled students viewed

Verdana more favorably than other students (t=2.39; df=122; p<0.05). From this result, it can

be said that visually disabled students perceive sans-serif font types to be more legible. Sans-

serif fonts have plain endings and appear blockier than serif fonts, so sans-serif fonts are more

suited to electronic formats, especially for the visually disabled. Serif fonts, on the other hand,

are characterized by flared extensions or strokes. Therefore, serif fonts may be difficult for

visually disabled people to read on a computer screen because the extensions or strokes may

cause the reader to misread letters.

Figure 7. Comparing the legibility of background-foreground color combinations

according to gender
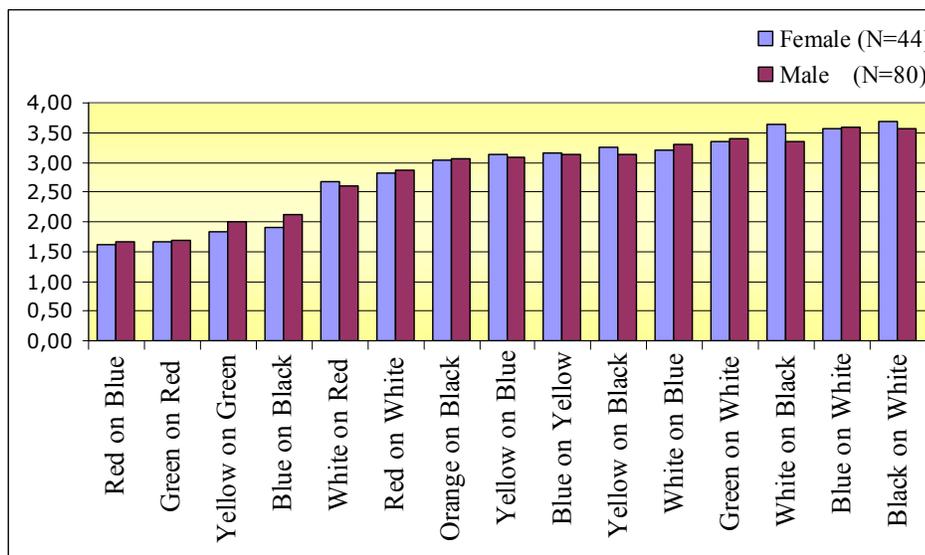
Researchers agree that varying the color of background and text in screen display affects legibility. As can be seen in Figure 7, the attitudes of students about color combinations were examined with respect to the gender variable. Results show that gender does not have a strong effect on color-combination preferences. However, the pages designed with white text on black ground were favored only by females, and there is a significant difference between males' and females' level of preference (t=2.18; df=122; p<0.05). For every group, black text on white ground is the easiest to read, and red text on blue ground is the most difficult to read.

Figure 8. Comparing the legibility of background-foreground color combinations

according to visual disability
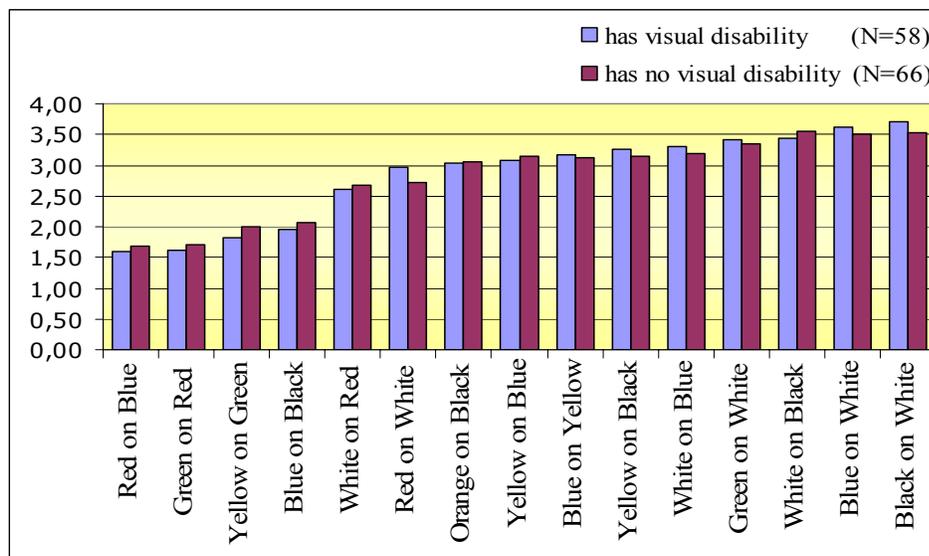
Figure 8 shows the attitudes of students about the color combinations with respect to the visual disability factor, and there are significant differences between the two groups. The students who don't have any visual disability favored the pages prepared with yellow text on green ground (t=2.08; df=122; p<0.05). However, the pages designed with black text or red text on white ground were rated more favorably by visually disabled students than by non-disabled students (t=3.03; df=122; p<0.05). In addition, as can be seen in Figure 9, visually disabled students perceived the pages designed with dark text on light ground to be more legible than other combinations. For example, visually disabled students maintain positive attitudes toward the pages designed with black text, red text or blue text on white ground, and also blue text on yellow ground. Considering these results, it can be stated that visually disabled students prefer pages with a high color contrast. These points will be investigated further in Figure 10.

Figure 9. Comparing the legibility of background-foreground color contrast combinations according to gender
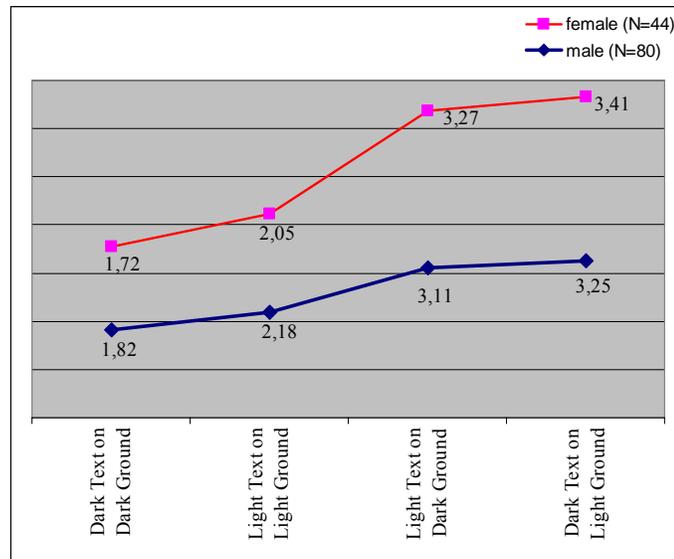
Figure 9 shows that background-foreground color combinations which maintain a high contrast are more legible than other combinations for both sexes. Also, it was found that dark text on a dark ground was the least legible contrast combination for all groups. Independent Samples T Test results reveal that the attitudes of female students toward the pages which have light text on dark ground are more favorable those of than male students (t=2.02; df=122; p<0.05). Parallel results were found for the pages designed with dark text on light ground (t=2.33; df=122; p<0.05). However, males' attitudes towards low-contrast pages are more positive than females. But because they are below the.05 level, these differences are not significant.

Figure 10. Comparing the legibility of background-foreground color contrast combinations according to visual disability
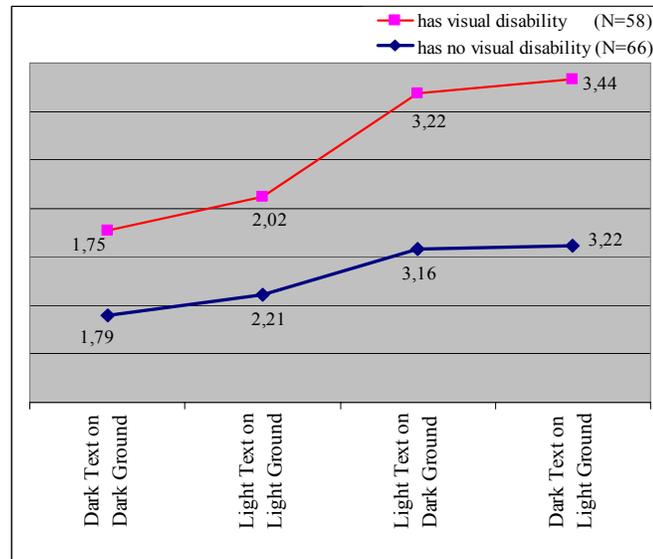
As shown in Figure 10, students who are visually disabled favored high-contrast pages. There is a significant difference only for the pages designed with dark text on light ground (t=3.23; df=122; p<0.05). From this result, it can be said that these pages are more legible than the others for visually disabled students.

Results and Discussion

In this study, the effects of gender and visual disability factors on the legibility of the web pages were examined. At the end of the study it was revealed that legibility of the font types and color combinations differ with respect to gender and visual disability variables.

According to the study results, Verdana had the highest preference ranking for both males and females when the two groups were considered together. However, there were no significant differences with respect to gender. These findings show parallel results with various earlier studies (Horton, 1990; Hozl, 1997; Bernard et al., 2001). The results also show that visually disabled students viewed Verdana more favorably than students without any visual disability (t=2.39; df=122; p<0.05). Verdana has exaggerated x-heights and is very large compared to more traditional typefaces in the same point size; it is designed specifically

for legibility on the computer screen. Thus, Verdana is easier to read in electronic formats,

especially for visually disabled people. Also, serif fonts such as Times New Roman and

Courier New are traditionally used for the printed page, but they do not always work well

when projected on computer screen (Crosby, 1994; Vetter et al., 1995).

The study also demonstrates that the effective use of color is vital for legibility in web

design. Researchers agree that varying the color of background and text in screen display

affects legibility. It is certain that some color combinations are better than others. In this

study, we found that black text on white ground is the easiest to read, and red on blue ground

is very hard to read. In addition to this, results show that gender does not have a strong effect

on color-combination preferences. However, females viewed the pages designed with white

text on black ground more favorably than did male students (t=2.18; df=122; p<0.05). In spite

of this result, Nielsen (2001) found that most of his conclusions regarding good web design

hold equally true for males and females. Furthermore, the pages designed with black text or

red text on white ground were scored higher by the visually disabled than by non-disabled

students (t=3.03; df=122; p<0.05). However, not surprisingly, black text on white ground was

the most legible color combination for all groups. This result is consistent with the findings

and recommendations of other studies. For instance, Hill and Scharff (1997) reported black

text on white as one of the best foreground-background combinations. Also, Nielsen (2000)

said optimal legibility requires black text on a white background.

In this study, it was revealed that text is much easier to read when there is a high

contrast between the text and the background. Also, it was found that low-contrast

combinations were the least legible for all groups. These results support Rivlin (1990), who

suggested maintaining high contrast, but do not fully support Powell (1990), who

recommended avoiding sharp contrasts. In addition, it was revealed that females viewed the

pages with light text on dark ground more favorably than did males. Parallel results were

found for the pages designed with dark text on light ground (t=2.33; df=122; p<0.05). On the

other hand, visually disabled students prefer high-contrast pages. They perceived the pages

designed with dark text on light ground as more legible than other combinations. For visually

disabled readers, low contrast can also be irritating and fatiguing.

Further research is needed to investigate the attitudinal differences between males and

females and between the visually disabled and non-disabled readers demonstrated in this

study. It would be interesting to investigate whether the same results would hold true for other

variables such as age and cultural differences.

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