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The effects of luminance contrast, colour combinations, font, and search time on brand icon legibility

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ABSTRACT

This study explored and identified the effects of luminance contrast, colour combinations, font, and search time on brand icon legibility. A total of 108 participants took part in the experiment. As designed, legibility was measured as a function of the following independent variables: four levels of luminance contrast, sixteen target/background colour combinations, two fonts, and three search times. The results showed that a luminance contrast of 18:1 provided readers with the best legibility. Yellow on black, yellow on blue, and white on blue were the three most legible colour combinations. One of this study's unique findings was that colour combinations may play an even more important role than luminance contrast in the overall legibility of brand icon design. The 12-s search time corresponded with the highest legibility. Arial font was more legible than Times New Roman. These results provide some guidance for brand icon and product advertisement design.

1. Introduction

A brand can be defined as “a name, term, sign, symbol, or design, or a combination of them, that is intended to identify the goods and services of one seller or a group of sellers and to differentiate them from those of competitors” (Kotler, 1997). Thus, a well-designed brand could help consumers easily recognize the brand's products. A name brand also helps consumers relate a product or service to its manufacturer or company, which in turn helps differentiate the uniqueness of the manufacturer's products and services. Therefore, investigating brand design and its effects on visual communication is important. Furthermore, as more consumers were exposed to PC and Internet advertisements, the impact of display characteristics on visual display terminals (VDTs) became critically important. Therefore, this study aims to investigate the effects of display characteristics, such as luminance contrast, colour combinations, character font and search time, on brand icon legibility.

Luminance contrast may significantly affect the visual performance of VDT brand icon design. McLean (1965) found that legibility was significantly affected by the contrast ratio, with the white-on-black contrast condition producing faster reading speeds than the black-on-white contrast condition. As the contrast ratio value increased, so did legibility. Low contrast sensitivity makes perceiving faces, objects, or road signs difficult (Boucart et al., 2008; Lin, 2003; Lott et al., 2005; Owsley and Sloane, 1987). Low luminance contrast is harmful when performing visual work (Shieh and Chen, 1997). According to the American National Standard for Human Factors Engineering of Visual Display Terminal Workstations (ANSI/HFS 100-1988, 1988), the luminance contrast should be at least 3:1 (0.667), and a contrast of greater than 7:1 (0.875) is optimal (ANSI/HFS 100-1988, 1988; Snyder, 1988). Zhu and Wu (1990) studied the operator's visual performance on a VDT and revealed that the contrast ratio and screen luminance interacted: optimal contrast ratios were approximately 11:1, 9:1 and 7:1 at background luminance levels of 20, 30 and 40 cd/m^2, respectively. Wang and Chen (2000) showed that the contrast ratio influences visual performance. Shieh and Lin (2000) noted that the contrast ratio may play a more important role than chromaticity contrast in visual performance. Ojanpää and Näsänen (2003) indicated that the visual search times increased strongly with decreasing luminance contrast despite the presence of colour contrast. Shieh and Huang (2004) found that, when the luminance contrast of prohibitive symbols (a red circle with a slash) was reduced below a degraded level, the pictorial size and thickness of the circles with slashes started to influence glance legibility. In

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general, across all colour combinations, visual performance increases as the contrast ratio increases (Lin, 2005). Huang (2007) also found that icon legibility can be enhanced with higher luminance contrast.

Colour combinations also influence legibility (Nilsson et al., 1983) and the visual performance of icon designs on a VDT (Pastoor, 1990; Silverstein, 1987). Some studies found that documents with white text on a blue background lead to the best reading performance (Neri et al., 1986; Ohlsson et al., 1981; Santucci et al., 1982), while using colours inappropriately can result in higher levels of visual discomfort and poor reading performance (Bruce and Foster, 1982; Luria et al., 1989; Matthews et al., 1989; Radl, 1982; Shieh and Chen, 1997). Ojanpää and Näsänen (2003) found that moderate or even high colour contrast does not guarantee quick visual perception, if the luminance contrast between characters and background is small. Interestingly, Health Canada studied coloured warnings on cigarette packages. To measure legibility distance, the researchers built an 8-m automated test track. Subsequently, the Canadian Space Agency systematically measured the legibility of all letter/background combinations on six primary colours: black, white, blue, green, yellow, and red. The results indicated that the legibility of several colour combinations was significantly higher than that of black on white (Nilsson, 2005; Nilsson and Kaiserman, 2004). Huang (2006) showed that, to achieve faster reading times, achromatic background colours were the most effective. Huang (2008) found that visual search performance can be significantly affected by colour combinations. White on yellow and white on blue performed better than black on blue and black on yellow. Yeh et al. (2013) revealed that colour combinations significantly affected the accuracy of icon legibility. Bhattacharyya et al. (2014) studied a searching task using 16 character/background colour combinations and found that blue on white and red on white were highly recommended under positive image polarity (a lower luminance colour image shown on a higher luminance colour background), while white on green and white on blue were highly recommended under negative image polarity (a higher luminance colour image shown on a lower luminance colour background). Humar et al. (2014) indicated that the highest ranked legibility for LCD displays are contrastive colour combinations with negative polarity.

Character font may also influence legibility. Boyarski et al. (1998) suggested that designers should consider whether newly designed screen fonts are better than those currently used online. Kingery and Furuta (1997) found that overall legibility could be best achieved with Times New Roman and Arial typefaces when skimming the headlines of an electronic newspaper. Eyles et al. (2003) found that 70% of 191 participants preferred Arial font to Times New Roman; Bernard et al. (2003) reported that readers perceived Arial as being easier to read than Times New Roman. Chaparro et al. (2006) showed that the legibility of Cambria font was the highest, followed by Constantia and Times New Roman (legibility was measured by participants' correct identification of briefly presented characters). Bernard et al. (2001) indicated that font size significantly affected legibility, e.g., 12-point fonts were less legible than 14-point fonts. Cai et al. (2008) found that letters with greater widths or heights were more legible than those with smaller ones; however, even though italicized Times New Roman letters had greater width, their legibility was worse than those that were not italicized. Gattullo et al. (2015) showed that, if one text style is needed for both types of head-worn displays (HWDs), coloured billboards with neutral white text are effective. When colour coding is not mandatory, white text on a blue billboard is more effective than other styles tested.

In summary, many studies have been conducted on text legibility, though not on brand design from the viewpoint of visual communication. In advertising and commercial applications, the legibility of brand design is more important than text legibility. In addition, for Arial font was preferred to Times New Roman (Eyles et al., 2003); however, “preference” is not synonymous with “legibility”. Furthermore, some findings on luminance contrast and colour combinations in the literature have not been at all consistent. Therefore, the issue of VDT brand design deserves further study. Since luminance contrast, colour combinations, and character font are important factors that affect legibility, this study will explore the effects of these display characteristics on the icon legibility of brand design.

2. Methodology

2.1. Participants

A total of 108 college students (52 men and 56 women) participated in this experiment. All participants were between 18 and 28 years of age (M = 22.8 years, = 1.8 years) and had 20/25 corrected visual acuity or better and normal colour vision. The participants were recruited through printed and electronic advertisements on notice boards, and they were paid 200 New Taiwan Dollars per hour (NT$200/hr).

2.2. Experimental design

Four independent variables were analysed: colour combinations, luminance contrast, character font and search time.

1. Colour combinations (including background colour and target colour): All the colours displayed on the VDT were generated from a red-green-blue (RGB) colour model. The following six chromatic colours were selected because they are the vertices and base midpoints of the Commission Internationale de l'Eclairage (2008) coordinate triangle: red (R), green (G), blue (B), yellow (R and G), turquoise (G and B), and purple (R and B). Black and white, two achromatic colours, were also used in this experiment. Their corresponding CIE chromaticity coordinates are shown in Table 1.

The eight colours were all displayed under negative image polarity (higher luminance colour image shown on a lower luminance colour background) including red, blue, purple, black background colours and white, yellow, green, turquoise target colours, forming sixteen target/background colour combinations.

2. Luminance contrast: the luminance contrast of the sixteen colour combinations were calculated by the contrast ratio (L_{High}/

Table 1
List of 8 colours used in the experiment and their corresponding CIE chromaticity coordinates.

Colours	CIE (x, y)		Luminance (cd/m^2)
	x	y	
Background			
Black	0.257	0.447	5.0
Blue	0.141	0.071	5.0
Red	0.723	0.256	10.0
Purple	0.375	0.171	10.0
Target			
Green	0.318	0.520	60.0
Turquoise	0.210	0.385	60.0
Yellow	0.465	0.469	90.0
White	0.336	0.266	90.0