Effect of Color Brightness Change on Interface Balance

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ABSTRACT

In web design, important text information is placed in the visual center of people, when there is too much information, it will cause the imbalance of interface layout. Color plays an important role in interface balance as a per-ceptive element. This paper introduces the experimental study on the effect of color brightness on interface balance. In this experiment, 11 geometric images were designed to verify the effect of brightness on the balance sub-ject score by changing the brightness properties only. The results of the ex-periment showed that compared with the reference image (50% of bright-ness), male and female subjects gave a score lower than the reference image when the image brightness was less than 50% or higher, and the test image was greater than 50%, and the score decreased linearly with the decrease of the image brightness.

Keywords: Interface Design, Interface Balance, Color Brightness

RESEARCH BACKGROUD

INTERFACE AESTHETICS AND EMOTIONS

When people first started using the Internet, web pages often focused on providing cognitive ease of use, such as designing search engines or directories to search information (Locher et al. 1998). Therefore, most previous studies on human-computer interaction in web page or interface design focus on the cognitive function of web pages. For example, there is an easy-to-use function called simultaneous menu layout, which is used to deal with complex tasks and multiple tasks more effectively (Bauerly et al. 2006). The recent research on website design guidelines clearly shows that the previous design principles mainly focus on the cognitive efficiency of websites. However, as users become accustomed to operating these basic functions in repeated use, they only provide cognitive ease of use and can not meet the needs of users. The development of computer graphics has further increased the importance of aesthetics in the user interface. This aesthetic interface provides users with emotional experience (Bauerly et al. 2006). Multimedia systems have long used a variety of visual design factors to provide users with richer emotional experience. The importance of stimulating users' positive emotions is increasing with the development of the Internet, because research shows that appropriate emotions can increase the value of physical products and software systems (Nodine et al. 1996). Aesthetics is closely related to stimulating users' emotion, especially in the context of multimedia web page design, aesthetics is considered to be an important determinant of site users' preferences (Locher et al. 1996). For example, beauty is the main predictor of users' overall impression of the website, and the aesthetic attraction of the interface or website is often associated with users' practicability, ease of use and entertainment (Lavie et al. 2004). Overall, these previous studies have shown that the problems related to aesthetic effects in visual interfaces involve the interaction of many factors. Although the exact mechanism of emotional and cognitive evaluation of visual interface is not clear, the research shows that aesthetics plays an important role in the design of general visual interface of computer system.

COGNITION OF BALANCE

Through the ages, many artists believe that balance is the main design principle to guide the distribution of various elements in art works. According to this view, balance is necessary and important in aesthetics. When graphic elements and their product characteristics are organized according to a certain relationship at or near their balance center, so that they look stable visually, this object is considered to be balanced (Locher et al. 1996). In daily cognition, the most common and obvious balance is symmetry, that is, the objects are left and right, up and down or diagonal, and some elements are arranged with corresponding relations in some properties. When half of the composition appears as the "mirror image" of the other half, it is said to show a formal balance, called bilateral symmetry, that is, the elements on the left and right sides of the symmetry axis are exactly the same (Lavie et al. 2004). In addition, another kind of balance is when the elements of the object and image are arranged or organized in an asymmetric manner around the balance center, but their visual effects can

offset each other in some nature, making the object and image more complex and changeable. This kind of balance is called dynamic balance (Lavie et al. 2004). In the web page or interface, it is common for text, graphics, color and size to interact to achieve dynamic balance and bring beauty. Based on the visual weight of the object in the balance page, some scholars describe the formal balanced composition as a perceptual phenomenon, and qualitatively show several main factors: number of elements, size, position, color, shape and texture, which will affect the visual weight of the perceptual object (Bauerly et al. 2006). In addition, size (i.e. area) is also one of the most important factors affecting balance perception, and the "contrast" between the object and other surrounding objects will also have a significant impact on its visual weight (Bauerly et al. 2006). In general, the contrast of an object usually depends on the color or texture of the surrounding object. For example, orange spots in the blue area are visually perceived more heavily than orange spots in the red color area. In addition to these three main factors affecting the balance, there are many secondary factors that may affect the visual balance of graphics. Color (hue, saturation and brightness) is also a common factor. For example, blue feels heavier than yellow, and colors with low brightness feel heavier than colors with high brightness. In terms of the number of elements, Gestalt's perceptual organization theory explains the role of symmetry, grouping and balance in visual perception (Lavie et al. 2004).

WEB INTERFACE DESIGN

As an important form of multimedia visual man-machine interface, web pages often take text, graphics and background as the carrier to decode users' physiological and psychological cognition of color, so that users can exchange information according to the requirements of designers. In the process of interaction, these are important guarantees to ensure interaction, including the position of subject information in the composition of object web pages, font style and character size, color and size contrast, color discrimination and graphic attributes. Through the research on the principle of color recognition in human-computer interaction, we can create visual beauty through the better comparison of visual subject and background color information in the design, and transmit the information to users correctly and effectively. In web design, important information is often placed in people's visual center. When the text information layout is unbalanced, it cause the interface imbalance easily, in this case, color as an important part of web design, its inherent weight attribute can play a regulatory role. The lower the brightness, the greater the visual weight. On Amazon and Twitter home pages, low brightness background colors are used in parts with less text information to ensure interface balance (Figure 1).

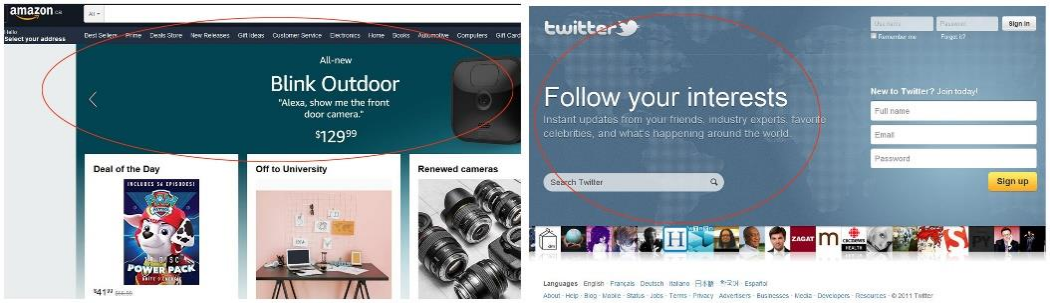

Fig. 1. Amazon homepage (left) and Twitter homepage (right)

EXPERIMENTAL INTRODUCTION

EXPERIMENTAL PURPOSES

This study conducted a set of experiments with two purposes: to determine whether the change of color brightness affects the subject score of balance, and to determine the relationship between color brightness and balance.

Before this study, the following assumptions were made: because the image was designed to have different areas on the left and right sides, and the area on the right side was larger than the area on the left side, based on the attribute that the color has a sense of weight, the balance score increased as the brightness of the right figure increased to a certain value. In terms of differences between men and female, no research shows that men and female have differences in balance perception.

EXPERIMENTAL DESIGN

In the current study, the balance is obtained by adding the visual torque in the horizontal and vertical directions to zero near the balance point (Locher et al. 1996). The cooling and heating characteristics of green are not obvious, which can reduce other effects caused by brightness changes (Ranjgar et al. 2019). Therefore, this experiment takes the rectangular color block filled with 120 degrees on the color ring and 50% green saturation as the experimental object. Take the green (120 degrees above the color ring, 50% saturation and 50% brightness) rectangle with the left and right area of 7:10 as the control group to simulate the imbalance of interface information layout. In this experiment, the left area of the image is set as a and the right area is set as b. The number of groups and colors on the left and right sides are the same, so the visual weight on the left and right sides depends on the region. According to formula (1), the balanced subject evaluation value (F) of the reference image is 70. The image of the experimental group keep the area size, area ratio and number of groups unchanged, only changed the color brightness on the right side of the experimental image, and gradually increased by 5%.

$$F=\frac{S_a}{S_h} * 100. \quad (1)$$

The experimenters designed 11 images, including one image as the reference image and 10 images as the test images (Figure 2). The subjects scored these images in balance. If the balance attraction of the test image is higher than the reference image, it is rated as 75, and if it is lower than the reference image, it is rated as 65. Subjects can use any positive number they think appropriate, and their scores are not limited by the fixed proportion requirements. Each image is displayed on the screen near the reference image. The experimenter asked the subjects to score quickly.

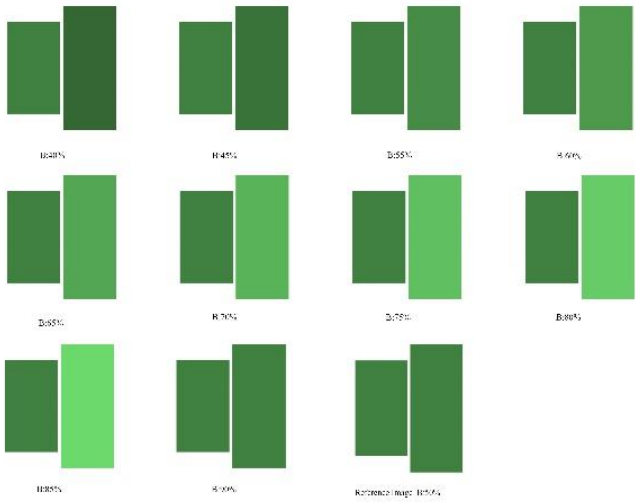

Fig. 2. Experimental images

EXPERIMENTAL PROCESS

Sixteen subjects aged 21-23 participated in the experimental study, including 8 males and 8 females, with gender as a covariate. All subjects have normal or corrected visual acuity and normal color vision. Most of the participants have art training. Aesthetic trained and untrained individuals are basically consistent in the perceptual structure framework of balance (Locher et al. 1996).

The experimenter recorded the oral answers to the subjects' scores on each image to collect all data. This experiment was carried out in a sound insulation and sufficient light laboratory. The participants sat at a table arranged by the experimenter and sat at 1024 on a 15 inch CRT display × View all images with a resolution of 768 pixels. The area of all images is 600 square pixels. Each participant took about 3 minutes.

EXPERIMENTAL RESULT

The experimental data are as follows:

Table 1. Subject scores of male subjects on image balance under different Brightness.

Subject	Brigthness										
	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
1	80	75	70	70	75	70	65	60	50	40	35
2	60	65	70	75	60	50	50	40	40	30	25
3	60	65	70	65	63	62	60	55	52	50	45
4	65	68	70	66	60	55	50	47	42	35	30
5	40	55	70	70	60	65	55	50	50	50	45
6	65	60	70	70	65	60	50	50	45	45	40
7	65	70	70	70	65	62	68	60	55	50	45
8	60	65	70	68	65	58	55	50	48	42	37
Average	61.88	65.38	70.00	69.25	64.13	60.25	56.63	51.50	47.75	42.75	37.75

Table 2. Subject scores of female subjects on image balance under different Brightness.

Subject	Brigthness										
	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
9	60	65	70	70	70	65	60	55	55	50	50
10	60	65	70	72	75	80	75	70	65	65	60
11	70	80	70	85	67	60	62	72	81	81	50
12	70	75	70	65	60	55	50	45	40	35	30
13	75	85	70	87	78	70	65	63	60	50	50
14	50	65	70	72	72	75	65	55	40	30	10
15	60	65	70	70	75	80	80	75	65	60	60
16	75	70	70	65	50	40	40	40	35	20	15
Average	65.00	71.25	70.00	73.25	68.38	65.63	62.13	59.38	55.13	48.88	40.63

The experimental results show that, contrary to the hypothesis, when the left and right sides of the picture are unbalanced (the right side feels heavier than the left side), when the brightness of the right side is greater than 55% or 50%, the balance score of the image becomes lower and lower with the increase of the brightness of the right side of the image . When the brightness is about 50% (55% or 45%), the balance score is the highest (Fig. 3)

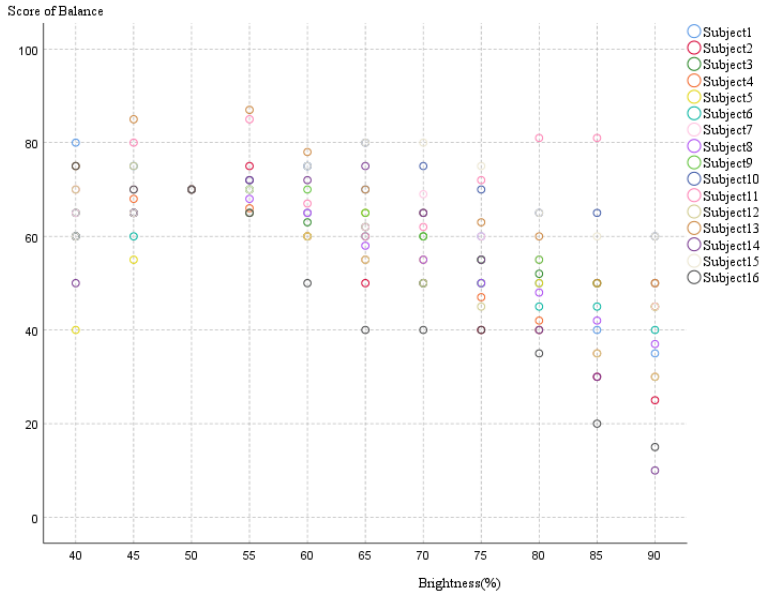

Fig. 3. Subject scores of image balance under different brightness

In terms of gender difference, compared with the reference image, when the brightness of male subjects is lower than 50% or higher, the scores given are lower than the reference image, and the test image is greater than 50%, with the decrease of image brightness, the scores gradually decrease. When the brightness of female subjects is lower than 50% or higher than 55%, the score given is lower than the reference image. When the brightness of the right side of the tested image is 55%, the balance score is the highest, and the measured image is greater than 55%. With the decrease of image brightness, the score decreases (Fig. 4). Overall, there was no significant difference between male and female subjects.

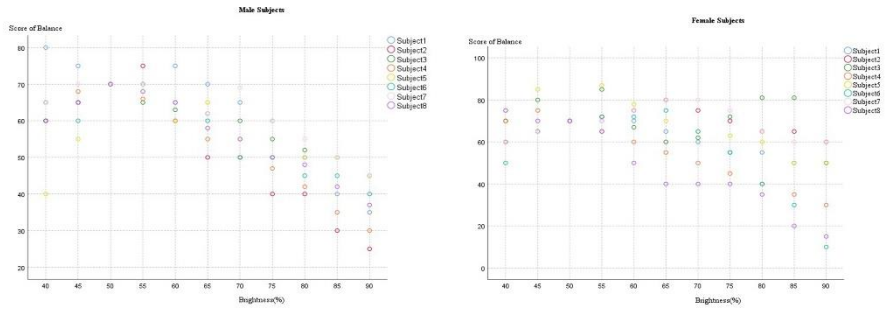

Fig. 4. The subject scores of male subjects (left) and female subjects (right) on the sense of image balance under different lightness.

CONCLUSION AND SIGNIFICANCE

The main purpose of this experiment is to verify whether the color brightness can improve the balanced layout when the interface information layout is unbalanced. The experimental design is to change the brightness of the right part of the image to simulate the unbalanced information layout in the interface design, and let the subjects score the balanced subject of these images. However, the experimental results show that only changing the color brightness can not effectively change the interface imbalance caused by the uneven distribution of information. With the increasing difference of color brightness, the sense of balance becomes lower and lower. These conclusions show that only considering the weight of color and changing its brightness can not be used as an effective means to improve the sense of interface balance. The study also showed that gender differences had only a slight effect on the experimental results. In addition, in this experiment, it is found that for a single color, the score is higher when the contrast of the left and right sides of the image is in the range of 10%. When the brightness on the right side of the image is greater than 55% (60% - 90%), the subject's score gradually decreases with the increase of brightness. When the brightness on the right side of the image is less than 55% (40% - 50%), the subject's score gradually increases with the increase of brightness. The reason for this result may be that the color brightness contrast becomes stronger, subjects developed visual imbalance. These findings pave the way for further exploring the relationship between other attributes of color and the sense of balance in interface aesthetics.

LIMITATIONS

The research on the emotional connotation of color confirms that color stimulation has an impact on the emotional state of its observers. For colors with high saturation and brightness, the arousal level of people's emotional state is also high (Oberfeld. 2018). Therefore, in this experiment, the change of color brightness will also lead to the change of saturation, and with the increase of experimental image brightness, it will have different effects on the emotional state of subjects and affect the accuracy of experimental results.

The experimenter also observed that with the progress of the experiment, the score given by the subjects became slower and slower, and the number of pauses increased. Through the inquiry of the experimenter, it is known that the subjects are less and less sensitive to small brightness differences. This is also one of the sources of experimental error.

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