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Colour Harmony in Clothing, Skin Tones and Hair Colours for Applications of Online Shopping

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ABSTRACT

There have been many studies into colour harmony and colour preference. Recent psychophysical findings have shown some "principles" of how to enhance harmony in a colour combination. The aim of this study is thus to use psychophysical methods to investigate some existing colour harmony principles that can apply to fashion colour in the context of online shopping. There were a total of 50 observers, including 25 males and 25 females, participating in this study. During the experiment, observers were asked to rate the test images in terms of colour harmony, liking and fashionableness. Results show that people with light skin tone wearing almost all color combinations used in this study tended to look harmonious. There seemed to be little difference between the two gender groups and the style groups.

KEYWORDS: Color Harmony, Color Preference, Clothes Colour

INTRODUCTION

Colour plays an important role in our daily life. Online shopping for clothing has become more and more popular. It is essential to pick up suitable colours for consumers since color is a major element of fashion design[1]. Various studies about colour harmony have been conducted by many researchers but most of the studies focused only on contextless colour patches.

This study was divided into three parts. In Part I, lightness of shirt colours varied under two skin tones (a light and a dark skin tones) and two styles (a long sleeves style and a short sleeves style) in order to investigate how changes in lightness may affect colour harmony. In Part II, chroma of shirt colours were varied under the two skin tones and the two styles to investigate the effect of chroma on colour harmony. Hue difference between shirt and trousers was investigated in Part III under the two skin tones and the two styles.

THEORY

Two of existing colour harmony principles were tested in Part I of this study. The high lightness principle [2] indicated that the high lightness values tended to enhance the harmony. The lightness difference principle [3] indicated that when lightness difference increased, the harmony score increased too. To see how chroma change affect harmony, Part II of the study tested the principle of complementary hue which was proposed by Goethe. The principle indicated that colours would appear harmonious if the colours were located on opposite sides of a hue circle [4]. In Part III, the principle of equal hue (or similar hues) proposed by Ostwald indicated that colors would be harmonious if they had equal hue (or similar hues) [5].

EXPERIMENTAL SETTINGS

In this study, test images each showing a girl wearing a shirt and a pair of trousers were presented individually on a 27-inch liquid crystal display with a luminance of 79 cd/m^2 for the peak white, situated in a dark room. A total of 50 observers were asked to rate each test image in terms of colour harmony, liking and fashionableness from score 1 to 4. Colours of the girl's shirt, trousers and skin tone were varied to create different combinations of colours. A total of 170 images were used as stimuli in the experiment, including 10 repeated

images for examining the observer accuracy. All images were presented against a background colour using a medium gray with lightness of 50 (L*=50).

In Part I, the lightness of shirts for all test images were set to 0, 25, 50, 75 and 100 in CIELAB lightness. And the colours of trousers were all set to an achromatic color, with a lightness value of 90. In Part II, the lightness of shirts were the same for all test images, while the chroma of shirts were set to 33.3, 48.3, 63.3, 78.3 and 93.3 in CIELAB chroma. There were two hues for the shirts: yellow and blue. The colours of trousers was all set to blue. In Part III, hue angles of shirt and trousers were set to 0.18, 50.18, 130.18, 240.18 and 300.18 degrees in CIELAB hue angle, while the lightness and chroma values were the same for all test images.

There were two styles (short sleeves and long sleeves) and two skin tone (light and dark) for all test images.

RESULTS AND DISCUSSION

To examine the data reliability, two methods were used: intra-observer variability and inter-observer variability, using Eq. (1). The intra- and inter-observer variability values are shown in Table 1 in terms of Root Mean Square (RMS) for the three scales. The lowest RMS value of intra-observer was 0.67 for the "like" scale, indicating that the observer response was most repeatable for "like" in this study. The RMS value of inter-observer was concerned with how well the observers agreed with each other for each of the three scales. As the table shows, there seems to be little difference in the inter-observer variability between the three scales.

As shown in Table 2, the correlation coefficients between the three scales are fairly high, indicating close correlation between these scales.

$$RMS = \sqrt{\frac{\sum_i (X_i - \bar{X}_i)^2}{N}}$$ (1)

Table 1. Intra- and Inter-observer variability in terms of Root Mean Square values

Intra-observer variability			Inter-observer variability		
Like	Harmony	Fashion	Like	Harmony	Fashion
0.67	0.75	0.73	0.81	0.81	0.80

Table 2. Correlations between different scale value

	Like	Harmony	Fashion
Like	1	.960	.968
Harmony	.960	1	.939
Fashion	.968	.939	1

Togerson's Law of Categorical Judgement was used in this study to transform the experimental raw data into z-score related interval scale values. Taking the "harmony" scale as an example, the higher the score, the more harmonious the color combination appears.

As shown in Figure 1, Part I with short sleeves, under light skin tone, the shirt in middle grey (L*=50) had the highest harmony score, while the black shirt (L*=0) had the highest harmony score under the dark skin tone. With long sleeves, shirt in dark grey (L*=25) was the most harmonious one under light skin tone, and middle grey was the most harmonious under dark skin tone. Scores of light skin tone are higher than dark skin tone.

The high lightness principle as mentioned above did not seem to work, as shown in the experimental results of Part I, especially under dark skin tone with short sleeves. The lightness difference principle seems to work for light skin tone and for both short and long sleeves styles.

In Part II, a comparison was made between yellow and blue shirts with different chroma values under the two skin tones and the two sleeve styles. As shown in Figure 2, it seems there was a trend that increasing chroma tends to reduce the harmony score, especially for blue long-sleeve shirts. For short-sleeve shirts, light skin tone was more harmonious than dark skin tone. Under light skin tone, chroma of 48.3 seems more harmonious than the others. Under dark skin tone, it seems that increasing chroma would reduce the harmony score. The most harmonious

combination is under light skin tone with long-sleeve shirt when chroma is 33.3. Comparing yellow shirts and blue shirts, the complementary hue principle performs better than similar hue principle.

Part III focuses on the equal hue principle. As shown in Figure 3, the radar plot shows harmony scores from -1.5 to 0.5, the outward the point is located, the higher the harmony score is. No matter whether it is light or dark skin tone, and no matter whether it is short- or long-sleeve shirt, only the colour pink agreed with the principle of equal hue. In addition, under light skin tone with short-sleeve shirt, colour green agreed with the principle of equal hue. Under dark skin tone with short shirt, colour green and orange agreed with the principle too. The pink trousers seem to create harmony with most of colours of shirt. The most harmonious combination was long blue shirt with pink trousers under light skin tone. The most disharmonious combination was short green shirt with pink trousers under dark skin tone.

Regarding the impact of the shirt styles, as shown in Table 2, correlation coefficients between the two styles were 0.86, 0.70 and 0.84 respectively, indicating that there was little difference between the two styles.
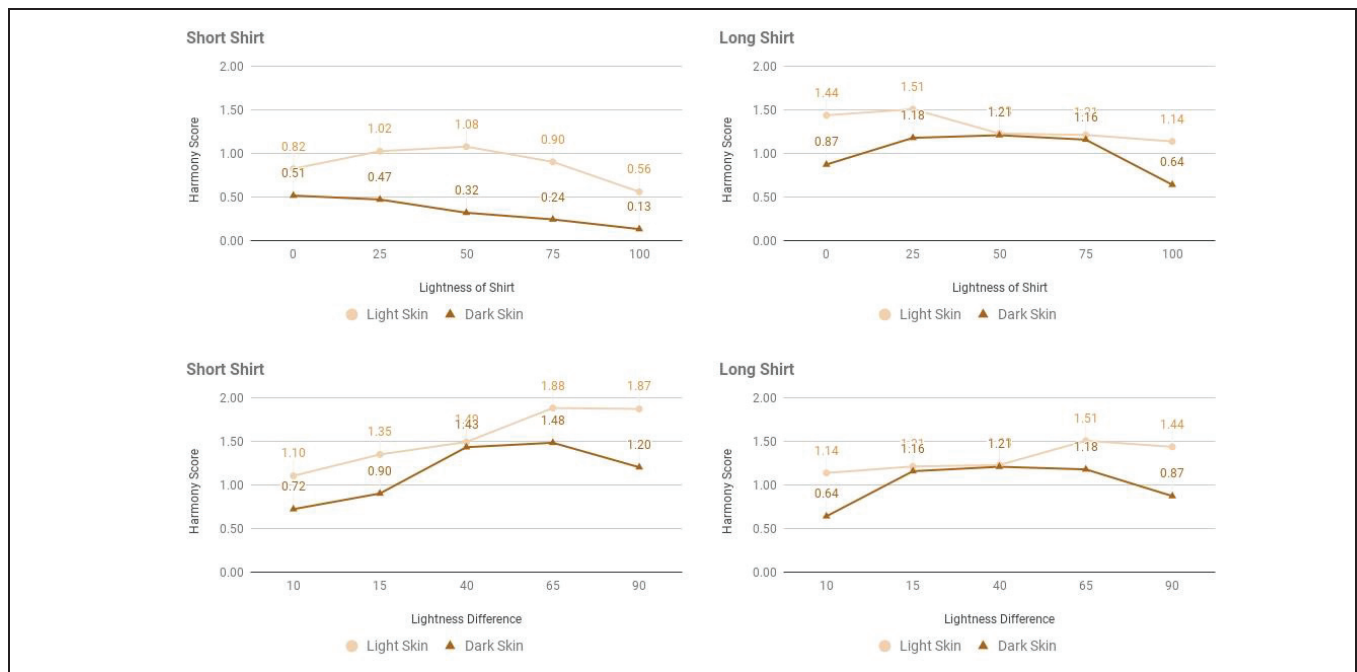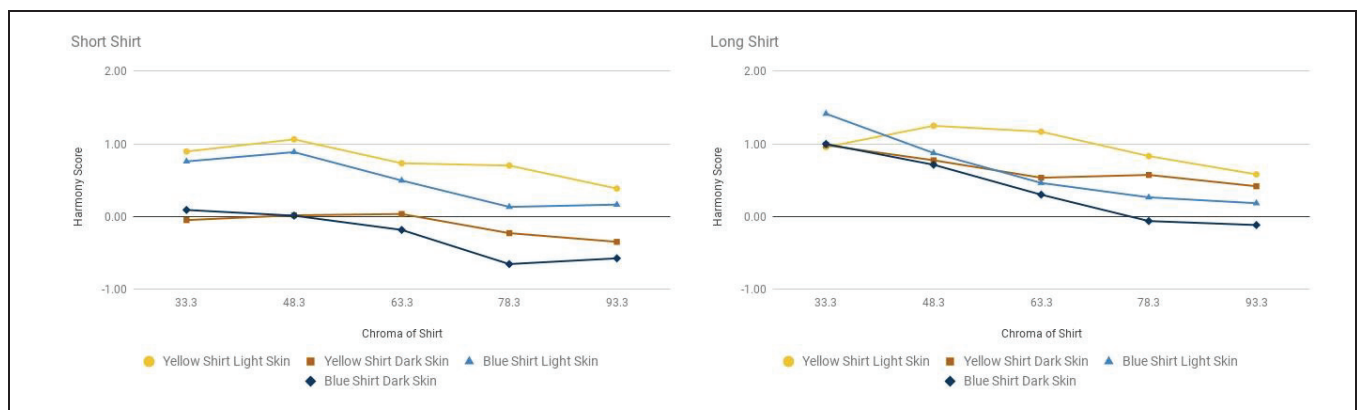

Figure 1: Results of Part I.

Figure 2: Results of Part II.

Table 2. Correlation coefficients between short-sleeve and long-sleeve styles

Part I	Part II	Part III
0.86	0.70	0.84

CONCLUSION

In Part I, under dark skin tone with short sleeves, the lighter the shirt was, the lower the harmony score was. Also found in Part I was that under the light skin tone with short sleeves, the higher the difference of lightness was, the higher the harmony score was. In Part II, we can suggesting that the higher the chroma was, the lower the harmony score was. The observers also preferred the complementary colour (i.e. the yellow) than similar colour (i.e. blue) to match the blue trousers. The results of Part III indicate that the observers preferred the light skin tone than dark skin tone.

The correlation coefficient between the two genders is 0.84, showing that there was little difference in gender. In addition, the high correlation coefficient between the two styles suggests that there was little difference on the styles (i.e. the long sleeves vs. the short sleeves).
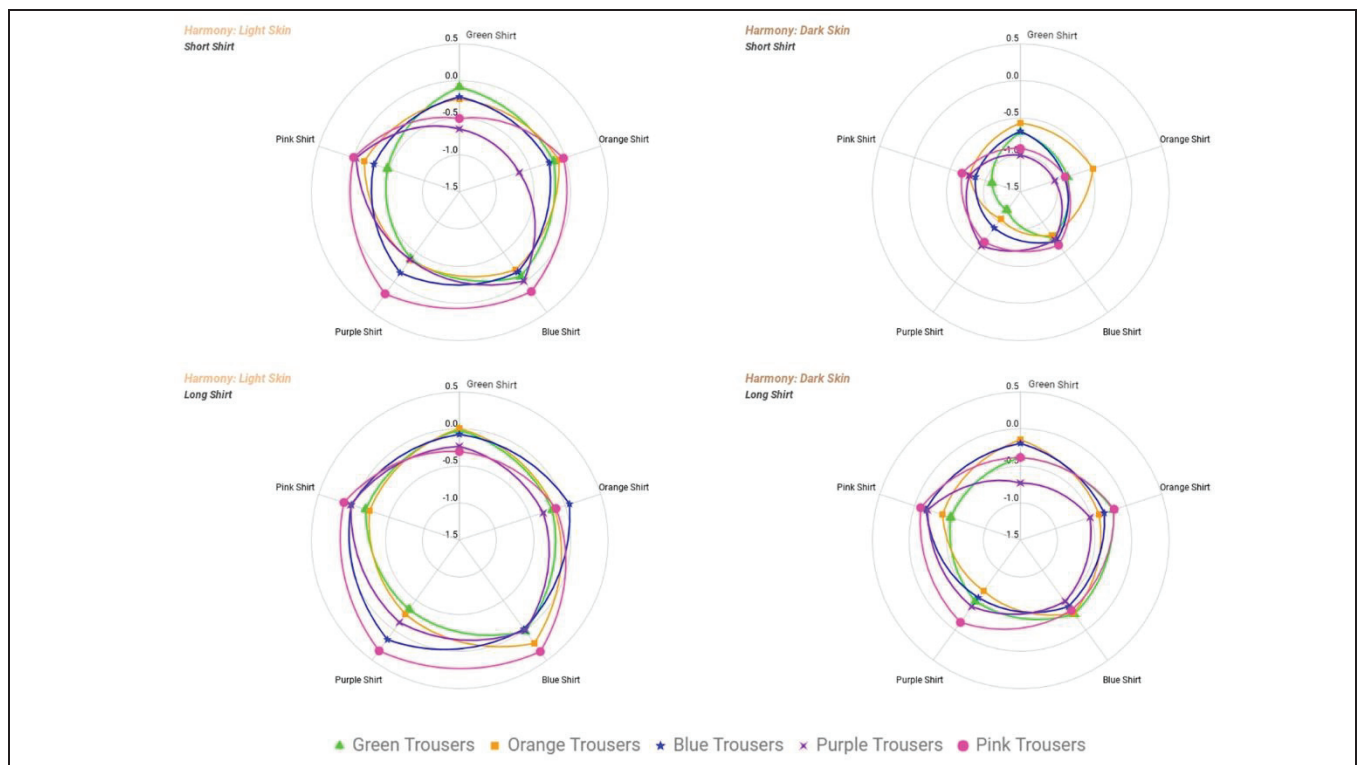

Figure 3: Results of Part III.

ACKNOWLEDGEMENTS

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