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Study on the Predictive Model of Influence of Clothing Color on Inter Personal Impression Formation

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***Abstract*—Clothing serves as a powerful clue in impression formation, and its color, as the first visual element, plays a decisive role in the impression formation of the wearer. In order to delve into the relationship model between clothing colors and interpersonal impressions, 59 kinds of T-shirts with different clothing colors were selected as stimulus pictures for behavioral experiments, It constructed a more accurate and efficient regression equation between clothing colors and interpersonal impressions. Through the analysis of regression equation parameters, it was found that the hue, saturation and brightness of clothing color all had an impact on impression formation. Among these factors, the brightness of clothing color has a significant impact on impression formation.**

***Keywords*—Clothing color; Impression; Regression equation**

I. INTRODUCTION

As one of the clues of human cognition, color plays a decisive role in clothing, which not only invisibly affects individuals' emotions and behaviors, but also affects others' impression of the individual. Different clothing colors will give people different impressions. For example, people commonly associate black with evil, aggression, and negativity, and this association can affect how people form impressions of others. Researches have found that individuals wearing black uniforms are more likely to be perceived as aggressive and hostile than those wearing white uniforms, and individuals wearing black uniforms are disciplined more for aggressive behavior than individuals wearing other colored uniforms (Vrij A,1997; Frank et al,1998; Johnson et al,2014; Johnson et al,2013). According to the stereotype theory of color, white symbolizes purity, while black is associated with negative impressions. correspondingly, people tend to evaluate individuals wearing black clothing more strictly (Meier,2005; Zegar et al,2022).

Furthermore, compared with other colors, individuals wearing red clothing are perceived as more attractive and are more likely to attract the attention of the opposite sex.Customers dining at restaurants tend to give more tips to waiters wearing red clothing (Gueguen,2012; Roberts et al,2010; Elliot et al,2010). However, red can also be perceived as having negative connotations. Studies have found that red shirts do not enhance impressions of one’s competence, and women wearing red dresses are rated as less sexually faithful (Elliot,2015; Kayser et al,2010; Pazda et al,2014a). In individual and group competitions, people dressed in red are perceived as more dominant, and red is positively correlated with success (Ilie et al,2008). Women are often defined as gentle, virtuous and understanding of the external impression, so they tend to consider red, yellow, orange, red purple and yellow green and other colors when purchasing clothing. It is not difficult to find that the color characteristics of clothing as a clue has become the basis of people's impression evaluation.

Clothing color also plays an important role in shaping professional impressions. Black police uniforms convey the external impression of authority, competence and professionalism to others, and are more likely to leave a positive impression on others than light-colored clothing (Nickels,2008). Blue police uniforms can create a sense of security and give the impression of reliability, helpfulness, and authority (Balkin et al,1983; Labrecque et al,2012). Adam H et al. (Adam H,2012) found that white lab coats are generally associated with attention and carefulness, and that wearing white clothing improves performance on attention-related tasks, so doctors wearing white coats are perceived as attentive. In addition, when women wear more masculine clothing rather than feminine dresses such as beige during job interviews, the interviewers perceive them as more competent and are more likely to hire them (Forsythe,1990). It can be seen that clothing color affects the self-image of the wearer and the impressions it brings to others, including the impression of the performance of work ability in daily life.

Hue, saturation and brightness of clothing colors have a certain impact on impression perception. Wen et al. (Wen et al,2022) explored the impact of clothing colors on perception of warmth and competence based on the "Big Two " model of social cognition. The results showed that individuals dressed in red were more likely to be perceived as warm and competent than those dressed in blue and white. Fan investigated the rule of influence of clothing color on women's professional impression, and found that color, brightness and saturation of clothing all have significant influence on impression perception. Perception evaluations of colorless clothing tends to focus on competence impressions, and the perception evaluation of high-brightness color is higher on agreeableness

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impression and creative impression. Low-purity clothing colors were also associated with impressions of professional competence and leadership (Fan,2021). Studies have shown that vocabulary describing high-brightness colors (e.g., yellow) is often used to describe extroverted impressions, such as lively and energetic; Words with low-light colors, such as gray, are often used to describe introverted impressions, such as cautious and gentle. In addition, the saturation of clothing color can affect individuals' judgments of others' personality traits. Compared with low saturation background, individuals are more likely to believe that others in high saturation background have positive qualities of optimism and extroversion (Wang,2020).

The above studies all show that there is a close relationship between clothing color and impression formation. From existing literature on clothing color and interpersonal impression formation, it can be seen that most of the researches on clothing color and impression formation at home and abroad only discuss whether there is an influence, but do not delve into the relationship between the two. Therefore, through behavioral experiments, this study constructs a relationship model based on the influence of different hue, brightness and saturation of clothing colors on the impression formation of the wearer, so as to further explore the influence mechanism of clothing colors on the impression formation.

II. EXPERIMENT

A. Participants

100 undergraduate and graduate students (41 male and 59 female, age range 20-25) were recruited in this experiment. All of them participated in this experiment voluntarily, and all of them were right-handed, without color blindness or color weakness, and without any physical or physiological diseases.

B. Color sample set

his study employed the HSB color model, selecting six typical hue values on the hue circle: among which 0° is red, 30° is orange, 60° is yellow, 120° is green, 240° is blue, 270° is purple. Therefore, six different hues are selected for this study, as shown in Table 1. Saturation and brightness are divided according to the average value. The most representative color sample set was selected through expert evaluation, and saturation values were divided into three levels: 35%, 65% and 100%. Since the color is dark when the value of brightness is low, it cannot be recognized and judged, so this study divides the value of brightness into three levels: 55%, 85% and 100%, as shown in Table 2. In view of the diversity of colors in daily clothing, this study added five achromatic in the sample set, such as black, white and gray, which are common in daily life according to the change of brightness. Therefore, the color sample set for this experiment contains a total of 59 different colors.

Tab.1 Division of hue (H) values

Hue	Value/ (°)	Hue	Value/ (°)
Red	0	Green	120
Orange	30	Blue	240
Yellow	60	Purple	270

Tab.2 Division of saturation (S) values and brightness (B) values

Saturation	Value/%	Brightness	Value/%
Low	35	Low	55
Medium	65	Medium	80
High	100	High	100

Since H belongs to 0 degrees to 360 degrees in the HSB color model, and S belongs to 0 to 1, and the image is stored in 24-bit mode, and each component of the pixel value should be between 0 and 255, the value range of the calculated H, S, and B component values should be consistent with it. Therefore, the values of H, S and B components need to be mapped accordingly. Specifically, the mapping formula are as follows:

$$H = \frac{H \times 255}{360},\ S = 255 \times S,\ V = 255 \times V \qquad (1)$$

The hue, saturation and brightness of the HSB color model are converted into three-dimensional values (x_1, x_2, x_3), as shown in Figure 1. For example, HSB values of a group of colors are (60°, 25%, 25%), and the values H = (60 × 255) /360 = 42.5, S = 255 × 0.25 = 63.75 can be obtained according to the mapping formula. V = 255 × 0.75 = 191.25, so a new set of three-dimensional values of HSB space (42.5, 63.75, 191.25) can be obtained, as shown in Table 3. During the experiment, RD means red, OG means orange, YW means yellow, GN means green, BE means blue, and PE mean purple.

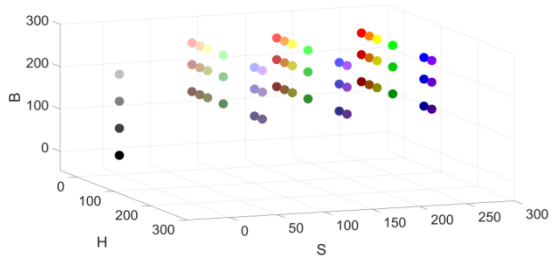

Fig. 1. 3D space generation example of HSB color sample set

Tab.3 Initial values and spatial encoding values of HSB color model

Initial value	（120°，30%，55%）	（120°，30%，80%）
Spatial coding	（85，76.5，140.25）	（85，76.5，204）
Initial value	（120°，65%，55%）	（120°，65%，80%）
Spatial coding	（85，165.75，140.25）	（85，165.75，204）
Initial value	（120°，100%，55%）	（120°，100%，80%）
Spatial coding	（85，255，140.25）	（85，255，204）
Initial value	（120°，30%，100%）	（120°，100%，100%）
Spatial coding	（85，76.5，255）	（85，255，255）

Note:This table takes GN green 120° as an example

C. Stimulus materials

The experimental stimulus materials were women's T-shirts of different colors. Experimental images were designed by PhotoshopCS6, and the selected colors were placed on the same feminine-style garment, as shown in Figure. 2, 3 and 4. RD represents red, 65%S represents 65% saturation, and 80%B

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Vol. 13 Issue 5, May 2024

represents 80%. In order to avoid the interference of other factors such as faces on the interpersonal impression scores, the stimulus pictures in this experiment only displayed the upper bodies of the model against a gray-white background.The image dimensions is 700 × 980 pixels. Therefore, there are 59 different colors of stimulus pictures in this experiment. Additionally, the study incorporated four interpersonal impression words, namely "optimistic," "rustic," "dignified," and "steady."

Fig. 2. Sample clothing colors of different hues

Fig. 3. Sample color of clothing with varying brightness (RD60°,65%S)

Fig. 4. Sample color of clothing with varying saturation (RD60°,80%B)

D. Experimental equipment

This experiment primarily utilized one computer installed with E-Prime 2.0 software, and the software was used for experimental programming. Stimulus images were presented on a 13.3-inch (IPS 2240 × 1400,60 HZ) monitor. The experimental procedure was designed in E-studio, and experimental programs are run in E-Run.

E. Experimental procedure

The subjects were sitting in front of the monitor, with their eyes of also fell in front of the center of the monitor, and the subjects were about 70cm away from the center of the monitor, The entire experimental background was gray-white. At the beginning of the each trial, a red "+" fixation point will be presented in the center of the screen for 100ms, and then there will be a white screen for 200ms. After the white screen disappeared, interpersonal impression words will be presented randomly for 500ms, followed by a 400ms blank screen, and then randomly displayed stimulus images of different colors for 500ms. At this time, the subjects need to judge the associative relationship between the images of differently colored clothing and the interpersonal impression words according to their first impression, and conduct a seven-level conformity score (" 1 "means" completely inconsistent ", "7" means "completely consistent"). At the end of the experiment, the E-Prime program will automatically record all the test data of the subjects, including reaction time and reaction results.

III. MODEL CONSTRUCTION AND VALIDATION

To explore the association between clothing color and the formation of interpersonal impressions, this study utilized behavioral experimental results as the primary data source,aiming to construct a model of the relationship between clothing color and its influence on interpersonal impressions. In elucidating the mapping relationship between the three elements of clothing color and the formation of interpersonal impression, based on the spatial color HSB model, this paper employed Matlab software to deeply investigate their relationship. The paper takes the average impression score of 80 (80%) of the 100 data sets as the target value for model construction. The remaining 20 (20%) datasets were used for model validation. When constructing the regression model of the influence of clothing color on the formation of interpersonal impression, the four impression words were combined with the three-dimensional HSB value equation. Firstly, simple linear regression analysis was conducted to build a three-variable linear equation. Secondly, the nonlinear regression model is introduced, which can deal with the multi-dimensional features of clothing color more flexibly, and can better reflect the complex mapping relationships between clothing color and impression formation. Through analysis of the Root Mean Square Error, it is found that the error is minimum when the power of four impression words is 4, so a three-variable fourth-degree equation was ultimately adopted to construct the nonlinear relationship between them.

A. Linear equation models of clothing color affecting interpersonal impression formation

Constructing a three-variable linear regression equation for the influence of clothing color in HSB on impression formation is as follows:

$$Y = [1 \quad x_1 \quad x_2 \quad x_3] \begin{bmatrix} \omega_0 \\ \omega_1 \\ \omega_2 \\ \omega_3 \end{bmatrix} \qquad (2)$$

Where: Y is the impression word, x_1 is hue H, x_2 is saturation S, x_3 is brightness B, ω_0 is a constant term, ω_1 is the parameter corresponding to hue, ω_2 is the parameter corresponding to saturation, ω_3 is the parameter corresponding to brightness.

1) Model construction of Linear Regression Equation .

a) The score value of clothing color on "optimistic" impression formation is represented by Y_1, and the final parameter $\omega_0 = 2.2378, \omega_1 = -0.000548, \omega_2 = 0.0017, \omega_3 = 0.011$ is determined through the method of least square. Therefore, the equation is as follows:

$$Y_1 = 2.2378 - 0.000548x_1 + 0.0017x_2 + 0.011x_3 \qquad (3)$$

International Journal of Engineering Research & Technology (IJERT)
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b) The score value of clothing color on "rustic" impression formation is represented by Y_2, and the final parameter $\omega_0 = 7.4161, \omega_1 = -0.0030, \omega_2 = -0.0058, \omega_3 = -0.0122$ is determined through the method of least square. Therefore, the equation is as follows:

$$Y_2 = 7.4161 - 0.0030x_1 - 0.0058x_2 - 0.0122x_3 \quad (4)$$

c) The score value of clothing color on "steady" impression formation is represented by Y_3, and the final parameter $\omega_0 = 6.9106, \omega_1 = -0.000146, \omega_2 = -0.0020, \omega_3 = -0.0153$ is determined through the method of least square. Therefore, the equation is as follows:

$$Y_3 = 6.9106 - 0.000146x_1 - 0.0020x_2 - 0.0153x_3 \quad (5)$$

d) The score value of clothing color on "dignified" impression formation is represented by Y_4, and the final parameter $\omega_0 = 7.5934, \omega_1 = -0.0010, \omega_2 = -0.0035, \omega_3 = -0.0158$ is determined through the method of least square. Therefore, the equation is as follows:

$$Y_4 = 7.5934 - 0.0010x_1 - 0.0035x_2 - 0.0158x_3 \quad (6)$$

According to the linear equation of the influence of clothing color on impression formation (Equation 3-6), it is observed that the parameter value of brightness in independent variable is relatively large, which indicates that the brightness of clothing color plays a dominant role in impression formation. Through a thorough analysis of the parameters in the linear equation, it is found that the hue, brightness and saturation of clothing color have certain effects on the impression formation. Specifically, there is a significant correlation between the brightness of clothing color and impression formation, while the correlation between hue and impression formation is low. This indicates that the brightness plays a major role in the influence of clothing color on impression formation..

2) Validation of the Linear Regression Equation Model.

To verify the reliability of the above linear equations, another 20 data sets will be used to predict and verify the model. Figure. 5 to Figure. 8 present the validation results of the predictions of different clothing colors on each impression word according to the linear model. Through the validation results, it can be observed that there is a gross error between the predicted value and the true value of the impression score of different clothing colors. Therefore, in order to improve the prediction accuracy of the model, this study further adopts nonlinear regression equation to construct a correlation model of clothing color on interpersonal impression formation.

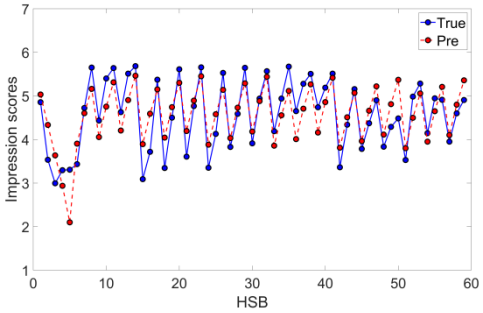

Fig. 5. Validation results of clothing colors on the impression of "optimistic"

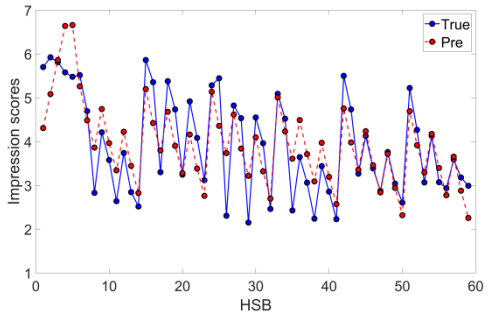

Fig. 6. Validation results of clothing colors on the impression of "rustic"

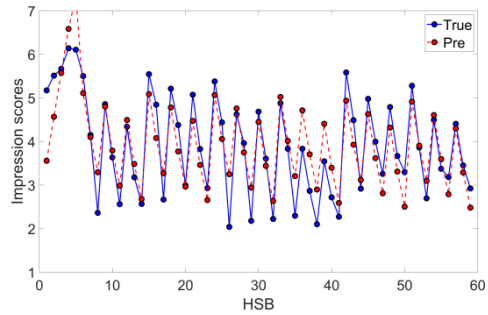

Fig. 7. Validation results of clothing colors on the impression of "steady"

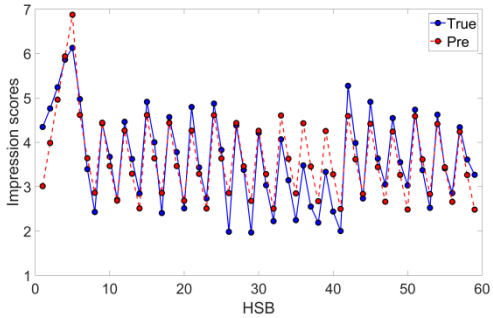

Fig. 8. Validation results of clothing colors on the impression of "dignified"

B. Nonlinear equation models of clothing color affecting interpersonal impression formation

The specific formula of constructing a ternary quartic equation model for the influence of clothing color on impression formation is as follows:

$$Y = [1 \quad X \quad X^2 \quad X^3 \quad X^4] \begin{bmatrix} \omega_0 \\ A \\ B \\ C \\ D \end{bmatrix} \quad (7)$$

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 5, May 2024

Where: $X = [x_1 \quad x_2 \quad x_3], A = [\omega_1 \quad \omega_2 \quad \omega_3], B = [\omega_4 \quad \omega_5 \quad \omega_6], C = [\omega_7 \quad \omega_8 \quad \omega_9], D = [\omega_{10} \quad \omega_{12} \quad \omega_{13}]$.

1) Model construction of Nonlinear Regression Equation .

a) The score value of clothing color on "optimistic" impression formation is represented by Y_1 . The final parameters, determined through the method of least square,are $\omega_0 = -6.325$, $A = [-0.0482 \quad 0 \quad 0.32]$, $B = [1.302 \quad 0.328 \quad -3.598] \times 10^{-3}, C = [-1.084 \quad -0.264 \quad 1.64] \times 10^{-5}$, $D = [2.769 \quad 0.561 \quad -2.57] \times 10^{-8}$, so the equation is as follows:

$$Y_1 = -6.325 - 0.0482x_1 + 0.32x_3 + 1.302 \times 10^{-3}x_1^2 + 0.328 \times 10^{-3}x_2^2 - 3.598 \times 10^{-3}x_3^2 - 1.084 \times 10^{-5}x_1^3 - 0.264 \times 10^{-5}x_2^2 + 1.64 \times 10^{-5}x_3^3 + 2.769 \times 10^{-8}x_1^4 + 0.561 \times 10^{-8}x_2^4 - 3.598 \times 10^{-8}x_3^4 \quad (8)$$

b) The score value of clothing color on "rustic" impression formation is represented by Y_2 . The final parameters, determined through the method of least square,are $\omega_0 = 14.4632$, $A = [0.0568 \quad 0 \quad -0.3114]$, $B = [-1.556 \quad -0.513 \quad 3.638] \times 10^{-3}, C = [1.223 \quad 0.396 \quad -1.651] \times 10^{-5}, D = [-2.957 \quad -0.825 \quad 2.530] \times 10^{-8}$, so the equation is as follows:

$$Y_2 = 14.4632 + 0.0568x_1 - 0.3114x_3 - 1.556 \times 10^{-3}x_1^2 - 0.513 \times 10^{-3}x_2^2 + 3.638 \times 10^{-3}x_3^2 + 1.223 \times 10^{-5}x_1^3 + 0.396 \times 10^{-5}x_2^2 - 1.651 \times 10^{-5}x_3^3 - 2.957 \times 10^{-8}x_1^4 - 0.825 \times 10^{-8}x_2^4 + 2.530 \times 10^{-8}x_3^4 \quad (9)$$

c) The score value of clothing color on "steady" impression formation is represented by Y_3 . The final parameters, determined through the method of least square,are $\omega_0 = 18.2696$, $A = [0.0394 \quad 0 \quad -0.4048]$, $B = [-1.333 \quad -0.494 \quad 4.525] \times 10^{-3}, C = [1.191 \quad 0.404 \quad -2.040] \times 10^{-5}, D = [-3.146 \quad -0.871 \quad 3.151] \times 10^{-8}$, so the equation is as follows:

$$Y_3 = 18.2696 + 0.0394x_1 - 0.4048x_3 - 1.333 \times 10^{-3}x_1^2 - 0.494 \times 10^{-3}x_2^2 + 4.525 \times 10^{-3}x_3^2 + 1.191 \times 10^{-5}x_1^3 + 0.404 \times 10^{-5}x_2^2 - 2.040 \times 10^{-5}x_3^3 - 3.146 \times 10^{-8}x_1^4 - 0.871 \times 10^{-8}x_2^4 + 3.151 \times 10^{-8}x_3^4 \quad (10)$$

d) The score value of clothing color on "dignified" impression formation is represented by Y_4 . The final parameters, determined through the method of least square,are $\omega_0 = 15.0636$, $A = [0.0162 \quad 0 \quad -0.3017]$, $B = [-0.847 \quad -0.347 \quad 3.327] \times 10^{-3}, C = [0.835 \quad 0.289 \quad -1.508] \times 10^{-5}, D = [-2.280 \quad -0.626 \quad 2.352] \times 10^{-8}$, so the equation is as follows:

$$Y_4 = 15.0636 - 0.0162x_1 - 0.3017x_3 - 0.847 \times 10^{-3}x_1^2 - 0.347 \times 10^{-3}x_2^2 + 3.327 \times 10^{-3}x_3^2 + 0.835 \times 10^{-5}x_1^3 + 0.289 \times 10^{-5}x_2^2 - 1.508 \times 10^{-5}x_3^3 - 2.28 \times 10^{-8}x_1^4 - 0.626 \times 10^{-8}x_2^4 + 2.352 \times 10^{-8}x_3^4 \quad (11)$$

2) Validation of the Nonlinear Regression Equation Model.

In order to verify the reliability of the above nonlinear equation, an additional 20 data sets will be used to utilized for predictive validation of the model. Figure. 9 to Figure. 12 show the validation results of the prediction of different clothing colors for each impression word according to the nonlinear model. Through the verification results. It can be observed from the validation results that there is a good fit between the predicted impression scores of different clothing colors and the actual values. Therefore, compared with linear regression equation, nonlinear regression equation has higher accuracy, can better adapt to the nonlinear characteristics of data, and provide more accurate predictive results for impression scores

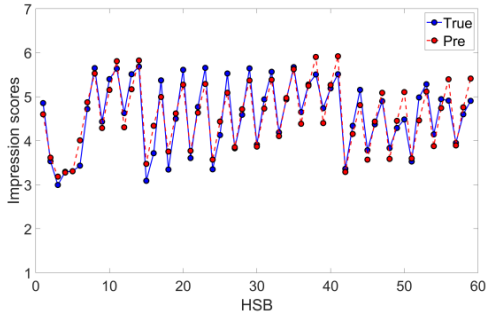

Fig. 9. Validation results of clothing colors on the impression of "optimistic"

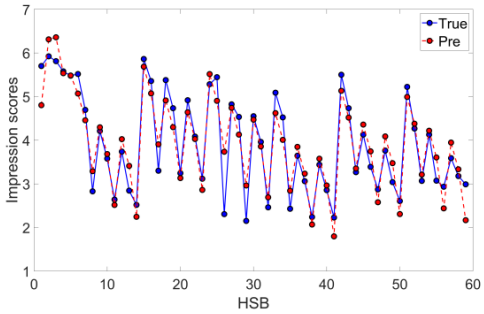

Fig. 10. Validation results of clothing colors on the impression of "rustic"

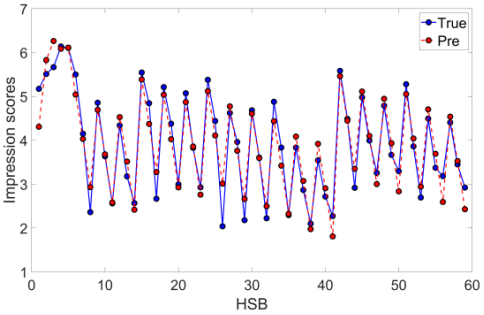

Fig. 11. Validation results of clothing colors on the impression of "steady"

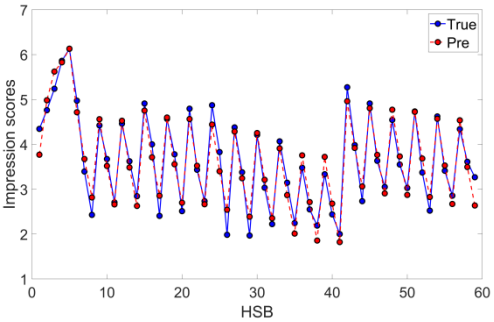

Fig. 12. Validation results of clothing colors on the impression of "dignified"

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IV. CONCLUSION

This study aims to construct a predictive model for the influence of clothing color on the formation of interpersonal impression, and comprehensively uses linear regression and nonlinear regression equations to reveal its internal influence mechanism from surface to depth analysis. Firstly, the three-dimensional score of clothing color space and the score value of each impression word are combined to establish a ternary linear regression equation model between clothing color and impression formation. Then, through data analysis, it is found that when the exponent N is 4, the relationship model between clothing color and four impression words has the minimum root-mean-square error value, indicating a better model accuracy. Therefore, this study adopts the ternary fourth-degree equation to construct a nonlinear relationship model for clothing color on the formation of impression. Finally, through the analysis of the independent variable parameters in the regression equation, it is found that the hue, brightness and saturation of clothing color have a certain influence on the impression formation. Specifically, there is a significant correlation between the brightness of clothing colors and impression formation, while the correlation between saturation and impression formation is low, which indicates that the brightness of clothing colors plays an important role in impression formation.

In this study, only a simple style of T-shirt casual clothing was involved, and no in-depth research was conducted on other styles of clothing. Therefore, future research can consider clothing style and dressing environment as variables to further explore their relationship models with impression formation.

The findings of this study will contribute to enhance the cognitive satisfaction and recognition degree of consumers on the color of clothing products, and promote the purchase decision of consumers. By revealing the inherent connection between clothing color and interpersonal impression formation, consumers can more deeply understand the information and emotion conveyed by clothing color, so as to make purchase choices with more confidence, and improve the quality and satisfaction of shopping experience. In addition, this study has important guiding significance for individuals in daily life and professional occasions in the choice of dress color. By inputting specific independent variables into the regression equation model, it is possible to accurately predict the specific impression evaluation bias of others to individuals, thereby helping individuals better present their self-image in interpersonal interactions and enhancing interactions with others. This has a positive impact on individual's social and professional development, and helps to enhance the individual's social adaptability and career competitiveness.

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