

Aesthetic Evaluation of Clothing Color Combination of Engineering Exposure Duration

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Abstract— The main purpose of the current study is to investigate the influence of exposure duration (ED) of clothing color on aesthetic judgments. In this study, clothing pictures with four contrasts of color combinations (45 °, 90 °, 135 ° and 180 ° in hue interval) served as stimuli and were evaluated at three EDs (50ms, 200ms and 1000ms) by 48 participants in a behavioral experiment. The results confirm previous findings that the higher contrast of color combinations is less attractive. The ED hardly impacts on the aesthetic scores, while it influences significantly on the difficulty of aesthetic judgments, the shorter the ED, the harder to perform aesthetic task. The results also indicate that the aesthetic cognitive process of clothing colors is immediate and consistent.

Index Terms—Exposure Duration; Aesthetic Cognitive Process; Color Contrast; Reaction Time

I. INTRODUCTION

As an element of clothing, color plays a critical role since it always contributes to the first impression of clothing aesthetic experience. In fast fashion consumption, color is also a vital ingredient to be considered for consumers in decision making. Therefore, investigating consumer sensitivity to the colors has become essential to clothing in products and services. Colors presented clothing are traditionally connected with monochromatic, bi-colored or multi-colored, the combination of which largely determines whether the clothing is good-looking or not and also has a variety of effects on the aesthetic perception of clothing. In general, the contrast intensity of color is mainly relied on the differences of the color combination, which can cause dissimilar aesthetic response [1]. In his study, OU et al. reported that the higher lightness sum of the color in the bi-colored combination, the more harmonious color was and harmony decreased as hue distance increased [2]. Richard researched the web page and found that the preference of color in color combination would result in higher aesthetic judgment as well as greater purchasing desire, and he also demonstrated that the color combination with larger interval would be paid more attention by subjects [3].

Aesthetic cognition is an ability of perception, which is a process of information processing during the aesthetic

judgment and experience. It begins sensation to objects, in which the physical attributes of the objects impact on the sensory organs of individuals through their nervous systems and brain activities, then the perception of objects have been formed [4]. Individuals, for instance, obtain and process external color information and rapidly form the first impression. After that, the brain will make more complex aesthetic cognition [5]. In fact, the aesthetic cognition deals with complicated process, some researchers assumed that it includes intuitive analysis, implicit memory integration, explicit classification, cognitive operations and evaluation, etc. [6]. Importantly, the complexity of information from objects can influence on aesthetic judgment [7].

It is well documented that the aesthetic is immediate. In the evaluation of web page cognition, users often make stable judgments on appeal of a web page within a split second before noticing any details and contents of the websites [8]. This first impression often impacted by visual complexity and colorfulness. Lindgaard et al. found that subjects could make a lasting opinion about the appeal of web pages after a brief exposure time of 500ms and also demonstrated that the formation of first impression is immediate and highly consistent [9]. This first impression was influential enough to affect later users' judgments of usability and trustworthiness of the site [10]. Similarly, a study of Tractinsky et al. showed that the users can have a good first impression on the product of websites even if web pages presented for 50ms only [11]. That is, the users can form the instantaneous aesthetic consciousness, and these impressions are highly stable. However, the study of Ke et al. suggested that subjects cannot perceive the picture which present for 20ms [12]. Some researchers believed that aesthetic perception is correlated with fluency of aesthetic judgment. Thomas defined the beauty as what makes the eye pleasure. The high fluency of aesthetic cognition to objects is reliably associated with more positive evaluations [13]. The previous study of color processing supported that it was more beautiful for the high figure-ground contrast than the low figure-ground contrast after viewing the pictures for 1s [14]. Furthermore, the more fluency of aesthetic judgments led to higher "prettiness" which has been applied for many studies including car design, furniture design and web design [15].

Prior work suggested that ED is an important factor to influence on the process of individual's color cognition. Jiang and colleagues examined color emotion at three EDs in the behavioural trials. The results showed the emotions of clothing colors tended to be consistent at diverse ED, The longer ED the shorter the response time were, and the response time were longer in emotional evaluation at short ED than what at long ones [16]. Experiments by Huo et al. have also proved that identification accuracy of color identifying for the subjects was different at the different EDs, and the

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shorter the ED, the lower degree of identification accuracy was [17].

In the current study, three EDs and contrasts of clothing colors were employed to evaluate, there were main objectives as follows: (1) To confirm the influence of different contrasts on behavioral aesthetic evaluation of clothing, and (2) To evaluate influence of EDs on aesthetic evaluation, and (3) To explore the time course during the aesthetic evaluation of clothing colors at three EDs.

II. EXPERIMENT

A. Participants

Forty-eight undergraduates (30 men, 30 women, and aged 19-24 years old) from Soochow University, whose majors have nothing to do with clothing, were volunteered to participate the experiment. All of them had normal or corrected-to-normal vision and were unaware of the purpose of experiment.

B. Materials

The colors were the same as those reported in Jiang [18]. Eight basic hues were evenly selected from the 360° color wheel with the interval of 45°, any two of them were combined as the contrast of colors and used in a suit. In this way, there were four contrasts of colors (45°, 90°, 135° and 180°). So the greater the interval, the higher the contrast of color it is. To ensure the precision of the results, the contrast color between tops and bottoms was exchanged with each other in the suit, namely, a contrast of color owned two pictures. Therefore, there were 56 pictures used as stimuli (Fig. 1).

C. Procedure

The experiment was carried out by E-Prime2.0 software. The stimuli were presented on a 17-inch monitor (1024×768 pixels, 60 Hz). The experiment consisted of three blocks according to the EDs (50ms, 200ms and 1000ms), each block had 56 trials, and each trial began with the presentation of a fixed cross in the centre of the screen for 100ms. While each stimulus was only allowed to be presented randomly for 4000 ms after onset for making responses before it switched to the next trial (Fig. 2). Before the experiment, participants were instructed to assign a quantitative score on a scale from 1 to 5



Fig. 1: Samples of contrast

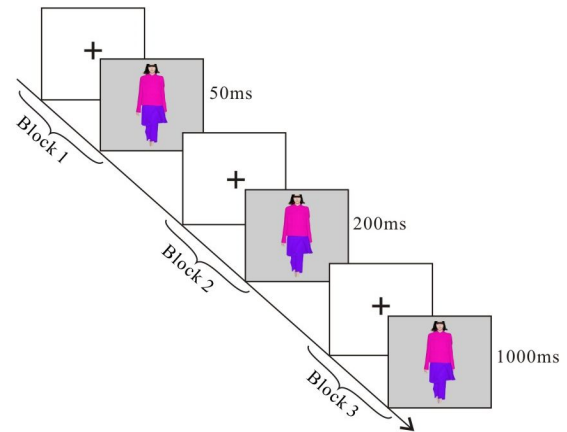


Fig. 2: Sequence of stimulus presentation

(1 for very ugly, 2 for ugly, 3 for neutral, 4 for beautiful and 5 for very beautiful), and the scores were entered on a keyboard after implementing the aesthetic judgments made by participants. The stimuli were viewed from a distance of 100cm at the centre. To ensure the precision of the results, subjects were divided randomly into three groups, and the sequence of three blocks was also decided randomly.

III. RESULTS

The scores and the RTs of aesthetic evaluation were analyzed by a combination of Microsoft Excel and SPSS16.0.

A. Contrasts of color combinations influence on the aesthetic evaluation

In Fig. 3, the result suggests that the pattern of results is highly regular. That is, the beauty cognition is reduced with the increase of the color contrast. The data were submitted to a one-way ANOVA. There was a significant main effect of contrast, $F(3,177) = 153.135, p = 0.000$, indicating that significant differences of scores existed among different color contrasts. However, the data analysis for contrast (45°, 90° and 135°), $F = 2.054, p = 0.129$, suggesting that although aesthetic diminished while the color contrast increased in 135°, there was no significant difference of aesthetic judgment. T-test was conducted for contrast, $t(45°, 90°) = 0.948, p = 0.344$; $t(90°, 135°) = 1.078, p = 0.282$; $t(135°, 180°) = 12.921, p = 0.000$.

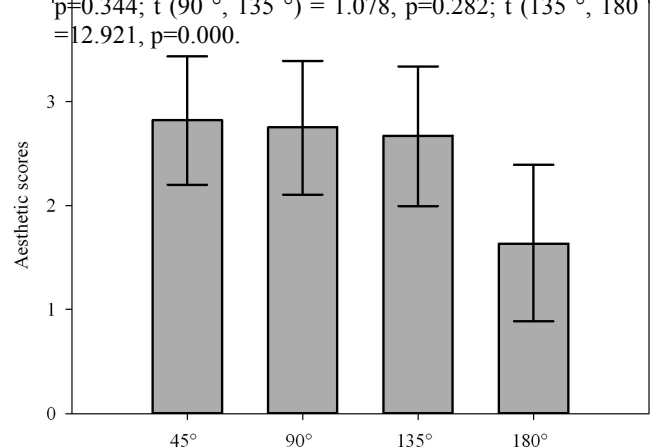


Fig. 3: Mean (M) and standard deviation (SD) for aesthetic evaluations

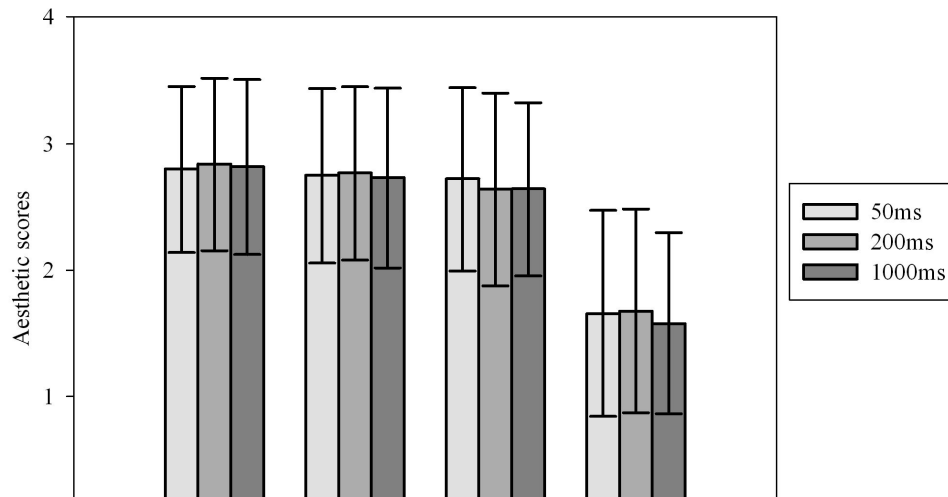


Fig.4: Mean (M) and standard deviation (SD) for aesthetic evaluations from different EDs

Table 1. T-test of aesthetic evaluations on EDs from different color contrasts

EDs	Contrast (45°)		Contrast (90°)		Contrast (135°)		Contrast (180°)	
	t	p	t	p	t	p	t	p
50ms,200ms	-0.321	0.748	-0.156	0.876	0.586	0.559	-0.113	0.895
200ms,1000ms	0.157	0.876	0.284	0.777	-0.016	0.988	0.691	0.491
50ms,1000ms	-0.159	0.874	0.129	0.897	0.602	0.548	0.546	0.586

B. EDs Impact on Aesthetic Evaluation

Fig. 4 shows the mean scores got from the aesthetic evaluation. It suggests that no matter what the ED is 50ms, 200ms or 1000ms, scores are consistent. The data were submitted to a two-way ANOVA of ED (50 ms, 200ms and 1000ms) × Contrast (45°, 90°, 135° and 180°) with repeated Measurement. There wasn't a significant effect of ED, $F(2, 118) = 0.419$, $p = 0.617$, indicating that EDs didn't result in obvious differences of aesthetic evaluation. The results demonstrated that the aesthetic consciousness is instantaneous, and these impressions are highly stable, it took participants only 50ms to be capable to accomplish an aesthetic judgment. However, There was no significant interaction effect between EDs and contrasts, $F = 1.644$, $P = 0.141$.

Moreover, a one-way ANOVA was performed on EDs of different contrasts, $F(ED_{45^\circ}) = 0.031$, $P = 0.969$; $F(ED_{90^\circ}) = 0.021$, $P = 0.980$; $F(ED_{135^\circ}) = 0.114$, $P = 0.892$; $F(ED_{180^\circ}) = 0.397$, $P = 0.673$ respectively, suggested that no significant effect on EDs. Multiple comparison among three EDs of the same contrast were submitted to t-test (Table 1), the result was also demonstrated that EDs has no significantly main effect on aesthetic evaluation, that is, subjects can accurately perceive the beauty of color at the 50 ms of ED and this perceptive evaluation is highly consistent.

On this basis, the stepwise regression method which can eliminate the independent variables has no significant effect on the dependent variables was used to analyze the independent variables and the dependent variables. The

symbol x_1 represents EDs where x_2 is color contrasts and y is aesthetic scores. By the analysis of regression, x_1 was

excluded. The formula is given in Eq. (1). The correlation coefficient is 0.467, $F = 261.498$, $P = 0.000$, so the regression model is significant.

$$y = 3.37 - 0.08x_2 \tag{1}$$

C. EDs affect RTs of Aesthetic Judgements

As shown in Fig. 5, the reaction times (RTs) spent by participants in making aesthetic evaluation are different at three EDs of each color contrast, and RTs were in inverse tendency to EDs: $RT_{50ms} > RT_{200ms} > RT_{1000ms}$. There was a significant main effect of time, $F(2, 118) = 43.394$, $p = 0.000$, indicating that there were obviously different RTs at three EDs, the participants needed more response time to evaluate the colors with the shorter exposure duration, and it was consistent in each contrast.

Moreover, the RTs kept relative stability among the same EDs even in different color contrast though intuitive analysis. There was no significant difference of contrasts, $F(3, 177) = 1.083$, $p = 0.349$, that is to say, different color contrast had no effect on the RTs of subjects. The interaction effect between EDs and contrasts was not significant, $F = 2.122$, $P = 0.095$. T-test performed on EDs of the same color contrast suggested that the RTs of subjects at 50ms of EDs were highly correlated with the RTs at 200ms of EDs. However, there was a significant difference of RTs at the 1000ms of EDs, compared to the 50ms or 200ms of EDs (Table 2).

The regression was also performed on RTs where x_1 is EDs, x_2 is color contrasts and y is RTs. However, x_2 was excluded though the analysis of regression. This relationship is

presented by Eq. (2). The correlation coefficient is 0.418, $F=152.138$, $P=0.000$, the regression model is significant.
 $y=1469.023-0.479x_1$ (2)

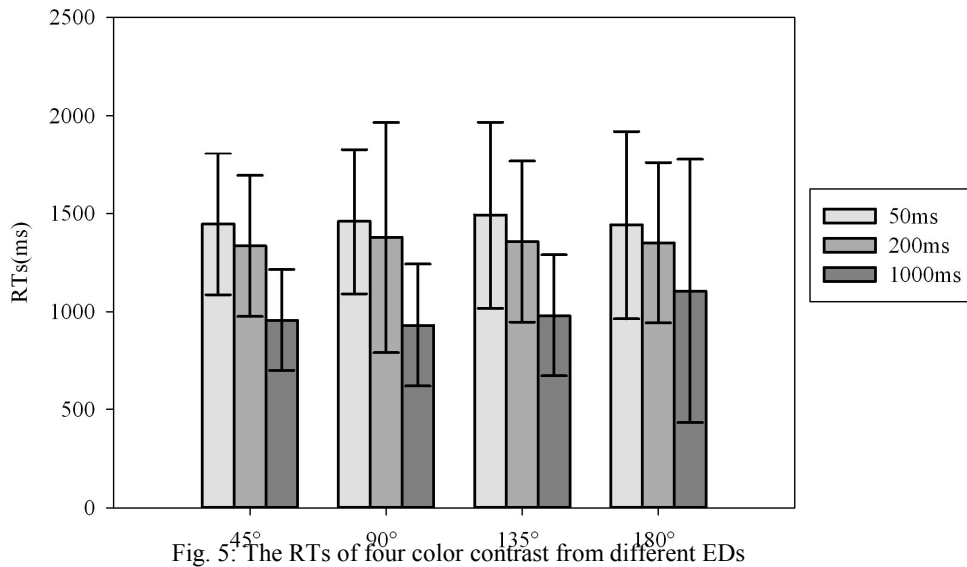


Table 2. T-test of RTs performed on EDs aesthetic evaluations color contrasts

EDs	Contrast (45°)		Contrast (90°)		Contrast (135°)		Contrast (180°)	
	t	p	t	p	t	p	t	p
50ms,200ms	1.689	0.094	0.888	0.376	1.662	0.099	1.116	0.267
200ms,1000ms	6.568	0.000	5.184	0.000	5.635	0.000	2.471	0.017
50ms,1000ms	8.484	0.000	8.399	0.000	6.938	0.000	3.153	0.002

IV. DISCUSSION

We investigated the aesthetic judgements by behavioral measures. The results of our experiment described here were to demonstrate the instantaneity and consistence of aesthetic evaluations of clothing color. We found the aesthetic scores decrease with the increase of color contrast, the evidence is consistent with some previous researches on color combination. It suggests that similar hue combination was more beautiful and more popular by individuals, while excessive color contrasts tend to be not accepted by consumers [19]. Noticeably, scores of 180 ° color contrasts are obviously lower than those of the other three contrasts, indicating an apparent tendency that individuals hate these color combinations. Because the 180 ° contrast is strongest among the color combinations and is easy to result in dizzying visual effect. What’s more, it can make individuals excited and causes visual and mental fatigue, which generates unstable and uncoordinated feeling. Therefore, the beauty of the 180 ° contrast of colors is reduced.

In terms of the influence of EDs on aesthetic judgment, the results from our investigation manifest that participants were able to make good decisions for only 50ms exposure of combined colors, although EDs were extend, the results of attractiveness rating are remarkably consistent. That is to say, individuals established a stable attitude towards the color combination at first glance. It suggests that the color aesthetic cognition of brain is immediate and consistent, which is useful to the color application of clothing. As we know it all starts

from the color for costume perception. If the color combination can be judged as like or dislike within a split second, we don’t need to spend more time trying ourselves or

others to like it.

We also analyzed the date of RTs to evaluate the impact of EDs on aesthetic judgment [20], and found that RTs are so closely related to EDs. That is, the shorter the ED is, the harder to perform aesthetic task. Importantly, it spent longest time for participants making judgments on color combinations at 50ms of EDs. The main reasons are: At 50ms of ED, the participants were not sure of what color they saw and needed to spend much time remembering the flashed clothing colors to acquire the stimuli information exactly, while they were able to acquire the color information accurately and dealt with them at 1000ms of ED. So the RTs became shorter. Furthermore, the prolonged ED would bring about the accumulation effect of strength, which made the RTs shorter, that is to say, the centurms processing became faster [21-23].

V. CONCLUSION

The current study explores the influence of color contrasts and exposure durations on aesthetic evaluations through the behavioral tests. Several significant findings have been revealed from the results:

- 1) The stronger the color contrast, the less beautiful the clothing it is;
- 2) The ED has no significant effect on aesthetic scores,

participants can accurately perceive the beauty of color at the 50 ms of ED, and the color aesthetic evaluation can be finished instantly;

- 3) The ED has an effect on the difficulty of the color aesthetic evaluation, the shorter the ED is, the harder to perform aesthetic task.

Since aesthetic information is evaluated immediately, it is largely responsible for the users' first impressions. From the results we can learn more about the details of clothing color cognition which will help designers better to cater to consumers' demand when designing clothes.

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