ICRP 2019

4th International Conference on Rebuilding Place

THE EFFECT OF COLOR TEMPERATURE AND BACKGROUND COLOR ON HANDWOVEN FABRIC EXHIBITION

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Abstract

Pieces of valuable handwoven fabrics are exhibited in museums to express their aesthetics, creativity, and knowledge from the locals. Therefore, the protective measures from the risk of deterioration must be carefully considered. Simultaneously, the display should enhance the attractiveness of these fabrics. The objective of this research is to investigate the effect of correlated color temperatures and the background colors of the exhibits on handwoven fabrics. A mock-up room is built for the assessment. The illuminance level as recommended for the conservation is applied. The evaluation of the perception is done by displaying the handwoven-natural dyed color silk fabric of three different colors in front of three different backdrop colors. Each setting is tested with two different color temperatures. Six different scenarios are evaluated by a sample group of 60 people. The data collected from questionnaires are assessed and analyzed by using the statistical calculation method. The findings will provide some appropriate techniques for enhancing the display of handwoven fabrics and promoting positive effects to the valuable fabric exhibition.

Keywords: Museum lighting, handwoven fabric exhibition, color temperature, background color, Audience perception.

1. Introduction

Handwoven fabric is a craftsmanship, which is one of the cultural heritages that represents the identity and wisdom of each nation. Their aesthetics and refinement reflect the perseverance and creativity. Therefore, the design of the environment for the exhibition is an important part of promoting both visual perception and emotion which can enhance audience appreciation and understanding on values and aesthetic qualities of these handwoven fabrics.

1.1. Design of the Environment for Exhibition in Museum

The design of the environment for the exhibition consists of 4 factors that affect the artifact and the audience: temperature, lighting, color and sound (Phumsom, 2014). However, based on scientific studies, more than 87 percent of human perception is visual perception, therefore, lighting and color are the most important factors for the design of the museum exhibition environment (Jirajindalap, 2016). The lighting factor in the museum aims to produce a reasonable evenness between two major themes: decreasing the potentially deleterious effects of light on artifact and reaching the optimum visual impression over lighting design (Ajmat et al., 2011).   Quality vision can be achieved by using higher illuminance values which may contain ultraviolet (UV) and infrared (IR) that ruin the artifact materials (Cuttle, 1996). However, using the low illuminance may create problems in the audience's visibility and perception on the artifacts may be distorted and affected in lack of dimension. The color factor is a human-perceived stimulus through vision that results in emotions and feelings, such as excitement, freshness, anxiety, sadness, sloth, etc. Since colors have psychological effects on humans (Padgham & Saunders, 1985), most designers use color to coordinate the space with artifacts for creating a better audience's experience and making artifacts more outstanding visually (Launcelot, 2013). On the contrary, choosing inappropriate colors can cause negative effects to the exhibition. In the exhibition room, the level of illuminance is frequently determined first by the sensitivity of the exhibits (Licht, 2010). In order to prevent deliberate artifacts from light destruction, it is important to limit the light exposure. As for the Society of Light and Lighting (SLL), light-sensitive objects are classified into three types, including non/low sensitivity objects, medium sensitivity objects and high sensitivity objects. Fabrics are classified as high sensitivity objects which have the limiting illuminance of 50 lux, the limiting annual light exposure is 15,000 lux hours per year and the amount of ultraviolet radiation not more than 75 microwatts per lumen. Moreover, an illuminance of 50 lux is a minimum for object presenting that requires the perception of clear details and colors (SLL, 2015). However, deterioration in fabric depends on the chemical composition of the dye which occurs rapid damage in natural dyes (Degani et al., 2017).

1.2. Previous Studies on Museum Lighting

There are number of researches that studied about light and colors in the museum on the audience's perception and satisfaction. Researchers have tested on multiple lighting configurations with different correlated color temperatures (CCTs) for naturalness and preference on paintings (Nascimento & Masuda, 2014). Some of them tested CCTs together with illuminance on viewing fine art paintings (Zhai, Luo, & Liu, 2015; Zhai, Luo, & Liu, 2016; Szabó, Kéri, & Csuti, 2017). Whereas, the others studied CCTs along with the size of exhibition area on viewing watercolors and oil paintings (Chen, Chou, Luo, & Luo, 2016),

the saturation level on viewing paintings (Bodrogi, Khanh, Vinh, & Guo, 2017) and the background lightness on viewing paintings with different predominant colors (Feltrin, Leccese, Hanselaer, & Smet, 2019).

2.   Problem Statement

Artifacts have their own values and meanings. Some of them are priceless and sensitive, thus the requirement of light and color study, which is suitable for exhibiting each type of artifacts. Nevertheless, most of the previous studies on light and colors that affect the perception of the audience but focusing only on the fine art paintings. There are no researches that focus on the effects of light and colors on the audience's perception of the handwoven fabrics which are national cultural heritage. These valuable exhibition objects should be promoted in order to raise awareness, understanding and appreciation of their cultural and aesthetic values.

3.   Research Questions

The research question is how to exhibit the handwoven fabrics with light and colors that promote positive audience perception by focusing on CCT and background color.

- How CCT and background color affect the audience's perception of the overall atmosphere of the fabric exhibition and the characteristics of the handwoven fabrics?
- Do handwoven fabrics with different colors require different CCTs and background colors in order to affect the perception of the audience in a positive way?

4.   Purpose of the Study

The purpose of the study was to examine the feasibility that handwoven fabric that ancillary on its colors, could be better improve in perception by audiences with a specific CCT and specific background color. The details of the objectives are as follows.

- To study the effect of CCT and background color on the overall atmosphere and the fabric characteristics in the exhibition through the perception of the audience.
- To suggest a selection of CCT and background color in the fabric exhibition in the museum.

5.   Research Methods

The setup of the experiment was designed to analogous a facile museum atmosphere: it was included of a background comprising a piece of handwoven fabric and three-side walls, generating a controlled angle of view for the observers. As background material, curtains were consonant to the backside of the wall to allow an expedient change of background. The setup room has grey walls, grey floor tiles, and a white ceiling. The average temperature was 22°C and the relative humidity was approximately 50-55 percent. The 8-watt LED E27 (Ra > 80) which can adjust the CCT was positioned at a height of 2.30 meters from the floor above each of the three pieces of handwoven silk, dyed with three natural colors: Lac-red, Teak-leaf-green and Curcuma-yellow, one piece for each color. The size of each silk piece is 0.65 x 2.00 meters.

According to the SLL, this study installed luminaire which measuring the illuminance on the sample fabric approximate 50 lux. Two CCTs were chosen to be displayed in the experiment, warm white (3,000 K), and cool white (4,000 K). Each CCT was presented under three different background colors: black, white and complementary color of the fabric (Lac-red with the green background, Teak-leaf-green with the red background and Curcuma-yellow with the purple background). Pairing 2 CCTs with 3 background colors, six conditions comprised for each handwoven sample fabric are shown in Figure 1.

Figure 01. Six conditions of each sample fabric in the experiment

Observers were chosen by the quota sampling method and all of them were normal color vision as tested by the color vision test (Ishihara, 1972). The age range of 60 observers who participated in the experiment is from 20 to 60 years old (average 34.15 years). The group comprised of 30 males (Mean age is 33.93 years) and 30 females (Mean age is 34.37 years). They were divided into 6 groups based on a similar average age, consisted of 10 observers (5 males and 5 females). Each group was randomly assigned to view different scene conditions. Then, observers were asked to rate each of the three colors handwoven fabrics in six conditions regarding the nine-word pairs of semantic differential scale (6 pairs for overall atmosphere; Dark-Bright, Low Contrast-High Contrast, Dull-Colorful, Business-Artistic, Boring-Attractive, Mediocre-Impressive and 3 pairs for fabric characteristics; Ordinary-Luxury, Artificial-Genuine, Hard-Soft) on a scale of 1 to 6. Observers were presented one by one condition of each handwoven sample fabric with a viewing distance of 1.00 meter from the sample. After watching the first sample fabric in the first condition, they were allowed to rate with no time limit. Then, they were presented to the second and the third sample fabrics in the first condition consecutively. The rate has been processed after viewing

each piece of fabric, as well as, the first sample fabric. Observers had a break for 30 seconds before starting on a latter condition. The same tests were conducted until the rating of the six conditions were completed.

6. Findings

Data and information from questionnaires used the BIM SPSS Statistics 24 program to analyze statistical data. Comparison of the mean of the variable group used T-test and one-way ANOVA by considering the p-value (statistically significant with p-value <.05, statistically highly significant with p-value <.001). (Table 01).

Table 01. The effect of CCTs and background colors on 3-color fabrics.

Perception		Lac-red					Teak leaf-green					Curcuma-yellow				
		Comp. CCT			Comp. BG		Comp. CCT			Comp. BG		Comp. CCT			Comp. BG	
		BG			CCT		BG			CCT		BG			CCT	
		B	W	C	WW	CW	B	W	C	WW	CW	B	W	C	WW	CW
Overall atmosphere	**Bright**	✓*	✓*	✓*	✓	✓*	✓*	✓*	✓*	✓*	✓	✓	✓	✓	✓	✓*
	High Contrast	--	--	--	✓*	✓*	--	--	--	✓*	✓*	--	--	--	✓*	✓*
	Colorful	✓	✓	--	✓	✓*	✓	✓	--	✓*	✓*	--	--	--	✓*	✓*
	Artistic	✓	✓	✓	✓	✓*	✓	✓	✓	✓*	✓*	✓	✓	✓	✓*	✓*
	Attractive	✓	✓	✓	✓*	✓*	✓	✓	✓	✓*	✓*	--	--	--	✓*	✓*
	Impres-sive	✓	✓	✓	✓*	✓*	✓	✓	✓	✓*	✓*	✓	✓	✓	✓*	✓*
Fabric charac.	**Luxury**	✓	✓	✓	✓*	✓*	✓	✓	✓	✓*	✓*	✓	✓	✓	✓*	✓*
	Genuine	✓	✓	✓	✓*	✓*	✓	✓	✓	✓*	✓	✓	✓	✓	✓*	✓*
	Soft	✓	✓*	✓*	--	--	✓	✓*	✓*	--	--	✓*	✓*	✓*	--	--

Comp. = Compare, CCT = Correlated color temperature, BG = Background color, Fabric charac. = Fabric characteristics
B = Black, W = White, C = Complementary, WW = Warmwhite (3,000K), WW = Coolwhite (4,000K)
✓= statistically significant with p-value <.05, ✓*= statistically highly significant with p-value <.001), -- non statistically significant

6.1. Effect of the correlated color temperature (CCT) on the audience's perception in the exhibition

The overall atmosphere of the Lac-red color silk regardless of the background color: only one out of six overall atmospheres that the cool white highlights better perception than the warm white on Bright with statistically significant, while the warm white is better in the area of Colorful (for black and white background only), Artistic, Attractive, and Impressive with statistically significant. However, there is low to none statistically significant on High Contrast for both CCTs. The overall atmosphere of the Teak-leaf-green color silk regardless of the background color: only two out of six overall atmospheres that the cool white highlights better perception than the warm white on Bright and Colorful (for black and white background only) with statistically significant, while the warm white is better in the area of Artistic, Attractive, and Impressive with statistically significant. However, there is low to none statistically significant on High Contrast for both CCTs. The overall atmosphere of the Curcuma-yellow color silk regardless of the background color: only one out of six overall atmospheres that the cool white highlights better perception than the warm white on Bright with statistically significant, while the warm white is better in the area of Artistic and Impressive with statistically significant. However, there is low to none statistically significant on High Contrast, Colorful, and Attractive for both CCTs. The perception of fabric characteristic

found that Luxuriance, Genuineness, and Softness of the warm white highlight's better perception than the cool white in all exhibition of color silk with statistically significant (for Luxuriance, warm white highlights better perception for black and complementary color background only).

6.2. The effect of the background color on the audience's perception in the exhibition

The overall atmosphere of the Lac-red color silk with regards to the background colors at the same CCT: the white background highlights the best perception in the area of Bright with statistically significant, while it is less in the area of High Contrast and Artistic. The complementary color (green) background highlights the best perception on Colorful with statistically significant. Nonetheless, the black background highlights the best perception on Attractive and Impressive (the complementary color (green) background is better than the white background with statistically significant), Whereas, for the perception of fabric characteristics: Luxuriance and Genuineness on the black background highlight the best perception with statistically significant. However, there is low to none statistically significant on Soft for all background colors. The overall atmosphere of Teak leaf-green color silk with regards to the background colors at the same CCT: the white background highlights the best perception in the area of Bright with statistically significant, while it is less in the area of Artistic, Attractive and Impressive. Nonetheless, the complementary color (red) background highlights the best perception on High Contrast and Colorful with statistically significant (for High Contrast, the black background is better than the white background with statistically significant). Whereas, for the perception of fabric characteristics: Luxuriance and Genuineness on the black background highlight the best perception with statistically significant (for Luxuriance, the complementary color (red) background is better than the white background with statistically significant). However, there is low to none statistically significant on Soft for all background colors. The overall atmosphere of Curcuma-yellow color silk with regards to the background colors at the same CCT: the white background highlights the best perception in area of Bright with statistically significant, while it is less in the area of High Contrast, Artistic and Attractive. The complementary color (purple) background highlights the best perception on Colorful with statistically significant (the black background is better than the white background with statistically significant). Nonetheless, the black background highlights the best perception on Impressive (the complementary color (purple) background is better than the white background with statistically significant), Whereas, for the perception of fabric characteristics: Luxuriance and Genuineness on the black background highlight the best perception with statistically significant (for Luxuriance, the complementary color (purple) background is better than the white background with statistically significant). However, there is low to none statistically significant on the Soft for all background colors. The researchers, therefore, have summarized guidelines for design applications, which is categorized into 2 methods; 1) Selection of background color when the CCT has been determined and 2) Selection of CCT when the background color has been determined, as shown in Figure 2. The above radar graphic illustrations are presented with axes specified as Bright, High Contrast, Artistic, Attractive, Impressive, Genuine, Soft for selecting CCT and background color for the museum exhibition, appropriate exhibition design should be considered by observing the area within the graph, that is, the larger the area, the better the perception. The 2-Bar graph under the radar graphic presents the Colorful and the Luxury for selecting CCT and background color for the museum exhibition. The museum can apply the graph to suit the design concept, that is, the more inclination of the graph toward the right side, the better the perception of the audience.
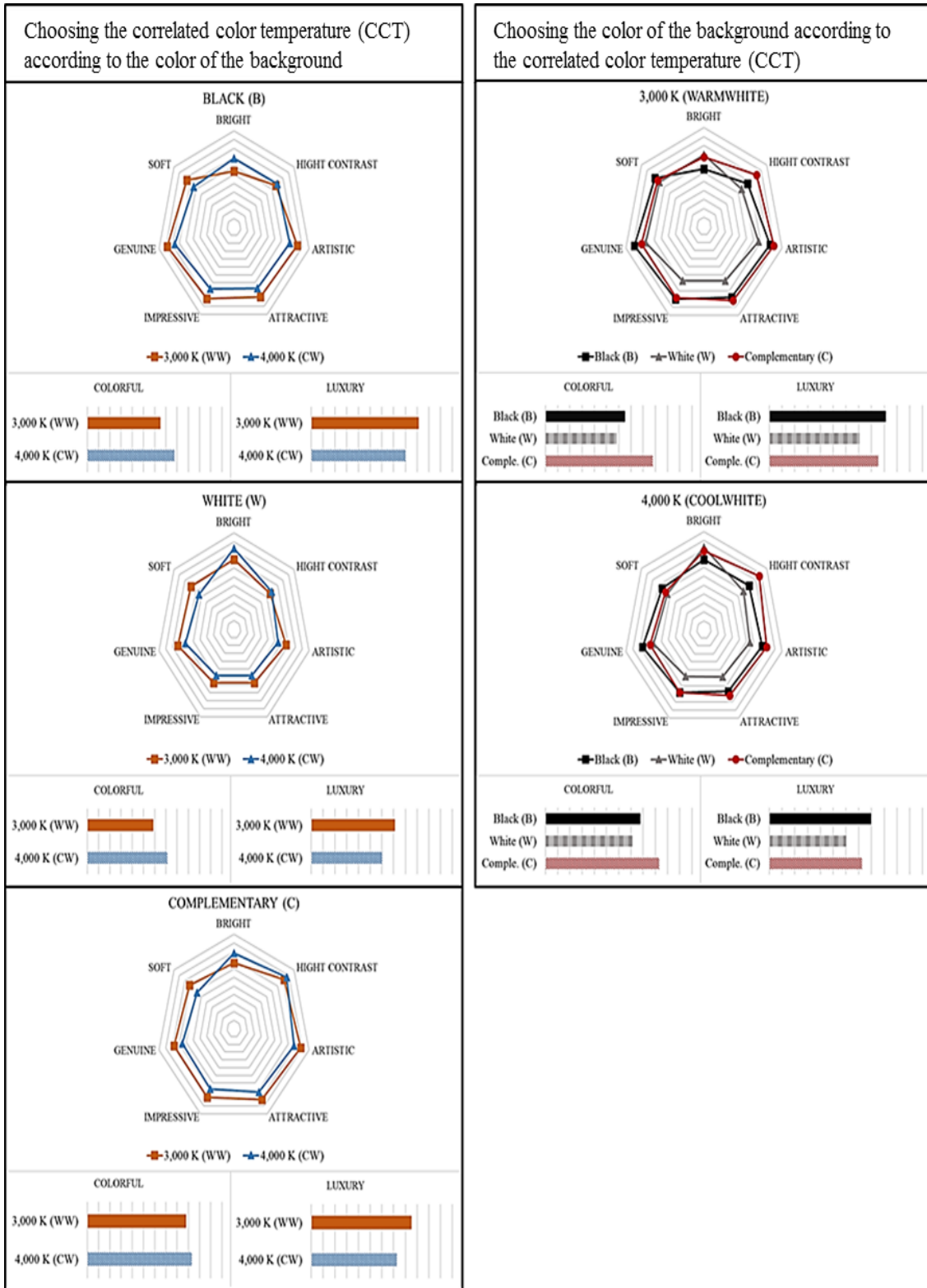
Figure 02. Example of design suggestions on CCT and background color for Teak leaf-green
handwoven silk and natural dyed silk with a similar color tone exhibition

7. Conclusion

The factors of light and color are factors that must be considered along with the design for fabric
exhibition in museums so that the effectiveness of viewing and perception can be achieved, which should

enhance understanding and appreciation on values of the exhibited fabrics. Results of this study show that the selection of CCT and background color have different effects on the audience's perception, based on the color of each piece of fabrics**.**

Acknowledgments

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