

Research on Color Perception Experience of Kiang Wu Hospital (Macao SAR, China) Building Exterior Based on SD Scale

Yanping Pang¹, Bin Jiao¹, Jingwen Meng^{1*}

¹ Graduate School of Design, Faculty of Innovation and Design, City University of Macau, Macau, China

Email Address

337690423@qq.com (Jingwen Meng)

*Correspondence: 337690423@qq.com

Received: 13 December 2021; **Accepted:** 24 February 2022; **Published:** 31 March 2022

Abstract:

In order to explore the influence mechanism of color perception of hospital environment on medical activities, in order to more accurately serve the perceived needs of medical staff, patients and their families. The semantic difference method was used to obtain and describe the psychological perception of the audience on the main color of the hospital environment. By introducing the perception description of the hospital environment color, the factor analysis was completed, and the common factors of the hospital environment color perception experience were obtained. With these two common factors as the coordinate axis, the image distribution diagram of hospital environment color is drawn. Through comparative experiments, it is verified that whether the actual environmental background affects the color perception experience of medical staff, patients and their families.

Keywords:

Hospital, Environmental Color, Semantic Scale, Perceptual Experience, Quantitative Research

1. Introduction

As the virus spreads to every corner of society and affects everyone's health, going to the hospital to see a doctor is also a normal trend, and people's demand for the intuitive feeling of the hospital is increasing day by day. The appearance design of hospitals has become an important basis for the performance and quality of hospitals. The appearance design is the established impression of the hospital when people start to seek medical treatment, which will directly affect the degree of trust and intuitive feeling. The architectural appearance and design of the hospital has become a vital basis for judging its safety, cleanliness, hygiene and quality. Decent appearance design can relieve patients' anxious feeling.

For most hospital buildings, the appearance of environmental system is faced with an increasingly expanding medical groups with lots of issues like, the spatial functions are complex, the system is indistinct, and the indication color is confused. Poor results

will make the hospital become dirty and messy, and influence doctors' and patients' mood. Such bad experience will directly make the hospital environment worse. Therefore, an overall harmonious and orderly design of building exterior color and surface finish becomes the key to improving the hospital's exterior quality and the first impression it gives to visitors.

2. The Important Role of Color in Architectural Design

2.1. The Role of Architectural Color

In urban architectural design, the most decorative beautification effect is the architectural color. Different architectural color decoration design brings dissimilar visual impact to people. Color decoration techniques are designed according to the building's own attributes and other characteristics in proportion, so it will form a contrast relationship with the surrounding environment to highlight temperament and character, and integrate with the surrounding environment to form a harmonious whole. Designers habitually use different collocation of color to create emotional and artistic atmosphere so as to let people experience different emotional feelings such as joy, anger, sorrow and happiness in psychology mood swings. Architectural color affects its image identity and recognition in visual factors.

Today, the impressive architectural image is easily recognized and remembered, forming a specific architectural character independent from others environment, and becoming a landmark building or even a city label. Color plays an essential role in the recognition of image symbols, and audiences often identify buildings which they are familiar with through the combined perception of urban color system and it can efficiently distinguish and identify other environments to enhance the design effect [1]. In terms of the design of dissimilar architectural styles and colors, people's different cultural backgrounds reflect diverse cognition. Different colors with changed perceptions, people are experiencing perception brought by changed cultural output [2].

2.2. Influencing Factors of Color Design in Kiang Wu Hospital

Different regions in geographical environment and climate cause dissimilar outward appearance of architecture. Compared to cold and dusty areas, warm colors or neutral colors with medium lightness that will help people to feel warmth are mostly selected. Kiang Wu Hospital is located in the southern part of China in the Pearl River Delta. In the urban area of Macau where the buildings are relatively dense and narrow so as the exterior color design of these buildings are considered to be in harmony with the natural, cultural and humanistic environment. Hence, the exterior color design of Kiang Wu Hospital should be coordinated and unified with the surroundings. It is appropriate to use bright and neutral color or cool color with a few lively colors for ornament and decoration in southern regions.

The particularity of Macau's culture and history makes it a region where Chinese and Western cultures blend. As a demonstration area for the integration of different cultures, the appearance colors are endowed with various symbolic meanings due to the varied nationalities and cultural beliefs. Therefore, the appearance color design of Kiang Wu Hospital should take full account of the diverse symbolic meanings with cultural traditions, the emotional content and psychological effect perceived by people in Macau.

In the 1960s and 1970s, perceptual engineering emerged in Japan, providing an innovative way for quantitative study of people's perception and experience that has been widely applied in color design [3,4]. Compared with other research on appearance color, there are relatively few on designs of hospital buildings. So far, the research on the design of hospital space color environment is mainly summarized and discussed from the aspects of color attribute, psychology, symbolic significance and aesthetic characteristics [5].

2.3. Current Research on Architectural Color Design

Color is a common element that can be perceived by all viewing space or objects. It is absorbed and is more intuitive and visually striking than other form elements. People's first impression of the environment usually comes from color. At the same time, color is also the easiest to improve in the spatial environment. Proper color matching design can greatly improve the image of the hospital environment at a lower cost.

Nowadays, the development of color theory has been relatively mature, as disciplines such as physics, physiology and psychology have clearly explained the nature of color and individual color vision. A large number of color theories have been applied to environmental design. The symbolic meaning and psychological experience of color have been deeply discussed and applied in a large number of domestic and foreign studies [6].

3. Illustrations

In view of the above research, this paper selects the Semantic Differential (SD) method to get the perception and experience of the exterior dominant tone of hospital buildings, and tries to find its inside rules. In addition, according to previous surveys and observations, the peripheral colors of hospitals may change the perceived and experienced results of appearance colors. Therefore, this study selects two kinds of samples: the first kind is the appearance picture of a hospital building with a pure black background, and the other kind is the real scene in actual use, so as to explore the influence of its color experience.

3.1. Research Methods

SD method (Semantic Differential Method) was a psychological measurement method proposed by Charles Osgood in 1957. The SD method used "discourse" in semantics as a scale to conduct psychological experiments and analyze various scales that have been established to quantitatively describe the concept and structure of the research object. In general, a series of pairs of adjectives are selected to describe something, and the subject is asked to rate the concept between the two adjectives, and an image describing the essence of the thing is constructed according to the average value of the scoring scale. It regularly referred to as Image Scale Research Method. Perceptual engineering also uses the SD semantic difference method scale questionnaire, which requires the subjects to select the adjectives describing the research object and score them, and then uses factor analysis method to extract 2 to 3 main factors of the description object [7]. Semantic analysis is based on human synesthesia and association. According to this feature, a semantic discrimination scale is designed to evaluate and measure the subjective evaluation of the subjects.

3.2. Research Process

First, we selected a typical general hospital (Kiang Wu Hospital) as research object to create an accurate 3D model using Rhino 3D NURBS, as shown in Figure 1. Then we endowed with different dominant colors the appearance of a model Hospital. This research focused on the perception evaluation of the main exterior color of hospital buildings, so we changed the samples from white which is without any hue.

Here we select 10 samples as the main colors, and refer to the ten colors according to Munsell's color wheel:

Red, Yellow Red, Yellow, Green Yellow, Green, Blue Green, Blue, Purple Blue, Purple, Red Purple and inspection to the hospital building exterior commonly used color comparison, Red, Orange, Yellow, Green Yellow, Green Blue, Blue, Purple and combined with gray and white. The actual design application cases used a total of 10 colors as samples.

This field research selected a total of 100 test personnel, including 55 design and construction personnel who are engaged in architecture-related work, and 45 students from design colleges and universities. There were 44 women and 56 men. The test was divided into three rounds, each with 35, 35 and 30 participants. During the test, the researchers used a computer to play images of the test material in sequence, each for 30 seconds, and asked participants to make judgments on a pre-designed SD scale. To eliminate tester's expectations, tone sequence, or distraction by the previous tone, the order in which the hue images are presented is disordered, and the three rounds of testing are performed in a different order than the order of the hue circle. After judging the 10 images with black background, participants were asked to have a rest for 5 minutes, and were tested in the same way with real background, as shown in Figure 2.

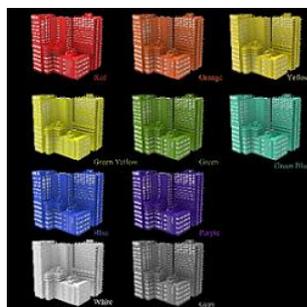


Figure 1. Hospital Building Appearance' 3Dmodel on Black Background.

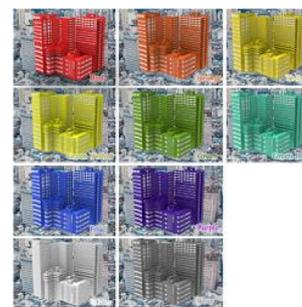


Figure 2. Hospital Building Appearance' 3Dmodel on Real Environment.

4. Data Analysis

All SD scales were collected to statistically obtain the evaluation value data of different adjectives for each color. See Table 1 and Table 2.

Table 1. Emotional evaluation of the hospital building appearance' color on black background.

Relative Adjective	Red	Yellow Red	Yellow	Green Yellow	Green	Blue Green	Blue	Purple	White	Grey
Beauty-Ugliness	-56	-25	-15	-22	1	11	38	-47	-17	-9
Excited-Calm	87	48	55	20	-20	-15	-68	36	-42	-51
Open-Close	96	54	13	30	23	3	0	13	-3	-11

Happiness-Sadness	-59	-23	56	-36	-21	13	21	18	-24	-51
Premium-Cheap	11	57	0	-42	-13	-15	1	-45	0	16
Big-Small	19	27	12	-9	22	24	30	5	18	35
Hard-Soft	56	17	16	-8	19	78	16	14	13	63
Cute-Disgust	-54	-19	-5	-10	-5	-22	26	-32	-12	-2
Harmony-Discord	-16	57	3	-70	-33	-7	-1	-63	-9	-20
Rich-Monotonous	-26	47	15	-30	-68	-32	57	20	-35	-51

Table 2. Emotional evaluation of the hospital building appearance' color on real environment.

Relative Adjective	Red	Yellow Red	Yellow	Green Yellow	Green	Blue Green	Blue	Purple	White	Grey
Beauty-Ugliness	-12	-43	5	-89	-39	22	49	-47	-47	-9
Excited-Calm	57	38	53	14	-68	-22	-67	-36	-54	-24
Open-Close	78	45	58	34	-23	34	-64	-84	-1	-23
Happiness-Sadness	-89	-6	8	-57	-50	-10	-12	-43	-4	-29
Premium-Cheap	-30	-17	63	-28	-1	-53	-9	31	82	67
Big-Small	23	38	21	-2	10	18	45	-2	21	22
Hard-Soft	60	41	13	10	53	29	70	16	20	63
Cute-Disgust	-46	-27	39	15	-61	21	39	-2	-31	-20
Harmony-Discord	-57	-24	-33	-65	-8	-3	-20	-57	55	23
Rich-Monotonous	46	39	13	30	3	7	-39	10	21	31

4.1. Perceptual Evaluation and Description of the Appearance Color of the Hospital Building without Background

Draw the score of adjectives judging the appearance of hospital buildings without background as a broken line, as shown in Figure 3, and analyze and find the rule:

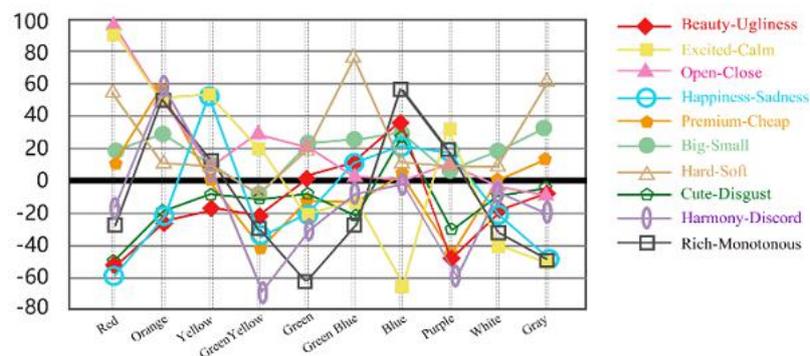


Figure 3. Describing curves of emotional evaluation of the hospital building appearance' colors.

(1). The judgment curves of the two groups of adjectives (beauty-ugliness, cute-disgust) with similar meanings are basically comparable, and their evaluation scores are sequentially blue, green, cyan, gray, yellow, white, yellow-green, orange, purple and red, as shown in Figure 4.

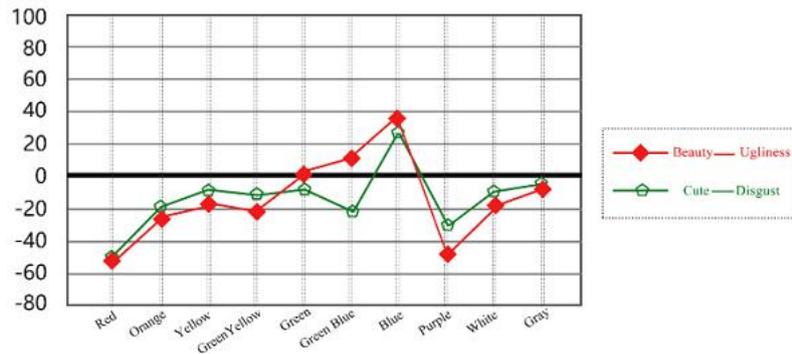


Figure 4. Describing curves of beauty-ugliness (Red line) and cute-disgust (Green line).

(2). The judgment curves of the two groups of adjectives (Excited - Calm, Open - Close) describing impact were basically similar, and the evaluation scores were: red, red-yellow, yellow, yellow-green, purple, green, cyan, white, blue and gray. It can be seen that the impact force and stimulus degree of hospital building exterior color are related to the coldness and warmth of color. Warm color makes people feel more excited, while cool color makes people feel more quiet and closed, as shown in Figure 5.

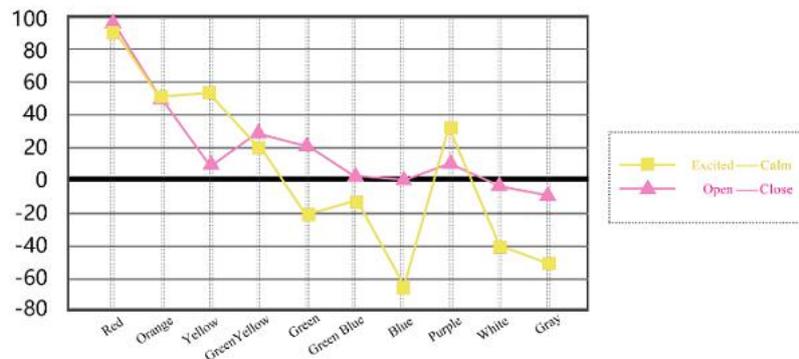


Figure 5. Describing Curves of excited-clam (yellow line) and open-close (pink line).

4.2. Analysis of Color Perception on Hospital Building Appearance

SD method is used to perceive the exterior color of the hospital building without background. First flip 1 data and input SPSS software for factor analysis, as shown in Figure 3. From the results, the first two common factors can explain 82.16% of the total information content, and they are taken as the simplified common factors.

10 variables in Figure 4 shows the raw data and the interrelation between the two common factors, using related degree to the two main factors named Affection factor and Impact factor: Rich-Monotonous, Harmony-Discord, Big-Small, Premium-Cheap, reflect the people's preferences in the hospital building exterior color; The impact factor was related to open - closed and Cute - Disgust, which reflected the stimulus degree of hospital building exterior color. Then, the evaluation of various phases was substituted into the common factor.

4.3. The Influence of Background on the Appearance Color Evaluation of Hospital Buildings

Based on the data in Table 1 and Table 2, a line graph drawn for the perceived description of the actual background without background. The blue curve is the

evaluation curve without scene, and the red curve is the evaluation curve with street scene background.

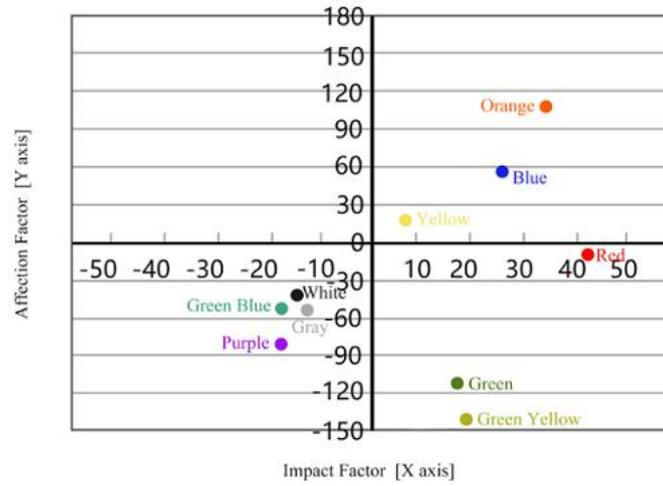
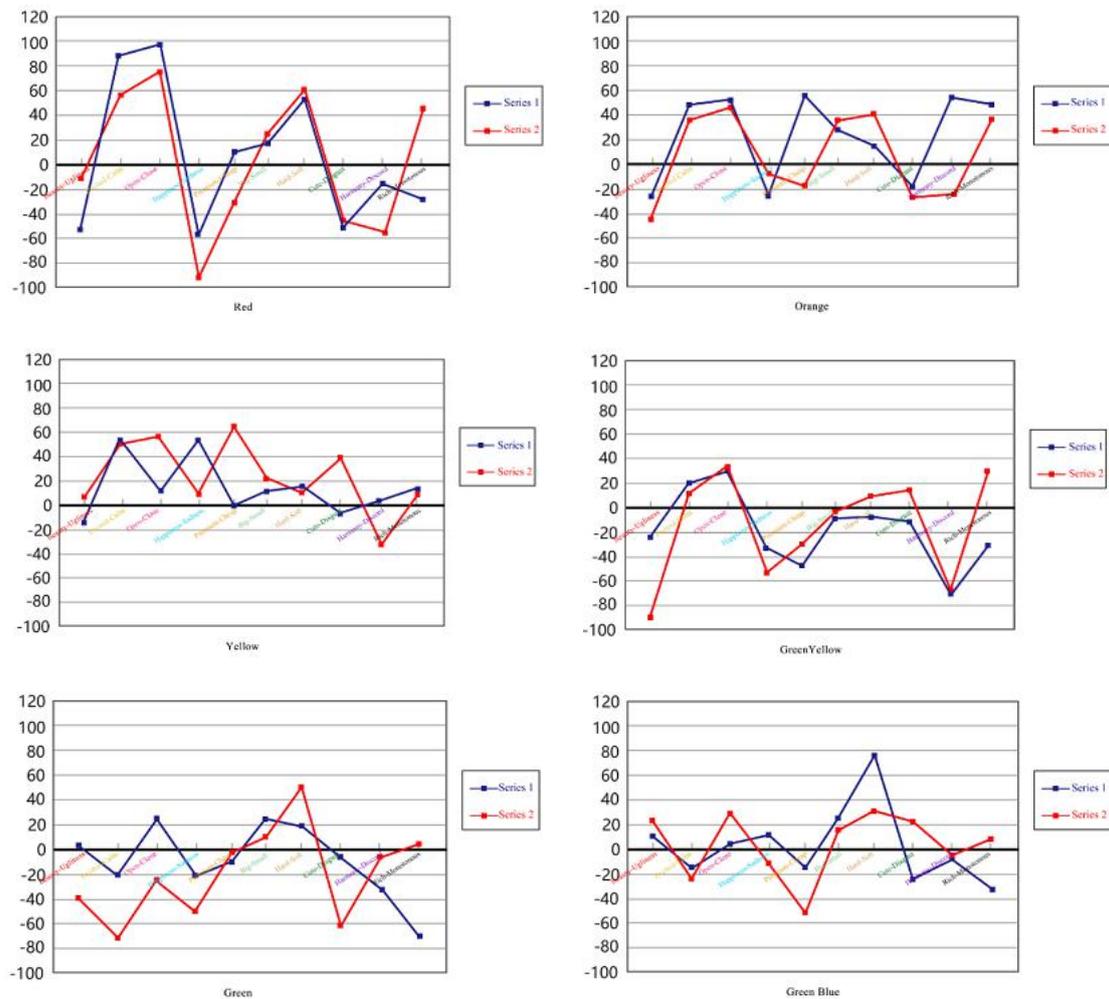


Figure 6. The Hospital Building Appearance' Color Images Map.



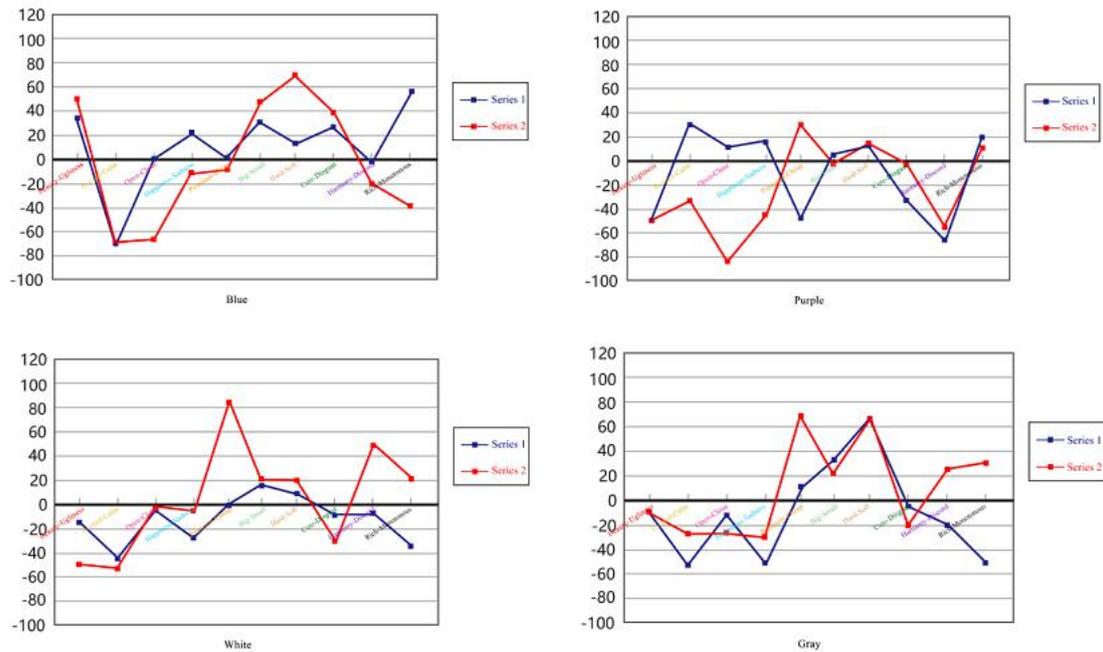


Figure 7. Comparison between hospital building appearance' color images on black back ground and on real environment.

5. Conclusions

This paper uses the SD scale to test the perceptual experience of various colors in the exterior design of hospital buildings, and tries to find people's evaluation of the exterior colors of hospital buildings. The external use environment of hospital buildings is relatively colorful. This paper studied the two test conditions of using pure black background as the test material and using the actual street scene background. The research results are as follows:

5.1. Obtain the Perceptual Description of Various Shades of Hospital Building Appearance

Among them, the judgment curves of the two adjectives with (B-U, C-D) similar meanings were basically the same. The scores of the adjectives with similar meanings were: blue, green, green-blue, gray, yellow, white, yellow-green, yellow-red, purple and red. Cool colors interpreted as clean and ideal were more popular.

The judgment curves of impact force expressed by exciting-calm and open-closed were basically the same, and the evaluation scores were: red, red-yellow, yellow, green, purple, green, green-blue, white, blue and gray. It can be explained that the impact and stimulation of the exterior color of the hospital building is related to the cold and warm color. Warm colors make people feel more excited, while cool colors make people feel calm and closed.

5.2. Common Factors

Two common factors describing the appearance color of hospital building are obtained by using factor analysis method, namely, affection factor and impact factor. Based on this, the color image distribution diagram of hospital building exterior shows that: red, red-yellow and blue have greater visual impact; red-yellow, blue and yellow have higher preference; purple, blue and white have less visual impact; yellow

and green is relatively low. Therefore, people do not like yellow-green and green as the exterior color of the hospital building. Warm colors such as red-yellow, yellow and red with high purity and clear tones like blue are popular.

5.3. Evaluation Difference

In addition to the red, red yellow, yellow, when various phases are characterized by no scene situation the evaluation difference is bigger, other hospital building exterior color under the condition of no scenario: yellow is apparent, but mostly for the positive rating, which shows that red, red yellow, yellow color evaluation is not subject to any scene change, other hues are greatly affected by the actual scene of the surrounding streetscape. The evaluation under the condition of no scene was compared with that under the condition of real street scene. The appearance of the colorless (white, gray) hospital building in the actual scene is obviously better than the judgment without background. It can be explained that in the streetscape environment where there are many actual parti-colors and most of them are grayscale colors, the color system that is close to the surrounding environment and integrates with harmony is better evaluated, while the appearance of the hospital building with red color is poorly evaluated due to its large relative ratio.

Therefore, it is suggested that in the design of the building appearance of Kiang Wu Hospital, it is best to consider the choice of cool colors with high purity, clear and popular and neutral colors, that are close to the surrounding environment and blend in with harmony. Considering the visitors' perception and experience of appearance color, humanized color expression is designed in line with the aesthetic psychology of the public.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Funding

This work was supported by the 2020 Henan Province Foreign Intelligence Introduction Plan: Foreign expert studio of design teaching system of Florence Academy of Fine Arts, grant number GZS2020009.

References

- [1] Guo, J.; Huang, L. Analysis on the identify-ability of architectural image. *Journal of Architectural Knowledge*, 2012, 9, 50.
- [2] Peng, Y. (Eds.): Building space combination theory, China Building Industry Press, 1983; pp. 27.
- [3] Wang, H.; Wang, Y., Color design of agricultural machinery products. *Journal of Shenyang Agricultural University*, 1992, A09, 8-11.
- [4] Zeng, F. Application of color regionalism in VIS design. *Journal of Design*, 2017, 9, 64-65.
- [5] Liu, S. Research on color perceptual experience of agricultural machinery products based on SD scale. *Journal of Agricultural Mechanization Research*, 2010, 32(4), 50-57.

- [6] Nagamachi, M.; Imada, A., Kansei Engineering: An ergonomic technology for product development. *International Journal of Industrial Ergonomics*, 1995, 15(1), 1.
- [7] Li, Z., Research on hospital interior design and visual guidance design based on color visual psychological characteristics. *Journal of Design*, 2020, 8, 113-115.



© 2022 by the author(s); licensee International Technology and Science Publications (ITS), this work for open access publication is under the Creative Commons Attribution International License (CC BY 4.0). (<http://creativecommons.org/licenses/by/4.0/>)