The environmental colour imagery survey via virtual reality

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The objective of environmental colour planning is to maintain a balance between the colour imagery of the local environment and the heritage of the local culture. Previous research has highlighted the significance of local environmental colour imagery as a key factor influencing colour scheme planning [1]. Environmental colour imagery studies focus on gathering, analysing, and extracting local colours to represent the colour imagery of a regional environment. This includes illustrating architectural colour palettes, incorporating local natural geographical features (such as indigenous materials), and establishing connections between environmental conditions and human geography (local cultural traditions, customs, etc.) [2-3]. All factors influencing the colour imagery of the environment are within the scope of investigation. An environmental colour imagery survey is conducted to gather regional colour information and establish an environmental colour database for further analysis. This survey employs a systematic approach [4] utilising panoramic photography, sampling, colour measurement, coding, and classification. A panoramic camera equipped with an UVA is utilised to capture 360-degree panoramic images encompassing regional environmental landscapes such as mountains, skies, landforms, buildings, and roads. Through a series of high-resolution panoramic images taken from various angles, an immersive virtual reality representation of the regional landscape is created, allowing observers to experience the scene as if they were present [5]. It is imperative that the environmental colour imagery survey via virtual reality [6] aids in better understanding the colour space of the regional environment and the cognitive semantics of local environmental colour perception by observers [7-8]. The findings of this study reveal that the distribution of certain colour imagery data shows conflicting intensities in certain distributions, with mean value appearing to be neutral but not actually unanimous consensus, as in the case of blue area. Further investigation and in-depth analysis of the semantic scale of colour imagery is needed to unravel these complexities.

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Introduction

The focus of the environmental colour imagery survey, based on Jean-Philippe Lenclos' theory of colour geography [2], is on gathering, analysing, and extracting local colour profiles to depict the colour chromatograms of a region. This includes illustrating architectural colour choices, incorporating local natural geographical features (such as indigenous materials), and exploring the relationship between environmental conditions and human geography (local cultural traditions, customs, etc.).

In previous research, an environmental colour analysis of Zheng-Bin Fishing Harbor was conducted using a systematic process to create a colour database consisting of 269 colour patches categorised into domain colours, secondary colours, and embellishments found in the harbour landscape [9]. A histogram colour chart (Figure 1) was generated to display the distribution of collected regional colour samples using NCS five colour categories [10,11].

Furthermore, an in-depth environmental colour imagery survey was conducted using virtual reality to provide a detailed environment image with comprehensive colour information about the region. It is anticipated that this approach will enhance understanding of the colour imagery space [5] of the regional environment and the observer's cognitive perception of the local environmental colour chromatograms.

Hue Range		Chromatogram	Colour Tone	
Natural	N	14	B/W grey scale	Embellishment colour
Colour	Y-Y90R	91	Medium-Low Lightness Medium-High Chroma	
	R-R90B	58	Medium-High Lightness Medium-Low Chroma	Secondary colour
	B-B90G	51	Medium-High Lightness Medium-Low Chroma	Domain colour
	G-G90Y	55	Medium-Low Lightness Medium-Low Chroma	

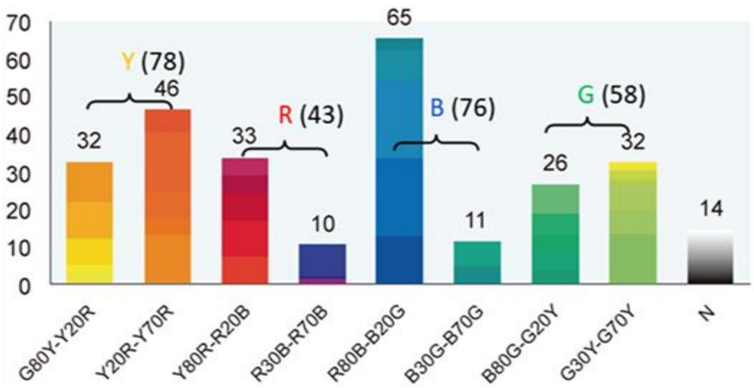


Figure 1: In a previous survey, 269 regional colours were collected using the NCS environmental colour survey tool. A histogram colour chart was used to illustrate the distributions of regional colour samples.

Methodology

The investigation is through a systematic process utilising photography, colour measurement, sampling, coding, and classification. Collected colour images are analysed, categorised, and presented using chart chromatography. Additionally, a subjective environmental colour imagery survey is conducted via virtual reality to gather observers' cognitive perceptions of the local environmental colour imagery space.

Environmental colour imagery survey tools

The environmental colour survey tools include landscape photography using a panoramic digital camera and UAV (Unmanned Aerial Vehicle). Adobe Colour software is employed to generate a colour palette for establishing a chromatogram chart based on image samples of the regional colours of Zheng-Bin Fishing Harbor [3,12]. See Figure 2.

Figure 2: Tools used for the environmental colour imagery survey.

Environmental colour Images and chromatograms

Samples of environmental colour images are selected from both macro (sky, sea, mountain, harbour, urban landscape, etc.) and micro (architecture, street, façade, etc.) levels, based on the characteristics of regional landscape colours, including main colours, auxiliary colours, and embellishment colours (Figure 3). These samples are respectively marked on the local cultural colour image space. Each environmental image sample is analysed using Adobe Colour palette generator to create a chromatogram, as shown in Table 1.

Figure 3: The Zhang-Bin Fishing Harbor environmental colour images samples.

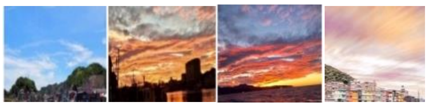
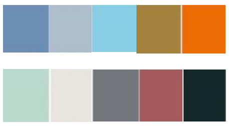
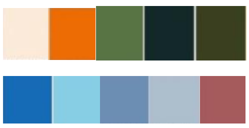
		Landscape elements site	Chromatogram	Photos of colour sample
Natural environment colour`	Sky			
	Sea			
	Harbour			
	Mountain			
Urban landscape colour	Coastline			
	Architecture			
	Street			
	Facade			
Local humanistic colour	Historical			
	Traditional			

Table 1: Chromatograms for Zhang-Bin Fishing Harbor regional colours.

The procedure of environmental colour imagery survey

1. A semantic differential scale (SDS) was developed based on Kobayashi Colour Image Scale to measure observers' perceptions of colour imagery [5,13]. Colour imagery semantic words were carefully selected to create a questionnaire for the SDS. The survey was conducted and analysed.

2. A video guidance of the local environmental colour image produced using virtual reality to enable the viewers to construct a comprehensive colour imagery of the region.

3. The colour psychophysical experiment method is used to measure the semantic perception of each of the observers regarding the environmental colour imagery. The experimental setup for the environmental colour imagery survey is shown in Figure 4. Volunteer research participants were recruited from the general public, a total of 30 individuals. Each participant did the experiment twice, resulting in a total of 60 trial data collected for statistical analysis [4]. The steps of the experiment are as follows:

    a) First, the Farnsworth Munsell 100 Hue Test is used to evaluate the research participant's colour recognition ability.
    b) The observer wears a VR helmet to watch the guide video of the local environmental colour landscape.
    c) The observer examines 2D local environment reference images on the computer screen to determine the semantic perception level between the local environmental colour image in memory via SDS [4]. The psychophysical measurement value of the environmental colour imagery is obtained based on the degree of cognitive strength, where a higher scale value indicates a stronger feeling.

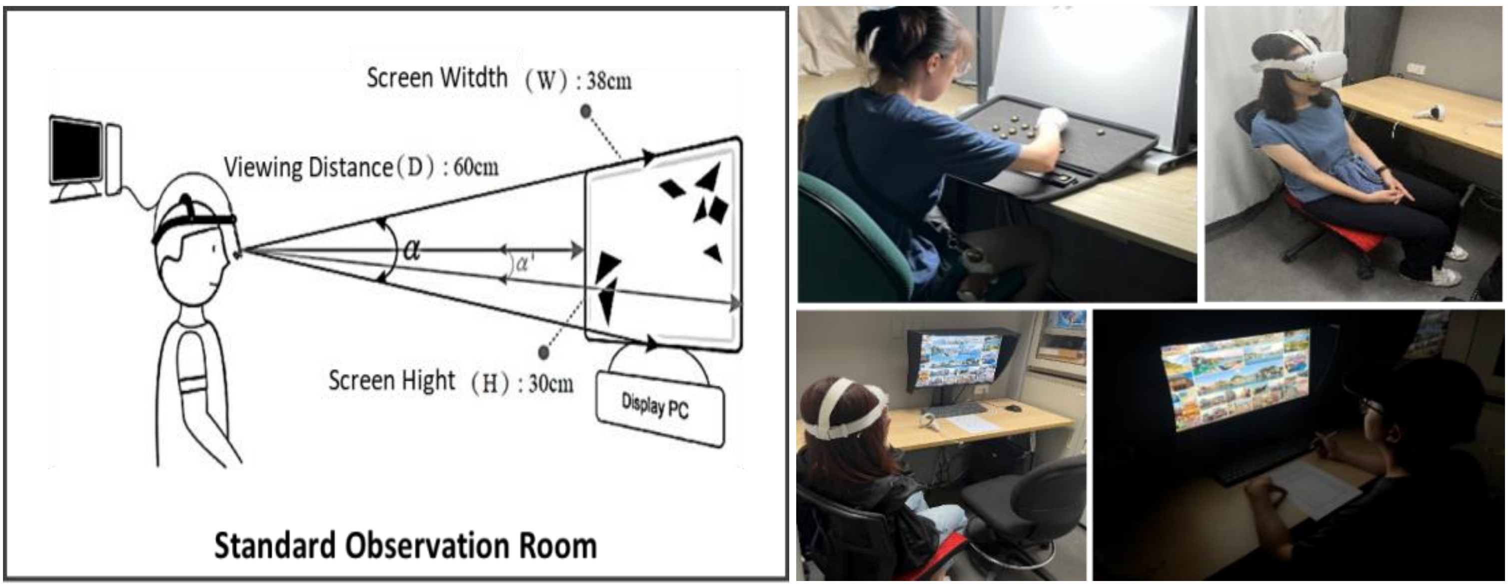


Figure 4: The experiment of environmental colour imagery survey.

Results

Environmental colours imagery and semantic differential analysis

Following statistical analysis, the spatial distribution of the local colour imagery is depicted using the Kobayashi colour image scale coordinate plane [14]. The evaluation and analysis of the relationship between the natural environment colour imagery and observers' perception of the environment colour imagery was conducted as follows:

1. Mapping the collected natural environment colour image sample chromatograms onto the Kobayashi colour image coordinate plane. Semantic colour image zones were established to illustrate the natural environment landscape colour imagery of Zheng-Bin Fishing Harbor. Four zones, as shown in Figure 5, were plotted as follows: 1. Pretty–Romantic–Natural–Clear, 2. Casual–Dynamic, 3. Classic–Stylish–Rough, 4. Modern–Cool–Chic.

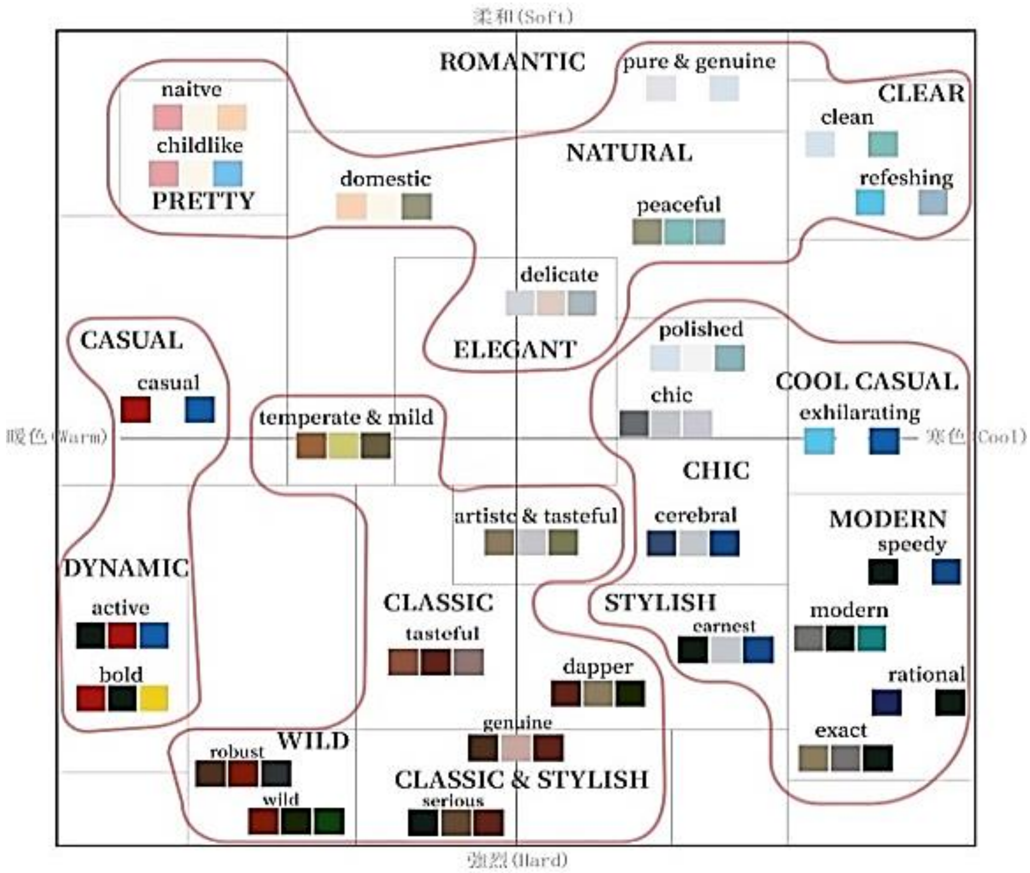


Figure 5: Natural environment colour image zones plotted on Kobayashi colour image coordinate plane.

2. e environmental landscape colour image (Figure 6) obtained through the SD (Semantic Differential) evaluation experiment is mapped onto the Kobayashi colour image coordinate plane. Semantic colour image zones were established to depict the perceived landscape colour image of Zhengbin Fishing Harbor. Four zones were plotted as follows, as seen in Figure 7: 1. Pretty-Romantic-Natural-Clear, 2. Casual-Elegant, 3. Dynamic, 4 Classic-Stylish-Rough.

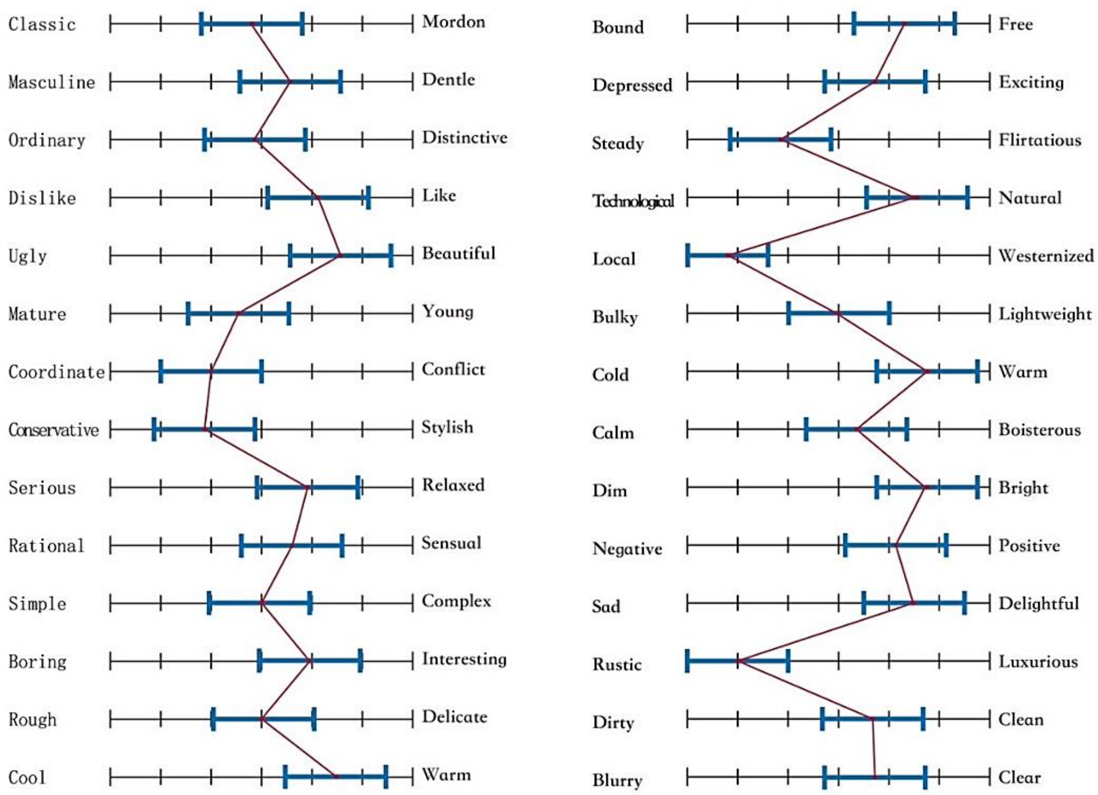


Figure 6: Colour imagery SD evaluation results.

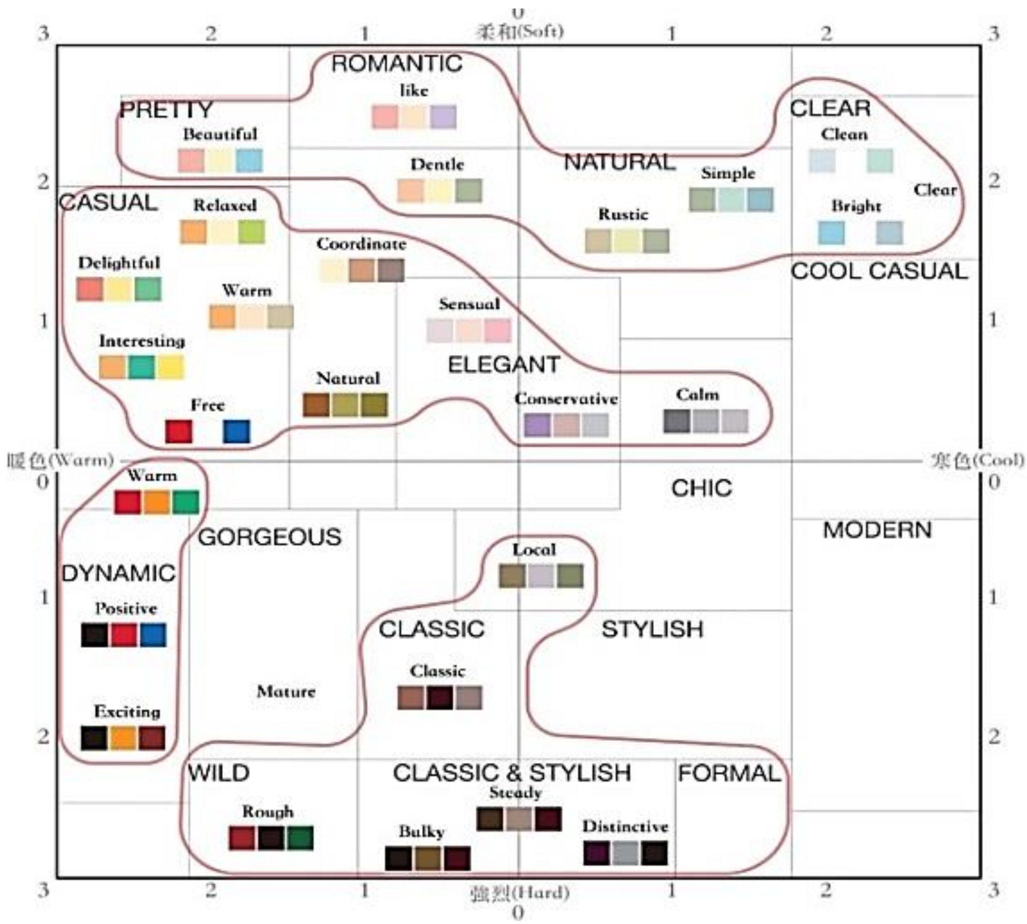


Figure 7: Perceived semantic colour imagery zones plotted on Kobayashi colour image coordinate plane.

Discussion

Environmental colour imagery survey and semantic differential analysis are methods used to study the perception and interpretation of colours in natural environments.

Environmental colour imagery involves gathering and analysing the colours present in various elements of the environment, such as landscapes, buildings, and natural features. This can be done through survey techniques as photography, colour measurement, and sampling. The goal is to understand the colour composition of a region and how it is perceived by observers.

Semantic differential analysis, on the other hand, is a method used to measure the subjective perceptions and interpretations of colours. It involves presenting participants with pairs of contrasting adjectives (such as "warm" vs. "cold" or "exciting" vs. "boring") and asking them to rate the degree to which each adjective describes their perception of a particular colour [8]. This allows researchers to analyse the nuanced meanings and associations that individuals attribute to different colours.

When combined, environmental colour imagery survey and semantic differential analysis provide valuable insights into how colours are perceived, interpreted, and experienced in different environmental contexts. These methods are particularly useful in fields such as architecture, urban planning, and environmental psychology, where understanding the impact of colours on human perceptions and behaviours is important.

The issues regarding the semantic analysis of environmental colour imagery are discussed as follows:

1. The results reveal the discrepancy between objective analysis of colour imagery of natural environments and subjective perceptions of observers. Particularly regarding the perception of blue area, colour imagery was inconsistent with the predicted significance of Kobayashi's colour imagery scale coordinate plane. Statistical analysis of colour semantic imagery shows that perceptions related to "modernity" exist differences in environmental imagery related to historical sentiments of the region and recent local renovation projects.

2. Statistical analysis of colour imagery data shows conflicting intensities in certain distributions, with mean value appearing to be neutral but not actually unanimous consensus, as in the case of blue area. Further investigation and in-depth analysis of the semantic scale of colour imagery is needed.

3. From the analysis of the first and second test data of all subjects, the difference was not significant, showing that the situation where personal subjective imagery may cause misjudgement is under control. The use of virtual reality to comprehensively present the colour imagery of the regional environment can effectively help observers form a visual understanding of the environmental colour space, thereby reducing potential judgment errors caused by personal stereotyped subjective cognition [4]. Therefore, the results of this study indicate that the use of virtual reality is more objective in forming a consensus on environmental colour imagery.

Conclusions

The study's findings suggest that colour imagery encompasses multiple meanings linked to local cultural heritage and emotional experiences. Consequently, achieving a universal colour imagery requires a broader cross-cultural communication discipline. This approach will facilitate ongoing exploration into integrating research between colour science and colour psychology.

Acknowledgement

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