

Color Analysis of Dementia Care Units Based on the NCS System

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Abstract:

Through an in-depth discussion of the mechanism of color's influence on the Behavioral and Psychological Symptoms of Dementia (BPSD), the color environment needs of dementia care units were elaborated, and based on this, the NCS color system was used as a tool to conduct a color study of three representative Based on this, a color study was conducted on three representative dementia care units using the NCS color system as a tool. The results show that although each unit has its own unique color environment, there are common design strategies to meet the safety, emotional relief, cognitive support and social interaction needs of the elderly with dementia. These findings not only deepen our understanding of the application of the NCS color system in dementia care settings, but also provide valuable guidance for future color design of dementia care units based on the NCS color system.

Keywords:

NCS Color System, Dementia Care Units, Color Impact, Elderly People with Dementia, BPSD

1. Introduction

As population aging intensifies, so does the prevalence of dementia among the elderly. According to China's Health Statistics in 2021, there are approximately 190 million seniors suffering from chronic diseases in China, and about 45 million of them are disabled or demented [9]. Dementia is a syndrome marked by cognitive dysfunction, often accompanied by behavioral and psychological symptoms (BPSD), such as anxiety, depression, hallucinations, delusions, etc., which severely impair the patients' quality of life and social function. Elderly people with dementia require specialized care and treatment, and dementia care units (DCU) are facilities that offer personalized, humanized and secure environments and services for them.

Color is a vital environmental factor that profoundly influences human vision, cognition and emotion. Color can not only affect how people perceive and appraise space, but also modulate their physiological and psychological states, and even alter their behavior [1]. Therefore, color is an element that deserves special attention in the design of dementia care units [2]. On one hand, color can assist elderly people with

dementia in recognizing spatial functions and directions, enhancing their spatial memory and orientation skills; on the other hand, color can mitigate BPSD of elderly people with dementia, improve their mood and disposition, and increase their life satisfaction [3]. For this purpose, the study employs NCS color system, surveys and analyzes the color conditions of typical dementia care units in China, and provides data foundation and theoretical support for the color optimization of dementia care units.

2. Color Status Study of Typical Dementia Care Unit

2.1. Research Overview

The study relies on the NCS color system (Figure 1), and consists of four stages: building image color quantification, positioning NCS color system, creating color chart, and analyzing spatial color strategy. First, by combining fieldwork and online research methods, the study integrates various spatial color data of dementia care units, and constructs an image database. The NCS+ website is used to upload the image library information and extract the color swatch data. The NCS ColourPin tool is used to fuzzily transform the RGB value of the extracted color swatch into NCS value, aiming to categorize and quantify the spatial color. Second, the study imports the NCS Navigate software to construct a three-dimensional color model, and locates the color circle and color solid using the NCS color system, and analyzes the hue, blackness, chroma and color application features of the three main spaces (public space, traffic space, residential space) of dementia care units. Then, based on the data, the study uses Illustrator and Photoshop software to create a color chart. Finally, the study analyzes the spatial color strategy of dementia care units, and summarizes their similarities and differences.

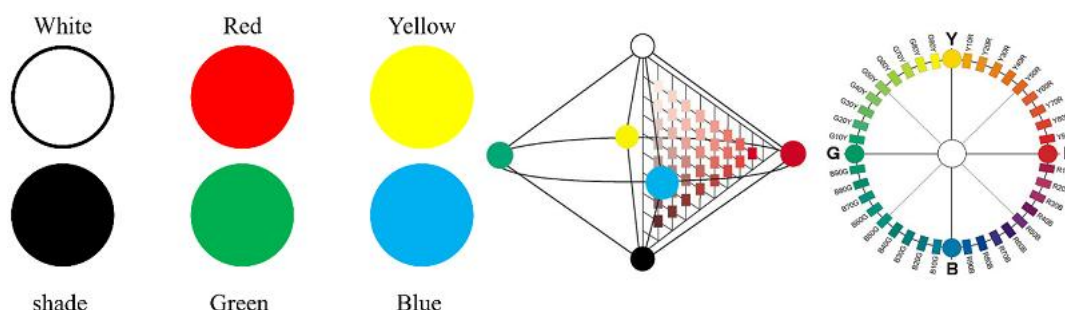


Figure 1. NCS Color Space.

2.2. Image Collection and Sorting

The study chose Shanghai Sheshan Nursing Home Dementia Care Area, Beijing Kang Yuxuan Elderly Apartment, Anshan Xiang Yiyuan Elderly Apartment Dementia Care Area as the research subjects (Hereafter abbreviated as b, s, a respectively). They represent different cultural and geographical backgrounds, aiming to uncover the features and tendencies of color design application in dementia care settings through cross-regional comparative study. At the same time, in order to precisely capture and quantify the features and tendencies of color arrangement, the study adopted a hybrid method of online and field data collection, and gathered a large amount of image data and physical samples. Through precise color measurement and data analysis, the study comprehensively revealed the intrinsic patterns and traits of color design of each care unit (Figure 2).



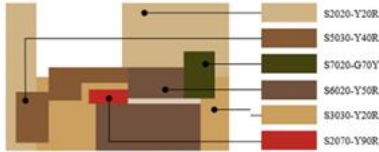
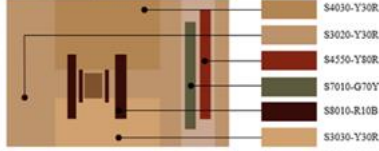
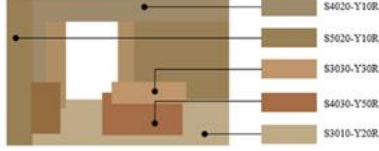
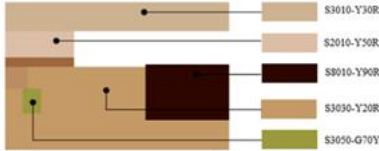
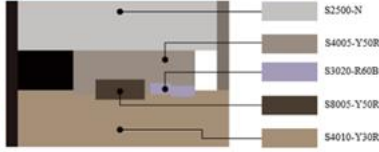
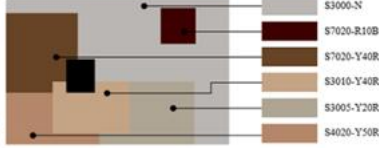
Figure 2. Research Photos.

2.3. Color Sampling of Dementia Care Unit Based on NCS System

In the color data investigation, different spaces within the care unit were sampled in levels. Based on the spatial function and usage situation, the care unit was divided into three main categories: public space, traffic space and residential space. Each category of space underwent corresponding color sampling and analysis. For public spaces, considering their communal and dynamic features, the investigation focused on the basic color and functional color of these spaces. The basic color mainly influences the overall ambiance of these spaces, while the functional color is used to guide or indicate specific behaviors, such as directing paths, marking equipment locations, etc. Traffic space is a crucial area that connects various functional areas. The choice and application of color not only have to ensure visual comfort, but also have to take into account orientation and safety. Therefore, the main research is on how color is applied in these spaces and how they affect traffic flow lines. Residential space is the private area for elderly people with dementia. Its color design should take into account comfort and personalization needs. For these spaces, the study focuses on the combination, proportion and impact of color on residents' mood and behavior. The specific color quantification of the three dementia care units is shown in Table 1.

Table 1. Color data collection for dementia care unit.

	Space	Actual photos of dementia unit	Dementia unit color block	Color Analysis
Beijing Kang Yuxuan Senior Living	Public Space			S0507-Y40R S2040-R90B S4030-Y20R S4030-G70Y S2040-Y10R S2005-Y30R
	Traffic space			S5010-Y10R S4005-Y50R S1010-R70B S5040-Y80R
	Living space			S3030-Y20R S3030-Y50R S4010-Y30R S2010-R10B
	Traffic space			S4550-G60Y S3040-Y30R S6030-Y50R

Shanghai Sheshan Home for the Aged	Public Space	 
	Traffic space	 
	Living space	 
Anshan Xiangyiyuan Elderly Residence	Public Space	 
	Traffic space	 
	Living space	 

3. Spatial Color Map Analysis

3.1. NCS Color System Positioning

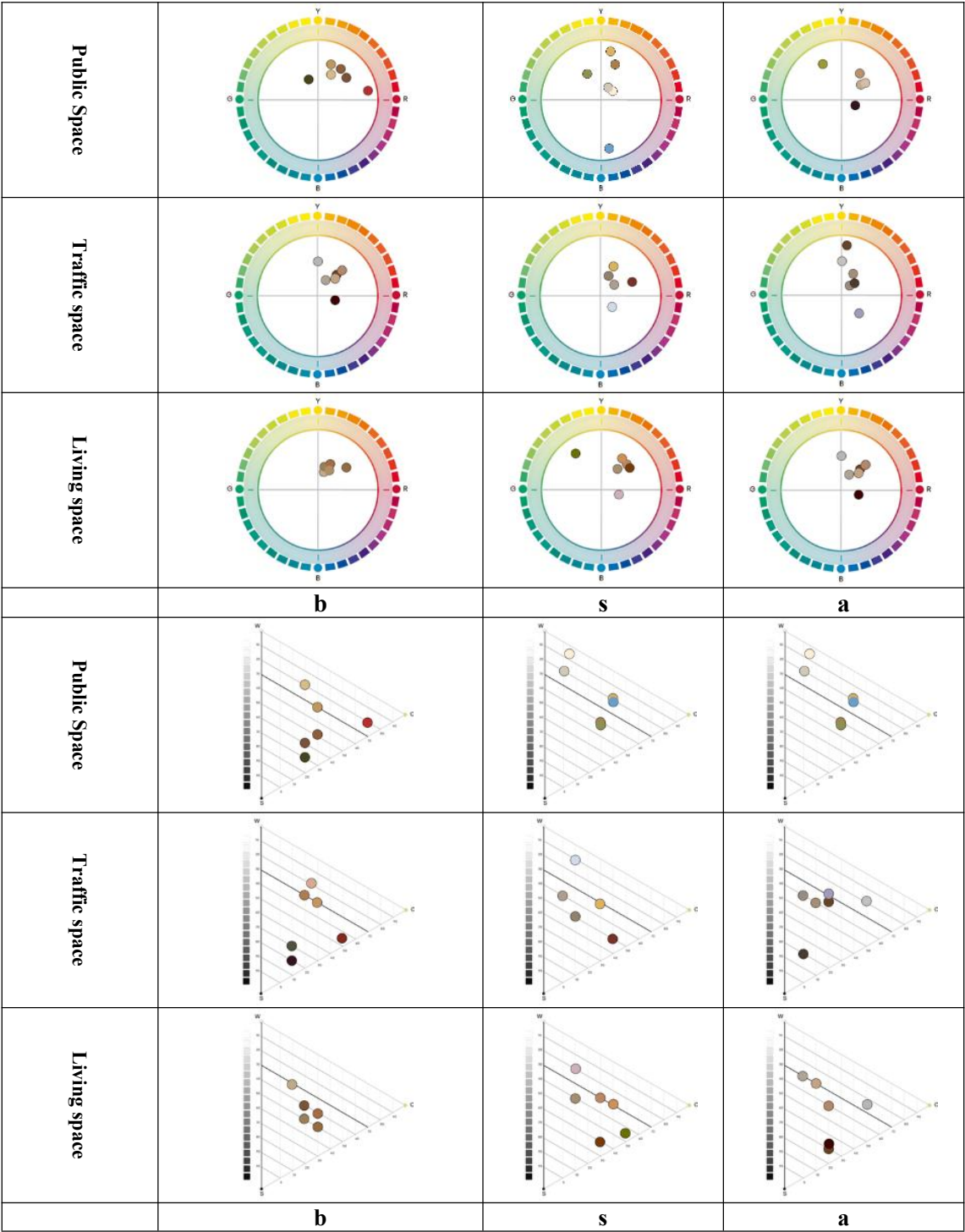
After collecting the color swatches, the data were quantified to satisfy the requirements of the subsequent color analysis work. The study employed a mixed method of quantitative and qualitative analysis, and the color data processing consisted of the following four steps:

- (1) Determine the basic analysis unit: Based on the color situation of dementia care unit spaces, identify the main color swatches as the basic unit of analysis.
- (2) Color data transformation: Use NCS ColourPin software to transform the RGB value of the color swatch into NCS value, and label its position on the NCS color circle. This step converts various color parameters (hue, brightness and saturation) into single values, which facilitates later analysis.
- (3) Deduce the current color chart: Use NCS Navigate tool to perform color transformation and construct a three-dimensional color model. While quantifying the color information, the color distribution and combination on site should also be

intuitively deduced to form a color chart. This step provides an intuitive comprehension of the current state of color application through qualitative observation of color, as shown in the figure.

(4) Establish a color information database: Integrate all processed color information together to form a systematic color information database, which facilitates subsequent color analysis and design work.

Table 2. NCS color ring and color stereo color positioning .



3.2. NCS Color Clustering

By comparing and clustering the color distribution models of the three care units, it can be seen that the three spaces exhibit a similar pattern of concentration, which reflects two evident color tendencies of the current domestic typical dementia care space color design. Firstly, the samples concentrated in the Y to R color domain made up 68%, roughly distributed in the fan-shaped area between the Y and R hue axes. The concentration level of warm color area is stronger than that of cold color, dominating the position, as shown in Table 5. Secondly, combined with the chart analysis,

it can be seen that the main brightness distribution of dementia care space color ranges from W20 to W80; the chroma mainly ranges from S05 to S60. High brightness ($70 < S$) samples constituted 24%, medium brightness ($30 < S < 70$) samples constituted 62%, and low brightness ($S < 30$) samples constituted 14%. High chroma ($60 < C$) samples constituted 4%, medium chroma ($30 < C < 60$) samples constituted 20%, and low chroma ($C < 30$) samples constituted 76%. It can be seen that the color displays a tendency of medium brightness and low chroma.

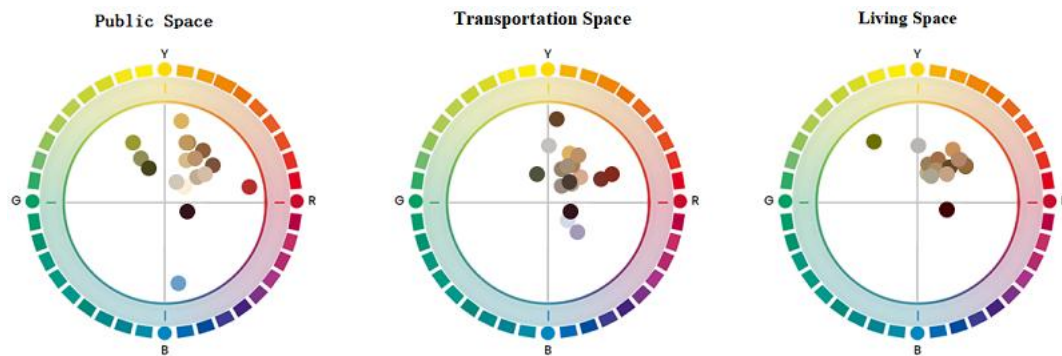


Figure 3. Color ring analysis.

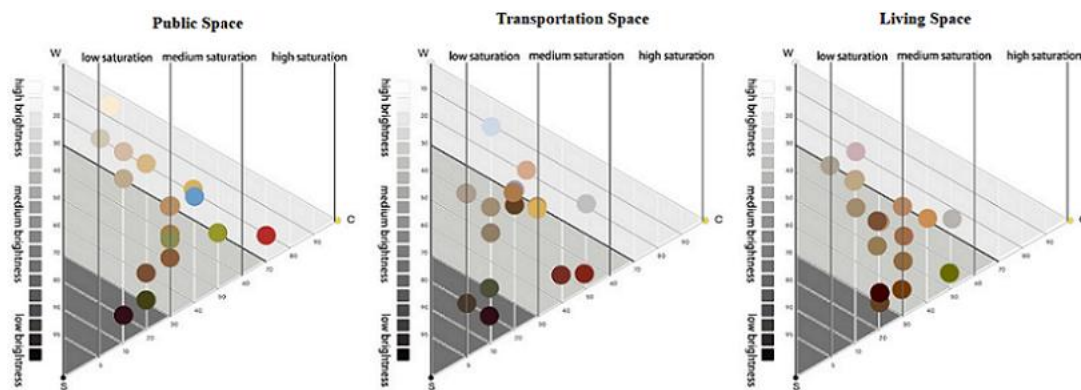


Figure 4. Color stereo color analysis.

It is noteworthy that each care unit has its distinctive color environment. These differences may be associated with the geographical location, cultural background and design concept of each unit. For instance, the color design of Shanghai Sheshan Nursing Home employs more green and blue, reflecting its pursuit of serene and natural design concept. While Anshan Xiangyiyuan Elderly Apartment favors warm and lively colors, such as red, orange and yellow, which may reflect its pursuit of vigor and upbeat design concept.

4. Spatial Color Design Strategy of Dementia Care Unit Based on NCS System

The use of color in dementia care unit spaces has its specificity, especially when taking into account the BPSD of elderly people with dementia, this use becomes more intricate. Based on the above spatial color chart, the use of color in public space, traffic space and residential space can be summarized into design methods.

4.1. Public Space Color Design Strategy

The color of public space should offer cognitive assistance. Public space, as the initial contact space, should provide psychological support and cognitive ability for the environment for elderly people with dementia in creating a reassuring and familiar atmosphere. Choose colors that are easy to comprehend, such as low brightness ($S < 30$), low chroma or ultra-low chroma ($C < 30$) colors, to create a gentle and tranquil environment, which helps to alleviate patients' anxiety and distress. The selection of this color is also easier for elderly people with dementia to comprehend, helping them to better understand and adjust to the environment. In addition, the selection of color should also reduce visual confusion and excessive stimulation, and avoid triggering patients' anxiety and agitation [6].

4.2. Traffic Space Color Design Strategy

The color design of traffic space should offer visual guidance. Traffic space is the corridor connecting different functional areas. The selection of medium-high brightness ($30 < S$) color can serve as an effective visual guidance, and also add some lively and bright elements to these functional spaces. Due to the visual deterioration and color recognition ability decline of elderly people with dementia, the color design of traffic space within the range of 10 levels, at least two levels of color value change can assist elderly people with dementia in distinguishing colors. There should be a more noticeable color contrast among the wall, floor and furniture. It can enhance the sense of space, facilitate identification, prevent bumping, and high chroma ($60 < C$) color can capture the attention of elderly people [3,4].

4.3. Residential Space Color Design Strategy

The color design of residential space should offer emotional soothing. Residential space is more about considering the personal needs and preferences of patients, using cozy adjacent colors and analogous colors, to create a serene and soothing environment atmosphere [7]. This aids their sleep quality and personal mood regulation. And furniture and beds can use striking colors to help them better recognize personal items, try to select colors that are similar or adjacent to the colors that patients are familiar with and fond of, to increase their acceptance and comfort of the environment. Furniture and beds can use brighter and more striking colors to help patients better recognize personal items, enhance their spatial cognitive ability, and effectively alleviate patients' BPSD symptoms [8].

5. Conclusions

According to the research analysis, the impact of color design on elderly people with dementia is not negligible. Color can influence elderly people with dementia through multiple pathways such as vision, cognition, emotion, etc. The study shows that suitable color design can modulate BPSD symptoms, help alleviate the anxiety of

elderly people with dementia, enhance their cognitive ability, and stabilize their emotional fluctuations.

But it should be noted that the color design of dementia care unit in China still needs to be further advanced. Based on the NCS color system, this paper fully considers the behavioral features of elderly people with dementia, the design principles and activity requirements of dementia unit, and conducts thorough analysis on the color design of three main spaces, thus proposing a series of design strategies. However, due to the limitations of the study, the color design strategies in this paper cannot encompass all situations. Therefore, it is necessary to conduct long-term and in-depth research and adjustment according to the changes of actual environment and patient needs. In future work, more thorough research is needed from both theoretical and practical levels, in order to propose more scientific and pragmatic color design recommendations.

Conflicts of Interest

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

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