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Space Color Design of Medical and Nursing Institutions Based on Adaptive Aging Characteristics

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Abstract With the acceleration of China's aging process and the rapid development of social economy, the government's strong support for the integration of medical and nursing has made the construction of medical and nursing buildings more efficient. At the same time, the need for old-age care is more diversified and hierarchical, and the life cycle is more obvious. Designing an aging color environment for the elderly with different visual abilities in medical care buildings has become a problem for investors, operators and designers. This paper takes the indoor color of medical and nursing buildings as the research object, and combines the characteristics of the elderly's visual acuity and the ratio and efficacy of indoor colors to investigate two high-end medical and nursing institutions in Beijing and Nanjing. Based on the physical, psychological and behavioral needs, this paper explores the appropriate aging color design method for the living space of the elderly in the medical institutions, aiming to make a meagre effort for the in-depth research and practice of indoor environment design of medical institutions in the future.

Keywords Medical care space, Elderly-oriented, Color design
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The General Office of the State Council issued the *Opinions on Promoting the Development of Elderly Care Services* in 2019, which pointed out the need to promote the construction of infrastructure for elderly care services. However, due to limited conditions, many medical and nursing institutions have not yet fully realized the construction of aging friendly environments. Among them, the problem of aging friendly indoor color environments is the most prominent, and color issues are often overlooked by designers. For example, medical and nursing institutions present a hospitalized space atmosphere due to monotonous indoor color matching, and the elderly suffer from optical illusion or psychological disease due to unreasonable color matching. The medical and nursing environment of ignoring aging color characteristics of space will cause the elderly to lose their sense of belonging and identity to medical and nursing institutions. Designers need to adhere to the principles of "taking the elderly as the foundation" and "meticulous consideration", and combine the physiological, psychological and behavioral characteristics of the elderly to deeply analyze the color design method suitable for aging characteristics, and strive to build a comfortable, peaceful and vibrant indoor environment for medical institutions.

1 Ratio and efficacy of indoor colors in buildings

1.1 Ratio of indoor colors in buildings

The indoor color of buildings can be divided into main color (background color), auxiliary color (theme color) and decorative color (pointed color) according to their proportion, accounting for 60%, 30% and 10% of the total indoor color respectively[1]. The main color is used for indoor walls, roofs, and floors, directly establishing the overall color characteristics of the interior. The auxiliary color is used for indoor furniture, doors and windows, etc., to coordinate or balance the main color and create an overall sense of comfort. Decorative color is used for indoor soft decoration and furnishings to awaken spatial vitality and enhance overall comfort.

1.2 Efficacy of indoor colors in buildings

The indoor color of buildings has the functions of improving the spatial environment and regulating the physical and mental health of users. In terms of improving the spatial environment, combining the local climate and indoor lighting environment, selecting different types of color hues and different shades of cold and warm can change people's subjective perception of room temperature and spatial scale, and can also play a role in regulating indoor lighting, guiding spatial sequences, and reshaping the user's mood. Colors with different lightness, hues and purity can affect the psychology of people who have lived in this color environment for a long time by stimulating the brain nerve[2], and then affect their personality characteristics, health status and behavior activities. For example, colors with high brightness and purity values can reduce the loneliness of the elderly, but they can also trigger sensitivity and fear of the elderly in special situations[3]. In addition, reasonable color matching of walls and signs can enhance the roles of positioning, guidance, and safety warnings. Therefore, reasonable application of colors in the interior of buildings is an important measure to achieve humanistic care for users.

2 Analysis of the characteristics of visual changes in the elderly

The common eye diseases of the elderly mainly include senile cataract, primary glaucoma, diabetic retinopathy, refractive error, etc[4]. With the increase of age, the incidence rate gradually increases, and eye diseases will seriously affect the vision and quality of life of the elderly. For example, senile cataracts (Fig.1) mostly occur in people over 45 years old. The incidence rate of people aged 50 to 60 years old is 60% to 70%. The incidence rate of people over 70 years old is even higher, even more than 80%[5]. The probability of diabetic retinopathy in patients with diabetes increases with the duration of the disease and age. The correlation between incidence rate and the duration of diabetes is shown in Table 1[5].

This type of disease not only reduces the visual adaptation ability of the elderly in low to high brightness environments, but also affects their perception of peripheral vision and depth[6]. The accompanying symptoms of presbyopia, blurred vision, and decreased sensitivity to blue not only directly affect the elderly's intuitive perception of indoor space and color[7], but

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Table 1 Correlation between the course of diabetes and diabetic retinopathy

Course of diabetes//a	Probability of retinopathy//%
6–10	36.4
11–15	58.0
> 15	72.0

also lead to eye fatigue and accelerate visual impairment.

From this, it can be seen that the elderly's vision will gradually decline, and there is a possibility of accelerated decline in later life. Therefore, designers need to make sustainable aging design considerations for the indoor color environment of the elderly based on the particularity and lifecycle of their visual changes.

3 Analysis of indoor color environment cases in medical and nursing institutions

3.1 Beijing Vanke Suiyuan Retreat Center

3.1.1 Facility overview. Beijing Vanke Suiyuan Retreat Center covers an area of approximately 40,000 m^2, with over 700 beds and public supporting spaces with more than 20 functions. It practices the CCRC elderly care model, creates an active social atmosphere in the neighborhood, provides an elegant aging living environment for different types of elderly (self-care, nursing and assistance), and follows the concept of "combination of medical care and nursing care". The self-run rehabilitation hospital and attentive housekeeper provide professional and high-quality medical care services and all-round life care, and it is committed to bringing a warm and dignified old age life to every resident elderly.

3.1.2 Indoor color environment. The interior of Suiyuan Retreat Center adopts similar colors to maintain the unity and coordination of spatial tones, presenting a soft texture. The walls of the elderly living room (Fig.2) are decorated with white tea latex paint and light oak wall panels, and the top is decorated with white latex paint. The ground is laid with a very casual natural wood color floor. The TV cabinet and sofa are respectively in walnut and orange gray to increase the visual weight of the space, while the curtains are in a stable dark coffee color, which not only balances the visual weight but also enhances the indoor comfortable atmosphere. The ceiling material color of the canteen space (Fig.3) adopts a combination of dark brown and black to weaken the visual conflict of equipment pipelines. The ground color is combined with dark gray and oak color to create a paving effect that echoes the ceiling. At the same time, the space is divided and organized according to different colors and materials. The gold and tea gold lighting fixtures, walnut colored dining tables, and low-purity orange and tea white dining chairs not only ensure the coordination of spatial color and visual weight, but also make the spatial atmosphere stable and vibrant. The walls of the painting room (Fig.4) are decorated with white and light oak wood boards, and the plastic floor on the ground is dark gray, and the writing desk panel is oak, creating a refined and simple spatial temperament together.

3.2 Nanjing Oubaoting Xianlin International Retreat Center

3.2.1 Facility overview. Oubaoting Xianlin International Retreat Center is built according to international standards, and is a long-term care institution for the elderly integrating European standards and Chinese culture. The building area is approximately 17,000 m^2, with 111 rooms and a maximum capacity of 140 beds. As a high-end medical care elderly care institution for elderly people with disabilities, semi disabilities, and dementia, the retreat center provides elegant aging environment facilities, advanced non drug therapy facilities, geriatric medical departments, professional and scientific nursing teams, and other facilities and services to safeguard the healthy life of the elderly who stay, hoping that the elderly can enjoy high-quality elderly life in a romantic atmosphere.

3.2.2 Indoor color environment. The walls and furniture of the elderly living room at Oubaoting Xianlin International Retreat Center (Fig.5) are made of large area teak and walnut wood panels, and the sofa and seats are in ivory color, laying a casual and warm spatial atmosphere. Dark brown curtains are easy to not only block out light but also coordinate the visual weight of the space. Lighting fixtures, hanging paintings, and other furnishings use relatively cool colors such as white and light cyan to enhance the exquisite and elegant atmosphere of the space. The canteen (Fig.6) has white walls, elegantly decorated Chinese painting, dark brown and dark red dining chairs, and white table cloth to create a noble and elegant dining environment. The corridor (Fig.7) is paved with beige tiles and walnut wood flooring on the ground, and the walls are decorated with wood panels with different brightness values to distinguish between rest and aisle spaces. The color of the cushion in the rest space is consistent with the color of the bedroom sofa, enhancing the correlation and integrity between public and private spaces.

4 Color design method for aging adaptability in medical and nursing institutions

4.1 Color design method for aging adaptability of residential space

Due to the privacy of the living room and being the space where the elderly stay for the longest time, the color design of the living room should consider the physiological acceptance and psychological preference of the elderly towards different colors. In terms of physiological acceptance, the indoor skylight environment formed by strong sunlight exposure can increase the excitability of the cerebral cortex, enhance fatigue in the elderly[3]. At the same time, the dazzling light sensation can exacerbate visual decline in the elderly. Therefore, the walls of the living room should not be pure white, and the ground should not use paving materials with high color brightness and purity values, as well as reflective materials[8]. In terms of psychological preferences, a warm and vibrant color environment helps the elderly maintain a peaceful mindset. Considering the different living habits and preferences of the elderly, warm gray or neutral warm colors can be selected for the walls, such as light yellow, natural wood color, light green (Fig.8), to facilitate the elderly to create an overall atmosphere of the room according to their own preferences.

The color of the floor material in the living room should be different from the color of the wall, using warm tone colors of low brightness, such as light earth colors that promote relaxation. When mosaic patterns are used on the ground, it is necessary to not only maintain the consistency and regularity of the patterns, but also ensure that the pattern color is similar to the background color, and the difference in lightness and purity is small, so as to avoid the safety accidents of the elderly due to optical illusion. When there is a height difference between the bathroom floor and the living room floor, its color should be different from the overall brightness or purity of the living room floor color to serve as a safety reminder. The interior walls of the bathroom should not be made of pure white materials with high glossiness to prevent the elderly from falling asleep again due to the bright visual environment stimulating the cerebral cortex when they wake up at night. The walls and floors should be colored differently from the sanitary ware and handrails, forming a strong contrast between the two. This is more convenient for the elderly to quickly identify target tools and adjust their behavior. For example, the sanitary ware and handrails in Fig.9 are pure white, and the walls

are golden brown with low brightness values.

The color matching of bedroom furniture and soft furnishings should refer to the personal preferences of the elderly. The furniture is mostly warm and tranquil light wood color, which can create a warm feeling in the living space[9]. The colors of soft furnishings such as curtains, bedding, sofas, wall photos, and indoor plants should ensure low brightness and warm hues compared to the colors of living room walls. They can be matched according to the personal personality and hobbies of the elderly in different seasons, enriching and regulating the living atmosphere, and enhancing the elderly's sense of identity and belonging in the living space of medical institutions. In addition, due to the decline in elderly people's situational memory ability, they often forget commonly used items that have been placed elsewhere for a short period of time. Therefore, the background color of the area where the items are placed should form a clear light and dark contrast with the color of the items themselves[3].

4.2 Design method of aging friendly color for canteen space

Due to the decrease in sensitivity of the eye organs of the elderly to blue, according to the color ring diagram (Fig.10), it can be seen that they have a higher sensitivity to the three shades of yellow, orange, and red. At the same time, yellow and orange have the effect of enhancing appetite. Therefore, it is advisable to use yellow or orange with different brightness and purity values to distinguish functional areas such as the preparation area, distribution area, dining area, and tableware recycling area in the canteen space wall in combination with indoor lighting environment. Moreover, the overall color temperature of the space could be balanced through local combinations of green or blue soft furnishings or furnishings with high brightness or purity values. When there are columns or columns protruding from the wall in the space, it is advisable to wrap the column corners with red or dark gray pads to prevent elderly people from getting injured.

The color of the canteen floor material should be pure gray with a medium brightness value, and it should ensure the consistency of the overall floor color to prevent elderly people from losing stability and falling due to accidentally stepping on the soup and food spilled on the ground. If it is necessary to use ground colors to divide the space, the color scheme should not exceed two, and it should ensure that the brightness and purity values of the two are similar. As shown in Fig.3, the ground is divided into two colors: oak and dark gray.

The colors of dining tables, chairs, and tablecloths should be consistent and distinct from the purity and brightness of wall and ground colors. They can be made in natural wood, light green, or light blue to create a natural and peaceful dining atmosphere.

4.3 Design method of adaptive aging color for public activity areas

A permanent activity room in medical and nursing institutions is convenient for the elderly to engage in entertainment and communication activities. Common activities include calligraphy and painting, reading, fitness, chess and cards, etc. By analyzing the dynamic and static characteristics of various activities, colors can be reasonably matched to meet the elderly's needs for space use. For example, when elderly people engage in calligraphy, painting, and reading activities, they need a bright and soft visual environment and a peaceful psychological state. Therefore, the walls should be light yellow or light yellow green, and the ground should be paved with light earth colored plastic flooring or walnut colored wood flooring to create a stable atmosphere in the space. Furniture should be in natural wood color, and green plants should be placed next to seats to reduce eye fatigue. When elderly people engage in fitness and chess and card activities, in order to enhance their interest and passion, local walls can be painted with vivid colored murals or orange or red latex paint with high brightness and purity values. In addition, due to the role of red and purple in promoting inspiration and enhancing memory[3], it is more meaningful to appropriately use red and purple with higher brightness and purity values in the activity room. As shown in Fig.11, the table tennis table in the activity room is made of high-purity purple, which can adjust the artistic atmosphere of the space and improve the quality of exercise for the elderly.

As a transitional space between indoor and outdoor areas in medical and nursing institutions, the foyer is a favorite gathering space for the elderly[10], and an important place for the elderly to stop, communicate, and observe the behavior of others. In order to create a warm and comfortable atmosphere for communication and rest in the foyer, and avoid discomfort for the elderly due to the strong contrast between the interior and exterior lighting environment after entering the foyer from the external space, it is advisable to use light yellow with higher brightness values on the walls, such as soft and elegant linen yellow or goose yellow. When the foyer is equipped with seats or green plants, the color of seats should be indigo or light green with lower lightness and purity to coordinate the color temperature of the space. In addition, the elderly have a higher recognition of text than graphics and sound. The color of various identification texts in foyer and other spaces should use red with a higher brightness value, while white or black, which forms a sharp contrast with red, can be used as the background color of the text.

Shared space and corridor are usually connected in series. In principle, the colors of the two should be consistent to ensure the overall sense and continuity of the space. However, with the decline of the elderly's situational memory ability and space recognition ability, the walls and furnishings with different colors and warm hues should be decorated in each shared space to reflect the characteristic space theme, such as the theme of four seasons, the theme of historical stories, the theme of the twelve zodiac signs, etc., which not only can enhance the story and interest of the space, but also facilitate the elderly to locate the space in time and ask for help in special circumstances. In the internal corridor style of medical and nursing institutions, the natural light environment of the corridor is poor. To ensure the illumination of the corridor and the safety of elderly passage, the walls should be made of pure white or light yellow with higher brightness values to enhance the diffuse reflection effect of light. The color of the corridor skirting line should be clearly contrasted with the ground color to emphasize the transition of two interfaces, thereby eliminating the safety hazards of elderly people accidentally stepping on their feet and falling. The corridor floor color should not be too low in brightness value, but also should not be decorated with color blocks or contain complex patterns. They can easily cause optical illusion to the elderly whose visual ability and reaction ability are reduced. The elderly walking in a cautious and nervous state of mind in order to ensure foot safety will enhance the sense of brain fatigue.

5 Conclusions

With the rapid improvement of China's national living standards and the increasing demand for elderly people's spiritual well-being, the adaptive aging color design methods for indoor spaces in medical and nursing institutions still need to be continuously explored and practiced. Designers should take the physiological, psychological, and behavioral demands of the elderly as the starting point,

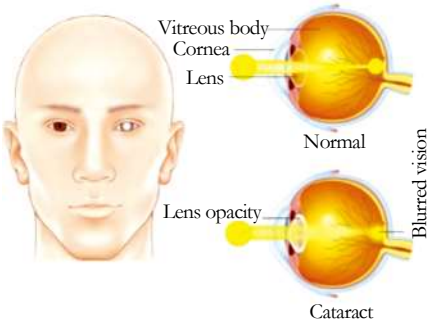

Fig.1 Cataract eye diagram

Fig.2 Bedroom of Suiyuan Retreat Center

Fig.3 Canteen of Suiyuan Retreat Center

Fig.4 Painting room of Suiyuan Retreat Center

Fig.5 Bedroom of Xianlin Retreat Center

Fig.6 Canteen of Xianlin Retreat Center

Fig.7 Corridor of Xianlin Retreat Center

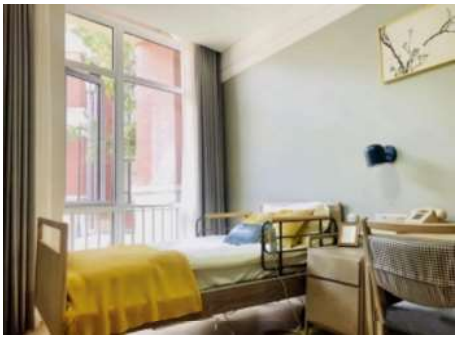

Fig.8 Bedroom of Yuenianhua Retreat Center

Fig.9 Toilet of Suiyuan Retreat Center in Beijing

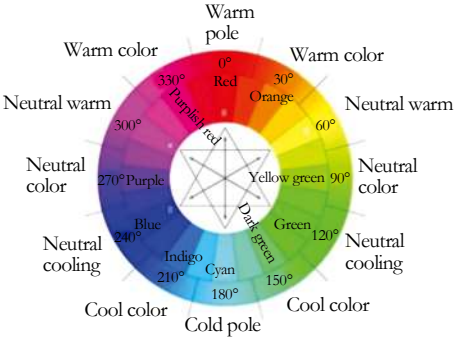

Fig.10 Color ring

Fig.11 Activity room of Suiyuan Retreat Center

adhere to the design concept of "people-oriented, elegant and considerate", and comprehensively coordinate and reasonably match indoor colors, thereby making what the elderly see and feel warm in their eyes and hearts. It should create the space color environment of medical institutions with a sense of belonging and suitability, improve the happiness index of the elderly in their later years, cultivate their optimistic attitude towards life and healthy habits, and provide them with spiritual satisfaction and comfort in a warm and comfortable spatial environment.

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