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Exploring the Application of Painting Art in Residential Space Design: A Study of Strategies to Enhance the Psychological Comfort of Occupants

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Abstract Under the background of contemporary rapid urban development and people's growing spiritual needs, residential space not only assumes the function of living, but also carries the role of psychological comfort and emotional regulation. Painting art, as an important component of soft furnishings, is becoming an important means to enhance the psychological comfort of the occupants. This study explores the influence of the application of painting art in different residential space styles on the psychological comfort of the occupants, constructs an evaluation index system with the dimensions of social, recreational and psychotherapeutic, and determines the weights of each index through the hierarchical analysis method (AHP). After carrying out empirical analysis on three types of residential styles (Chinese classical, European classical, and modern styles), it was found that the painting art of the modern style had the highest score on psychological comfort, 80.9; the Chinese classical style was 70.1, and the European classical style was 69.6. The critical role of the 14 evaluation indexes in psychological comfort enhancement was further verified through the analysis of necessity and sufficiency conditions. The study concludes that modern style painting art is more advantageous in promoting emotional regulation, spatial perception and active activities, which can significantly improve the psychological comfort and humanistic care level of residential space.

Index Terms painting art, psychological comfort, residential space, hierarchical analysis, modern style, evaluation index system

I. Introduction

Maslow's Pyramid Needs Theory, a famous American psychologist, proposes that human needs are divided into five basic levels from low to high, i.e., physiological, safety, social, and esteem needs, as well as self-actualization needs [1]. Maslow believes that once people's basic needs are satisfied, other higher-level needs will emerge, i.e., the generation of human needs is a development process from low-level physiological needs to high-level self-actualization needs [2]. At present, people's demand for residential space design has been not only to live, but to have a good living environment, indicating that the level of people's needs is gradually developing to a higher level. In the current residential space design, only the physiological health needs of the occupants are paid attention to, and the psychological health needs are neglected, while the two are mainly reflected in the comfort requirements of the functional space [3]-[5]. Residential comfort mainly includes three aspects: reasonable functional partition, appropriate scale space and appropriately enlarged accessory space [6], [7]. Designers should consider the design needs from the aspects of humanization, health, culture, intelligence, art, etc., through targeted and in-depth analysis in order to meet the physiological and psychological comfort [8], [9].

In the design of residential space, wall paintings often appear as decorations and are most common in well-decorated houses, but the uniform style of wall paintings (mostly simple oil paintings) leads to the occupants of the space to meet the demand for art and aesthetics can not be met, and the occupants often need to remodel the space [10], [11]. Murals, on the other hand, are less often implemented in spatial design due to implementation costs and design difficulties. However, murals can affect human cortisol levels, which in turn affects mood, heart rate, perception, and helps regulate physical adaptation under short-term stress. Painting can promote human brain fatigue recovery and stress relief. Different color paintings can affect human sleep quality and mood pleasure situation [12]-[16]. Therefore, designers should incorporate the art of painting as much as possible based on the overall consideration of the proportion, shape, texture, color, light, and smell of the space in conjunction with the design scenario in order to create a psychologically comfortable environment suitable for occupants [17], [18].

Driven by the wave of social transformation and urbanization, people's expectations for the living environment are no longer limited to the functional level, and the spiritual and psychological needs are becoming more and more

prominent. As a container for human emotional expression and psychological projection, the artistic and emotional aspects of spatial design have become a subject that designers must face. In the process of long-term living, the aesthetics of space has a subtle influence on the psychological state of individuals, and the art of painting, as a visual emotional medium, not only creates a spatial atmosphere, but also evokes the emotional resonance of the viewer in color, theme and composition. Therefore, how to optimize the design of residential space and enhance the psychological comfort of the occupants through the art of painting has become a new direction of current design research.

This study focuses on “the application of painting art in residential space”, takes the enhancement of occupants' psychological comfort as the core objective, and adopts a quantitative method to construct an evaluation system. The study first determines the three major dimensions of psychological comfort: social, recreational and psychotherapeutic through literature review and interviews; then constructs an evaluation model by using the hierarchical analysis method (AHP) and determines the weights of the indicators by combining with expert questionnaires; then conducts empirical evaluations on three types of spatial styles (Chinese classical, European classical, and modern styles), and draws out the differences in the influence of different styles of painting art on psychological comfort; finally, through the analysis of necessity and sufficiency, the evaluation system is determined by the analysis of necessity and sufficiency. , through the necessity and sufficiency analysis to determine the core path of the influencing factors, so as to put forward the integration strategy of ecological design, humanistic care and technological empowerment.

II. Creation of atmosphere in residential spaces by the art of painting

II. A.Ethnic and classical style traditional art atmosphere creation

(1) Chinese classical style

Chinese style has become one of the popular fashion elements in today's society. In the field of interior design, the Chinese style of home soft decoration design is not only loved by middle-aged and old people, but also favored by young people. Home accessories with Chinese cultural flavor is endless. Such as lacquer ware, pottery, tea art, embroidery, paintings, vases, Chinese knots and so on. Chinese classical style art atmosphere of elegant, calm and generous, strong culture, the living room environment has a high aesthetic interest and a symbol of social status. The soft decorative design of the space to create a symmetrical layout, decorative materials to wood-based, decorative patterns to traditional auspicious patterns, decorative color calm to red, black, yellow-based. Indoor furnishings pay attention to the space level, very heavy cultural implication, mainly Ming and Qing dynasty furniture, supplemented by screen partitions, plaques and couplets, transparent curtains, woven tents and bead curtains, embellished with scrolls and paintings, antiques, bonsai, etc. [19]. Rendering Chinese home culture unique classical flavor and mood. So that the human body and mind to get the traditional culture and art atmosphere of cultivation, to meet the spiritual needs of people.

It should be noted that the Chinese classical style of home soft decoration design is not a pile of Chinese elements, the full meaning of the retro Ming and Qing dynasties, but the past, heritage and innovation, through the understanding of traditional culture, traditional elements and modern design concepts combined together to draw on the traditional Chinese decorative “form and spirit” features, reflecting national characteristics, The traditional elements are combined with modern design concepts through the understanding of traditional culture. And then create a rich Chinese flavor, subtle and dignified oriental culture and art atmosphere. So that modern people's home life can enjoy the material civilization of modern society, but also can really feel the cultural heritage of the Chinese themselves.

(2) European classical style

European classical style as one of the traditional styles of interior design, with its decorative classic romantic, gorgeous and noble, strong Western artistic heritage, historical connotations and has been popular with the pursuit of love. European classical style home soft decoration design emphasizes the gorgeous decorations, heavy colors, exquisite shape to achieve a graceful and noble decorative effect. Decorative motifs such as flowers and plant motifs are dominant. Home accessories to multiple wrinkled Roman curtains, fine carpets, exquisite tapestries, elegant European-style lamps, sculpture crafts, landscape paintings and other European elements to render the artistic atmosphere of the European style. It should be noted that the overly luxurious decorations should be avoided to destroy the natural atmosphere of the home.

II. B.Modern style of simple art atmosphere creation

The minimalist style of modern home soft decoration advocates the decorative concept of fewer than many and simplicity over complexity. The essence of its design is to make the atmosphere of the room and the life of the occupants more free. This requires the designer to go deep into the life, carefully scrutinize, carefully refine, use the

least design language, express the deepest design connotation, to create a rich and moving space effect. Specific methods of creation: (1) from the functional point of view, discard unnecessary interior elements, often simplify the design elements, color, lighting, raw materials to the minimum degree. (2) Emphasize the appearance of simple and bright, pay attention to the proportion of the shape of the moderate, space, the sense of transparency and extension. (3) Choose modern furniture with simple and smooth modeling and few decorative elements in the furniture configuration. (4) Decorative colors are often black, white, gray-based, and embellished with jumping colors. Decorative materials focus on their own texture. (5) Furnishing arrangements generally use geometric elements (points, lines, surfaces, blocks) for the combination to reflect a strong form of beauty and abstract beauty, so that people feel simple and bright sense of the times.

III. AHP-based model for evaluating the psychological comfort of occupants

III. A. Construction of evaluation index system of psychological comfort of occupants

The construction of the evaluation system should not only consider the comprehensiveness and rationality of the system, but also take into account the relevance and operability of the evaluation indexes, and combine the qualitative and quantitative indexes. This paper constructs the evaluation index system of occupants' psychological comfort from three dimensions of residential sociality, recreation and psychotherapy, and the results are shown in Table 1. Sociality includes six indicators: indoor and outdoor communication space, creating a sense of belonging, not disconnected from modern society, care services, social interaction, and optional private space. Recreationality contains 4 indicators: development of hobbies and interests, promotion of active sports, indoor activity space, and exposure to natural landscapes. Psychotherapeutic includes 4 indicators: emotional regulation and release, psychological projection and therapy, emotional resonance and linkage, and sense of space.

Table 1: Evaluation index system of the residents' psychological comfort

Target layer	Criterion layer	Index layer
Evaluation of the psychological comfort of the occupant	Sociality (B1)	Indoor and outdoor communication space (C1)
		Feel a sense of belonging (C2)
		It's not out of touch with modern society (C3)
		Care service (C4)
		Social interaction (C5)
		Optional private space (C6)
	Entertainment (B2)	Develop hobbies (C7)
		Promote active motion (C8)
		Indoor space (C9)
		Natural landscape (C10)
	Psychotherapy (B3)	Mood regulation and release (C11)
		Mental projection and treatment (C12)
		Emotional resonance and links (C13)
		Sense of space (C14)

III. B. Comparative judgment matrix construction

The occupant's score rate (score rate = average score/total score) for a particular type of indicator stratum was used as the basis for constructing a comparative judgment matrix. If there is overall agreement (higher scores) on a particular category of factors, then that category of factors has been better considered in the design of residential spaces. Conversely, it indicates that the design involving that category of factors is in dire need of improvement. In order to quantify the results of two-by-two comparisons, the judgment scale of AHP is used to construct a comparison judgment matrix [20]. It is defined as follows:

"1" indicates that the two categories of factors are of equal importance.

"3" indicates that factor i scored 10% higher than factor j in both categories (i is slightly more important than j).

"5" indicates that factor i scored 20% higher than factor j in both categories (i is significantly more important than j).

"7" indicates that factor i scored 30% higher than factor j for both categories (i is significantly more important than j).

"9" indicates that factor i scored 40% higher than factor j for both types of factors compared to each other (i is extremely important than j).

"2, 4, 6, 8" is in the middle of the above two adjacent judgment scales.

If the difference between factor i and factor j scores is not an integer multiple of 0.05 $(0.05n+k, n>1, 0<k<0.05)$, the difference is closer to whichever neighboring judgment scale it belongs to. For example, if the difference between the two is 0.13, it is obviously closer to 0.15 than to 0.10, so the judgment scale chosen is 4. When the difference is negative, the absolute value is taken as the reciprocal of the corresponding judgment scale.

Let the score rate of residential social, recreational, and psychotherapeutic be B_1, B_2, and B_3, respectively, and in accordance with the principle of stipulating the weights of relative importance, then the judgment matrix from the target layer A to the criterion layer B is:

$$R=\begin{bmatrix} B_1-B_1 & B_1-B_2 & B_1-B_3 \\ B_2-B_1 & B_2-B_2 & B_2-B_3 \\ B_3-B_1 & B_3-B_1 & B_3-B_3 \end{bmatrix} \tag{1}$$

A matrix of correlation coefficients can be obtained based on the judgment scale:

$$R_1=\begin{bmatrix} 1 & 1/2 & 1 \\ 2 & 1 & 2 \\ 1 & 1/2 & 1 \end{bmatrix} \tag{2}$$

For the indicators of the social component of the dwelling, the matrix of constructed correlation coefficients is:

$$R_2=\begin{bmatrix} 1 & 1 & 3 & 4 & 3 \\ 1 & 1 & 3 & 3 & 1 \\ 1/3 & 1/3 & 1 & 1 & 3 \\ 1/4 & 1/3 & 1 & 1 & 4 \\ 1/3 & 1 & 1/3 & 1/4 & 1 \end{bmatrix} \tag{3}$$

For the indicators of the recreational part of the residence, the matrix of constructed correlation coefficients is:

$$R_3=\begin{bmatrix} 1 & 3 & 1 \\ 1/3 & 1 & 1/3 \\ 1 & 3 & 1 \end{bmatrix} \tag{4}$$

For the indicators of the residential psychotherapeutic component, the matrix of constructed correlation coefficients is:

$$R_4=\begin{bmatrix} 1 & 1/2 & 3 & 2 \\ 2 & 1 & 2 & 1/2 \\ 1/3 & 1/2 & 1 & 1/2 \\ 1/2 & 2 & 2 & 1 \end{bmatrix} \tag{5}$$

III. C. Ordering of the hierarchy

Hierarchical single sorting has to compute the eigenvalues λ and eigenvectors W of the judgment matrix R, $\lambda_{\max}=\max(\lambda)$, i.e., satisfy $RW=\lambda_{\max}W$, and perform the normalization operation on the eigenvectors W with the respective component of each vector W being the weights of the corresponding elements.

In order to test the consistency of the judgment matrix, it is necessary to calculate its consistency index CI and random consistency index CR. Among them:

$$CI=\frac{\lambda_{\max}-n}{n-1} \tag{6}$$

$$CR=\frac{CI}{RI} \tag{7}$$

where n is the matrix order. The values of RI are shown in Table 2.

Table 2: The value of RI

Exponent	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49

When $CR < 0.1$, the judgment matrix is considered to have satisfactory consistency. For the judgment matrix $R_1 : \lambda_{\max} = 4.01, CI = 0.001, CR = 0.001 < 0.1$ for overall evaluation, it passes the consistency test. For residential sociality the judgment matrix $R_2 : \lambda_{\max} = 5, CI = 0.0015, CR = 0.0024 < 0.1$, passes the consistency test. For residential recreational the judgment matrix $R_3 : \lambda_{\max} = 3.2, CI = 0, CR = 0 < 0.1$, passes the consistency test. For residential psychotherapeutic the judgment matrix $R_4 : \lambda_{\max} = 4.063, CI = 0.229, CR = 0.0252 < 0.1$, passes the consistency test.

III. D. Empirical analysis

III. D. 1) Determination of indicator weights

Questionnaires were distributed to 20 experts, of which 18 were valid questionnaires, and the validity rate of the questionnaires was 90%, which was in line with the validity standard. Establish the hierarchical analysis model in Yaahp software and import the relative importance data of the two layers of indicators, and get the weight coefficients of each indicator in the evaluation system of psychological comfort in healthy elderly buildings after normalization and consistency test.

The indicator layer weights are shown in Table 3. In the criterion layer, recreationality has the highest weight of 0.462. Which promotes active movement (0.136), indoor activity space (0.132), and so on have relatively large weights. This is followed by psychotherapeutic (0.332), which has the highest percentage of spatiality among the psychotherapeutic indicators, occupying 26.7% of the indicators in this criterion layer. Again, sociality, with a weighting factor of 0.206, sociality is more concerned with providing occupants with socially interactive, optional private spaces.

Table 3: Index weight

Criterion layer	W	Index layer	W	RW
B1	0.206	C1	0.152	0.031
		C2	0.136	0.028
		C3	0.139	0.029
		C4	0.096	0.02
		C5	0.257	0.053
		C6	0.22	0.045
B2	0.462	C7	0.136	0.063
		C8	0.294	0.136
		C9	0.286	0.132
		C10	0.284	0.131
B3	0.332	C11	0.226	0.075
		C12	0.261	0.087
		C13	0.246	0.082
		C14	0.267	0.088

III. D. 2) Evaluation results and analysis

Using the evaluation model constructed above, this paper evaluates the impact of the painting art of Chinese classical style, European classical style and modern style on the psychological comfort of the occupants, and the evaluation results are shown in Table 4. Among the three styles, the modern style of painting art has the highest overall score of 80.9 points on the psychological comfort of the occupants, followed by the Chinese classical style with 70.1 points. The evaluation score of European classical style is not much different from that of Chinese classical style. The above study shows that the modern style of painting art is the most effective in enhancing the psychological comfort of the occupants.

Table 4: Evaluation results of the residents' psychological comfort

Criterion layer		B1	B2	B3
Chinese classical style	Score	15.5	28.8	25.8
	Full mark	20.6	46.2	33.2
	Scoring rate	75.2%	62.3%	77.7%
	System score	15.5+28.8+25.8=70.1		

European style	Score	13.6	30.7	25.3
	Full mark	20.6	46.2	33.2
	Scoring rate	66%	66.5%	76.2%
	System score	13.6+30.7+25.3=69.6		
Modern style	Score	18.6	32.8	29.5
	Full mark	20.6	46.2	33.2
	Scoring rate	90.3%	71%	88.9%
	System score	18.6+32.8+29.5=80.9		

IV. Paths for improving the psychological comfort of occupants

IV. A. Necessity analysis of individual conditions

Prior to conducting the condition grouping sufficiency analysis, it is necessary to test whether there is a single condition variable that can be used as a necessary condition to influence the psychological comfort of the occupants. If the consistency level of a condition variable is greater than 0.9 and the coverage is greater than 0.5, the condition variable meets the requirement of being a necessary condition. The results of the necessity analysis of the condition variables are shown in Table 5.The consistency level of the 14 variables is greater than 0.9 and the coverage is greater than 0.5.Therefore, these 14 variables are considered as the necessary conditions to influence the psychological comfort of the occupants.

Table 5: Conditional variable necessity analysis results

Var	Aggregate consistency	Aggregate coverage	Intergroup consistency alignment distance	Intergroup consistency alignment distance
C1	0.937	0.507	0.065	0.328
C2	0.931	0.708	0.086	0.466
C3	0.966	0.703	0.45	0.154
C4	0.978	0.839	0.602	0.322
C5	0.973	0.817	0.082	0.218
C6	0.955	0.77	0.146	0.475
C7	0.992	0.514	0.011	0.133
C8	0.901	0.696	0.19	4.617
C9	0.992	0.569	0.006	0.094
C10	0.976	0.89	0.207	0.535
C11	0.924	0.644	0.116	0.195
C12	0.907	0.865	0.161	0.441
C13	0.901	0.891	0.054	0.241
C14	0.963	0.738	0.159	0.453

IV. B. Sufficiency analysis of conditional groupings

Based on the actual situation of the study, this paper sets the consistency threshold, the PRI threshold, and the frequency threshold in the sufficiency analysis to 0.7, 0.6, and 1, respectively.The results of the group-state analysis are shown in Table 6. The overall solution summary consistency and individual grouping consistency are both greater than 0.9, and the inter-group consistency adjustment distance and intra-group consistency adjustment distance for individual groupings are both less than 0.2, indicating that all groupings can be used as the sufficiency condition for their results. Further examination of the time effect of each grouping shows that the intergroup consistency adjustment distance of the eight groupings does not exceed 0.2, and the consistency levels are all greater than 0.9, indicating that there is no significant time effect. The intra-group consistency adjustment distance of each group state does not exceed 0.2, indicating that there is no obvious regional effect of each group state, i.e., the explanatory strength of each group state does not differ significantly in each region Therefore, the results of this paper have strong applicability to the enhancement of occupants' psychological comfort.

Table 6: Configuration analysis results

	Residential psychological comfort level			Residential psychological discomfort level				
Conditional variable	1	2	3	4	5	6	7	8
Consistency	0.984	0.989	0.983	0.994	1.006	1.005	0.987	0.992
PRI	0.966	0.899	0.967	0.982	1	0.985	0.873	0.714

Coverage	0.815	0.379	0.677	0.625	0.338	0.462	0.301	0.254
Unique coverage	0.084	0.011	0.002	0.193	0.035	0.111	0.017	0.012
Intergroup consistency alignment distance	0.006	0.008	0.03	0.012	0.004	0.002	0.014	0.001
Intergroup consistency alignment distance	0.03	0.026	0.01	0.054	0.009	0.017	0.022	0.028
General PRI	0.981			0.984				
Overall consistency	0.975			0.974				
Overall coverage	0.834			0.826				

IV. C. Strategies for Improving the Psychological Comfort of Occupants

(1) Green ecological design

Green ecological design of living space refers to the use of ecological means of living space design, try to avoid the adverse impact of the design on the environment, the use of ecology can be recycled and reuse and energy-saving principles of indoor space design to achieve ecological balance and harmony. Creating a living space environment suitable for people's survival and spiritual pleasure is the essential requirement for sustainable design of living space.

This requires to do:

(1) The design follows the principle of not polluting the environment and saving energy. Green ecological design of living space refers to the design, decoration and use of the living space environment in the process of design, decoration and use of the surrounding environment does not cause damage; in the process of using the living space as much as possible to use renewable energy to reduce the utilization rate of non-renewable energy, in the process of use to achieve the reuse of energy to achieve recyclable, which is the key to achieving sustainable development of living space design [21].

(2) Living space design pursues natural beauty and ecological beauty. Ecological beauty is an extension of traditional art aesthetics, through the combination of modern aesthetics and integration of ecological sustainable development elements and the formation of a new aesthetic point of view. In the design process of living space, not only to consider the environment in the living space to follow the laws of nature, ecological beauty, but also to consider the artificial sculpture of natural beauty, the realization of human subjective initiative, give full play to the creative talents of mankind, to create a simple, simple, comfortable, pleasant living space environment, to give the occupants a visual enjoyment. Living space aesthetic design process focuses on the harmony and unity of man and nature, and ultimately realize the perfect combination of natural beauty and humanistic beauty.

(3) Ecological living space design of moderate consumption. Ecological living space design against the traditional design of overly luxurious decorative style, advocate in the design to strengthen the respect for the environment and communication, cherish the resources, in the form of the most minimalist design pleasant living environment. Ecological living space design in the premise of protecting the comfort and beauty of the living environment, advocating a frugal way of consumption, moderate consumption reflects a new view of the living room culture, values.

(2) The use of science and technology

The development of science and technology for the progress of human life has played an unnoticeable role in the modern design of living space, whether it is decorative materials or decorative methods are inseparable from the power of technology. The development of advanced science and technology will save energy and reduce emissions, and the harmonious development of the environment of the living space design ideas into reality. The combination of living space design and modern science and technology is fully reflected in the application of energy-saving technology and intelligent technology in the living room. It is the development of science and technology to make the living environment in the lighting, ventilation, heat preservation and moisturizing, greening and other energy-saving design requirements. Electric curtains, voice-activated lighting, security systems and other intelligent technology applications make the living space environment more comfortable and more humane.

(3) Humanistic care

With the continuous progress of people's living standards, material life has been greatly satisfied, people's living space comfort requirements, such as reasonable light layout, spacious and bright space, appropriate temperature and humidity. For designers, people's need for spiritual culture is becoming more and more important, due to the differences in regional culture, character hobbies, living habits and other aspects of the aesthetic comfort of people's living space design differences, so designers need to be designed from a humanistic point of view to meet the preferences of different regions, different types of people. The more thorough consideration of humanistic factors, the better the design effect, the degree of humanistic care directly determines the design level of living space designers. In order to the sustainable development of living space, the environment must be grasped as a whole,

especially the regional culture, the surrounding environment, so that the design of living space to achieve a higher level, more content, more pleasing to the eye.

V. Conclusion

In this study, the modern style has the best performance in the integration of painting art into residential design, with a score of 80.9, which is outstanding in the three dimensions of social, recreational and psychotherapeutic. The weight of “sense of space” in the psychotherapeutic index is 0.088, and the proportion of “promoting active movement” in the recreational index is 0.136, which indicates that the modern style not only meets the aesthetics of modern people in visual aesthetics, but also reflects the significant advantages of the modern style in the levels of functional layout and psychological needs. This shows that modern style not only better meets the aesthetics of modern people in terms of visual aesthetics, but also reflects significant advantages in functional layout and psychological needs. In contrast, the Chinese classical style has cultural advantages in social interaction and sense of belonging, with a score of 70.1, while the European classical style, with a score of 69.6, has a strong artistic atmosphere but a slightly weaker score in psychotherapeutic properties. Indicator layer analysis shows that “natural landscape contact” and “optional private space” are also supported by 0.131 and 0.045 weights respectively. In summary, modern style painting art has advantages in functionality, emotion and spatial adaptability, and injects more humanistic and psychological care values into residential design.

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