

Aesthetic Preferences of Minnan Folk Wooden Altar Table

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The Minnan region in China boasts a rich religious culture, giving rise to the distinctive Minnan folk wooden altar table (MFWAT). This study investigated the MFWAT's artistic characteristics and aesthetic preferences using Kansei Engineering (KE) and eye tracking (ET). The Semantic Differential (SD) method assessed perceptual evaluations, while eye tracking (ET) tests analyzed design elements *via* heat maps and areas of interest (AOI). Preference ratings complemented the objective measures. Factor analysis indicated that perceptual imagery comprised two principal components: stable-lightweight/dignified-relaxed and simple-complex/ceremonial-practical. Eye movement metrics showed decorative components (AOI-3) attracted significantly more attention than leg-foot (AOI-2) and panel components (AOI-1). Sample GA1 achieved the highest preference score, supporting the eye tracking (ET) findings. Decorative components were the most dominant elements. This integration of subjective and objective methods revealed MFWAT's aesthetic characteristics and provides references for modern wooden furniture's innovative design.

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INTRODUCTION

Traditional Chinese furniture embodies the wisdom of ancient Chinese artisans, serving as a material carrier of historical lifestyles and spiritual culture (Lei *et al.* 2024). From design philosophy and material selection to craftsmanship, these pieces reflect the aesthetic characteristics of their time (Xue *et al.* 2024). In ancient Chinese society, ritual systems held great significance, with sacrificial rites occupying a central position. Sacrificial furniture is also the most typical type of traditional Chinese furniture, mainly including Gongzhuo (GZ) and Gongan (GA) in China. There is a distinction between “table” and “recessed-leg table”. A table has legs at the four ends of the tabletop, while a recessed-leg table has legs set inward from the tabletop, and GA holds the highest status of them (Fu *et al.* 2024). The forms of wooden altar tables can be traced back to the “Zu” of the Shang and Zhou dynasties and reach maturity during the Ming and Qing periods (Wang *et al.* 2025a). The folk saying “a temple every three steps, a hall every five steps” is used to describe the prosperity of the sacrificial culture in Minnan, which has given rise to a wealth of folk sacrificial furniture in the region. The Minnan sacrificial rites, commonly known as ‘baibai’, express reverence for deities and remembrance of ancestors,

thereby providing psychological solace and self-redemption. Minnan folk beliefs are rich, and its sacrificial culture is vast and complex.

This study focused on the MFWATs, where the associated sacrificial rites primarily involve lighting incense, presenting offerings, and kneeling to pray for blessings. Within these rituals, the MFWATs primarily serve to display ancestral tablets, divine statues, incense, offerings, and other ritual objects. Generally, in the sacrificial spaces of traditional Minnan residences, one will typically find a GA or a GZ paired with an eight immortals table (Pang and Cheng 2019). The GA are tall and imposing, the GZ are light and elegant, and the eight immortals tables are stable and practical (Miao *et al.* 2024a,b,c). MFWAT serves as an imprint of Minnan's historical heritage, a reflection of economic prosperity, and an extension of architectural artistry, demonstrating distinct geographical characteristics and aesthetic value (Hang *et al.* 2025a,b,c; Liang *et al.* 2025). Nowadays, the Minnan region still places great emphasis on sacrificial traditions. The MFWAT in the Minnan traditional residences are largely well-preserved and also serve as incense tables or other furnishings. Therefore, the aesthetic significance of the MFWATs is worthy of further exploration. To facilitate their adaptation to modern society, this study delves into the aesthetic preferences surrounding MFWAT, offering practical insights for revitalizing their value and reinterpreting their design.

The artistic characteristics of MFWAT embody rich aesthetic connotations. Firstly, the materials are meticulously selected. MFWAT are typically made of hardwoods. Rosewood, wenge, longan wood, camphor wood, and oak are commonly used for high requirements for support or load-bearing parts of the furniture, while softwoods such as fir and pine are used for low requirements for support or decorative parts of the furniture (Tao and Yu 2016). Secondly, the forms are refined. MFWAT exhibits elegant formality in its construction (Wang *et al.* 2024a). GA are categorized into plane-ended narrow tables and long tables with upturned ends. GZ mostly adopts a four-sided flat table; the eight immortals tables are further divided into waisted and waistless (Xu and Chen 2025, Zhang *et al.* 2025a,b). Their dimensions strictly adhere to the auspicious and inauspicious measurements dictated by the Menguang ruler and Dinglan ruler (Zhu *et al.* 2023; Wei and Chen 2025; Zhou *et al.* 2025b). Their structure is stable, primarily relying on the mortise-and-tenon structure. Thirdly, the decorations are exquisite. Decorative techniques of the MFWAT mainly involve carving and lacquering, commonly having a red or black base coat, with gold powder applied locally to create a dignified and elegant appearance (Miao 2024a). Their decorative patterns mainly include animals and plants, figures and antiques, and geometric shapes. The chi-dragon motif is quite common, complemented by a rolling grass pattern or a rolling cloud pattern, all rendered with vivid craftsmanship (Zhou *et al.* 2025a, Dong *et al.* 2025a,b). Finally, the arrangements are solemn. MFWATs are usually placed in the central hall (Yan *et al.* 2025). As the highest-status space in Minnan traditional residential architecture, the central hall serves functions such as ancestral worship, wedding and funeral ceremonies, and formal discussions, making the furniture arrangement especially deliberate (Zhan *et al.* 2024). Usually, GA and GZ are positioned centrally in front of the Taishi wall, with an eight immortals table placed before it, flanking the GA and the eight immortals table are the plant stand and the old-fashioned wooden armchair. Two symmetrical sets of the old-fashioned wooden armchair and the tea table are arranged along the sides of the central hall.

Traditional Chinese furniture has a brilliant history, and there is a great deal of research on its aesthetics. Currently, many scholars have focused on research related to users' aesthetic preferences for traditional Chinese furniture and have achieved significant

progress (Hao and Guan 2025a,b). Fu *et al.* (2024) took Ming-style furniture as an example, based on Kansei Engineering (KE) to collect emotional requirements, analyze, and deconstruct the product form. They used spherical fuzzy analytic hierarchy process (SFAHP) and criteria importance through intercriteria correlation (CRITIC) to calculate the subjective and objective weights of emotional requirements respectively, determined optimal balanced weights with game theory (GT) to identify key emotional requirements, and combined particle swarm optimization (PSO) and support vector regression (SVR) to build a smart evaluation system linking key emotional requirements to product design features. Lei *et al.* (2024) combined psychological and physiological cognitive measurement methods with Kansei Engineering theory (KE) to study people's perception of the Ming-style official hat chair. They extracted principal components of perceptual evaluation through principal component analysis (PCA), calculated subjective cognitive weights using the analytic hierarchy process (AHP), and determined physiological cognitive weights through ET technology. Based on these, they selected the main structural components and principal perceptual evaluation components to establish a multiple linear regression equation, constructing a mathematical mapping relationship between perceptual imagery and core design elements. Hu *et al.* (2025) conducted research on Mongolian box and cabinet furniture based on Glamour Engineering (GE). They created the glamour factor evaluation construction diagram and the glamour factor matrix for Mongolian box and cabinet furniture, obtained the public mean value of the glamour evaluation of Mongolian box and cabinet furniture, and established a multiple linear regression model using Type I Quantification Theory. The study effectively linked public aesthetic preferences with the characteristic elements of Mongolian box and cabinet furniture. The research clarified the direction and degree of influence of each characteristic element on public aesthetic preferences. Xue *et al.* (2024, 2025) used structural equation modeling to examine the relationship between perception and preference of Ming-style furniture patterns. In the structural model of Ming-dynasty furniture pattern perception preference, significant positive correlations were found among the three variables of perception, preference, and interest. Among these, familiarity was identified as the best measurement indicator. While the model showed differences between professional and non-professional groups, interest levels consistently exerted significant positive moderating effects on perceptual preferences in both groups. The study provides references for contemporary aesthetic research on Ming-style furniture patterns. Zhu *et al.* (2024) investigated the aesthetic elements and principles of Qing-style furniture carving patterns. Used the Scenic Beauty Estimation (SBE) and Semantic Differential (SD) to evaluate the aesthetics and analyze the influencing factors of Qing-style furniture carving patterns, calculated the standard value of SBE and the mean value of the influencing factors of SD, and performed regression analysis as the dependent and independent variables, respectively, to obtain the aesthetics evaluation model. The research contributes to investigating the aesthetics and standardization of aesthetic appraisal for Qing-style furniture carving patterns. It can be seen that these studies on the aesthetic preferences of traditional furniture have employed diverse methods, providing a reference foundation for subsequent academic expansion. However, current research predominantly focuses on aesthetic preferences for Ming and Qing dynasty furniture, with insufficient attention given to regional furniture aesthetics preferences. As an important category within traditional Chinese furniture, the MFWAT nurtured by the unique regional culture of Minnan, has developed a distinctive style throughout history and remains prevalent to this day. Existing research on the MFWAT mostly focuses on the cultural background, with relatively scant exploration of their design

elements and aesthetic value. This type of furniture with regional aesthetic value has not yet been empirically studied in the field of design. Therefore, this study aimed to fill this gap. By systematically constructing an aesthetic preference framework for the MFWAT, it sought to enrich regional furniture studies in China, deepen understanding of the aesthetic diversity within traditional Chinese furniture, reveal how regional culture manifests in furniture aesthetics, promote the inheritance of traditional furniture culture, and provide theoretical guidance for innovative designs of traditional furniture, thereby advancing its modernization.

The main aim of this study was to investigate cognitive and visual characteristics of MFWAT's aesthetics using subjective and objective experimental methods in terms of KE and eye tracking (ET) technology, respectively. The specific aims of this study focused on following aspects: (1) The perceptual image evaluation of MFWAT was obtained through the semantic differential (SD) method; (2) The patterns of aesthetic preferences for MFWAT were summarized by combining ET experiment and preference rating; (3) The implications of research on aesthetic preferences of MFWAT were obtained for design practice. The study established a three-tiered framework progressing from perceptual imagery research to ET experiments to preference rating, systematically analysing the cognitive chain underlying aesthetic preferences for MFWATs. Based on the stylistic characteristics of MFWATs, the study refined perceptual and visual aesthetic mechanisms, conducted multidimensional analyses of perceptual imagery, and implemented a secondary classification of areas of interest to guide ET experiments and preference ratings. This approach yielded more actionable aesthetic insights. This study will contribute to the inheritance of Chinese traditional furniture culture as well as to its sustainable application in modern furniture design.

EXPERIMENTAL

Research Materials

Images of MFWAT

Figure 1 shows 72 image samples of MFWATs collected through field investigations, relevant publications, and online searches. The 72 pieces of the MFWAT furniture collected were preliminarily classified into three primary types: Gongzhuo, Gonggan, and eight immortals tables. Selection criteria for the MFWAT samples were established. Firstly, each sample must represent the most typical and recognizable piece within its category. Secondly, each group of samples must encompass diverse forms, structures, and decorations. For instance, typical panel components include plane-ended narrow table, long table with upturned ends, and square-fronted table, while typical leg-foot components include outcurved foot, splayed foot, and horse-hoof foot. Finally, the samples should exhibit these features and avoid repetitive combinations. Six furniture design experts were invited to select four classic shapes from each group as samples, with the side view chosen as the observation material (Xiong *et al.* 2025). Beyond adhering to the selection criteria, these choices also relied heavily on their expertise and experience. They are as follows, GA group: 1) the crutch pattern valgus foot plane-ended narrow table, 2) the chi-dragon pattern and elephant-head pattern long table with up-turned ends, 3) the flower-bird pattern straight leg long table with up-turned ends, 4) the Bogu pattern footrest long table with up-turned ends; GZ group: 1) the circular longevity pattern altar table, 2) the curved foot altar table, 3) the edge plastering line long table with up-turned ends, 4) the

curling limbed dragon pattern altar table; Eight immortals table (EIT) group: 1) the longevity character pattern and card flower eight immortals table, 2) the crutch pattern eight immortals table, 3) the scroll and fruit pattern eight immortals table, 4) the hundred treasures pattern eight immortals table (Chen and Zhang 2025; Dong and Yan 2025).

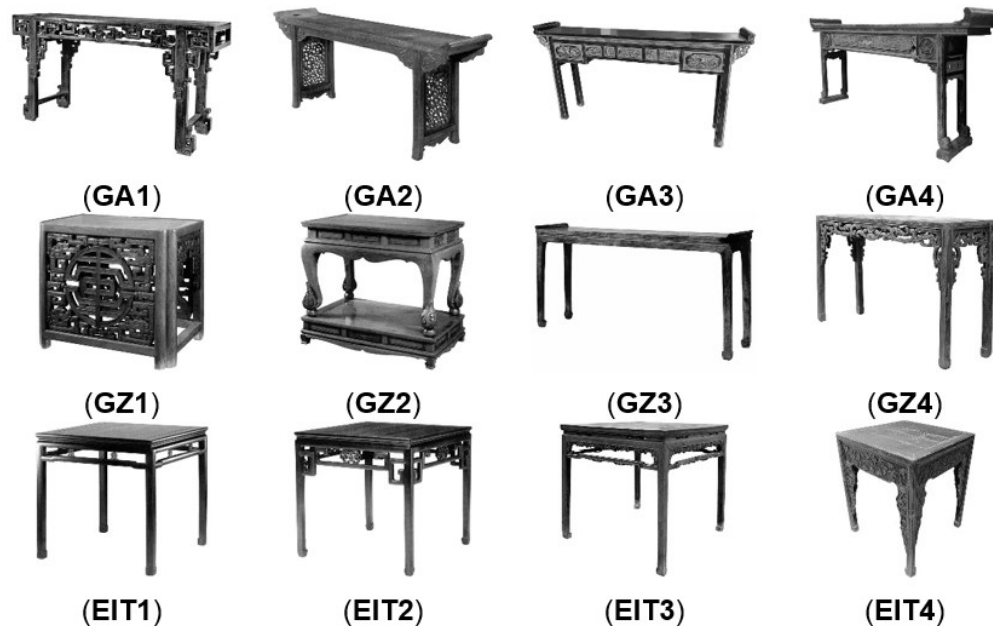


Fig. 1. Image samples of MFWATs evaluated in this study

User base

All participants in this study are from the Minnan region or have lived there; they can be regarded as being knowledgeable about the folk sacrificial culture of Minnan.

Perceptual vocabularies

Through collecting literature and materials on MFWAT, 105 perceptual vocabulary terms were initially gathered based on aspects of material, form, dimensions, structure, decorative techniques, decorative patterns, and functions of MFWAT (Zhou *et al.* 2023). After eliminating terms with similar meanings, irrelevant terms, and meaningless terms, 25 perceptual vocabulary terms describing MFWAT were further selected. Subsequently, six furniture design experts were invited to review these 25 perceptual vocabulary terms, ultimately selecting four groups of the most representative terms across four aspects: structure, decoration, function, and overall style (Wang *et al.* 2025b). These four representative word groups are: stable-lightweight, simple-complex, ceremonial-practical, and dignified-relaxed.

Methods

Semantic differential method

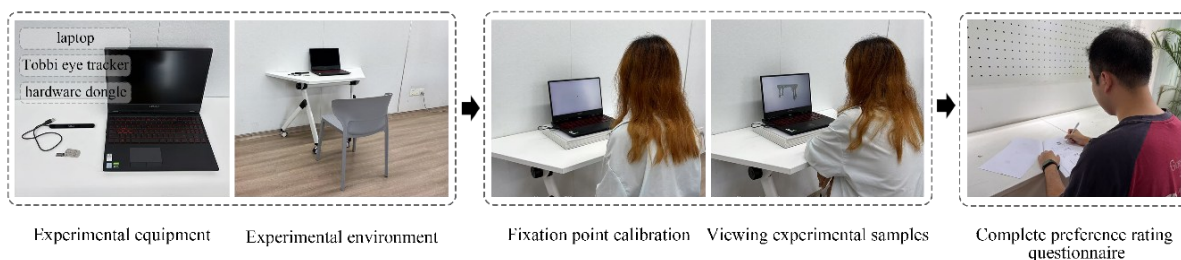
Table 1 shows the semantic differential scale used to evaluate the MFWATs by a 7-point semantic differential scale. The values of “-3, -2, -1, 0, 1, 2, 3” correspond to degrees of “very, moderately, slightly, neutral, slightly, moderately, very”, respectively (Palacios-Ibáñez *et al.* 2023). The negative values correspond to the left-side adjective, while the positive values correspond to the right-side adjective.

Table 1. 7-Point Semantic Differential Scale for Evaluating the Aesthetic Preferences of MFWATs

Perceptual Vocabulary		Evaluation Scale							Perceptual Vocabulary
Structure (stable-lightweight)	Stable	-3	-2	-1	0	1	2	3	Lightweight
Decoration (simple-complex)	Simple	-3	-2	-1	0	1	2	3	Complex
Function (ceremonial-practical)	Ceremonial	-3	-2	-1	0	1	2	3	Practical
Overall style (dignified-relaxed)	Dignified	-3	-2	-1	0	1	2	3	Relaxed

Eye tracking method

Figure 2 shows the set-up for evaluating the preferences of MFWATs using the eye tracking (ET) method. The ET method is a scientific tool for studying human psychological processes such as visual attention, cognitive processes, and emotional responses (Tabbaa *et al.* 2021; Novák *et al.* 2024). The experiment used a Tobii eye tracker (Tobii Pro Fusion, Xiamen Academy of Arts and Design, Fuzhou University, Xiamen, China), with ErgoLAB 3.0 software recording and analyzing participants' gaze behavior (Wang *et al.* 2024b). To ensure testing accuracy, all image samples (Fig. 1) were uniformly processed in terms of picture size, resolution, furniture dimensions, brightness, grayscale, and white background parameters. Moreover, in order to minimize the interference of color on visual factors, all samples were presented as grayscale images. The sample images were displayed full-screen on a 15.6-inch monitor with 1920×1080 pixel resolution. Participants were young adults aged between 18 and 35 years (inclusive), all of whom held a bachelor's degree or higher. Sixteen participants were selected with a 1:1 male-to-female ratio. All participants were confirmed to be viewing the test images for the first time, with either normal naked-eye or corrected vision within the standard range, and without color blindness or color weakness (Kuo *et al.* 2021).

**Fig. 2.** Set-up for evaluating the preferences of MFWATs using the eye tracking method

The experimental procedure was as follows: 1) participants were briefed on the experimental task and guided into the laboratory and seated approximately 600 mm from the display screen; 2) eye calibration was performed, and the experiment commenced after successful calibration (Chen *et al.* 2025); 3) participants were instructed to view the experimental sample images with sequence of the GA group, the GZ group, and the EIT group. Before each image appeared, a “+” was displayed at the center of the screen for 2 seconds, with each image presented for 10 seconds (Kuo *et al.* 2021). 4) After the experiment, data were recorded and saved, and participants were asked to complete a

personal information form and a questionnaire evaluating their preferences for the design elements of MFWAT.

The selected eye movement metrics were the heat map and area of interest (AOI). Heat maps use color gradient variations to display overall viewing distribution patterns, with areas closer to red indicating higher levels of attention (Shin *et al.* 2022). AOI refers to specific parts of the experimental sample images that are delineated as independent elements for analysis, facilitating comparison of attention levels across different design features (Mercier *et al.* 2024). Based on the formal characteristics of MFWAT, the study divided each experimental sample into three primary AOIs: panel components (AOI-1), leg-foot components (AOI-2), and decorative components (AOI-3). Furthermore, the decorative component (AOI-3) of each sample was subdivided into more specific AOIs according to their compositional types. For example, the decorative component of Sample GA2 was further divided into four AOIs: apron, apron head, baffle, and foot stretcher. The AOI division for Sample GA2 is shown in Fig. 3.



Fig. 3. AOI division of the experimental samples: AOI-1: Panel components; AOI-2: leg-foot components; AOI-3: decorative components (with sample GA2)

According to feature integration theory, visual cognition primarily involves five stages: pre-processing, parallel processing, serial processing, feature integration, and memory comparison (Treisman *et al.* 2024). In the ET experiment, parallel processing and serial processing manifest as saccades and fixations. Therefore, the ET experiment focused on two sets of variables: visual attention and visual search (Lu *et al.* 2016). The eye movement metrics for visual attention included: AOI total fixation duration (s), AOI average fixation duration (s), and AOI number of fixations (n). The eye movement metrics for visual search included: AOI average fixation frequency (times·s⁻¹), AOI average transition instances the number of fixations before first entry into the AOI (n) (Liu *et al.* 2017). The ET experiment variable design is presented in Table 2.

Table 2. Variable Design of the Eye Tracking Experiment: Comprising Visual Attention and Visual Search

Measurement Group	Measured Variable	
Visual Attention	AOI total fixation duration (s)	Statistics on AOI total fixation duration (s)
	AOI average fixation duration (s)	Statistics on AOI average fixation duration (s)
	AOI number of fixations (n)	Statistics on AOI number of fixations (n)
Visual Search	AOI average fixation frequency (times·s ⁻¹)	Statistics on AOI average fixation frequency (times·s ⁻¹)
	AOI average transition instances (n)	Statistics on AOI average transition instances (n)
	number of fixations before first entry into the AOI (n)	Statistics on number of fixations before first entry into the AOI (n)

Preference rating

To investigate users' evaluations of the design elements and overall aesthetic of MFWAT, a preference rating questionnaire was administered to participants after the ET experiment to collect their aesthetic preferences regarding the forms of MFWAT (Niu and Huang 2022). Similar to the SD method, the preference rating utilized a 7-point Likert scale questionnaire, with Fig. 1 serving as the experimental sample. However, the preference rating focused on specific design elements of the MFWAT as evaluation dimensions. The design elements of the experimental samples were categorized into panel components, leg-foot components, and decorative components. Because of the complexity of decorative components, they were further subdivided based on the specific features of each experimental sample (the division of design elements in the preference rating aligned with the division of AOIs in the ET experiment). The SD method employed perceptual vocabulary as evaluation dimensions. Figure 4 shows the aesthetic preference questionnaire for the design elements of MFWAT. Taking Sample 2 as an example, its decorative components were divided into: apron, apron head, baffle, and foot stretcher. Participants were asked to rate their subjective preferences for each design element of the experimental samples, with scores ranging from -3 (dislike) to 3 (like).

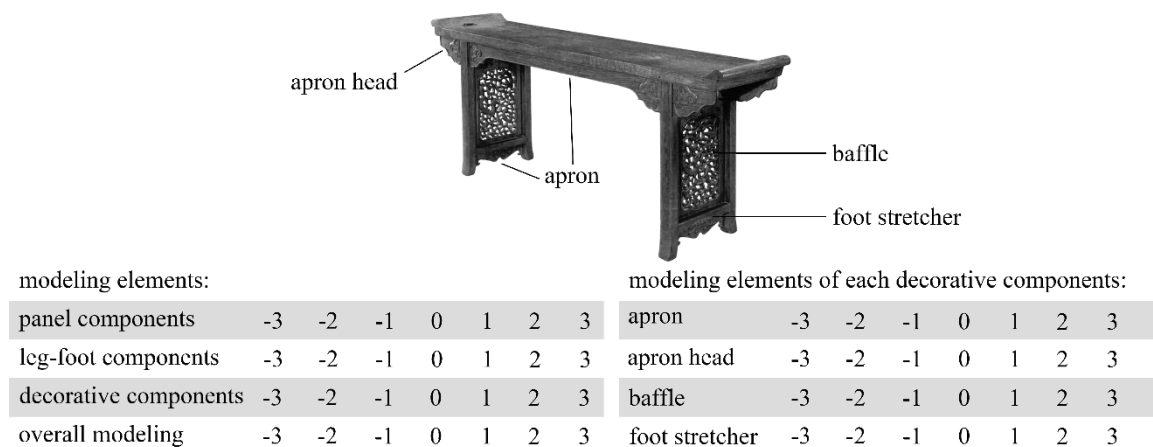


Fig. 4. Questionnaire for preference rating of design elements and overall aesthetics of MFWAT (with sample GA2)

RESULTS AND DISCUSSION

Results of Semantic Differential Evaluation

A questionnaire survey on the perceptual imagery research of MFWAT was conducted among design students, design industry practitioners, and some members of the public. A total of 136 questionnaires were collected, with 16 invalid questionnaires removed, resulting in 120 valid questionnaires. Based on the 120 valid questionnaires received, the average score for each pair of perceptual vocabulary terms for each experimental sample was calculated. Positive values indicated that the sample leaned more toward the right-side vocabulary term, while negative values represented that the sample leaned more toward the left-side vocabulary term. The mean scores of the perceptual vocabulary terms are shown in Table 3.

Table 3. Means (Standard Deviation) of Perceptual Vocabulary Scores

Sample Number	Stable-lightweight	Simple-complex	Ceremonial-practical	Dignified-relaxed
GA1	-0.33(1.932)	0.06(2.186)	-0.68(1.941)	-0.74(1.890)
GA2	-0.87(1.878)	-0.52(1.847)	-0.49(1.927)	-0.97(1.909)
GA3	-0.53(1.979)	-0.33(1.955)	-0.55(1.896)	-0.17(1.876)
GA4	-0.50(1.927)	-0.38(1.691)	-0.80(1.895)	-0.30(2.048)
GZ1	-0.68(2.079)	0.03(2.124)	-0.47(1.940)	-0.32(1.918)
GZ2	-0.69(2.106)	-0.73(1.973)	-0.29(2.209)	-0.48(1.773)
GZ3	-0.38(2.227)	-1.07(1.900)	-0.28(2.115)	-0.19(2.092)
GZ4	-0.43(2.007)	-0.18(2.021)	-0.18(1.766)	-0.29(2.068)
EIT1	-0.50(2.042)	-1.27(1.804)	-0.31(2.245)	0.22(2.013)
EIT2	-0.64(2.153)	-0.46(1.922)	-0.68(1.914)	-0.44(1.823)
EIT3	-0.45(1.828)	-0.46(1.833)	-0.28(2.066)	-0.16(2.177)
EIT4	-0.52(2.037)	-0.43(2.003)	-0.73(2.049)	-0.59(1.683)

The data from the Semantic Differential Scale questionnaire were imported into SPSS 27.0 statistical software for reliability analysis. The overall sample's Cronbach's alpha coefficient was $0.870 > 0.8$, indicating high reliability of the questionnaire results. Factor analysis was employed to reduce the dimensionality of the perceptual vocabulary (Yang *et al.* 2023). The KMO and Bartlett's tests were performed on the correlation matrix of the questionnaire data to validate the structural validity and interrelationships of the factor analysis (Zuo *et al.* 2023). The experimental results showed that the KMO value was $0.548 > 0.5$, confirming the suitability for factor analysis. Significance value of Bartlett's test of sphericity < 0.05 , indicating statistically significant differences. Therefore, both the KMO and Bartlett's test confirmed that the data were suitable for factor analysis. However, particular attention must be paid to the fact that the KMO value is at a critical level. Therefore, while factor analysis provides valuable preliminary insights into the perceptual imagery of the MFWAT in our research, the extracted components should be interpreted with caution.

The communality (Table 4) indicates the degree to which variables can be represented by the extracted principal component. The extracted communality for all variables was > 0.6 , demonstrating that the variables were well represented by the common factor.

Table 4. Communality Analysis of Perceptual Vocabulary in Factor Analysis

Perceptual Vocabulary	Incipient	Extraction
Stable-lightweight	1.000	0.922
Simple-complex	1.000	0.721
Ceremonial-practical	1.000	0.602
Dignified-relaxed	1.000	0.783

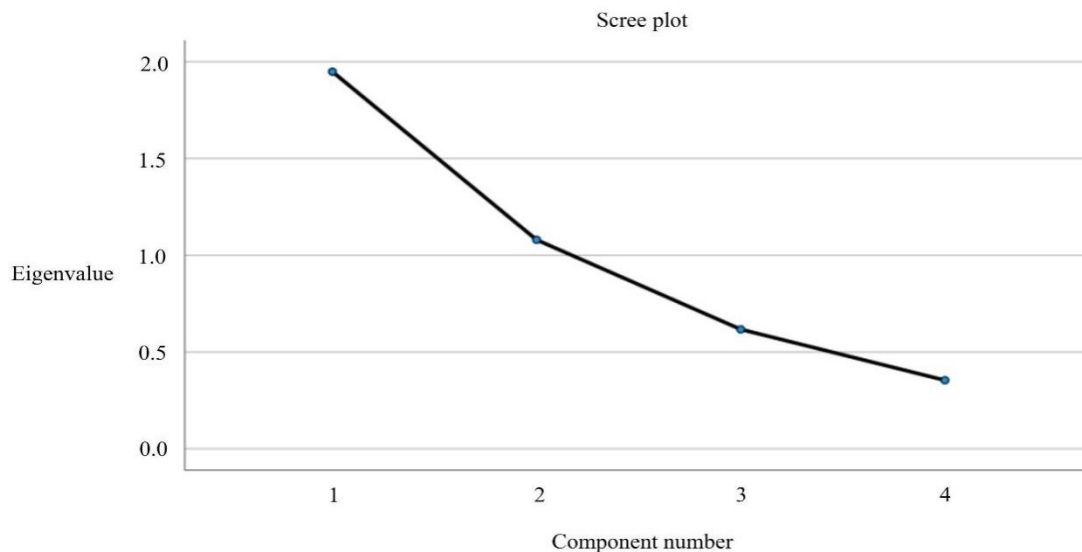
Principal components with eigenvalues greater than 1 were retained for variance explained, revealing the variation process and explanatory degree of the overall variables (Zhou *et al.* 2023). The total variance explained is shown in Table 5. Two principal components could be extracted from the results: Component 1 had an eigenvalue of 1.949, and Component 2 had an eigenvalue of 1.080. Together, Principal Component 1 and Principal Component 2 explained 75.713% of the data's main information, indicating minimal data loss and effective interpretation of the initial data.

Table 5. Total Variance Explained of Perceptual Vocabulary in Factor Analysis

Component	Initial Eigenvalues			Sum of Squared Loadings			Rotation Sums of Squared Loadings		
	Sum	Variance proportion	Cumulative %	Sum	Variance proportion	Cumulative %	Sum	Variance proportion	Cumulative %
1	1.949	48.717	48.717	1.949	48.717	48.717	1.754	43.843	43.843
2	1.080	26.997	75.713	1.080	26.997	75.713	1.275	31.870	75.713
3	0.617	15.431	91.145						
4	0.354	8.855	100.000						

The scree plot was primarily used to aid in determining the number of factors to extract. From the scatter plot (Fig. 5), it is evident that two indicators exceeded 1. Therefore, retaining the first two factors sufficiently summarized most of the statistical information, and the first two principal components were selected based on their eigenvalues.

To investigate the composition of the principal component and better interpret the extracted factors, orthogonal rotation was performed using Kaiser's normalized varimax rotation, yielding a rotated component matrix. The component matrix and rotated component matrix are shown in Table 6.

**Fig. 5.** Scree plot analysis of perceptual vocabulary in factor analysis.**Table 6.** Component Matrix and Rotated Component Matrix of Perceptual Vocabulary in Factor Analysis

Perceptual Vocabulary	Component Matrix		Rotated Component Matrix	
	1	2	1	2
Stable-lightweight		0.865		0.959
Simple-complex	-0.727		-0.848	
Ceremonial-practical	0.712		0.773	
Dignified-relaxed	0.861		0.660	0.590

Two factors were extracted from the perceptual vocabulary for MFWAT. Factor 1 consisted of the two perceptual vocabulary "stable-lightweight" and "dignified-relaxed," indicating that the forms of MFWAT exhibit a sense of relaxation. Factor 2 comprised the two perceptual vocabulary "simple-complex" and "ceremonial-practical," suggesting that the decoration of MFWAT leans toward minimalism, and from a functional perspective, they emphasize practicality more than ritualistic qualities.

Comparing the perceptual factors extracted from this study with those derived from research on other styles of furniture reveals divergent perceptual imagery. For instance, in terms of overall furniture style, this study leaned towards 'relaxed', whereas scholarly research on the perceptual imagery of Mongolian box and cabinet furniture tends towards 'solemn' (Hu *et al.* 2025). This suggests that furniture may be influenced by regional factors, with pieces from different geographical areas and nationalities potentially evoking distinct emotional responses. The Minnan region possesses a profound cultural heritage and has developed a unique aesthetic system, rendering aesthetic research on the MFWAT of significant importance.

Results of the Eye Tracking Tests

Heat map data analysis

The heat map is shown in Fig. 6. Analysis of the experimental samples' Heat Map revealed that: 1) Participants paid more attention to complex and distinctive areas of the samples, as confirmed by all sample heat maps. 2) The heat map distribution was more concentrated for furniture with compact forms than for those with expansive forms. Comparisons among the GA group, GZ group, and the eight immortals table group showed that the Heat Map for the larger-form GA group and GZ group were more dispersed. Participants' heat maps were more concentrated for ornately decorated furniture than for minimally decorated pieces. For instance, the heat map of Sample GA1 was more intensive than that of Sample GZ3, indicating that Sample GA1 had more complex decorations than Sample GZ3. Similarly, heat maps were more concentrated for furniture with unified decoration than for those with dispersed decoration. For example, Sample GZ1, with most decorations concentrated on the baffle, showed a more focused heat map, whereas Sample GZ2, with decorations scattered across the leg-foot, drawer front, and apron, showed a more dispersed heat map pattern. 3) Participants' visual focus was primarily on decorative components and leg-foot components, with relatively less attention paid to Panel components. Stronger attention was paid to areas with distinctive decorative features and complex patterns, such as the distinctive longevity character pattern on the baffle of Sample GZ1, and the complex hundred treasures pattern on the lobed apron of Sample EIT4, whose heat map was darker in these areas, with a stronger visual preference. Attention was stronger for the furniture experimental samples with leg and foot styles than those with straight legs and feet, and the leg-foot components of sample GZ3, sample GZ4, and sample EIT of the incurved horse-hoof foot received significantly more attention than those of sample GA3 and sample GZ1 of the straight-legged and straight-footed styles. More attention was paid to the furniture experimental samples of the long table with upturned ends than to those of the plane-ended narrow table. The Panel components of samples GA2, GA3, GA4, and GZ3 of the long table with upturned ends received significantly more attention than those of samples GA1, GZ1, GZ2, GZ4, and EIT of the plane-ended narrow table.

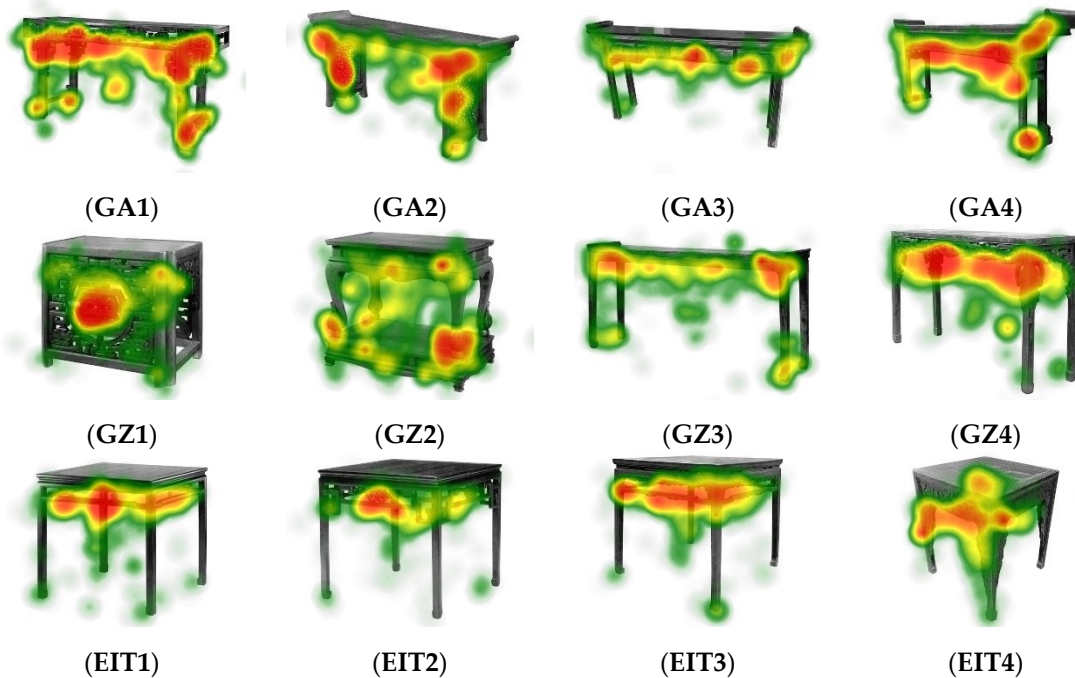


Fig. 6. Heat maps of all evaluated images of MFWAT using the eye tracking method

AOI data analysis

The mean values of visual attention and visual search eye movement metrics across all Areas of Interest (AOIs) in the experimental samples were compiled (Lin *et al.* 2024). Taking sample GA2 as an example, Table 7 presents the average values of its key eye movement metrics. The key eye movement metrics of sample GA2 show that, in terms of visual attention, there were significant differences among the three areas of interest. AOI-3 exhibited the longest AOI total fixation duration (s) and the highest AOI number of fixations (n), indicating that participants paid the highest level of visual attention to AOI-3. In contrast, AOI-1 showed the lowest values across all metrics, suggesting its relatively weak attractiveness to participants.

Regarding visual search, AOI-3 had the highest AOI average transition instances (n), reflecting more complex visual search activities by participants in this area. Although AOI-1 displayed a higher AOI average fixation frequency ($\text{times} \cdot \text{s}^{-1}$), it showed the lowest AOI average transition instances (n), which may be attributed to the simpler or more concentrated visual information in AOI-1, enabling participants to rapidly scan and complete visual searches. Within the sub-regions of AOI-3 in sample GA2, the baffle was the most attention-grabbing and engagement-inducing component, followed by the apron head.

The weaker metrics for the foot stretcher and apron suggest that these areas were visually less prominent and generally less attractive to participants. The disparities in visual attention and visual search reveal that participants exhibited differentiated focus levels across AOIs when observing the MFWAT, demonstrating certain regularity and preferences. Visually richer areas or those located in the visual center tended to attract stronger participant attention, whereas areas with simpler visual presentations or positioned at the visual periphery struggled to capture attention.

Table 7. Mean Values of Visual Attention and Visual Search Eye Movement Metrics Data for GA2

Sample Number	AOI	Visual attention eye movement metrics			Visual search eye movement metrics		
		AOI total fixation duration (s)	AOI total fixation duration (s)	AOI number of fixations (n)	AOI average fixation frequency (times·s ⁻¹)	AOI average transition instances (n)	Number of fixations before first entry into the AOI (n)
GA2	AOI-1	0.34	0.12	1.25	3.66	0.11	10.13
	AOI-2	1.81	0.40	4.63	2.55	0.36	5.38
	AOI-3	3.81	0.39	10.38	2.72	0.54	3.38
GA2 AOI-3	baffle	2.34	0.39	6.06	2.59	0.39	4.50
	foot stretcher	0.08	0.06	0.38	4.86	0.04	16.60
	apron	0.42	0.20	1.56	3.70	0.15	9.00
	apron head	1.00	0.41	2.44	2.45	0.23	7.36

The visual attention ET metrics data were imported into SPSS 27.0 statistical software for one-way ANOVA, with the structural components of MFWAT (AOI-1, AOI-2, AOI-3) as fixed factors and three visual attention ET metrics – AOI total fixation duration(s), AOI average fixation duration(s), and AOI number of fixations(n) – as dependent variables, to explain differences in ET metrics data across different AOI. The one-way ANOVA results for visual attention ET metrics are presented in Table 8.

The multiple comparison analysis for visual attention ET metrics is shown in Table 9. First, the assumption of homogeneity of variance was met for all visual attention ET metrics ($p > 0.05$), allowing for the use of standard ANOVA. Then, according to the ANOVA results, all visual attention ET metrics showed $p < 0.05$, demonstrating significant differences in means. Finally, multiple comparison analysis was conducted to examine specific differences among AOIs in visual attention ET metrics. The results revealed that the decorative components (AOI-3) had significantly higher AOI total fixation duration(s) and AOI number of fixations(n) than the other two areas of interest, indicating that decorative components (AOI-3) could attract subjects' sustained and repeated attention, exhibiting strong dominance.

Table 8. One-way ANOVA Results of Visual Attention Eye Tracking Indicators

		Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
AOI total fixation duration(s)	between-groups	69.896	2	34.948	51.275	.000
	within-groups	22.492	33	.682		
	total	92.389	35			
AOI average fixation duration(s)	between-groups	.708	2	.354	28.398	.000
	within-groups	.411	33	.012		
	total	1.120	35			
AOI number of fixations(n)	between-groups	507.298	2	253.649	51.789	.000
	within-groups	161.626	33	4.898		
	total	668.924	35			

Table 9. Mean Comparison of Visual Attention Parameters

Visual Attention Parameters	AOI-1	AOI-2	AOI-3
AOI total fixation duration (s)	-1.05000*(.004) AOI-2	1.05000*(.004*) AOI-1	3.33750*(.000) AOI-1
	-3.33750*(.000) AOI-3	-2.28750*(.000) AOI-3	2.28750*(.000) AOI-2
	-.27750*(.000) AOI-2	.27750*(.000) AOI-1	.31417*(.000) AOI-1
AOI average fixation duration (s)	-.31417*(.000) AOI-3	-.03667(.427) AOI-3	.03667(.427) AOI-2
	-2.61417*(.007) AOI-2	2.61417*(.007) AOI-1	8.94167*(.000) AOI-1
	-8.94167*(.000) AOI-3	-6.32750*(.000) AOI-3	6.32750*(.000) AOI-2

Table 10. One-way ANOVA Results of Visual Search Eye Tracking Metrics

		Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
AOI average fixation frequency (times·s ⁻¹)	between-groups	4.732	2	2.366	4.267	.022
	within-groups	18.296	33	.554		
	total	23.028	35			
AOI average transition instances (n)	between-groups	.888	2	.444	78.993	.000
	within-groups	.185	33	.006		
	total	1.073	35			
number of fixations before first entry into the AOI (n)	between-groups	219.429	2	109.715	27.402	.000
	within-groups	132.129	33	4.004		
	total	351.558	35			

A one-way ANOVA was performed on the visual search ET metrics data, with the structural components of MFWAT (AOI-1, AOI-2, AOI-3) as fixed factors and three visual search ET metrics – AOI average fixation frequency(times·s⁻¹), AOI average transition instances (n), and number of fixations before first entry into the AOI(n) – as dependent variables to explain differences in ET metrics across different AOI. The one-way ANOVA results for visual search ET metrics are presented in Table 10.

The multiple comparison analysis for visual search ET metrics is shown in Table 11. First, the homogeneity of variance test results showed that the assumption was met for two visual search ET metrics – AOI average transition instances (n) and number of fixations before first entry into the AOI (n) ($p > 0.05$). In contrast, the assumption was violated for AOI average fixation frequency (times·s⁻¹) ($p < 0.05$). Then, according to the ANOVA results, both AOI average transition instances (n) and number of fixations before first entry into the AOI (n) showed $p < 0.05$, demonstrating significant differences in means. Finally, multiple comparison analysis revealed that all areas of interest showed

significant differences in AOI average transition instances (n) (all $p < 0.05$). The decorative components (AOI-3) of the number of fixations before first entry into the AOI (n) were significantly greater than those of the other two visual search ET metrics, indicating that they can quickly capture subjects' attention with strong attractiveness.

Table 11. Mean Comparison of Visual Search Parameters

Visual Attention Parameters	AOI-1	AOI-2	AOI-3
AOI average fixation frequency (times·s ⁻¹)	.81750*(.011) AOI-2	-.81750*(.011) AOI-1	-.70917*(.026) AOI-1
	.70917*(.026) AOI-3	-.10833(.724) AOI-3	.10833(.724) AOI-2
	-.20917*(.000) AOI-2	.20917*(.000) AOI-1	.38417*(.000) AOI-1
AOI average transition instances (n)	-.38417*(.000) AOI-3	-.17500*(.000) AOI-3	.17500*(.000) AOI-2
	2.00833*(.019) AOI-2	-2.00833*(.019) AOI-1	-5.94417*(.000) AOI-1
	5.94417*(.000) AOI-3	3.93583*(.000) AOI-3	-3.93583*(.000) AOI-2

It is not difficult to find that both heatmap and AOIs indicated the dominant role of decorative components in guiding visual aesthetics, consistent with previous research on Ming and Qing dynasty furniture (Lei *et al.* 2024). Given the significant influence of Ming and Qing furniture on the MFWAT, it is understandable that their aesthetic characteristics exhibited considerable overlap. Since decorative components constitute a particularly prominent aspect of Ming and Qing furniture, some scholars have specifically conducted aesthetic studies on the decorative components (Zhu *et al.* 2024; Xue *et al.* 2025). Future research may similarly consider undertaking further aesthetic investigations into the decorative features of the MFWATs.

Analysis of the Preference Rating Research

Following the ET experiment, participants were required to complete an aesthetic preference questionnaire on stylistic elements. Table 12 shows the statistics of the mean values of the users' scores on the styling elements of the MFWAT. From the mean values of the design elements of all experimental samples, the order of preference is overall design, decorative components, leg-foot components, and then Panel components. For MFWAT, the overall design was found to be superior to individual components, with decorative components receiving the highest evaluation among partial elements. Thus, the conclusions drawn from the MFWAT aesthetic preference questionnaire were consistent with those obtained from the ET experiment.

The statistical results of the aesthetic preference questionnaire for design elements are shown in Table 13. Sample GA1, which received the highest comprehensive design score, was selected for detailed analysis of its specific design elements' aesthetic preferences. Sample GA1 is a rosewood crutch pattern valgus foot plane-ended narrow table, representing typical Zhangzhou craftsmanship. It measures 236 cm in length, 68.5 cm in width, and 123 cm in height. It is a recessed-leg table with shoulder-tenon joint and frame-panel construction, and with crutch pattern composing its leg-foot components, apron components, and apron head components. The overhanging ends are assembled from multiple crutch patterns to form a chi-dragon motif.

Table 12. Means (Standard Deviation) of Design Elements Scores

Sample Number	Panel Components	Leg-foot Components	Decorative Components	Overall Shape
GA1	0.37(1.147)	1.38(1.204)	1.94(0.929)	1.44(1.590)
GA2	1.31(0.873)	0.63(1.544)	0.56(1.672)	0.75(1.438)
GA3	1.31(0.946)	-0.44(1.365)	1.13(1.544)	1.38(1.204)
GA4	1.19(1.328)	0.06(1.340)	0.88(1.147)	1.13(1.408)
GZ1	0.25(1.528)	0.00(1.414)	1.44(1.094)	0.94(1.237)
GZ2	0.69(1.014)	1.31(1.702)	1.06(1.181)	1.25(1.291)
GZ3	0.69(1.195)	0.06(1.652)	-0.44(1.672)	0.75(1.571)
GZ4	0.19(1.601)	0.75(1.291)	1.88(1.258)	1.38(0.885)
EIT1	0.94(1.181)	0.31(1.580)	0.50(1.317)	1.38(1.204)
EIT2	1.00(1.265)	0.56(1.365)	1.69(1.250)	1.44(1.153)
EIT3	0.94(1.237)	0.19(1.515)	0.31(1.493)	1.00(1.211)
EIT4	0.37(1.455)	1.00(1.713)	0.62(1.708)	0.87(1.455)
Total	0.771(0.406)	0.484(0.557)	0.964(0.706)	1.143(0.207)

Table 13. Statistical Results of the Questionnaire on the Aesthetic Preference of Design elements

Sample Number	Mean	Standard Deviation	Sample Number	Mean	Standard Deviation
GA1	1.283	0.658	GZ3	0.265	0.564
GA2	0.813	0.341	GZ4	1.050	0.737
GA3	0.845	0.863	EIT1	0.783	0.478
GA4	0.815	0.521	EIT2	1.173	0.498
GZ1	0.658	0.656	EIT3	0.610	0.419
GZ2	1.078	0.279	EIT4	0.715	0.279

The design elements' scores for Sample GA1 are presented in Table 14. Participants gave high ratings to the table's overall design, particularly its decorative components and leg-foot components. However, the panel components received slightly lower scores, possibly due to being less remarkable compared to other elements. Among the decorative components, the apron and apron head were more favored, whereas the straight stretcher was less preferred. Combined with Sample GA1's perceptual vocabulary scores, it leans toward being structurally stable, decoratively ornate, functionally ritualistic, and overall solemn in style. Heat map and AOI metrics from the ET experiment also confirmed that the apron, apron head, and leg-foot attracted more attention from participants.

Table 14. Mean Statistics of Design Elements' Scores (with Sample GA1)

Design Elements	Mean	Design Elements	Mean	Design Elements	Mean	Design Elements	Mean
Panel components	0.37	Leg-foot components	1.38	Decorative components	1.94	Overall shape	1.44
Apron	1.50	Apron head	1.31	Straight stretcher	-0.5		

Limitations and Future Directions

Limitations

(1) The research primarily focused on perceptual measurements of the MFWATs, without delving into the underlying sacrificial rituals or exploring users' cultural

identification with the Minnan folk custom. (2) All participants in this study possessed some familiarity with Minnan folk sacrificial culture, rendering the research inherently partial. The study lacked investigation into the aesthetic preferences regarding MFWATs among users without this cultural background. (3) All participants in the study viewed the stimulus samples in the same sequence (GA→GZ→EIT). This fixed presentation order may not entirely preclude the potential influence of serial order effects or fatigue effects on the experimental results. (4) Presently, research focuses primarily on exploring the aesthetic characteristics and preferences of MFWATs through systematic empirical content. There is a lack of detailed research on the design innovation issues such as how the MFWAT inspire modern design and how to achieve the modern translation design of the MFWAT offering tables.

Future directions

(1) Further research may be conducted into the regional culture of Minnan as expressed through the MFWAT, systematically introducing readers to the historical development, cultural significance, and symbolic meaning of the Minnan ritual activities, whilst examining participants' sense of identification with these local cultural traditions. (2) Further research could explore the aesthetic preferences of users without a background in Minnan regional culture towards the MFWAT, particularly investigating whether participants' perceptions of the MFWAT change before and after learning about Minnan folk sacrificial culture. (3) Research may present fixed samples to participants in randomized order, for instance by employing Latin squares, thereby effectively controlling variables to mitigate potential influences such as order effects or fatigue effects. (4) Modernizing the aesthetic elements of MFWATs. Firstly, building upon this research, cultural genes can be extracted from the structure, ornamentation, and cultural connotations of MFWATs to establish a cultural gene bank for the MFWATs, serving as an inspiration repository for contemporary product design. Secondly, to realize its transformation in contemporary design and utilize AIGC tools for auxiliary design generation. Depending on the nature of the research, image generation may employ a combination of generative methods and prompting techniques (Zhu *et al.* 2024). This involves inputting suitable experimental samples, descriptive statements, and lexical weighting values to achieve generative design. Finally, conduct the evaluation and iterative optimization of the design solutions.

CONCLUSIONS

This study explored aesthetic preferences for the distinctive Minnan folk wooden altar table (MFWAT). The semantic differential method from Kansei engineering (KE) was used to assess their perceptual imagery. Eye-tracking (ET) experiments with heat maps and areas of interest (AOIs) were used to study visual features. Preference rating questionnaires were used to evaluate their design elements. These three steps enabled an analysis of aesthetic preferences in the MFWAT. This systematic investigation into aesthetic preferences for the MFWAT provides a reference framework for traditional furniture research while establishing a theoretical foundation for innovative designs of the MFWATs.

1. The study categorized and extracted perceptual vocabulary based on the artistic characteristics of the MFWATs to construct a semantic differential scale. A factor analysis was conducted to study their perceptual imagery. Perceptual image evaluation of MFWAT was as follows: The eigenvalues of perceptual imagery for MFWAT, ranked from high to low might be: stable-lightweight, dignified-relaxed, simple-complex, and ceremonial-practical. Perceptual vocabulary related to structure and overall style had greater effects on users' perception, followed by those related to decoration, while functional terms had relatively weaker effects. The principal components of perceptual imagery for MFWAT appear to consist of what might be interpreted as an explicit factor composed of the two perceptual vocabulary pairs "stable-lightweight" and "dignified-relaxed," suggesting that these may represent dominant perceptual imagery components. Similarly, the results indicate an implicit factor could be composed of the two perceptual vocabulary pairs "simple-complex" and "ceremonial-practical", potentially serving as supplementary perceptual imagery components.
2. The study divided the modeling components of the MFWATs into AOIs. Then it conducted ET experiments and preference rating based on these AOIs to study the aesthetic preference of the MFWATs. Aesthetic characteristics of MFWAT modeling were as follows: In the cognitive process of perceiving the forms of MFWAT, the visual focus primarily centers on decorative components, with leg-foot components and Panel components being secondary. Panel components are categorized into plane-ended narrow tables and long tables with upturned ends, and long tables with upturned ends attract significantly greater attention. Regarding leg-foot component styles, there is a preference for incurved horse-hoof foot, out-curved foot, splayed foot, and triple-curved leg with ball foot over straight leg-foot. As for decorative components, there is a preference for elements with aesthetic interest, such as apron head, apron, drawer front, baffle, and openwork spacer. Conversely, elements such as straight stretcher and foot stretcher, are considered dull and simple, and thus less interesting. Therefore, vivid and lifelike design components play an important guiding role in the aesthetic perception of MFWAT and can be analyzed through specific deconstruction.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical Statement

All experiments were previously approved by the local Ethics Committee of Fuzhou University and conducted following the Declaration of Helsinki. All participants knew and agreed on this publication.

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