The Relationship of Young Adults' Visual Attention and Aesthetic Preferences Toward Traditional Wooden Furniture Patterns of the She Ethnic Group

Linyi Zhong, Ziheng Que, Yuling Wang, Jiafang Huang, Luxi He,* and Zujian Chen *

Traditional patterns are visual carriers of cultural heritage, and understanding young adults' aesthetic preferences and visual attention may inform contemporary dissemination. This study examined, at the category level and individual sample level, subjective evaluation and objective behavior among 30 university students from one setting in response to 26 traditional wooden furniture patterns of the She ethnic group in eastern Fujian, using preference evaluation questionnaires, semantic differential ratings, and eye tracking. Results showed that (1) subjective evaluation was multidimensional: plant patterns received the highest category-level average (Avg.) score for aesthetic preference (Avg. = 1.811), whereas the Round Longevity Pattern in the abstract patterns performed best at the individual sample level (Avg. = 2.133); (2) Friedman tests showed significant differences in fixation count (FC) at both levels ($p < 0.001$), with the highest FC for human-figure patterns at the category level (Avg. = 22.950), and the Panhu Pattern at the individual-sample level (Avg. = 28.867); (3) aesthetic preference and visual attention were generally consistent, but at the participant-by-stimulus level, a negative binomial generalized linear mixed model showed no clear independent association between any subjective dimension and FC. This study supports a subjective-objective approach to traditional pattern perception and cultural dissemination.

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Keywords: Traditional patterns; She ethnic; Young adults; Visual attention; Aesthetic preferences; Eye-tracking; Wooden furniture

Contact information: College of Landscape Architecture and Art, Fujian Agriculture and Forestry University, Fuzhou 350002, China;
**Corresponding authors: heluxi@fafu.edu.cn; ZujianCHEN@fafu.edu.cn*

INTRODUCTION

Visual elements of traditional Chinese culture, including totems, patterns, symbols, artifacts, and spaces, carry historical memory, aesthetic values, and cultural connotations, while serving as important media for cultural communication (Li 2022). Among them, traditional patterns, characterized by highly condensed forms and strong recognizability, not only serve decorative functions but also increasingly become a medium connecting traditional culture with modern design (Wu and Liu 2019; Xiao and Legino 2022; Ling and Maaruf 2025). In particular, traditional patterns of ethnic minorities are usually closely related to specific regional environments, myths, and folk beliefs, thereby highlighting the diversity and distinctiveness of traditional Chinese culture. Therefore, this study further

focuses on traditional wooden furniture patterns of the She ethnic group in eastern Fujian, which retain their cultural characteristics while being embedded in specific artifacts. However, how contemporary audiences respond to them in terms of aesthetic preference and visual attention remains insufficiently understood.

The She ethnic group is one of the ethnic minorities in southern China with deep historical accumulation. It is mainly distributed across Fujian, Zhejiang, Jiangxi, Guangdong, and Guizhou provinces, and its members refer to themselves as "Shanha" because most of its population has long lived in hilly areas. Eastern Fujian is an important region for the preservation, continuation, and dissemination of She culture. It is also one of the major settlements where the She population is concentrated nationwide, mainly distributed in Fu'an, Xiapu, Fuding, and the surrounding mountainous, hilly, and coastal areas (Fig. 1), showing a certain degree of regional clustering, and is highly representative in She ethnic studies. On the one hand, because of its distinctive geographical environment, the She ethnic group in eastern Fujian has preserved strong regional, ethnic, and visual characteristics in material culture and ritual practices. On the other hand, through long-term migration, settlement, and everyday life, they have gradually formed and retained a distinctive local ethnic culture, with ancestral beliefs, ritual practices, and decorative arts together forming an important basis for their cultural expression (Yan *et al*. 2012). Related research has found that traditional handicrafts, folk arts, and other cultural forms in traditional settlements of eastern Fujian are highly clustered, demonstrating the region's notable value for cultural heritage research (Han *et al*. 2024). During their long development, the She ethnic group has preserved cultural memory largely through oral transmission, images, artifacts, and rituals. Their patterns function not merely as decorative forms in a general sense, but also as carriers of life ideals and aesthetic order, presenting visual and aesthetic features distinct from other decorative patterns (Yan 2018).

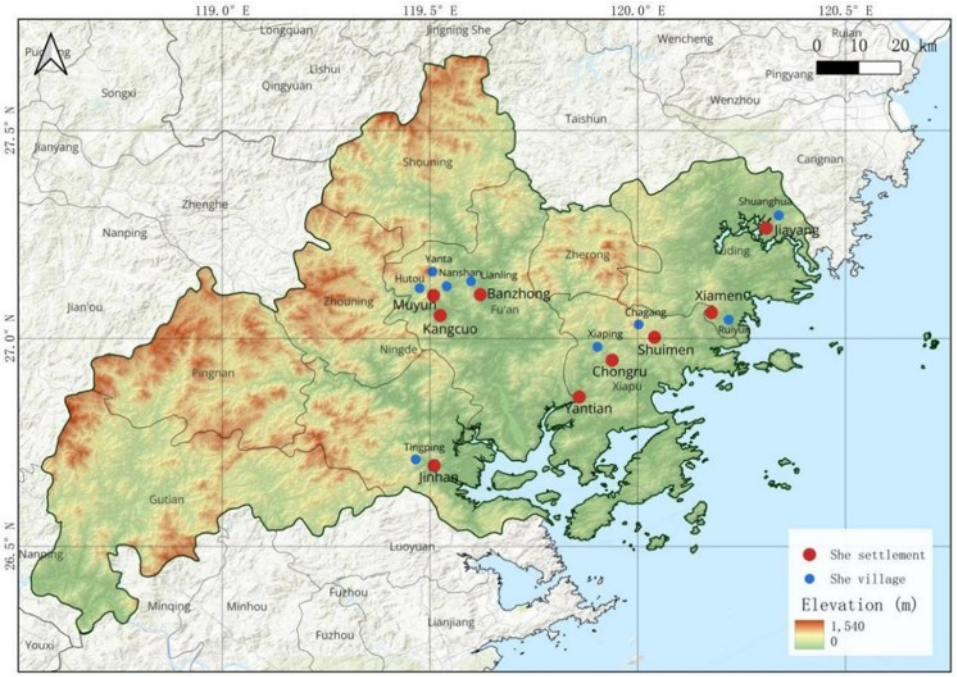

Fig. 1. Spatial distribution map of She ethnic settlements in Eastern Fujian. The map provides the regional cultural context of the study rather than the exact collection locations of the original pattern samples.

Existing studies on She culture have mainly focused on clothing, representative patterns, and architecture. In computational research, Ding *et al*. (2016) examined She clothing patterns and used SIFT, K-means, and other methods to extract and classify their visual features, achieving a recognition accuracy of 92.3% in cross-validation, demonstrating that the morphological features of She patterns are highly recognizable and valuable for computational analysis, and suggesting their potential as comparable and quantifiable visual stimuli. In design research, Zhang *et al*. (2025) used the representative Panhu pattern of the She ethnic group as a case study and integrated the Kano model, extension semantics, and shape grammar to construct an innovative design path for traditional patterns, extracting semantic terms such as "gallant," "auspiciousness," "strength," "power," and "mystery." Their study emphasized that the contemporary transformation of traditional patterns should consider cultural memory, modern innovation, and design aesthetics, indicating that She patterns have not only cultural symbolic value but also visual features that can be perceived and transformed by users. In perception research, Du *et al.* (2025) extended the research to decorative patterns in She architectural heritage, and, using semiotics, eye-tracking, semantic differential evaluation, and other methods, found gender-based differences in visual cognitive processing strategies, while figurative symbols with clear historical and cultural meanings were more likely to evoke emotional resonance, indicating that subjective evaluation and objective experiments can be jointly used to reveal the visual acceptance process of traditional patterns. However, existing studies on She patterns have paid limited attention to aesthetic preference and visual attention toward traditional wooden furniture patterns. Building on this work, the study further introduced crossed mixed-effects models for participant-by-stimulus into eye tracking and semantic differential analyses.

Additionally, the value of traditional patterns is reflected not only in historical culture and symbolic meaning, but also in the perceptual processes through which viewers generate visual attention, aesthetic preference, and cultural acceptance when encountering these patterns. Young adults are one of the audience groups for the visual communication of traditional culture, and their digital media and multicultural environment provides a relevant context for examining the perception of traditional visual forms (Gu 2025). Therefore, examining young adults' visual attention and aesthetic preference toward traditional patterns can help clarify how traditional culture is received in contemporary visual contexts and inform its subsequent reinterpretation and communication.

Visual attention and aesthetic preference are important entry points for understanding how young adults accept traditional patterns, but the two are not identical. Differences in individual thinking styles, preference tendencies, and visual processing, together with stimulus complexity, unfamiliarity, and visual conflict, may be associated with distinct perceptual responses (Ma *et al*. 2023), while aesthetic preference and visual attention may show either consistency or divergence (Chen *et al*. 2023b). Combining the two helps clarify the contemporary acceptance of traditional patterns from the perspectives of objective and subjective. Their relationship has been examined using different methodological perspectives. Holmes and Zanker (2012) constructed an oculomotor signature composed of multiple eye-tracking indicators and found that participants' total fixation time on images was associated with their final preference, with this association becoming stronger as viewing time increased, demonstrating that eye-tracking data can provide objective complementary evidence for aesthetic choice. Studies using evaluation methods, such as preference ratings and emotional arousal ratings, have revealed that aesthetic preference is related not only to visual attention but also to individual visual

processing modes and thinking styles (Mitrovic *et al*. 2020; Chen *et al*. 2023a). Research objects with clear morphological features and cultural attributes may elicit be associated with differences in viewers' attention allocation and aesthetic evaluation due to variations in their type, form, and structure (Zhang *et al*. 2021; Wu *et al*. 2023). However, for traditional patterns as visual elements with cultural attributes, quantitative, multidimensional, and systematic research remains limited, and little is known about how pattern-related factors are associated with young adults' visual attention and aesthetic preferences.

Therefore, this study combined a subjective evaluation questionnaire, the semantic differential method, and eye-tracking to measure young adults' subjective evaluations and visual attention characteristics when viewing the 26 traditional patterns, and uses methods including Friedman tests and mixed-effects models were used to compare the corresponding indicators separately at the pattern-category and individual-sample levels to examine the relationship between subjective evaluation and objective attention, providing empirical evidence for understanding young adults' contemporary perception and acceptance of traditional wooden furniture patterns of the She ethnic group in eastern Fujian. Accordingly, two research questions (RQ) were mainly proposed:

RQ1. Do subjective evaluations and objective eye-tracking metrics differ across patterns at the category and individual sample levels?

RQ2. What relationships exist between the dimensions of subjective evaluation and objective eye-tracking metrics, and do these relationships remain after accounting for variability across participants and stimuli?

EXPERIMENTAL

This study was conducted from March to April 2026 in the laboratory of the College of Landscape Architecture and Art, Fujian Agriculture and Forestry University. Ethical approval was obtained from the Institutional Review Board of the College of Landscape Architecture and Art, Fujian Agriculture and Forestry University (Protocol No. FAFUIRB2026-03; approval date: 7 March 2026).

Participants

This experiment recruited 30 university students through on-campus and online channels. They were 20 to 30 years old, with an average age of 24.7 years and a standard deviation of 1.76 years. The sample included 15 men and 15 women, all of whom were Han Chinese. Twenty-four participants were from design-related disciplines and 6 from other disciplines, while 27 had prior education or training in art or design. Regarding familiarity with She culture, 4 participants reported being relatively familiar, 23 had some awareness but limited familiarity, and 3 were unfamiliar. All participants had normal or corrected-to-normal vision and no visual impairments such as color blindness or other color vision deficiency. The sample size was determined by considering the sample sizes used in related eye-tracking studies, the repeated-measures design of the present study, and the feasibility of experimental implementation. The study followed basic ethical principles for research involving human participants. Before the experiment, all participants were informed that the data would be used solely for academic research and participated voluntarily without compensation after providing written informed consent.

Experimental Equipment

The experiment used a Tobii Pro Glasses 3 wearable eye-tracking system provided by Beijing Kingfar International Inc., China, for data collection. The system includes four eye-tracking sensors and a high-definition scene camera, supports a sampling rate of 100 Hz, and has an eye-tracking accuracy of approximately 0.6°. ErgoLAB 3.0 was used for experimental data analysis. To ensure consistency in stimulus presentation, all stimuli were displayed on the same 21.5-inch Lenovo computer monitor with a resolution of 1920 × 1080 pixels. The wearable eye tracker allowed participants to maintain a natural seated posture without head fixation during screen viewing.

Experimental Materials

A total of 261 traditional wooden furniture patterns of the She ethnic group were collected through field photography in museums in eastern Fujian and from private collections, with their provenance identified through museum records or information provided by the collectors. Based on their categorical attributes, the samples were classified as abstract, animal, plant, human-figure, and composite patterns, with 26 stimuli ultimately selected through subsequent screening. To minimize the interference of irrelevant factors with participants' judgments, all selected samples were standardized. The images were converted to grayscale and their backgrounds were removed, and each pattern was placed on a 1000 × 1000-pixel white background to ensure consistency in stimulus presentation. Each pattern retained its original proportions and was centered on the canvas. Occupied area, scale, and visual complexity were not artificially equalized, preserving the original form.

Experimental Procedure

Before the experiment, a pre-test was conducted to familiarize participants with the stimulus presentation and procedure, and practice data were excluded from formal analyses. Participants were then informed of the study purpose, procedure, and relevant instructions. After providing informed consent, they wore the eye tracker and completed a one-point manual calibration individually using a Tobii calibration card by fixating on its central point. The formal experiment began only after the control software indicated successful calibration, which served as the calibration acceptance criterion. No numerical calibration error threshold was retained in the experimental records, and calibration was repeated until successful if the initial calibration failed. The experiment was conducted in a quiet eye-tracking laboratory under stable lighting conditions, as shown on Fig. 2.

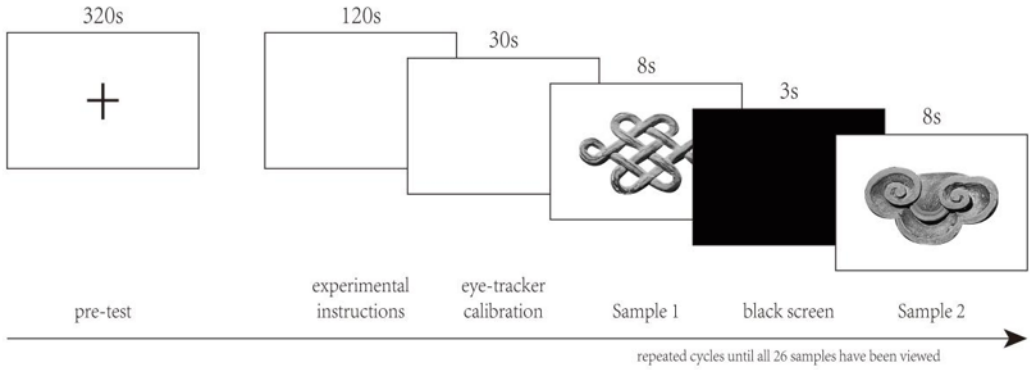

Fig. 2. Experimental procedure of the eye-tracking experiment

To maintain a natural seated posture and keep the entire stimulus within a comfortable viewing range, the viewing distance was set at 45 to 60 cm based on the 45 to 70 cm recommendation of the Yong Loo Lin School of Medicine, National University of Singapore (2023) and the experimental conditions. Participants were instructed to view each pattern freely without any specific search task or fixation target. The 26 stimuli were centered at their original size and presented in a randomized order for each participant, corresponding to an approximate physical size of 24.8 × 24.8 cm and a visual angle of 23.3° to 30.8°. Each stimulus was presented for 8 s, providing sufficient time for free viewing, with a 3 s black screen between stimuli to reduce visual fatigue and attentional interference. This procedure continued until all stimuli had been presented. After eye tracking, participants completed the preference evaluation and semantic differential questionnaires to provide subjective evaluations complementary to the eye-tracking data. All 30 participants were retained, yielding 780 valid trials, with no participant or trial exclusions.

To quantify visual attention to traditional furniture patterns of the She ethnic group, eye-tracking metrics were extracted from contour-fitted areas of interest (AOI) manually traced along the actual outline of each pattern, including Fixation Count (FC), Percentage of Total Fixation Time (TFT%), Average Fixation Time (AFT), and heatmap visualization. FC was the number of valid fixations identified within the AOI during each stimulus presentation, measured as a count (Lai *et al*. 2013). TFT% was the percentage of cumulative fixation duration within the AOI relative to the 8 s stimulus presentation (Tao 2025). AFT was the average duration of valid fixations within the AOI, measured in seconds (Holmqvist and Andersson 2017). Heatmaps visualized the spatial distribution of fixation points, with red indicating the highest attention and yellow and green progressively lower attention (Shin *et al*. 2023).

Fixation events were identified using the built-in Identification by Velocity Threshold algorithm in ErgoLAB, based on the angular velocity of consecutive gaze points, with a velocity threshold of 30°/s and a minimum fixation duration of 100 ms. Blinks and invalid eye-tracking data were automatically processed by the built-in procedure, with no additional manual filtering, smoothing, or blink correction. Subsequent analyses included Friedman tests, Wilcoxon signed-rank tests, Spearman correlation analysis, linear mixed models (LMM), and generalized linear mixed models (GLMM), with mixed-effects models serving as the primary inferential framework. All statistical analyses were conducted in Python 3.14.5. Bayesian mixed effects models were fitted using Bambi 0.20.0 with PyMC 6.3.1, and model diagnostics and LOO comparisons were performed using ArviZ 1.3.0.

Questionnaire Design

The questionnaire included preference evaluation and semantic differential sections, covering six dimensions: aesthetic preference, formal texture, formal coordination, organizational order, visual vitality, and cultural cognition. These dimensions were determined based on relevant literature and research on traditional pattern aesthetics. The Chinese questionnaire used in the formal experiment was reviewed by two experts experienced in traditional culture and design research to assess item wording, conceptual correspondence, and suitability. A pilot test with six participants not included in the formal experiment was then conducted to assess comprehensibility and the appropriateness of the evaluation format.

The preference evaluation directly measured participants' overall aesthetic liking for each pattern, whereas the semantic differential method further assessed specific pattern features from the perspectives of visual perception and cultural cognition, providing a more comprehensive account of the factors underlying aesthetic preference. A 7-point bipolar semantic differential scale was used, with participants selecting the position between the two endpoints that best matched their immediate perception of each pattern, without predetermined correct answers. Because each participant repeatedly evaluated 26 patterns, one representative item was selected for each dimension to limit response burden and experimental duration; therefore, each dimension was measured using a single item. Content appropriateness was supported by relevant literature, expert review, and pilot testing. The questionnaire structure is presented in Table 1. The English version of the complete questionnaire and participant instructions are provided in Supplementary Material S1.

Table 1. Questionnaire Structure and Measurement Items

Section	Evaluation Aspect	Dimension	Measurement Item	Scoring
Preference Rating	Aesthetic Preference	Overall Preference	Dislike-Like	-3, -2, -1, 0, 1, 2, 3
Semantic Differential	Visual Perception	Formal Texture	Coarse-Exquisite	-3, -2, -1, 0, 1, 2, 3
		Formal Coordination	Rigid-Harmonious	-3, -2, -1, 0, 1, 2, 3
		Organizational Order	Complex-Orderly	-3, -2, -1, 0, 1, 2, 3
		Visual Vitality	Dull-Interesting	-3, -2, -1, 0, 1, 2, 3
	Cultural Cognition	Cultural Richness	Culturally shallow-Culturally rich	-3, -2, -1, 0, 1, 2, 3
* Positive scores indicate a stronger tendency toward the right-hand adjective, negative scores indicate a stronger tendency toward the left-hand adjective, and 0 represents the midpoint.				

RESULTS

Stimulus Material Screening Results

This study conducted an initial screening of 261 original pattern samples based on image quality, excluding samples with high duplication, incomplete motifs, blurred boundaries, or unsuitable presentation, leaving 72 candidate pattern samples. The samples were classified by experts into five categories according to their formal characteristics: abstract (A, 18 samples), animal (B, 18 samples), plant (C, 20 samples), human-figure (D, 9 samples), and composite (E, 7 samples). Based on the content validity index (CVI), eight experts with experience in traditional culture and design research independently evaluated the candidates based on five criteria: image integrity, visual clarity, cultural recognizability, category representativeness, and experimental suitability using a four-point scale, with scores of 3 and 4 regarded as approval. The item-level content validity index (I-CVI) was then calculated for each evaluation criterion. Subsequently, the five I-CVI values were averaged and used to rank and select the samples. If scores were tied, the experts conducted an additional round of rating to determine the final selection. Considering the unequal

number of candidate samples across categories and the need to control the number and duration of experimental stimuli, 26 stimuli were selected through stratified quota screening: six from each of the larger categories A, B, and C (A1 to A6, B1 to B6, C1 to C6), and four from each of the smaller categories D and E (D1 to D4, E1 to E4), as shown in Table 2.

Table 2. Content Validity Results for the Eye-Tracking Experimental Materials

Code	Image	Name	Average I-CVI	Code	Image	Name	Average I-CVI
Abstract Patterns (A)				Animal Patterns (B)			
A1		Panchang Pattern	0.975	B1		Bat Pattern	1.000
A2		Cloud Pattern	0.925	B2		Dragon Pattern	0.900
A3		Ruyi Pattern	0.950	B3		Panhu Pattern	1.000
A4		Round Longevity Pattern	0.975	B4		Phoenix Pattern	0.975
A5		Geometric Leiwen Pattern	0.900	B5		Angular Dragon Pattern	0.900
A6		Longevity Character Pattern	0.925	B6		Curved Dragon Pattern	0.925
Plant Patterns (C)				Human-Figure Patterns (D)			
C1		Baoxiang Flower Pattern	0.975	D1		Lü Dongbin Pattern	0.950
C2		Hibiscus Spray Pattern	0.975	D2		Han Xiangzi Pattern	0.950
C3		Orchid Pattern	0.950	D3		He Xiangu Pattern	0.975
C4		Roundel Hibiscus Pattern	0.975	D4		Lan Caihe Pattern	0.900
C5		Scrolling Grass Pattern	0.900				

C6		Pomegranate Pattern	0.900	
Composite Patterns (E)				
E1		Spring Flower And Bird Pattern	0.900	
E2		Auspicious Beast Pattern	0.925	
E3		Bogu Pattern	0.975	
E4		Summer Flower And Bird Pattern	0.950	

Subjective Questionnaire Results

The averages (Avg.) and standard deviations (SD) of preference evaluation scores for the 26 pattern samples are presented in Table 3.

Table 3. Averages and Standard Deviations of Aesthetic Preference Evaluation

Code	Average	SD	Code	Average	SD	Code	Average	SD
Group A			Group B			Group C		
A1	1.867	0.776	B1	1.433	1.501	C1	1.933	1.081
A2	0.967	0.928	B2	1.467	1.196	C2	1.933	1.015
A3	0.933	1.413	B3	1.767	1.305	C3	1.767	0.971
A4	2.133	1.008	B4	1.267	1.081	C4	1.867	1.008
A5	1.700	1.489	B5	0.733	1.081	C5	1.700	0.988
A6	0.567	1.832	B6	0.633	1.326	C6	1.667	1.398
A Avg.	1.361	0.766	B Avg.	1.217	0.783	C Avg.	1.811	0.516
Group D			Group E					
D1	1.267	0.868	E1	1.633	1.129			
D2	1.267	1.015	E2	1.600	1.163			
D3	1.700	0.915	E3	1.767	1.455			
D4	1.567	0.898	E4	1.533	1.479			
D Avg.	1.450	0.729	E Avg.	1.633	1.048			
* A1 to E4 indicate individual pattern sample codes within groups A to E; Group A = Abstract Patterns; Group B = Animal Patterns; Group C = Plant Patterns; Group D = Human-Figure Patterns; Group E = Composite Patterns; SD = Standard Deviation								

At the category level, each participant's scores were first averaged across all patterns within a category. Category average, SD, and 95% confidence interval (CI) were then calculated across the 30 participant-level means to reflect participant-level uncertainty. Category C received the highest average score (Avg. = 1.811, 95% CI [1.619, 2.004]), followed by category E (Avg. = 1.633, 95% CI [1.242, 2.025]) and category D (Avg. = 1.450, 95% CI [1.178, 1.722]), whereas categories A (Avg. = 1.361, 95% CI [1.075, 1.647]) and B (Avg. = 1.217, 95% CI [0.924, 1.509]) received relatively lower average scores. At the individual-sample level, A4 received the highest average score (Avg. = 2.133, SD = 1.008), followed by C1 (Avg. = 1.933, SD = 1.081), C2 (Avg. = 1.933, SD = 1.015), A1 (Avg. = 1.867, SD = 0.776), and C4 (Avg. = 1.867, SD = 1.008), indicating that participants showed stronger subjective aesthetic preference for these patterns. In contrast, A6 (Avg. = 0.567, SD = 1.832), B6 (Avg. = 0.633, SD = 1.326), and B5 (Avg. = 0.733, SD = 1.081) received relatively lower scores.

The average scores for the visual perception evaluations of the semantic differential questionnaire are presented in Table 4. At the category level, the five pattern categories differed across the four visual perception evaluations. For formal texture (coarse–exquisite), categories D (Avg. = 1.775, 95% CI [1.460, 2.090]) and E (Avg. = 1.767, 95% CI [1.434, 2.099]) had higher average scores, indicating an overall leaning toward "exquisite." For formal coordination (rigid–harmonious), categories D (Avg. = 1.783, 95% CI [1.545, 2.022]) and C (Avg. = 1.700, 95% CI [1.325, 2.075]) scored higher and were more strongly perceived as "harmonious." For organizational order (complex-orderly), category A showed the highest average score (Avg. = 1.672, 95%CI [1.334, 2.011]), followed by category C (Avg. = 1.217, 95% CI [0.595, 1.839]), pointing to an overall "orderly" impression, whereas category D showed a negative average score (Avg. = −0.550, 95% CI [-1.273, 0.173]) and was closer to "complex." For visual vitality (dull–interesting), categories E (Avg. = 1.633, 95% CI [1 .181, 2.085]) and D (Avg. = 1.617, 95% CI [1.147, 2.086]) received the highest scores and were more likely to be judged as "interesting."

At the individual-sample level, the four visual perception evaluations also showed considerable variation. For formal texture, E3 received the highest score (Avg. = 2.267), followed by C2 (Avg. = 2.133), D3 (Avg. = 2.133), and B3 (Avg. = 2.100), and these samples were more likely to be perceived as exquisite. In contrast, A6 received the lowest score (Avg. = −0.733) and leaned toward coarse, followed by A2 (Avg. = 0.300) and A3 (Avg. = 0.467), which had positive scores but were perceived as less exquisite. For formal coordination, C1 obtained the highest score (Avg. = 2.400), followed by C5 (Avg. = 2.067) and D4 (Avg. = 2.000), and these samples were generally perceived as more harmonious. A6 (Avg. = 0.200), B5 (Avg. = 0.633), and B6 (Avg. = 0.667) scored relatively low, indicating weaker formal coordination.

For organizational order, A1 (Avg. = 2.167), A4 (Avg. = 2.067), and A3 (Avg. = 1.967) received higher scores, indicating a stronger orderly impression. D2 (Avg. = −0.700), D3 (Avg. = −0.467), D4 (Avg. = −0.467), and B3 (Avg. = −0.367) all showed negative values and tended more toward complex. For visual vitality, B3 received the highest score (Avg. = 2.233), followed by C1 (Avg. = 1.867) and E3 (Avg. = 1.833), demonstrating that these patterns were more likely to evoke perceived interest. In contrast, A6 obtained the lowest score (Avg. = −0.567), showing a tendency toward dullness, followed by A3 (Avg. = 0.100) and C3 (Avg. = 0.633), which had weaker perceived interest.

Table 4. Averages of Semantic Differential Scores in the Visual Perception Evaluations

Code	Coarse-Exquisite	Rigid-Harmonious	Complex-Orderly	Dull-Interesting
Group A				
A1	1.467	1.867	2.167	0.767
A2	0.300	1.467	1.833	0.867
A3	0.467	1.200	1.967	0.100
A4	1.833	1.800	2.067	0.900
A5	2.067	1.967	0.567	0.833
A6	-0.733	0.200	1.433	-0.567
A Avg.	0.900	1.417	1.672	0.483
Group B				
B1	1.967	1.867	0.233	1.700
B2	1.433	1.333	0.433	1.200
B3	2.100	1.833	-0.367	2.233
B4	1.000	1.500	0.200	1.167
B5	0.900	0.633	0.333	0.833
B6	1.200	0.667	0.867	0.867
B Avg.	1.433	1.306	0.283	1.333
Group C				
C1	2.067	2.400	1.633	1.867
C2	2.133	1.433	1.167	1.200
C3	1.233	1.533	1.267	0.633
C4	0.767	1.267	1.233	1.133
C5	1.600	2.067	1.100	1.700
C6	1.467	1.500	0.900	1.600
C Avg.	1.545	1.700	1.217	1.356
Group D				
D1	1.667	1.800	-0.567	1.333
D2	1.433	1.500	-0.700	1.700
D3	2.133	1.833	-0.467	1.800
D4	1.867	2.000	-0.467	1.633
D Avg.	1.775	1.783	-0.550	1.617
Group E				
E1	1.533	1.700	0.633	1.733
E2	1.400	1.300	0.367	1.533
E3	2.267	1.667	0.733	1.833
E4	1.867	1.300	0.267	1.433
E Avg.	1.767	1.492	0.500	1.633

The average scores for the cultural cognition evaluation (culturally shallow–culturally rich) are presented in Table 5. At the category level, the five pattern categories showed some differences in perceived cultural meaning. Category B obtained the highest average score (Avg. = 2.117, 95% CI [1.869, 2.364]) and was more likely to be perceived as having strong cultural characteristics, whereas category C had a relatively lower average score (Avg. = 1.411, 95% CI [1.099, 1.724]). At the individual-sample level, B3 received the highest score (Avg. = 2.433), followed by B4 (Avg. = 2.300), E3 (Avg. = 2.267), and B1 (Avg. = 2.233), suggesting that their cultural characteristics were more readily perceived. In comparison, C3 (Avg. = 0.967), A2 (Avg. = 1.133), and C4 (Avg. = 1.167) scored lower, indicating relatively weaker perceived cultural meaning.

Table 5. Averages of Semantic Differential Scores in Cultural Cognition Evaluation

Code	Average	Code	Average	Code	Average	Code	Average	Code	Average
Group A		Group B		Group C		Group D		Group E	
A1	2.167	B1	2.233	C1	2.033	D1	1.767	E1	1.600
A2	1.133	B2	1.767	C2	1.300	D2	1.967	E2	1.867
A3	1.333	B3	2.433	C3	0.967	D3	1.433	E3	2.267
A4	2.000	B4	2.300	C4	1.167	D4	1.933	E4	1.633
A5	1.900	B5	2.100	C5	1.467	D Avg.	1.775	E Avg.	1.842
A6	1.733	B6	1.867	C6	1.533				
A Avg.	1.711	B Avg.	2.117	C Avg.	1.411				
* A1 to E4 indicate individual pattern sample codes within groups A to E; Group A = Abstract Patterns; Group B = Animal Patterns; Group C = Plant Patterns; Group D = Human-Figure Patterns; Group E = Composite Patterns									

Considering the variability arising from different participants and stimuli on subjective evaluation results, this study established separate linear mixed models (LMM) for each subjective evaluation dimension, with pattern category treated as a fixed effect and participant and stimulus as crossed random effects. The results are shown in Table 6. Significant overall category differences were found for organizational order [LR $\chi^2(4) = 44.400$], visual vitality [LR $\chi^2(4) = 18.308$], and cultural cognition [LR $\chi^2(4) = 13.049$] (all $p < 0.050$), indicating that these evaluations varied across pattern categories. By contrast, aesthetic preference [LR $\chi^2(4) = 8.490$], formal texture [LR $\chi^2(4) = 6.669$], and formal coordination [LR $\chi^2(4) = 3.889$] did not show significance (all $p > 0.050$), suggesting that no clear overall category differences were detected for these dimensions and may have been influenced by individual pattern characteristics within each category.

Table 6. Overall Category Differences in Subjective Evaluations Based on Linear Mixed Models

Evaluation Dimension	LR χ^2	df	p
Aesthetic Preference	8.490	4	0.075
Formal Texture	6.669	4	0.154
Formal Coordination	3.889	4	0.421
Organizational Order	44.400	4	＜0.001
Visual Vitality	18.308	4	0.001
Cultural Cognition	13.049	4	0.011
* N = 780 participant-by-stimulus observations. Category was treated as a fixed effect, with participant and stimulus included as crossed random effects. LR x^2 values were obtained from likelihood-ratio tests comparing models with and without the category term.			

Friedman tests were used to examine differences in participants' subjective evaluations at both the category level and individual-sample level. At the category level, the average of each participant's original ratings for all patterns within the same category was calculated as the category score, and the results showed that the five traditional pattern categories differed significantly across all evaluations (all $p < 0.050$). For aesthetic preference, the result was $\chi^2(4) = 16.659$, $p = 0.002$, and Kendall's $W = 0.139$. Among

the visual perception, the category-level difference was most evident in "complex–orderly" [$\chi^2(4) = 30.658$, $p < 0.001$, Kendall's $W = 0.255$], whereas the difference in "rigid–harmonious" was relatively weaker [$\chi^2(4) = 10.525$, $p = 0.032$, Kendall's $W = 0.088$]. For cultural cognition, the result was $\chi^2(4) = 20.118$, $p < 0.001$ and Kendall's $W = 0.168$.

At the individual-sample level, scores also differed significantly across all evaluations (all $p < 0.001$). For aesthetic preference, the result was $\chi^2(25) = 100.490$ and $W = 0.134$, demonstrating that participants showed different preference tendencies toward patterns. Among the visual perception, the largest difference was found for "coarse–exquisite" [$\chi^2(25) = 191.328$, $W = 0.255$], followed by "complex–orderly" [$\chi^2(25) = 176.722$, $W = 0.236$] and "dull–interesting" [$\chi^2(25) = 172.246$, $W = 0.230$]. In comparison, "rigid–harmonious" showed a smaller effect size [$\chi^2(25) = 86.851$, $W = 0.116$]. For cultural cognition, the result was $\chi^2(25) = 109.758$ and $W = 0.146$, indicating that perceived cultural meaning varied across individual traditional patterns.

Given the significant overall differences in the Friedman tests, exploratory Wilcoxon signed-rank tests were conducted for the representative category levels and individual-sample levels with the highest and lowest average scores in each evaluation. Effect sizes were reported as r, with $N = 30$ for all paired comparisons. At the category level, all comparisons were significant for aesthetic preference (C *vs.* B, $Z = -3.693$, $r = 0.674$, $p < 0.001$), formal texture (D *vs.* A, $Z = -3.982$, $r = 0.727$, $p < 0.001$), formal coordination (D *vs.* B, $Z = -3.055$, $r = 0.558$, $p = 0.002$), organizational order (A *vs.* D, $Z = -3.946$, $r = 0.720$, $p < 0.001$), visual vitality (E *vs.* A, $Z = -4.276$, $r = 0.781$, $p < 0.001$), and cultural cognition (B *vs.* C, $Z = -4.294$, $r = 0.784$, $p < 0.001$). At the individual-sample level, all comparisons were also significant for aesthetic preference (A4 *vs.* A6, $Z = -3.188$, $r = 0.582$, $p = 0.001$), formal texture (E3 *vs.* A6, $Z = -4.514$, $r = 0.824$, $p < 0.001$), formal coordination (C1 *vs.* A6, $Z = -3.917$, $r = 0.715$, $p < 0.001$), organizational order (A1 *vs.* D2, $Z = -4.263$, $r = 0.778$, $p < 0.001$), visual vitality (B3 *vs.* A6, $Z = -4.678$, $r = 0.854$, $p < 0.001$), and cultural cognition (B3 *vs.* C3, $Z = -4.594$, $r = 0.839$, $p < 0.001$). Because six representative pairwise comparisons were conducted at each level, the Bonferroni method was applied, yielding a corrected significance threshold of $p < 0.0083$, and all comparisons remained significant after correction.

Eye-tracking Results

Quantitative eye-tracking metrics

Descriptive statistics were computed for the eye-tracking metrics within the area of interest (AOI) across the 30 participants, including fixation count (FC), percentage of total fixation time (TFT%), and average fixation time (AFT). The results are presented in Table 7 and Fig. 3. For FC, at the category level, categories D (Avg. = 22.950) and C (Avg. = 21.772) had higher average scores, whereas category A had the lowest average score (Avg. = 18.483). At the individual-sample level, B3 obtained the highest average score (Avg. = 28.867), followed by A4 (Avg. = 27.533), C2 (Avg. = 24.133), and D2 (Avg. = 24.067), which received more fixations during viewing. In contrast, A6 had the lowest average score (Avg. = 12.400), followed by B6 (Avg. = 14.367) and A3 (Avg. = 15.500).

For TFT%, at the category level, category D had the highest average score (Avg. = 66.646), followed by category C (Avg. = 65.058), while category A had a relatively lower average score (Avg. = 61.218). At the individual-sample level, A4 showed the highest average score (Avg. = 70.343), followed by C2 (Avg. = 67.726), B3 (Avg. = 67.615), and C1 (Avg. = 67.240), which received a larger share of visual attention. A6 had the lowest average score (Avg. = 51.109), followed by B6 (Avg. = 56.427) and B5 (Avg. = 56.539).

Table 7. Averages of Quantitative Eye-tracking Metrics

Code	FC(N)	TFT(%)	AFT(s)	Code	FC(N)	TFT(%)	AFT(s)
Group A				Group B			
A1	21.467	66.153	0.250	B1	18.700	63.024	0.237
A2	15.667	58.730	0.232	B2	17.833	59.943	0.241
A3	15.500	57.977	0.236	B3	28.867	67.615	0.272
A4	27.533	70.343	0.293	B4	18.033	64.541	0.240
A5	18.333	62.996	0.244	B5	18.133	56.539	0.232
A6	12.400	51.109	0.220	B6	14.367	56.427	0.222
A Avg.	18.483	61.218	0.246	B Avg.	19.322	61.348	0.241
Group C				Group D			
C1	22.333	67.240	0.259	D1	23.200	66.805	0.248
C2	24.133	67.726	0.272	D2	24.067	67.117	0.255
C3	21.400	64.070	0.249	D3	23.167	66.932	0.271
C4	21.700	66.487	0.255	D4	21.367	65.730	0.243
C5	20.533	63.232	0.244	D Avg.	22.950	66.646	0.254
C6	20.533	61.593	0.243				
C Avg.	21.772	65.058	0.254				
Group E							
E1	19.600	61.465	0.241				
E2	19.833	60.658	0.239				
E3	22.033	66.108	0.257				
E4	19.567	60.409	0.236				
E Avg.	20.258	62.160	0.243				

* A1 to E4 indicate individual pattern sample codes within groups A to E; Group A = Abstract Patterns; Group B = Animal Patterns; Group C = Plant Patterns; Group D = Human-Figure Patterns; Group E = Composite Patterns

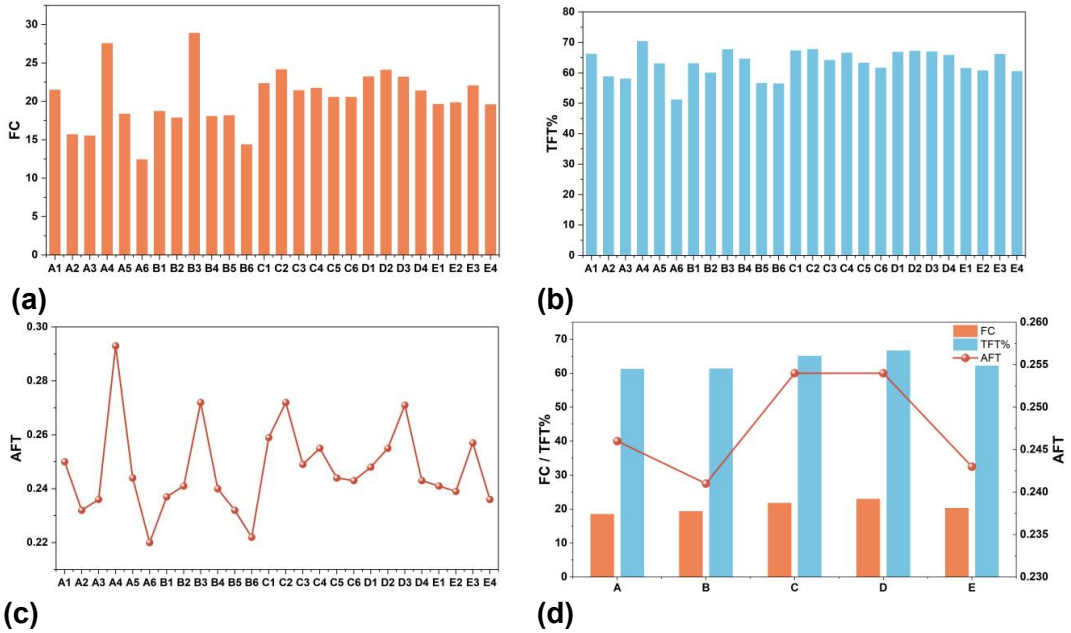

Fig. 3. Eye-tracking indicators for traditional wooden furniture patterns of the She ethnic group in eastern Fujian: (a) FC of the 26 individual pattern samples; (b) TFT% of the 26 individual pattern samples; (c) AFT of the 26 individual pattern samples; (d) category-level comparison of FC, TFT%, and AFT across the five pattern categories

For AFT, at the category level, categories C and D had the joint highest average score (both Avg. = 0.254), whereas category B had a relatively lower average score (Avg. = 0.241). At the individual-sample level, A4 had the highest average score (Avg. = 0.293), followed by B3 (Avg. = 0.272), C2 (Avg. = 0.272), and D3 (Avg. = 0.271), showing relatively longer single-fixation durations. In contrast, A6 (Avg. = 0.220), B6 (Avg. = 0.222), A2 (Avg. = 0.232), and B5 (Avg. = 0.232) had relatively lower average scores.

To account for the influence of different participants and stimuli on eye-tracking metrics, separate generalized linear mixed models (GLMM) were fitted for FC, TFT%, and AFT, with pattern category as a fixed effect and participant and stimulus as crossed random effects. FC followed a negative binomial distribution, TFT% a beta distribution, and AFT a gamma distribution with a log link. As shown in Table 8, comparisons between full models including pattern category and null models excluding it showed no clear improvement in predictive performance for FC (ΔELPD= –0.014, dSE=0.939), TFT% (ΔELPD=–0.720, dSE=1.920), or AFT (ΔELPD=–1.241, dSE=1.172). In addition, all 95% highest density intervals (HDI) for category contrasts relative to reference category A included zero, indicating no clear category differences in the three eye-tracking metrics. Thus, variation in the eye-tracking data should be further interpreted in relation to individual-sample characteristics and heatmap results.

Table 8. Overall Category Comparisons for Eye-tracking Metrics Based on Generalized Linear Mixed Models

Eye-tracking Metric	Distribution	Full ELPD-LOO	Null ELPD-LOO	ΔELPD	dSE
Fixation count	Negative binomial	-2559.286	-2559.272	-0.014	0.939
Percentage of total fixation time	Beta	148.023	148.743	-0.720	1.920
Average fixation time	Gamma (log link)	1122.185	1123.427	-1.241	1.172

* Full models included pattern category as a fixed effect, whereas null models excluded the category term. Participant and stimulus were included as crossed random effects in all models. ΔELPD represents the difference in expected log predictive density between the full and null models (Full - Null), and dSE represents the standard error of this difference.

Friedman tests were used to examine overall differences in visual attention at both the category and individual-sample levels. At the category level, the five traditional pattern categories differed significantly in FC [$\chi^2(4) = 28.757$, Kendall's W = 0.240] ($p < 0.001$), whereas TFT% [$\chi^2(4) = 5.253$, Kendall's W = 0.044] and AFT [$\chi^2(4) = 4.133$, Kendall's W = 0.034] did not reach statistical significance ($p > 0.050$). At the individual-sample level, all three metrics showed significant differences ($p < 0.001$), with FC [$\chi^2(25) = 149.967$, Kendall's W = 0.200], TFT% [$\chi^2(25) = 106.635$, Kendall's W = 0.142], and AFT [$\chi^2(25) = 138.233$, Kendall's W = 0.184].

Given the significant overall test results, exploratory Wilcoxon signed-rank tests were conducted for the representative categories or individual samples with the highest and lowest average scores for each eye-tracking metric. At the category level, because only FC showed a significant difference, a pairwise comparison was conducted between category D, with the highest average score, and category A, with the lowest average score. The result showed a significant difference ($Z = -2.581$, $r = 0.471$, $p = 0.010$). At the individual-sample level, significant differences were found for FC (B3 *vs.* A6, $Z = -4.316$, $r = 0.788$, $p <$

0.001), TFT% (A4 *vs.* A6, Z = −2.725, r = 0.498, p = 0.006), and AFT (A4 *vs.* A6, Z = −4.042, r = 0.738, p < 0.001). Because three representative pairwise comparisons were conducted at the individual-sample level, the Bonferroni method was applied, yielding a corrected significance threshold of p < 0.0167. The three individual sample comparisons remained significant after correction.

Visualized Eye-tracking Metrics

Building on the quantitative eye-tracking metrics, the heatmaps of the 26 pattern samples created by visualizing and overlaying the gaze positions of 30 participants (Fig. 4) were qualitatively examined as an exploratory visual analysis, and four types were identified according to their hotspot distributions.

The first type was center-focused, with hotspots mainly concentrated in the center or core areas of the pattern, and this distribution was most evident in A4, C1, and C3. The second type was vertical-axis focused, with hotspots extending from top to bottom along the main contour or central axis of the pattern, and typical samples included B3, B6, D2, D3, C6, and E3. The third type showed a horizontal band-like distribution, with hotspots forming clear left-right bands, as seen in B4, C5, and E1. The fourth type was multi-core dispersed, with hotspots distributed across several relatively independent areas, which may be associated with multiple scanning points and local shifts during viewing, as shown in A2, A3, D4, and E2.

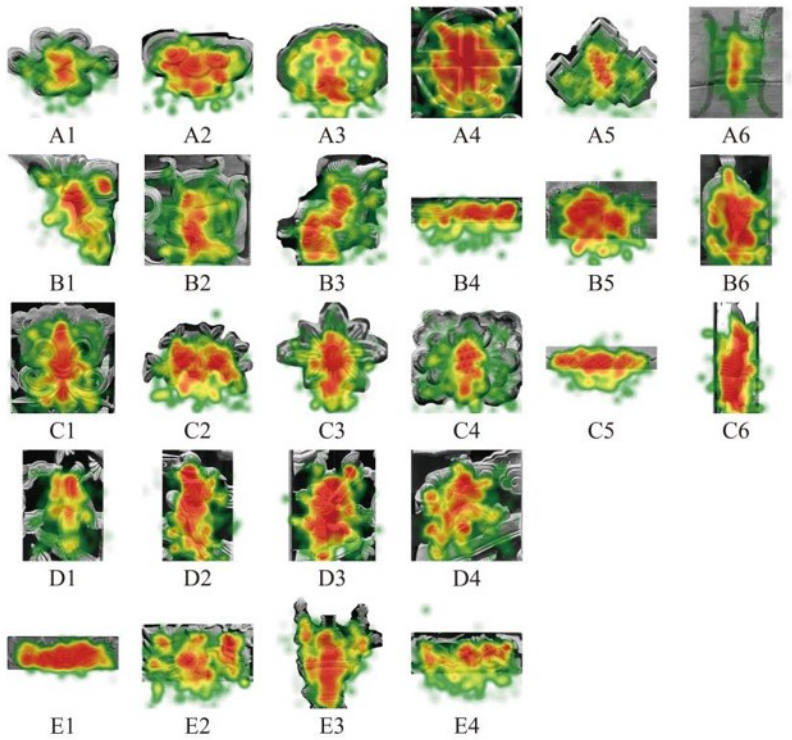

Fig. 4. Eye-tracking heatmaps of traditional patterns

Relationship Between Subjective Evaluation and Objective Behavior

The correlation matrix heatmap (Fig. 5) presents the associations among aesthetic preference, formal texture, formal coordination, organizational order, visual vitality, cultural cognition, FC, TFT%, and AFT. The analysis used the 26 patterns as the unit of

analysis (N = 26), with each variable represented by the average across 30 participants for the corresponding pattern, reflecting between-pattern associations. The 95% confidence intervals for Spearman correlations were estimated using 10000 bootstrap samples, and the Benjamini-Hochberg method was used to control the false discovery rate (FDR) across 36 correlation tests. The lower-left triangle shows the correlation coefficients and FDR-adjusted significance markers, while the upper-right triangle shows the corresponding 95% bootstrap confidence intervals. Orange indicates positive correlations, blue indicates negative correlations, and color intensity represents correlation strength. Aesthetic preference, formal texture, formal coordination, and visual vitality showed significant positive correlations with the three metrics, whereas organizational order and cultural cognition showed relatively weaker correlations with them.

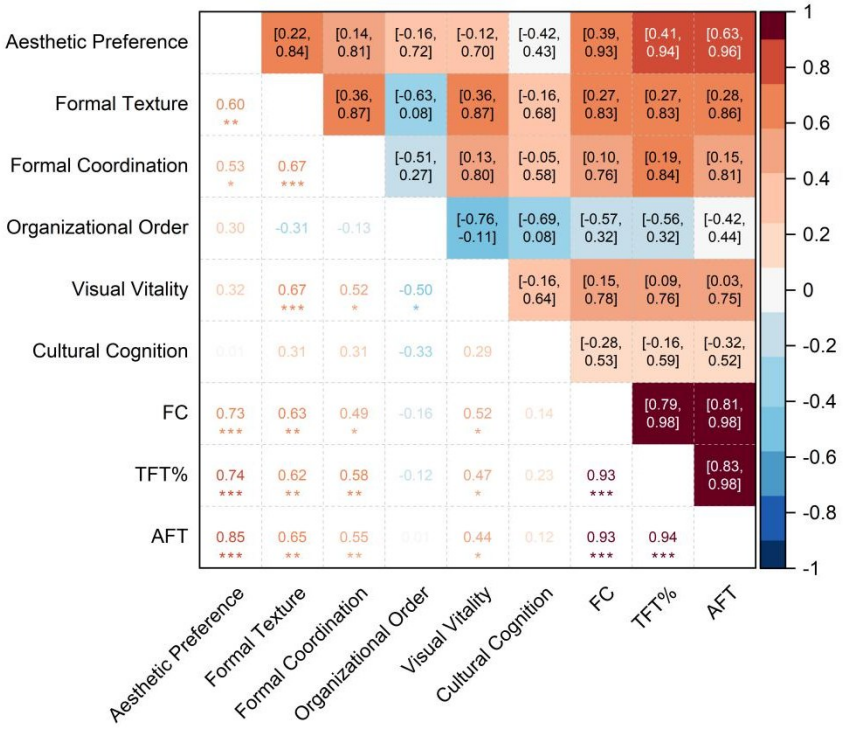

Fig. 5. Spearman correlation matrix heatmap between subjective evaluation and objective behavior based on stimulus-level means across 26 pattern samples (N = 26). The lower-left triangle shows Spearman correlation coefficients, with significance determined using Benjamini–Hochberg FDR-adjusted p values across all 36 unique pairwise correlations. The upper-right triangle shows the corresponding 95% bootstrap confidence intervals estimated from 10000 samples; * p ≤ 0.05, ** p ≤ 0.01, *** p ≤ 0.001.

Because only FC was significant at both the pattern-category and individual-sample levels, and FC is counting data with overdispersion, a Negative Binomial Generalized Linear Mixed Model (NB-GLMM) with a log link was further used to examine its associations with the six subjective evaluation dimensions. The six dimensions were treated as fixed effects, with participant and stimulus as crossed random effects (Table 9, Figure 6). The model was specified as FC ~ Aesthetic Preference + Formal Texture + Formal Coordination + Organizational Order + Visual Vitality + Cultural Cognition + (1 | Participant) + (1 | Stimulus) and included 780 participant-by-stimulus observations with no missing values in the model variables. All six predictors were entered on their original

scales without standardization. The model was estimated using Bayesian MCMC sampling with four chains, 2000 tuning iterations, and 2000 posterior draws per chain. The 95% HDIs for all six dimensions crossed zero, with visual vitality showing the highest posterior average (B = 0.020, 95% HDI [-0.005, 0.044]), while Cultural Cognition had the largest absolute negative estimate (B = −0.019, 95% HDI [-0.045, 0.006]). The posterior random-effect variances for participant and stimulus were 0.343 (95% HDI [0.220, 0.590]) and 0.031 (95% HDI [0.014, 0.060]), respectively. Multicollinearity was low among the six subjective evaluation dimensions, with variance inflation factor values ranging from 1.171 to 1.543. No divergent transitions were observed, R-hat values were approximately 1.00, and posterior predictive checks indicated adequate reproduction of the observed FC distribution.

Table 9. Negative Binomial Generalized Linear Mixed Model Results for the Associations Between Subjective Evaluation Dimensions and FC

Predictor	Estimate	SD	95% HDI
Intercept	2.833	0.114	[2.600,3.100]
Aesthetic Preference	0.001	0.014	[-0.026,0.028]
Formal Texture	-0.003	0.014	[-0.030,0.023]
Formal Coordination	0.017	0.014	[-0.010,0.043]
Organizational Order	0.011	0.009	[-0.008,0.029]
Visual Vitality	0.020	0.013	[-0.005,0.044]
Cultural Cognition	-0.019	0.013	[-0.045,0.006]
* FC was modeled using a negative binomial distribution with a log link. Participant and stimulus were included as crossed random intercepts. Estimates are posterior means, and HDI denotes the 95% highest density interval			

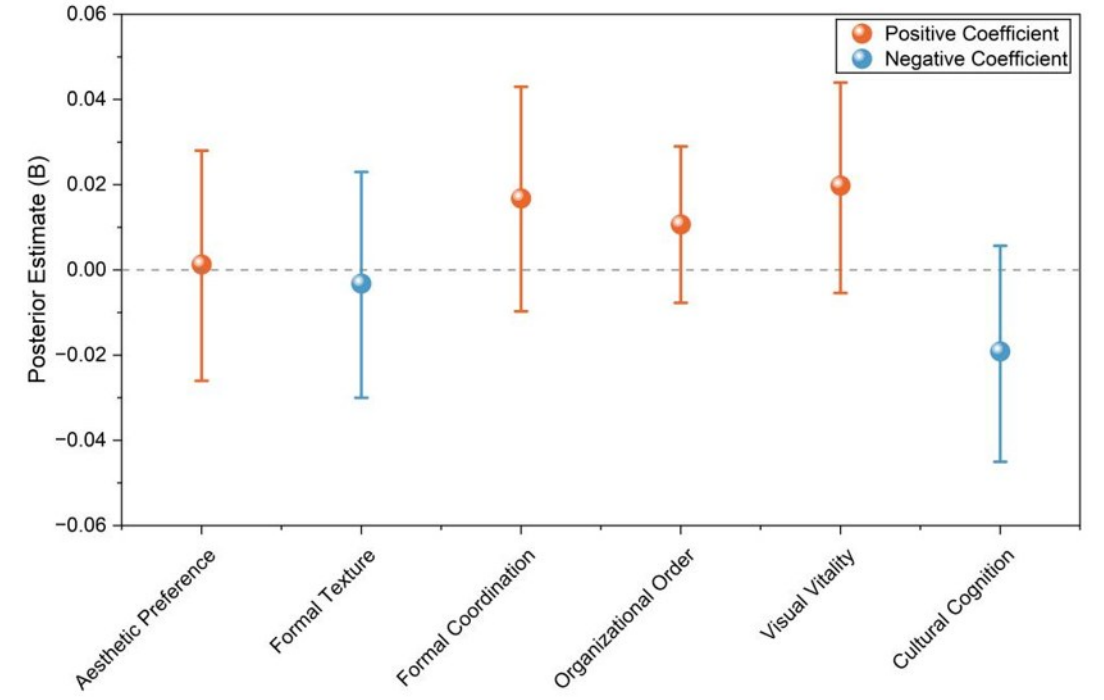

Fig. 6. Posterior estimates and 95% highest density intervals for the fixed effects in the negative binomial generalized linear mixed model. The horizontal dashed line indicates zero.

DISCUSSION

Aesthetic Preference in Subjective Evaluation

The subjective evaluation results showed that participants were able to form clear perceptual distinctions at both the pattern-category and individual-sample levels. At the category level, plant patterns (C) received the highest aesthetic preference score. Their curved forms, floral and leaf structures, natural imagery, and relatively stable decorative order may be associated with lower perceptual burden and produced a softer aesthetic experience. The contemporary dissemination of traditional patterns should therefore not focus only on the role of category-level characteristics but also consider how visual features and emotional value at the individual-pattern level shape user perception (Qin *et al*. 2025).

At the individual-sample level, the highest-scoring sample was the Round Longevity Pattern (A4) in the abstract category (A), indicating that specific visual factors, such as central composition and visual order, may correspond to differences in overall aesthetic evaluation. Moreover, within animal patterns (B), the category with the lowest aesthetic preference score, the Panhu Pattern (B3) performed prominently in visual vitality and cultural cognition, suggesting that lower overall category preference does not mean that samples within the category lack perceptual value. Taken together, participants' subjective acceptance of traditional She ethnic wooden furniture patterns represents a multidimensional evaluative process.

Visual Attention in Objective Behavior

The eye-tracking results showed that participants' visual attention toward traditional wooden furniture patterns of the She ethnic group in eastern Fujian was not evenly distributed.

At the category level, only FC showed a clear difference. Among these categories, human-figure patterns (D) received the highest number of fixations, suggesting that specific narrative cues and content may be associated with repeated viewing or local information search. The overall heatmap results showed that participants' fixation hotspots tended to cluster around visually salient local elements, such as central symbols, main contours, and axial structures.

At the individual-sample level, differences in visual attention were more evident. B3, which received the highest FC, indicated that distinctive morphological features and cultural symbols coincide with more frequent visual search. A4 showed prominent TFT% and AFT results, suggesting that strong central composition and visual order may correspond to more stable attention. In contrast, the Longevity Character Pattern (A6) showed relatively low eye-tracking metrics, with relatively limited visual attention observed, which may be related to its simple structure and weak visual layering. Further observation of the heatmaps revealed that patterns with a clear center and strong order may show more concentrated fixation distributions, whereas samples with distributed information or extended structures may be associated with more complex fixation paths.

Linking Aesthetic Preference and Visual Attention

Aesthetic preference reflects viewers' overall subjective evaluation of the patterns, whereas quantitative visual attention results can supplement the immediate responses that traditional questionnaires may not capture and help explain viewer's attentional focus and differences across samples (Motoki *et al*. 2021; Reppa and McDougall 2022; Pedrini *et al*. 2025).

The results showed that aesthetic preference and eye-tracking metrics partially overlapped but were not equivalent, as A6 had the lowest results in both, but this did not apply to all samples. At the category level, category C received the highest aesthetic preference score, whereas category D had the highest FC. Similarly, at the individual-sample level, A4 had the highest aesthetic preference score, whereas B3 had the highest FC. Considering the other subjective dimensions, category D and B3 performed more prominently than category C and A4, while showing weaker organizational order and relatively greater information complexity, which may be associated with their higher fixation frequency. From a spatial perspective, heatmaps complement the analysis by suggesting that factors, such as composition and organization, help explain visual attention distribution and aesthetic preference (Fang 2022; Stojilović 2025).

The correlation matrix heatmap showed an overall association between subjective evaluation and objective behavior. However, the negative binomial generalized linear mixed model results indicated that this did not imply clear associations across all dimensions (Soydaner and Wagemans 2024; Wang *et al*. 2026). When all six dimensions were entered into the model together, some subjective evaluation dimensions were associated with FC at the individual-sample level. After accounting for the multidimensional evaluations and participant and stimulus differences, Visual Vitality showed a relatively stronger positive association trend, whereas Cultural Cognition showed a relatively stronger negative association trend. However, neither direction showed a clear independent association with FC.

Therefore, examining both subjective and objective perspectives helps provide a more comprehensive understanding of participants' perception of traditional wooden furniture patterns of the She ethnic group in eastern Fujian. However, practical applications should also consider constraints related to the placement, production techniques, surface treatment, and other conditions of patterns on actual furniture. Because these factors were not experimentally tested in study, their specific roles require further examination in future research.

Limitations

This study still has several limitations. First, the sample comprised only 30 university students with relatively concentrated academic and cultural backgrounds, the findings mainly apply to the present participants, and future studies should include larger and more culturally diverse samples. Second, to control irrelevant visual factors, patterns were presented after background removal, grayscale conversion, and standardization, excluding wood color, texture, material qualities, and the context of actual wooden furniture. Therefore, the findings primarily reflect participants' subjective evaluations and objective attention to traditional wooden furniture patterns and cannot be directly generalized to furniture or wood materials themselves. The stimuli may differ in features such as simplicity, visual complexity, and contrast, which were not independently quantified in this study. Future research could retain or systematically manipulate pattern color and quantify or control these related visual features. Third, the five stimulus categories contained unequal numbers, and the six subjective dimensions were each measured with a single item, precluding internal-consistency assessment. Finally, although stimulus order was randomized and the mixed-effects models accounted for variability across participants and stimuli, external influences such as the experimental setting cannot be fully excluded. Heatmap analysis was also based mainly on fixation distributions, so interpretations of pattern characteristics and visual search processes should be considered

tentative. Future research should further examine these findings using more diverse experimental designs and methods.

CONCLUSIONS

Building on the subjective perspective of existing traditional culture research, this study further incorporated objective behavior to examine participants' aesthetic preferences and visual attention toward traditional patterns, and their relationship, at the category level and individual-sample level.

1. The results revealed that participants' subjective evaluation of traditional wooden furniture patterns of the She ethnic group in eastern Fujian showed multifactorial characteristics. They preferred plant patterns at the category level (Avg. = 1.811) and the Round Longevity Pattern at the individual-sample level (Avg. = 2.133).
2. For objective behavior, participants' visual attention was unevenly distributed and was mainly reflected in fixation count (FC). At the category level, they showed higher FC for human-figure patterns (Avg. = 22.950), whereas the Panhu Pattern showed the highest FC at the individual-sample level (Avg. = 28.867). These differences may be associated with specific narrative content or distinctive morphological features of patterns, with gaze usually clustering around visually salient elements.
3. Further analysis reflected that aesthetic preference and visual attention partially overlapped but were not equivalent. However, the negative binomial generalized linear mixed model showed that visual vitality had the largest positive posterior estimate for FC (B = 0.020), whereas cultural cognition showed the largest absolute negative posterior estimate (B = –0.019). The 95% highest density intervals for all dimensions included zero, indicating no clear independent association with FC.

Overall, this study supports the feasibility of a combined subjective-objective perspective in traditional pattern perception research, helping clarify the association between participants' aesthetic preferences and visual attention toward traditional patterns. However, given the limited and relatively homogeneous sample, grayscale and standardized stimuli, unequal numbers of stimuli across categories, and single-item subjective measures, the findings may inform future dissemination of traditional culture but require further investigation and validation.

ACKNOWLEDGEMENTS

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DATA AVAILABILITY STATEMENT

De-identified questionnaire ratings, trial-level eye-tracking summaries, and analysis code are available from the corresponding author upon reasonable request. Processed gaze data may also be provided where ethically and technically feasible.

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APPENDIX

1. Complete Questionnaire (English Version)

* The questionnaire was administered to participants in Chinese. The English version is provided here for reference.

Thank you for participating in this study. **The information and responses collected in this questionnaire will be used solely for academic research.** Please evaluate each pattern based on your immediate impression. For each item, select the position on the 7-point bipolar scale that best represents your perception of the pattern. There are no right or wrong answers. The scale ranges from −3 to +3, with 0 representing the midpoint. Negative values indicate positions toward the left endpoint, whereas positive values indicate positions toward the right endpoint.

Part 1. Participant Information

Please provide the following information.

1. **Age:** _____ years
2. **Sex:**

☐ Male ☐ Female

3. **Academic Major:** _____
4. **Ethnicity:** _____
5. **Have you received any education or training related to art or design?**

☐ Yes ☐ No

6. **How familiar are you with She culture?**

☐ Relatively familiar ☐ Aware of it but not very familiar ☐ Unfamiliar

7. **Vision:**

☐ Normal vision ☐ Corrected-to-normal vision

8. **Do you have color blindness or other color vision deficiencies?**

☐ Yes ☐ No

Part 2. Preference Evaluation

Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like

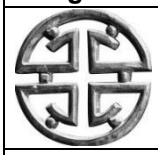
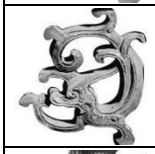
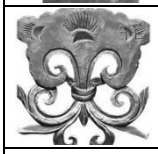
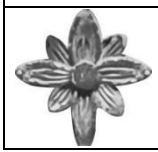
Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like

Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like
	Aesthetic Preference	Dislike	○	○	○	○	○	○	○	Like

Part 3. Semantic Differential Evaluation

Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite

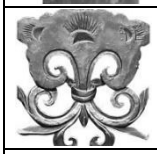
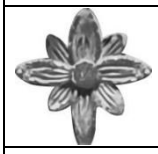
Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite

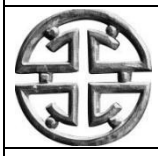
Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Texture	Coarse	○	○	○	○	○	○	○	Exquisite
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious

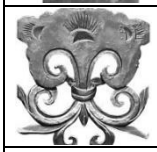
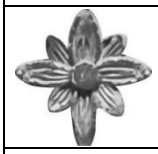
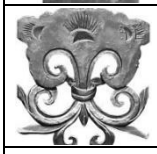
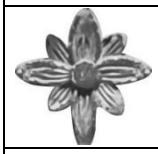
Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious

Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Formal Coordination	Rigid	○	○	○	○	○	○	○	Harmonious
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly

Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
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	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly

Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Organizational Order	Complex	○	○	○	○	○	○	○	Orderly
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting

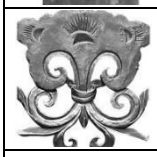
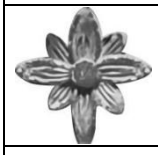
Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting

Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Visual Vitality	Dull	○	○	○	○	○	○	○	Interesting
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich

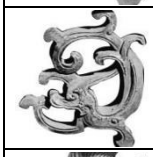
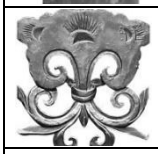
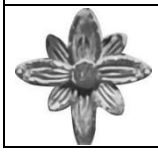
Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich

Figure	Dimension	Left endpoint	−3	−2	−1	0	+1	+2	+3	Right endpoint
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich
	Cultural Cognition	Culturally shallow	○	○	○	○	○	○	○	Culturally rich

Thank you for your participation. This concludes the questionnaire.

2. Participant Instructions (English Version)

* The instruction was administered to participants in Chinese. The English version is provided here for reference.

Thank you for participating in this experiment. The following provides a brief introduction to the experiment and the relevant instructions. Please read it carefully before the experiment begins.

(1) Purpose of the Experiment

This experiment aims to examine participants' subjective perceptual evaluations and objective visual responses when viewing traditional wooden furniture patterns of the She ethnic group in eastern Fujian. The experiment consists of an eye-tracking session followed by a questionnaire evaluation.

There are no correct or incorrect ways of viewing or evaluating the patterns. Please complete the experiment according to your own perception and judgment.

(2) Eye-Tracking Equipment and Use

Eye movements will be recorded using Tobii Pro Glasses 3, a wearable eye-tracking device. The device allows you to view the stimuli in a natural seated position without head fixation.

Before the experiment, the researcher will assist you in putting on and adjusting the eye-tracking glasses. Please wear the device naturally and comfortably. During the experiment, do not touch, move, or readjust the glasses unless instructed by the researcher.

Please remain comfortably seated in front of the monitor and maintain a natural viewing posture throughout the experiment.

(3) Calibration and Practice

Before the formal experiment, a one-point calibration will be conducted using the Tobii calibration card. Please look naturally at the designated calibration point as instructed by the researcher.

The experiment will proceed only after the system indicates successful calibration. If calibration is unsuccessful, the procedure will be repeated.

After calibration, you will complete an approximately 320 s practice and familiarization session to become familiar with the eye-tracking equipment, stimulus presentation, and overall experimental procedure. Data collected during this session will not be included in the formal analysis.

(4) Experimental Procedure

The experiment will proceed in the following order:

①Putting on and adjusting the eye-tracking glasses;
②Eye-tracking calibration;
③Practice and familiarization;
④Formal eye-tracking session;
⑤Questionnaire evaluation after completion of the eye-tracking session.

During the formal eye-tracking session, 26 pattern images will be presented individually at the center of the monitor. All patterns will be presented individually, and no information about their category classifications will be provided during the experiment.

Each pattern will be displayed for 8 s, followed by a 3 s black screen between successive stimuli. The presentation order of the 26 patterns will be randomized separately for each participant.

(5) Viewing Instructions

Please view each pattern naturally during stimulus presentation and maintain a comfortable viewing distance of approximately 45-60 cm from the monitor.

There is no specific visual search task or required fixation target. You do not need to deliberately search for any particular shape, symbol, or local feature. Simply view each image as you normally would.

(6) Questionnaire Instructions

After completing the eye-tracking session, you will evaluate the 26 stimuli using a questionnaire.

For each pattern, you will first complete an aesthetic preference evaluation, followed by a semantic differential evaluation.

The semantic differential evaluation uses a seven-point bipolar scale ranging from −3 to +3. Positive scores indicate a tendency toward the adjective on the right, negative scores indicate a tendency toward the adjective on the left, and 0 represents the midpoint. Please make each evaluation independently according to your own perception of the pattern. There are no correct or incorrect answers.

3. Stimulus List

Experimental Stage	Stimulus ID	Type/Category	Name	Image
pre-test	Test1	Test	Test Pattern	
pre-test	Test2	Test	Test Pattern	
pre-test	Test3	Test	Test Pattern	
pre-test	Test4	Test	Test Pattern	
pre-test	Test5	Test	Test Pattern	
pre-test	Test6	Test	Test Pattern	
pre-test	Test7	Test	Test Pattern	
pre-test	Test8	Test	Test Pattern	
eye-tracker calibration	-	Calibration	Tobii calibration card	

formal experiment	-	Break	Black screen	
formal experiment	A1	Abstract Patterns (A)	Panchang Pattern	
formal experiment	A2	Abstract Patterns (A)	Cloud Pattern	
formal experiment	A3	Abstract Patterns (A)	Ruyi Pattern	
formal experiment	A4	Abstract Patterns (A)	Round Longevity Pattern	
formal experiment	A5	Abstract Patterns (A)	Geometric Leiwen Pattern	
formal experiment	A6	Abstract Patterns (A)	Longevity Character Pattern	
formal experiment	B1	Animal Patterns (B)	Bat Pattern	
formal experiment	B2	Animal Patterns (B)	Dragon Pattern	
formal experiment	B3	Animal Patterns (B)	Panhu Pattern	

formal experiment	B4	Animal Patterns (B)	Phoenix Pattern	
formal experiment	B5	Animal Patterns (B)	Angular Dragon Pattern	
formal experiment	B6	Animal Patterns (B)	Curved Dragon Pattern	
formal experiment	C1	Plant Patterns (C)	Baoxiang Flower Pattern	
formal experiment	C2	Plant Patterns (C)	Hibiscus Spray Pattern	
formal experiment	C3	Plant Patterns (C)	Orchid Pattern	
formal experiment	C4	Plant Patterns (C)	Roundel Hibiscus Pattern	
formal experiment	C5	Plant Patterns (C)	Scrolling Grass Pattern	
formal experiment	C6	Plant Patterns (C)	Pomegranate Pattern	

formal experiment	D1	Human-Figure Patterns (D)	Lü Dongbin Pattern	
formal experiment	D2	Human-Figure Patterns (D)	Han Xiangzi Pattern	
formal experiment	D3	Human-Figure Patterns (D)	He Xiangu Pattern	
formal experiment	D4	Human-Figure Patterns (D)	Lan Caihe Pattern	
formal experiment	E1	Composite Patterns (E)	Spring Flower And Bird Pattern	
formal experiment	E2	Composite Patterns (E)	Auspicious Beast Pattern	
formal experiment	E3	Composite Patterns (E)	Bogu Pattern	
formal experiment	E4	Composite Patterns (E)	Summer Flower And Bird Pattern	

4. Image-Standardization Procedure

The 261 original patterns were initially screened to retain 72 candidate samples, from which 26 formal experimental stimuli were selected through expert evaluation. To reduce interference from irrelevant visual factors such as background and color, the final stimuli were standardized by removing the background, converting them to grayscale, and centering them on a 1000 × 1000 px white canvas. The original aspect ratio of each pattern was preserved without stretching or distortion, while occupied area, scale, and visual complexity were not artificially equalized to retain the original formal characteristics as much as possible. Stimulus A1 is shown as a representative example of this standardization procedure.

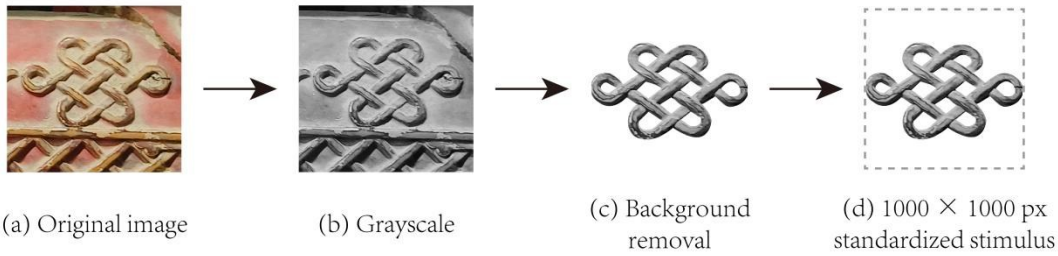


Fig. S1. Image-standardization procedure for the experimental stimuli, illustrated using Stimulus A1 as a representative example. The procedure included (a) the original image, (b) grayscale conversion, (c) background removal, and (d) placement of the pattern at the center of a 1000 × 1000 px white canvas while retaining its original aspect ratio. The gray dashed outline in (d) indicates the canvas boundary for illustration only and was not present in the actual experimental stimulus.