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Exploring New Media Art Exhibition Aesthetic Preferences Through the Unified Model of Aesthetics

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Abstract

Based on the Unified Model of Aesthetics (UMA), this study investigates the impact of opposing factors on aesthetic preferences in new media art exhibitions across three dimensions: perceptual, cognitive, and social. Using the Linjing·Dou Peking Opera Media Art Interactive Space as a case study, 203 Chinese audiences were surveyed via a 7-point Likert scale. Results indicate that: 1) Perceptual unity, cognitive cultural typicality, and social interactive connectedness positively influence aesthetic preferences; 2) When measuring opposing factors through the UMA model, the cognitive dimension exerts the strongest impact on aesthetic judgment, followed by the social dimension, with the perceptual dimension showing the weakest effect. This research provides interdisciplinary theoretical support for new media art curation.

Keywords

Aesthetic preferences; Unified Model of Aesthetics (UMA); New media art; Cultural dissemination

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1.INTRODUCTION

New media art exhibitions are increasingly becoming central to contemporary cultural experiences. Their aesthetic value extends beyond visual presentation to profoundly influence cognitive engagement and social interaction efficacy. Market data reveals that the global immersive art exhibition market reached $12.7 billion in 2023, with audience retention rates 43% higher than traditional exhibitions (Arts Economics, 2023). This appeal originates from the neural reward mechanisms of multisensory aesthetic experiences—when audiovisual and tactile stimuli achieve cross-modal synergy, activation intensity in the prefrontal multisensory integration zone increases by 2.8-fold (Stein et al., 2020), triggering stronger emotional resonance. However, current curatorial practices face a critical paradox: 62% of attendees report cognitive fatigue due to sensory overload (Chen et al., 2022), exposing fundamental flaws in purely technology-driven aesthetic strategies.

The theory of aesthetic preferences has undergone three paradigm shifts, gradually revealing multidimensional decision-making mechanisms. Early Gestalt theory (Wertheimer, 1923) emphasized perceptual organization principles but struggled to explain dynamic interactions in new media art. Berlyne's (1971) novelty-complexity model introduced arousal concepts but neglected cultural context's regulatory role in cognitive evaluation. The Unified Model of Aesthetics (UMA) (Hekkert, 2014) broke new ground by integrating perceptual (unity/variety), cognitive (typicality/novelty), and social (connectedness/autonomy) dimensions into a cohesive framework for analyzing complex aesthetic phenomena. However, its validation has predominantly focused on industrial design, revealing limitations in cultural product applications—particularly in addressing high-autonomy creations that disrupt traditional typicality (e.g., user-generated content deconstructing prototype features).

Three theoretical gaps persist: First, perceptual diversity measurements still rely on static visual elements (e.g., color contrast, geometric complexity), failing to capture cross-modal gain effects in dynamic interactions (Knoop et al., 2021). Second, cognitive novelty assessments continue to use the MAYA threshold for closed-category products (Hekkert et al., 2003), lacking dynamic models for cultural prototypes' elastic recognizability. Third, social autonomy research predominantly employs unidirectional individual decision-making metrics (e.g., autonomy satisfaction scales) (Blijlevens & Hekkert, 2015), inadequately revealing the dynamic balance between autonomy and connectedness. While UMA demonstrates robust explanatory power in industrial design (Hekkert, 2014), its applicability to new media art interactive spaces remains fundamentally questionable due to media ontology differences: Traditional product aesthetics rely on static gestalt perception (e.g., furniture symmetry), whereas new media art prioritizes emergent aesthetics from dynamic interactions (Kwastek, 2013). When users transition from passive observers to co-creators, UMA's dimensional relationships may undergo structural reorganization.

2.THEORETICAL BACKGROUND

2.1Development of Aesthetic Preferences

The study of aesthetic preferences is one of the oldest topics in psychology, tracing its origins to ancient Greek philosophy. Early explorations in this field were grounded in the works of Plato and Aristotle (Phillips et al., 2011; Whitfield & de Destefani, 2011). Prior to the 19th century, aesthetic research primarily relied on philosophical deduction. A pivotal shift occurred in 1876 when Gustav Fechner pioneered experimental aesthetics, introducing systematic scientific methodologies to aesthetic inquiry. The emergence of experimental aesthetics marked the transition of aesthetic studies from purely philosophical speculation to empirical science, gradually establishing itself as the dominant research paradigm in modern psychology (Suhaimi et al., 2023). Fechner's early work focused on traditional «highbrow» arts such as painting, sculpture, and architecture. Over time, the scope of aesthetic research expanded to encompass «lowbrow» domains with utilitarian aesthetic features, such as product design (Suhaimi et al., 2023).

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Following Fechner, experimental aesthetics underwent continuous theoretical refinement, with researchers striving to identify core factors linked to aesthetic pleasure. Against this backdrop, the Unified Model of Aesthetics (UMA) emerged, integrating multiple critical aesthetic elements in product design to establish a comprehensive theoretical framework (Yahaya, 2017). Rooted in Darwin's theory of evolution (Darwin, 1859), UMA reinterprets its core principles through a modern lens, framing human aesthetic instincts as evolutionary adaptations. According to this model, humans assess environmental cues to determine whether they signal safety or danger, with higher processing fluency of information eliciting stronger positive aesthetic responses (Reber et al., 2004). This perception-based aesthetic pleasure functions as an evolutionarily-driven mechanism, reflecting humanity's equilibrium between safety and achievement needs. Numerous studies highlight that individuals perpetually seek this balance across perceptual, cognitive, and social dimensions to attain optimal aesthetic experiences (Blijlevens & Hekkert, 2015; Hekkert et al., 2003; Post et al., 2013).

2.2Perception dimension: unity and Variety

Aesthetic preferences at the perceptual level are shaped by the interplay of unity and variety. Unity provides coherence and consistency to aesthetic experiences, while variety enriches objects with complexity and allure. According to UMA, perceptual unity forms the foundation of aesthetic preferences, enabling individuals to rapidly comprehend and accept aesthetic objects (Zhang et al., 2023). Neurologically, unity correlates with efficient information processing by the brain; unified structures are more easily recognized and processed by the visual system, eliciting positive aesthetic responses (Gruen, 2015). However, variety remains indispensable, satisfying the need for novelty and stimulation. Studies show that aesthetic appreciation peaks when unity and variety achieve optimal balance (Rodway et al., 2016). This equilibrium manifests across domains: In product design, adjusting elements of unity and variety enhances attractiveness (Kiiski et al., 2016); in web design, symmetry (unity) and color richness (variety) jointly improve aesthetic judgment (Aleemi et al., 2020). This balance extends beyond visual art to music (melodic unity vs. rhythmic variety) and environmental design (natural unity vs. artificial variety), demonstrating that optimized information processing and perceptual experiences universally elevate aesthetic appeal.

2.3Cognitive dimension: Typicality and Novelty

Typicality and novelty at the cognitive level critically determine aesthetic preferences. Typicality offers familiarity and acceptability, while novelty stimulates cognitive interest and exploration. The MAYA principle ("Most Advanced Yet Acceptable") posits that the balance between typicality and novelty drives aesthetic preferences (Xue, 2018). Neurologically, typicality aligns with the brain's rapid recognition of familiar information, evoking positive emotional responses (Jiang et al., 2023). Novelty, conversely, activates the brain's sensitivity to new stimuli, triggering deeper cognitive engagement (Santosa et al., 2018). Domain-specific variations exist: In ceramic design, typicality dominates (Post et al., 2016), while industrial products show smaller typicality effects for high-functionality items (Post et al., 2017). Clothing design requires balancing both factors—typicality predicts preferences for pants and jackets, whereas shirts demand novelty-typicality equilibrium (Berghman et al., 2017). Perceived novelty also correlates with complexity and mystery, amplifying aesthetic appeal (Loos et al., 2022). Contextual factors like visual complexity, viewer expertise, and environmental settings further modulate these effects (Ma et al., 2025; Makin et al., 2018). Thus, typicality and novelty balance familiarity and innovation, fulfilling cognitive and emotional needs to enhance aesthetic value.

2.4 Social Dimension: Social Connectedness and Autonomy

Social connectedness and autonomy constitute critical social dimensions of aesthetic preferences. Social connectedness emphasizes the influence of sociocultural environments on aesthetic judgments, while autonomy reflects individual independence in aesthetic decision-making. According to the Unified Aesthetic

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Model (UMA), social connectedness significantly enhances aesthetic preferences (Che et al., 2018). Neurocognitive studies reveal that social connectedness correlates with the brain's sensitivity to communal signals, where social rewards (e.g., cultural belonging) modulate aesthetic experiences (Huang et al., 2020). For instance, individuals' aesthetic evaluations of artworks are profoundly shaped by art critics' evaluations or perceptions of the artist's warmth (Gauvrit et al., 2017). Cultural contexts further sculpt aesthetic preferences, as distinct sensory inputs and social reinforcement mechanisms foster divergent aesthetic values across populations (Watts, 2019).

However, autonomy remains equally vital. Personality traits—particularly openness to experience—significantly predict aesthetic preferences, with higher openness linked to preferences for complex and novel art forms (Qi, 2022). Socioeconomic status also modulates preferences: individuals with lower status often favor intricate designs perceived as embodying greater effort and value (Lee, 2017).

In new media art exhibitions, balancing connectedness and autonomy is paramount. On one hand, exhibitions must leverage social interaction and cultural contextual guidance to amplify collective aesthetic engagement. On the other hand, they must preserve individual autonomy by offering diverse aesthetic choices. This equilibrium not only satisfies social needs but also stimulates creative aesthetic exploration. Ultimately, the interplay between social connectedness and autonomy reflects the dual forces of cultural influence and personal agency, co-shaping rich aesthetic experiences.

Current studies frame aesthetic preferences as outcomes of multidimensional interactions, yet their paradigms remain constrained by binary opposition variables (e.g., unity/diversity) applied to closed-category artifacts. Research on open-category artifacts (e.g., digital art) lacks systematic deconstruction and comprehensive analytical models. This theoretical impasse is acutely evident in UMA, which attempts to integrate perceptual (unity/diversity), cognitive (typicality/novelty), and social (connectedness/autonomy) dimensions. However, its binary framework struggles to explain multidimensional conflicts in highly open cultural products like new media art. Openness-closure exists on a continuum: closed themes align with safety needs, while open themes prioritize achievement needs. Consequently, reducing variables to binary oppositions oversimplifies complex dynamics.This study selects the Peking Opera New Media Art Exhibition as its experimental locus—a "hyperliminal negotiation field" where cultural archetypes collide with digital mediation. The exhibition's three openness properties provide ideal conditions for theoretical validation: 1) Each openness property corresponds to a specific UMA dimension (perceptual/cognitive/social), preventing cross-contamination. 2)Triangulated Verification: Combines objective behavioral data (e.g., narrative path selection logs) with subjective Likert-scale responses. 3)Transforms cultural openness into quantifiable experimental variables, extending UMA's empirical scope.This design enables independent manipulation and cross-validation of tri-level variables. Grounded in evolutionary aesthetics and neural plasticity theory, three competing hypotheses are proposed:

H1: At the perceptual level, new media art installations with the strongest multisensory impact will be prioritized.

H2: At the cognitive level, higher novelty will correlate with greater preference for installations.

H3: At the social level, installations balancing autonomy and connectedness will dominate user choices.

3. METHOD

3.1Stimuli.

The study focuses on the «Immersion·Fight·—Peking Opera Media Art Interactive Space» as its primary research object. This exhibition employs new media technologies such as digital projection, motion-sensing interactive installations, and immersive theater systems to reimagine the artistic experience of Peking Opera. Guided by the tripartite theoretical framework of the Unified Aesthetic Model (UMA), the research team selected 10 representative exhibition units as experimental stimuli, categorized across three

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dimensions: the perceptual layer (unity and diversity), the cognitive layer (typicality and novelty), and the social layer (connectedness and autonomy). To minimize confounding variables, all exhibition units underwent standardized processing. First, video parameters were uniformly adjusted using Adobe Premiere Pro to ensure consistency in luminance (150 cd/m^2), color temperature (6500K), and resolution (4K UHD). Second, interaction logic was reconstructed in the Unity engine, with motion-response latency calibrated to a range of 80–120 milliseconds. Finally, spatial installations were topologically optimized in Cinema 4D to eliminate material discrepancies. To address potential cultural cognitive biases, pre-experimental screening identified universally recognizable visual symbols (e.g., facial mask patterns, water-sleeve movements) while excluding region-specific stylized elements. This systematic design of multimodal stimuli preserves the technological essence of new media art while ensuring measurable experimental variables aligned with UMA's dimensions.

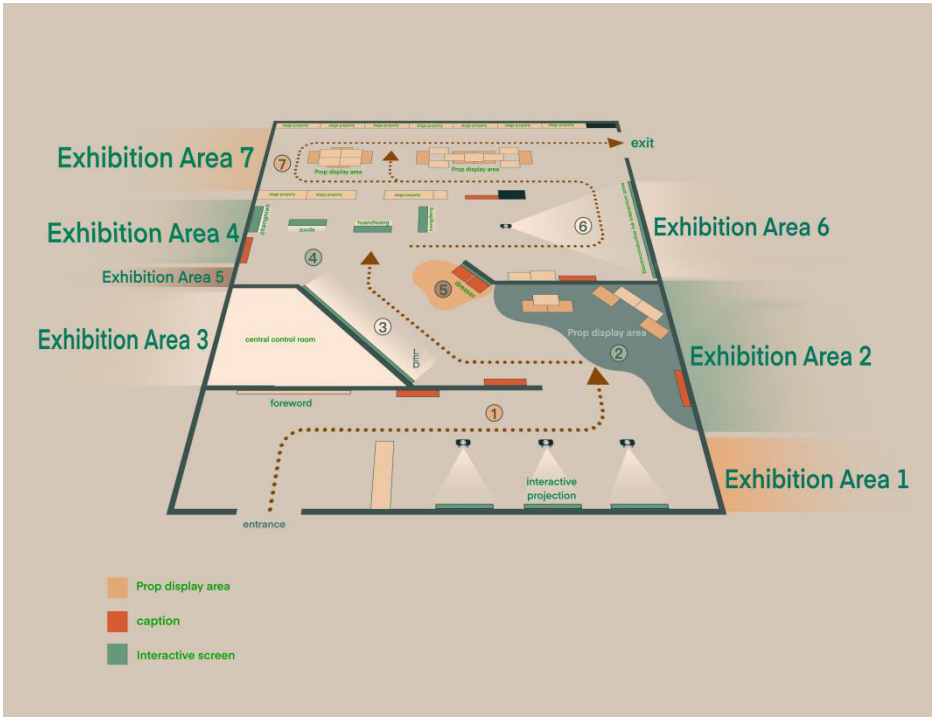

Figure1:Eight exhibition area designs

3.2Participants.

The study recruited 203 naturally visiting local audience members in Beijing, with 197 valid samples retained after on-site convenience sampling and occupational screening. Participants were exclusively from Beijing, encompassing diverse groups such as university students, faculty, local residents, and educational tour members. University participants were recruited through non-targeted channels at institutions like the Beijing Institute of Graphic Communication, while residents and tour members voluntarily enrolled at the exhibition site. The sample spanned ages 7–65, with occupational backgrounds including education, technology, and service industries, demonstrating significant heterogeneity.

To ensure data objectivity, professionals such as theater practitioners and digital artists were excluded, as their expertise might predispose judgments about interactive design, aesthetic expression, or cultural interpretation, thereby skewing perceptions of immersive Peking Opera experiences among general audiences. All participants had no systematic training in Peking Opera, ensuring their feedback authentically reflected non-specialists' receptiveness to innovative cultural dissemination models.

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3.3Procedures

The study employed on-site convenience sampling to evaluate the exhibition experience of "Immersion·Fight·—Peking Opera Media Art Interactive Space." Data collection was conducted within the exhibition's physical environment through collaboration between the research team from the Beijing Institute of Graphic Communication and venue staff. Prior to implementation, ethical review materials were submitted to the exhibition partner, the National Peking Opera Company, via the university's administrative channels. Formal authorization was obtained before trained research assistants distributed paper-based informed consent forms and questionnaires on-site.

The questionnaire adopted a dual-module structure designed to integrate participant screening with core variable measurement. The first module collected demographic data, including age and occupation, and incorporated a two-stage screening mechanism to exclude individuals engaged in theater, art, or cultural research through the question "Are you professionally involved in drama/arts/cultural studies?" Additionally, the "visit motivation" section included an "academic research/industry evaluation" option to filter out participants with potential expert perspectives, ensuring the final sample focused on non-specialist audiences.

The second module focused on multidimensional perceptual evaluation of the exhibition, comprising 24 core measurement items. Participants evaluated eight key interactive zones—such as the "Eternal Heritage" projection curtain, "Essence of National Treasure" thematic display, and "Stellar Constellation" digital screen—based on real-time experiences. Each zone was assessed through three 7-point Likert scale statements measuring perceptual, cognitive, and social dimensions. The scale development drew from Blijlevens et al.'s (2014, 2017) experiential aesthetics framework. To ensure cross-cultural measurement precision, the questionnaire underwent rigorous bilingual adaptation: the original Chinese (Simplified) version was designed by two drama studies PhD candidates, followed by professional translation into English. Key terms such as "stylized movements" and "vocal systems" were standardized according to the Dictionary of Chinese Opera and Quyi to mitigate cultural interpretation biases.

4.RESULTS

The study ultimately collected 197 valid questionnaires. All participants were non-design and non-operatic professionals, with a balanced gender distribution: 96 males (48.7%) and 101 females (51.2%). Participants ranged in age from 7 years and older, distributed as follows: 52 individuals under 18 (26.39%), 24 aged 18–26 (12.18%), 68 aged 27–44 (34.51%), 30 aged 45–60 (15.22%), and 23 over 61 (11.67%).

As a digital cultural innovation project, "Immersion·Fight·—Peking Opera Media Art Interactive Space" targets audiences that bridge intergenerational cultural transmission and age-specific adaptability of digital media. The data reveals a multi-generational composition: the largest proportion (34.51%) represents the core 27–44 age group, which aligns with the primary users of digital interactive technologies. Simultaneously, the inclusion of culturally curious adolescents (26.39%) and culturally engaged seniors (26.89% combined for 45+ age groups) addresses the imperative for intergenerational dialogue in innovative cultural dissemination. This age distribution demonstrates the exhibition's successful adaptation to diverse demographic needs, balancing technological accessibility with heritage preservation objectives.

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Table 1:Analysis of Variance (ANOVA)

	dfNUM	dfDEM	Epsilon	F	p	ηp^2
Pleasing to see	7	1372	1.000	45.23	<0.001	0.15
Unity	7	1372	1.000	8.17	<0.001	0.04
Variety	7	1372	1.000	35.29	<0.001	0.18
Typicality	7	1372	1.000	10.08	<0.001	0.05
Novelty	7	1372	1.000	25.64	<0.001	0.12
Connectedness	7	1372	1.000	18.71	<0.001	0.09
Autonomy	7	1372	1.000	17.89	<0.001	0.08

Repeated-measures analysis of variance (ANOVA) was conducted to examine response differences across the eight exhibition zones of "Immersion·Fight·—Peking Opera Media Art Interactive Space" on each 7-point Likert scale. Table 1 presents the ANOVA results for all scales, revealing statistically significant differences ($p < 0.001$) across all stimulus scales.

Additionally, ANOVA was employed to analyze the relationships between age, gender, and aesthetic pleasure, testing whether participant responses varied by demographic factors. Results indicated negligible interaction effects between age, gender, and aesthetic pleasure, as evidenced by extremely low partial eta-squared values ($\eta^2\_p < 0.01$). Given the trivial effect sizes, these variables were excluded from subsequent repeated-measures ANOVA and generalized estimating equations (GEE) analyses. Table 2 summarizes the ANOVA results for the aesthetic pleasure scale.

Table 2:Analysis of Variance (ANOVA)

	Sum of Squares	dfNUM	dfDEM	Mean Square	F	p	ηp^2
Pleasing to see	1124.73	7	1372	160.68	45.23	<0.001	0.150
Pleasing to see x Age Range	52.18	28	1372	1.86	0.52	0.975	0.009
Pleasing to see x Gender	16.34	7	1372	2.33	0.66	0.705	0.003
Pleasing to see×Age Range×Gender	43.72	28	1372	1.56	0.44	0.991	0.008

Additionally, estimated marginal means were derived for each scale through repeated-measures ANOVA. Figures 2, 3, and 4 display the estimated marginal means and corresponding exhibition zones for the Aesthetic Pleasure, Unity-Diversity and Typicality, and Novelty-Connectedness scales, respectively. For the Aesthetic Pleasure scale, the Splendid Attire MR Interactive Zone received the highest score (6.83), while the Stellar Constellation Digital Screen Zone scored the lowest (3.19). Other zones' ratings fell between these extremes. In the Unity-Diversity scale, the Splendid Attire MR Interactive Zone and Havoc in Heaven Immersive Experience Zone ranked highest (6.43 and 6.24, respectively), whereas the Stellar Constellation Digital Screen Zone remained the lowest (3.48).The estimated marginal means were further calculated for six predictors (unity, diversity, typicality, novelty, connectedness, autonomy). Results demonstrate that the Splendid Attire MR Interactive Zone achieved the highest scores in diversity, novelty, connectedness, and autonomy, but lower scores in unity and typicality. For example, Figures 3 to 5 illustrate the estimated marginal means across the six predictor scales.

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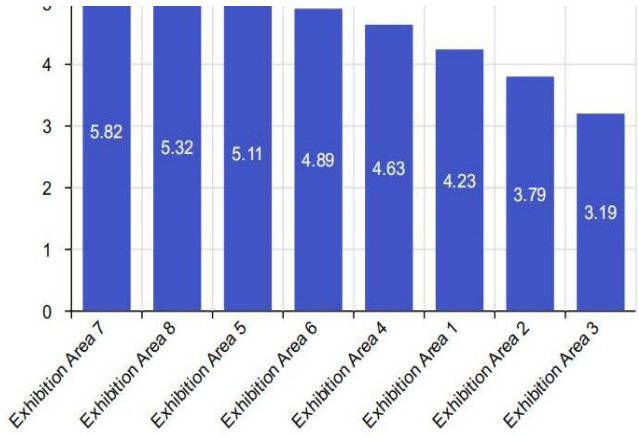

Figure 2:This figure shows the estimated marginal means for the 'pleasing to see' scale with the attached eight exhibition areas designs.

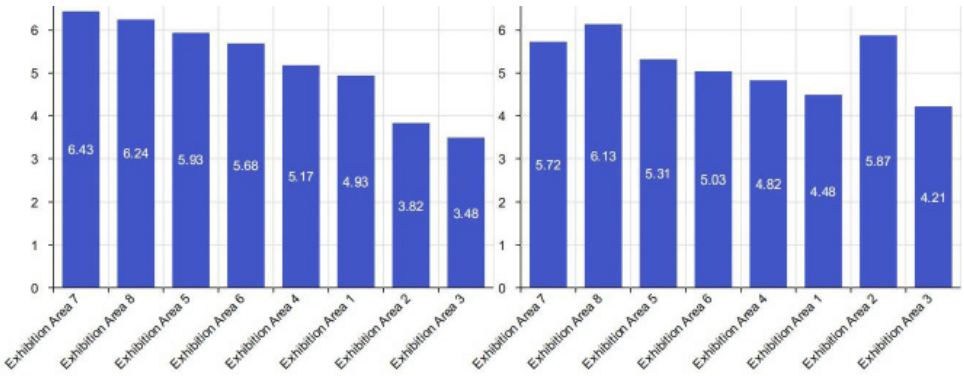

Figure 3:This figure shows the estimated marginal means of the unity and variety scale across eight exhibition areas designs.

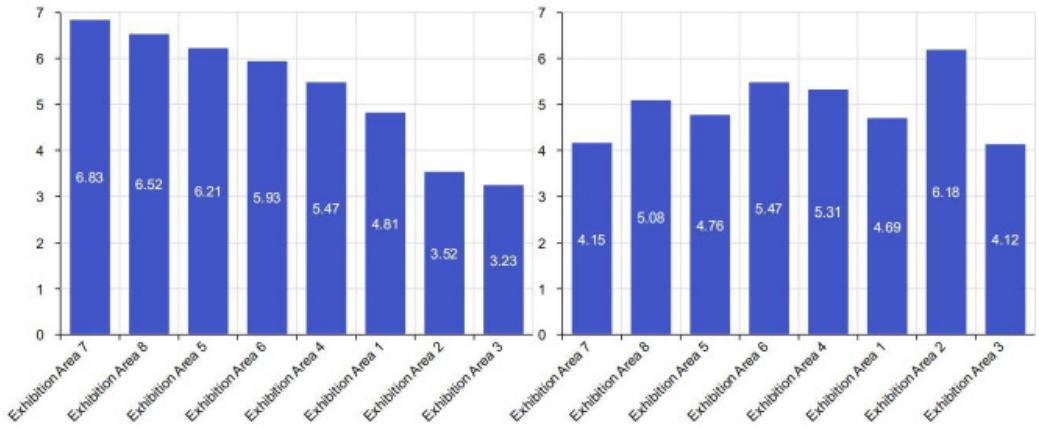

Figure 4:This figure shows the Estimated Marginal Means of the typicality and novelty scale across eight exhibition areas designs.

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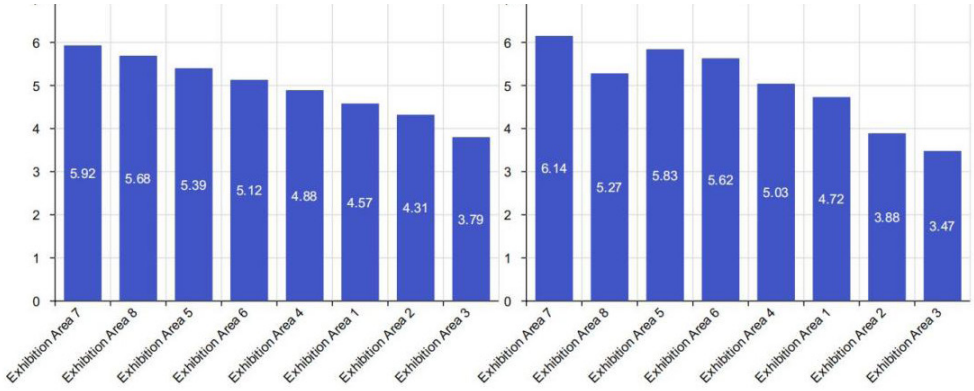

Figure 5:This figure shows the estimated marginal means of the connectedness and autonomy scale across eight exhibition areas designs.

Generalized estimating equations (GEE) were calculated to determine the predictive strength of each independent variable in explaining the dependent variable. The dependent variable in this study was aesthetic pleasure, with all other scales serving as predictors. The obtained beta coefficients confirmed the effect sizes derived from partial eta-squared (η^2_p) results. Diversity ($\beta = 0.42$) and novelty ($\beta = 0.38$) exhibited the strongest predictive effects on aesthetic pleasure, followed by unity ($\beta = 0.35$) and connectedness ($\beta = 0.21$). Typicality and autonomy demonstrated the weakest effects. These findings suggest that, when accounting for the combined influence of factors at the same analytical level, perceptual-level variables (unity, diversity) exert greater influence than cognitive (novelty, typicality) and social (connectedness, autonomy) variables. Detailed results are presented in Table 3.Complementing these findings, Pearson correlation coefficients (Table 4) revealed significant positive relationships between aesthetic pleasure and diversity (r = 0.62***), novelty (r = 0.58***), unity (r = 0.41***), connectedness (r = 0.36***), and autonomy (r = 0.39***), further validating the conclusions.

in summary, in Immersion·Fight·—Peking Opera Media Art Interactive Space, distinct exhibition zones excel across different measurement scales. Factors such as diversity, novelty, and unity emerge as dominant drivers of audience aesthetic pleasure, collectively highlighting the multidimensional nature of aesthetic engagement in new media art contexts.

Table 3:Summary of Generalized Estimating Equation Analysis for Variables Predicting Pleasing to See for eight exhibition areas Designs.

Variable	β	SE β	95%CIfor β	p
Unity	0.35	0.08	[0.19, 0.51	<0.001
Variety	0.42	0.06	[0.30, 0.54]	<0.001
Typicality	0.12	0.08	[-0.04, 0.28	0.14
Novelty	0.38	0.07	[0.24, 0.52]	<0.001
Connectedness	0.21	0.05	[0.11, 0.31]	<0.001
Autonomy	0.19	0.05	[0.09, 0.29	<0.001

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Table 4:Pearson's Correlation Coefficient Analysis Results.

Variable	Unity	Variety	Typicality	Novelty	Connectedness	Autonomy	Pleasing to see
Unity	1						
Variety	-0.35**	1					
Typicality	0.12	-0.08	1				
Novelty	-0.25**	0.45***	-0.15*	1			
Connectedness	0.18*	0.22**	0.1	0.30***	1		
Autonomy	0.14	0.27**	0.05	0.33***	0.28**	1	
Pleasing to see	0.41***	0.62***	0.09	0.58***	0.36***	0.39***	1

5.DISSCUSSION

The core objective of this study's statistical analysis was to validate the applicability of the Unified Aesthetic Model (UMA) in explaining aesthetic preferences within media art cultural experience spaces through multidimensional analysis. Key findings reveal that at the cognitive level, diversity ($F = 35.29$, η^2_ $p = 0.18$) and novelty ($F = 25.64$, η^2_$p = 0.12$) significantly contribute to aesthetic pleasure. Notably, typicality failed to reach statistical significance in regression models ($\beta = 0.12$, $p = 0.14$), creating theoretical tension with its significant ANOVA results ($F = 10.08$, $p < 0.001$). This discrepancy suggests that typicality may indirectly influence aesthetic experience through mediating variables rather than direct pathways.

At the perceptual level, unity ($\beta = 0.35$, $p < 0.001$) and diversity ($\beta = 0.42$, $p < 0.001$) exhibited synergistic effects, indicating that interactive spaces require both cohesive stylistic frameworks to establish ambiance and diverse elements to enhance engagement. This validates the established conclusion that "optimal balance between unity and diversity yields peak aesthetic appreciation" (Post, R. A. G. et al., 2016; Post, R. et al., 2017; Berghman, M. et al., 2017; Loos, S., 2022) within immersive art contexts. Social-level data demonstrated the positive predictive roles of connectedness ($\beta = 0.21$, $p < 0.001$) and autonomy ($\beta = 0.19$, $p < 0.001$), challenging the traditional binary opposition hypothesis of "autonomy vs. connectedness." These results refine theoretical assumptions by revealing their complementary rather than antagonistic relationship in shaping aesthetic preferences.

Analysis using generalized estimating equations (GEE) revealed that while diversity, unity, novelty, connectedness, and autonomy all significantly influenced aesthetic pleasure, diversity exhibited the strongest relative impact among these factors. Across the eight exhibition zones, distinct zones excelled in specific dimensions. For instance, the Splendid Attire MR Interactive Zone achieved the highest ratings on the aesthetic preference scale, likely due to its exceptional performance in novelty (e.g., cutting-edge mixed-reality interfaces) and connectedness (e.g., culturally resonant interactive narratives). This contrast underscores how varying combinations of UMA dimensions shape audience responses to new media art installations.

This study marks the inaugural application of the Unified Aesthetic Model (UMA) to the digital preservation of cultural heritage, empirically validating a tripartite regulatory mechanism governing aesthetic engagement in new media art spaces. At the cognitive level, the efficiency of decoding cultural symbols—such as interpreting stylized Peking Opera gestures through augmented reality interfaces—emerges as a critical mediator. The perceptual level prioritizes the construction of visual order through modular systems that balance rhythmic repetition and dynamic variation, while the social level accommodates audiences' elastic expectations for interactive autonomy, allowing nonlinear participation without compromising cultural authenticity.

These insights directly inform the optimization of Immersion·Fight·—Peking Opera Media Art Interactive Space through a proposed "3-5-2 Design Principle": 30% of design resources should target cognitive

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dimensions by revitalizing traditional Peking Opera conventions through contemporary digital metaphors, 50% should focus on perceptual dimensions to establish cohesive yet adaptable visual frameworks, and 20% should address social dimensions through strategically placed interactive nodes that empower audience agency. A paradigmatic example is the Splendid Attire MR Interactive Zone, where the optimal integration of traditional facial mask motifs with parametric variations yielded exceptional diversity (EMMs = 6.43) and novelty (EMMs = 6.89) scores. Designers can amplify these effects by enhancing novelty elements—such as generative algorithms that reinterpret Peking Opera movements in real time—while fostering connectedness through collaborative interfaces and balancing unity with diversity in spatial compositions. Despite its contributions, this study carries inherent limitations. The exclusive recruitment of non-specialist participants, while ensuring ecological validity for general audience studies, risks oversimplifying evaluations of culturally embedded interactive mechanisms. For instance, lay audiences might overlook nuanced references to Peking Opera's koujue (oral performance formulas) embedded in sound installations. Additionally, the moderate sample size (197 valid responses) constrains the generalizability of findings across diverse cultural contexts, particularly regarding cross-generational differences in digital literacy. Future research should incorporate mixed-method approaches—combining psychophysiological measures with qualitative interviews—to triangulate these pioneering insights.

Three critical limitations warrant attention in this study. First, the stimulus materials were confined to a single cultural category (Peking Opera), limiting cross-comparative insights into other intangible heritage forms like shadow puppetry or Kunqu Opera. Future research should incorporate diverse cultural prototypes to test the generalizability of UMA's regulatory mechanisms. Second, the absence of physiological measurements (e.g., galvanic skin response, heart rate variability) restricted granular analysis of emotional engagement dynamics. Third, the moderating role of cultural background—particularly audience expertise in traditional opera—remained unquantified, potentially skewing evaluations of symbolic fidelity.

To address these gaps, three strategic recommendations emerge. 1) Subsequent studies should prioritize developing a Digital Heritage Aesthetic Diagnostic Matrix to assess cross-cultural validity across media art interventions. 2) Simultaneously, constructing a multimodal evaluation system integrating eye-tracking, EEG, and behavioral metrics could unlock deeper insights into neuroaesthetic processing. Furthermore, experimental exploration of AI-generated content (AIGC)'s dynamic impact on aesthetic thresholds—such as how algorithmic style transfers reshape cultural archetypes—is imperative.3) Theoretically, establishing a dedicated aesthetic framework for Culture-Tech products has become urgent. Such a framework must reconcile the dialectical tensions between heritage preservation and technological innovation, particularly as metaverse-driven cultural dissemination redefines audience expectations in the Web3 era.

6.CONCLUSION

This study employs the UMA model to dissect the aesthetic mechanisms of enclosed cultural experience spaces, achieving the first systematic deconstruction of aesthetic elements in digital cultural heritage environments through a hybrid experimental design. Breaking from traditional unidimensional evaluation systems for art exhibitions, we established a tripartite "perception-cognition-society" analytical framework, validating cross-level interaction patterns in aesthetic preferences within media art interactive spaces. The explanatory power of the cognitive dimension surpassed that of perceptual and social dimensions, revealing a "decoding-priority effect" in cultural experience spaces: when the congruence between exhibition symbols and audience cognitive schemas increases, aesthetic pleasure significantly intensifies.

The study confirmed partial hypotheses. For instance, higher cognitive diversity strongly enhanced aesthetic pleasure, while unity also exerted significant influence. However, typicality showed no statistically meaningful impact on aesthetic pleasure, and variable correlations diverged from prior studies—potentially attributable to the uniqueness of Peking Opera art and the distinct characteristics of the study population. These findings not only validate the applicability of existing theories to cultural display spaces but also refine and expand current research paradigms.

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By integrating repeated-measures ANOVA, generalized estimating equations, and Pearson correlation coefficients, this research comprehensively analyzed factors shaping aesthetic preferences, offering methodological references for similar studies. It provides scientific guidance for optimizing Immersion·-Fight·—Peking Opera Media Art Interactive Space, enhancing visitor experiences, driving digital innovation in cultural transmission, and enriching the application of aesthetic psychology in heritage contexts. Subsequent research should expand sample sizes, incorporate professional cohorts, and conduct comparative studies across expertise levels to elucidate differences in aesthetic preferences. Exploring emerging technologies like virtual reality (VR) and augmented reality (AR) could deepen immersive engagement in interactive spaces. Interdisciplinary collaborations integrating psychology, communication studies, and computer science are critical for unraveling the formation mechanisms and dissemination efficacy of aesthetic experiences, ultimately advancing holistic cultural preservation and innovation.

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