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Article

Digital Immersive Experience of Auspicious Pattern Cultural Symbols: Effects on Consumers' Purchase Decisions and Brand Attachment

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Abstract: This study examines the application of innovative auspicious pattern design under a digital technology integration perspective. Moreover, the significant findings show that cultural symbol immersive experience could indicate a core independent variable shaping consumer behavior. Furthermore, the study demonstrates that consumer purchase decision-making and brand attachment appear to function as key dependent variables in this analytical framework. Given that the evidence demonstrates a chain structure, the results show that a four-stage mediation model could establish the pathway: digital immersive experience → cultural identity activation → product value perception → behavioral decision-making. Study shows three methods combined: AR (Augmented Reality) experiment, physiological measurement, questionnaire survey. However, the significant methodological findings show that data could indicate important patterns across 500 Chinese consumers examined in this study. Additionally, the results demonstrate that the study systematically explores how the immersive experience quality of AIGC (Artificial Intelligence Generated Content)-generated auspicious patterns might indicate differential activation of cultural identity. In light of these significant results, the findings show that this activation subsequently shows that shape consumer behavior in relevant ways. Evidence shows AR immersion links cultural identity activation. Thus, the key results show that experiential value has risen to become the primary dimension driving value perception in digital immersive contexts (β = 0.68). Notwithstanding this important result, the evidence shows that willingness to pay a price premium could demonstrate stronger prediction of brand commitment than purchase intention (β = 0.52). Data shows pathway distinct, fosters long-term brand attachment.

Keywords: Auspicious Pattern Digital Design; Cultural Symbol Immersive Experience; Augmented Reality; Artificial Intelligence Generated Content; Cultural Identity; Purchase Decision-Making; Brand Attachment

1. Introduction

Traditional cultural symbols show that their re-entry into contemporary consumer culture represents a significant shift in the findings of design scholarship. Moreover, the evidence indicates that two forces drive this movement: the expansion of globalization and the revival of local cultural identity. Among these symbols, auspicious patterns (jíxiáng wényang) demonstrate that they represent one of the most historically rich visual systems in Chinese culture. Furthermore, the significant results show that their structure operates across three overlapping layers—the pictorial, the semantic, and the ritual—encoding meanings such as the warding off of evil, harmony between humanity and nature, and the continuity of family lineage. Study shows guócháo brings motifs mainstream. However, the key findings indicate that the rise of guócháo (national trend) consumption culture has brought dragon-

and-phoenix motifs, rúyì scrolls, and Eight Auspicious Symbols into mainstream product design across fashion, cultural merchandise, food and cosmetics. In light of the significant evidence, these applications show that they have produced a recognizable category of culturally coded consumer goods. Additionally, the important results demonstrate that Bi Xinyi argues the widespread use of traditional auspicious patterns in guócháo product design does more than extend a national visual tradition. Additionally, Hong, Alli, and Shaari argue that the application of traditional auspicious patterns in modern product design does more than extend a national visual tradition; it actively reactivates and reproduces cultural meaning within commercial contexts, endowing products with cultural and commercial value that exceeds mere decoration [1]. Therefore, Du et al., in a semiotic and cognitive study of She ethnic decorative motifs, further observes that effective symbolic communication in contemporary design depends on two things: a precise grasp of the symbol's structural hierarchy and a deep understanding of the target audience's cultural psychology [2].

However, the results show that this process is not simply formal borrowing. Furthermore, the significant evidence demonstrates that it involves the re-anchoring of symbolic referents and the selective activation of cultural memory. Given that the key findings support this view, digital redesign shows that traditional patterns could establish new pathways to circulate within contemporary visual communication systems [3]. Study shows computer-aided design changes how patterns are generated. At the same time, Korur and Erbaş's research on Islamic geometric patterns shows that kaleidoscopic digital tools could demonstrate the capacity to overcome the complexity barrier of traditional geometric design. Moreover, parametric methods enable modular recombination and innovative generation of classical motifs. Therefore, the important evidence shows that this approach offers a direct methodological reference for the digital innovation of auspicious patterns [4]. Findings further show that morphological generation models can automate complex design tasks.Liu et al. show that morphological generation models based on univariate conditional variational autoencoders can automate complex pattern design in manufacturing contexts. Furthermore, this cross-domain breakthrough in AI-generated design demonstrates that deep learning systems provide meaningful technical support for the digital innovation of auspicious patterns [5]. Nevertheless, in today's digitally intensive consumer environments, immersive technologies—augmented reality, virtual reality, and AI-generated content—can serve as entirely new vehicles for meaning transmission. Given that the results appear to support this view, consumer engagement with cultural symbols appears to be shifting from passive visual reception toward multidimensional immersive interaction.

Cross-disciplinary research in environmental psychology and engineering optimization shows that digital visual stimuli could demonstrate significant effects on consumer psychology. Moreover, the findings from Gu et al. and Luna et al. indicate that color and pattern design of ground murals significantly affects pedestrians' emotional states and their perception of environmental restorativeness. Furthermore, the evidence shows that specific visual patterns activate affective schemas, which could demonstrate how individuals evaluate their surroundings and form behavioral intentions. In light of these significant findings, the results appear to support that visual patterning serves a key psychological function in environmental contexts [6,7]. The study's theoretical contributions operate at three levels. First, this study introduces immersive experience theory into the study of cultural symbol consumption behavior. Moreover, the evidence shows that demonstrate that the theoretical account of how cultural symbols exert psychological influence in digital consumption contexts is thereby enriched. Furthermore, the key results shows that the existing three-dimensional value perception framework is extended by adding an experiential value dimension, broadening the theoretical scope of consumer value evaluation in technology-mediated environments. In light of these findings, the study demonstrates that incorporating brand attachment into the cultural symbol consumption behavior framework provides systematic empirical evidence for how digital immersive experience generates long-term brand emotional connection. Evidence shows attachment links brand outcomes. On the practical side, the significant findings shows that the results offer targeted guidance for guócháo brands in three areas. However, the key evidence indicates that designing digital strategies for auspicious pattern applications represents the first area of focus. Additionally, the results appear to demonstrate that constructing AR-based immersive retail environments constitutes a second critical domain, while the findings shows that developing AI-assisted cultural content generation systems forms the third. Therefore, this work demonstrates that it aims to support the deeper and broader value transformation of traditional cultural symbols in the digital consumption era, and the significant evidence shows that suggest that solid academic grounding for the creative transformation and innovative development of traditional culture is thereby provided.

Existing research shows that the symbolic value and commercial applications of auspicious patterns have received significant attention, yet the evidence shows that a critical gap remains in the current literature. However, the findings demonstrates that few studies have integrated digital immersive technologies, AIGC-generated content, and consumer cultural identity mechanisms into a unified analytical framework. Furthermore, the results shows that empirical evidence is particularly scarce regarding the core question of how AR immersion intensity moderates the activation pathway through which symbolic hierarchy shapes cultural identity. In light of these significant gaps, the present study examines both theoretical and practical dimensions systematically to address this dual deficiency. Studies show that symbolic hierarchy affects cultural identity through AR-moderated pathways.

2. Literature Review

Auspicious patterns shows that they function as a core carrier of Chinese traditional visual culture. Moreover, the significant findings of Shi et al. indicate that the design genes embedded in auspicious patterns reveal multiple layers of cultural information—form, color, meaning, and emotion—that have consolidated into relatively stable symbolic encoding rules through historical transmission [8]. However, the evidence shows that these rules continue to serve important functions of cultural identification and emotional connection in contemporary design practice. In light of these results, Chantamool et al.'s research on Phu Thai handwoven silk textile patterns demonstrates that the ancestral wisdom and ethnic memory carried by traditional textile motifs retain a significant capacity to activate cultural identity and reinforce group belonging in modern consumer contexts [9]. Cross-cultural findings show auspicious patterns share similar cultural-psychological mechanisms. Furthermore, the key results of Cui et al. show that image-guided non-planar slicing technology could support the technical feasibility of computer vision and image processing for the accurate reproduction of complex motifs, offering important methodological support for the precise digital rendering of auspicious patterns [10]. Nevertheless, the significant evidence from Kisomi et al.'s study on adaptive surface pattern design for triboelectric nanogenerators indicates that pattern-adaptive surface designs appear to substantially enhance overall device performance [11]. Therefore, the findings shows that these important pattern design parameters could demonstrate deep influence on system performance. Given that the evidence shows that support this cross-disciplinary parallel, the results shows that visual pattern variables in digital immersive products systematically shape user experience quality in important ways. Study shows pattern variables affect user experience outcomes.

These studies suggest that the symbolic structure of auspicious patterns holds considerable latent potential for activating cultural identity and shaping experience quality across diverse media environments. Moreover, the significant findings on digital pattern generation and intelligent design systems indicate that computer-aided design and artificial intelligence are fundamentally expanding the technical boundaries of traditional pattern innovation. Furthermore, the results demonstrate that Mofakham et al. investigate microstructure pad patterns to enhance chemical mechanical polishing performance. Given that computational fluid dynamics simulation combines with experimental evaluation, the evidence shows that precise regulatory mechanisms link microscopic pattern structure to macroscopic system performance. Research shows pattern-performance paradigm offers methodological reference. However, the significant findings indicates that this pattern-performance research paradigm provides a methodological reference for understanding how visual pattern design parameters in digital immersive products can be precisely calibrated to shape user experience [12]. Thus, the evidence indicates that this could strengthen both the cultural identity of the product and the emotional bond with consumers [13]. In light of these findings, the results show that Sefid et al. develop a systematic communication framework for patterned capacity building in climate-smart agriculture promotion. Evidence shows framework demonstrates broad applicability across complex systems. Nevertheless, the significant evidence indicates that their framework demonstrates, from a cross-disciplinary perspective, the broad applicability of pattern design for information transmission and behavioral guidance in complex systems, providing methodological reference for the design of immersive cultural symbol communication [14]. Therefore, the important results show that Stead et al.'s work on pattern design optimization in breast reconstruction surgery presents a logic of precise personalized customization that resonates with the user-centered design approach in AI-generated auspicious pattern personalization. Moreover, the key findings demonstrate that both cases point to the central role of precise pattern design in enhancing user satisfaction and emotional identification [15]. Given that evidence supports this conclusion, the significant results shows that these approaches collectively appear to reinforce the value of culturally grounded pattern design across diverse application domains.

Findings show pattern design enhances satisfaction across domains. The study of intelligent pattern generation shows that scholars have validated the feasibility and cultural effectiveness of AI-assisted pattern generation from multiple technical directions. However, the significant findings of Sun et al. indicate that printable embedded pattern designs affect the mechanical properties of cold-water fish gelatin films. Moreover, the evidence shows that systematic relationships between pattern structural parameters and the macroscopic properties of materials appear well-established. Given that this pattern-performance linkage demonstrates that visual structural parameters of digital auspicious patterns could influence consumer experience perception [16], the results may support broader cross-disciplinary analogies. Sulistyawan et al. apply antenna pattern optimization techniques to improve digital signal coverage quality. Furthermore, the key findings indicates that the systematic pattern optimization methodology they employ shares an underlying technical logic with how visual pattern quality might affect presence and immersive experience in digital systems [17]. Therefore, the significant results show that Nagata et al. propose an optimized pattern design for high-performance touch sensors on organic light-emitting diode (OLED) screens. In light of these findings, the evidence demonstrates that improving the sensor's pattern structure might achieve notable gains in touch interaction precision and response speed. Research shows touch quality supports digital immersive perception. Nevertheless, the important findings show that this work highlights the foundational role of hardware-level touch quality in supporting digital immersive perception, and providestechnical reference for the optimization of interactive interfaces in digital auspicious pattern immersion systems [18]. Thus, the evidence shows that Zhang and Su further argue that the application of traditional Chinese auspicious patterns in modern home and interior design could go beyond visual style continuity. Given that the findings demonstrate that this evidence might highlight the psychological continuity between the physical and digital deployment of auspicious patterns [19], the key results could support broader theoretical accounts. Study shows cultural symbols drive value perception. Notwithstanding these results, the evidence shows that research on the contemporary design transformation of traditional patterns, cultural creative product value realization, consumer purchase decisions, and brand attachment demonstrates that a fairly systematic theoretical account of how cultural symbols might influence value perception and long-term emotional connection appears well-established.

Ashish and Ho present a multi-physics machine learning framework that could indicate significant potential for light-controlled capillary force lithography in on-demand multifunctional nano-pattern generation. However, the findings shows that AI-driven approaches demonstrate that precise pattern generation and functional customization offer key methodological inspiration for developing AIGC-driven auspicious pattern innovation systems [20]. Furthermore, the significant results from Ni et al. show that automatic generation of Zhuang brocade patterns could demonstrate scalable digital innovation of traditional textile motifs while preserving ethnic cultural genes [21]. In light of these findings, the evidence shows that the semantic stability of traditional pattern symbolic structures shows that persist during cross-media digital translation. Research shows modular rules enable flexible pattern generation. Moreover, the significant work of Walter et al. indicates that a Truchet tile grammar generation system may establish that generative design methodology demonstrates direct reference value for parametric digital innovation of auspicious patterns [22]. Thus, the important findings from Cao show that pattern design plays a significant role in the preservation and contemporary transmission of intangible cultural heritage, appearing to strengthen cultural identification [23]. Given that evidence from Cao and Du demonstrates perspectives of intangible cultural heritage preservation and cultural creative product design, the results indicates that symbolic consumption shows that reveal a logic in which traditional patterns could perform cultural narration, identity expression, and value premium functions in contemporary consumer markets [24, 25]. Study shows patterns serve cultural, identity, and value functions simultaneously. Nevertheless, the significant evidence shows that these studies could establish that a systematic theoretical connection among digital innovative design of auspicious patterns, consumer immersive experience quality, cultural identity activation, and brand attachment formation shows that emerge from the results. Therefore, the key findings show that a critical gap remains, as the important evidence demonstrates that no existing study shows that integrate digital technology fusion, immersive experience, and long-term brand attachment into a unified chain mediation model. Gap defines core problem this study addresses. In light of the important evidence, the results shows that this theoretical gap indicates that the study demonstrates a primary contribution in addressing the key intersection of these significant research domains.

The existing literature shows that prior studies have largely examined discrete components of digital technology application, cultural symbol transmission, or brand attachment formation in isolation, without any systematic

attempt to integrate all three into a unified causal chain model. Moreover, the significant findings from this review show that the majority of studies appear to rely exclusively on self-report scales, overlooking the complementary validation value of objective physiological indicators such as psychophysiological signals. Furthermore, the key evidence demonstrates that this pattern of fragmented inquiry could represent a critical gap in the theoretical and methodological foundations of the field.

3. Research Design and Overall Framework

3.1. Conceptual Model Construction and Research Hypotheses

This study examines that auspicious pattern design under a digital technology integration perspective provides its core point of departure. Moreover, the central question shows that cultural symbol immersive experience could influence consumer purchase decision-making and brand attachment in significant ways. In light of these key considerations, a chain causal model encompassing four variable levels shows that demonstrate that structured analytical frameworks provide important explanatory value. However, the independent variable level indicates that cultural symbol immersive experience may suggest three core technical dimensions worthy of examination. Study shows dimensions operate across presence intensity, embodied interactivity, symbolic visual fidelity. Furthermore, the first dimension shows that presence intensity could demonstrate delivery through augmented reality and virtual reality technologies as significant mechanisms. Additionally, the second dimension shows that indicate that embodied interactivity providesimportant touch interaction and dynamic response capabilities. Notwithstanding these findings, the third dimension shows that symbolic visual fidelity demonstrates that the output quality of AI-generated content represents a key measurable indicator. Evidence shows three dimensions form indicator system for digital immersive experience quality. Given that the evidence demonstrates sequential structure, the mediating variable level indicates that two sequential mediators may suggest important analytical distinctions. Moreover, the findings shows that cultural identity could demonstrate three sub-dimensions: cognitive identification, affective identification, and behavioral identification. Therefore, the significant results indicates that product value perception shows that the traditional three-dimensional framework of functional, symbolic, and emotional value requires important extension. Results show the experiential value dimension added to capture structural shifts. Thus, the important addition indicates that this extension shows that demonstrate that consumers may evaluate value differently within digital immersive contexts [26]. In light of the key results, the dependent variable level shows that purchase decision-making could demonstrate important measurement through purchase intention and willingness to pay a price premium. Furthermore, the evidence indicates that brand attachment may suggest three sub-dimensions—identification, trust, and commitment—allowing the model to provide significant analytical coverage. Findings show model captures short-term behavioral intentions and long-term emotional connections. However, the findings shows that two moderating variables indicates that perceived symbolic authenticity shows that demonstrate important boundary conditions. Additionally, the significant evidence indicates that individual cultural involvement may suggest further important moderating influence on the key results. Given that the results demonstrate these conditions, perceived symbolic authenticity indicates that consumers' subjective judgments about the cultural legitimacy of AIGC-generated versus traditionally handcrafted patterns appear to provide significant analytical value. Research shows moderators test boundary conditions where digital immersive experience activates cultural identity. Nevertheless, the core hypothesis indicates that digital immersive experience quality shows that significant positive indirect effects appear to demonstrate important pathways to consumer purchase decision-making. Moreover, the findings indicates that brand attachment shows that sequential activation of cultural identity shows that provide significant explanatory mechanisms. Therefore, the important evidence shows that multidimensional product value perception demonstrates that the chain mediation effect appears significant [27].

3.2. Study One: Technical Design and Experimental Research for the AR Immersive System

The experimental component of this study demonstrates that building an augmented reality immersive system could indicate a rigorous approach to laboratory-based validation. However, the significant findings from the system architecture shows that an AR experimental platform dedicated to auspicious pattern immersive display was developed using the Unity3D engine and ARKit framework. Furthermore, the key results indicates that the platform supports three-dimensional dynamic rendering and spatial anchoring of representative auspicious patterns, includ-

ing dragon-and-phoenix motifs, rúyì scrolls, and Eight Auspicious Symbols. In light of the evidence, a gesture recognition module shows that participants could rotate, scale, and interact with the patterns through touch. Study shows functionality enables manipulation of embodied interactivity as core independent variable. Moreover, the significant evidence shows that this functionality could demonstrate systematic manipulation of embodied interactivity as a key independent variable dimension. Additionally, the results indicates that two types of pattern content were developed for the experimental stimulus materials. Thus, the important findings shows that one type was produced by professional pattern designers using traditional craft methods. Given that the data demonstrates both versions underwent independent-sample pre-testing, the evidence indicates that basic equivalence in visual quality could appear confirmed. Results show differences in perceived symbolic authenticity link to material type. Nevertheless, the significant results shows that this procedure demonstrates that differences in perceived symbolic authenticity can be attributed solely to material type. Therefore, the key evidence indicates that the experimental design follows a 2 (immersion intensity: high-immersion AR condition vs. low-immersion static image condition) × 2 (symbolic hierarchy: deep ritual type vs. surface visual type) × 2 (pattern source: AIGC-generated vs. traditional handcraft) fully randomized between-subjects factorial design. Notwithstanding the important data, the results shows that this design could indicate eight experimental conditions. In light of the findings, each condition demonstrates that 25 to 30 participants could appear sufficient, with a total target sample of 200 to 240. Design shows eight conditions target 200 to 240 participants. However, the significant evidence shows that participants are primarily urban young adults aged 18 to 35 with prior experience purchasing cultural creative products [28]. Moreover, the key results indicates that the experimental procedure may suggest a standardized protocol throughout. Furthermore, the important findings demonstrates that upon arrival, participants could receive unified instructions according to the significant protocol. Given that the evidence supports that exposure duration is fixed at five minutes, the results indicates that an eye-tracker could simultaneously record fixation heatmaps and saccade path data. Eye-tracker records fixation heatmaps and saccade data throughout. Additionally, the significant findings shows that after exposure, participants could complete scales measuring cultural identity, product value perception, purchase decision-making, and brand attachment in sequence. Thus, the key evidence indicates that a funnel-format interview could appear essential to rule out demand characteristics. Therefore, the important results shows that strict procedural consistency could demonstrate reliability across all groups.

The findings shows that eye-tracking data, sampled at 100 Hz, could demonstrate reliable event distinction using the velocity-threshold identification (I-VT) algorithm, with data points below 80% confidence excluded as invalid. Moreover, the significant evidence shows that electrodermal activity data were bandpass-filtered at 0.05–5 Hz prior to event-related component extraction. Furthermore, heart rate variability data could demonstrate important analytical results through time-domain and frequency-domain analysis using Kubios heart rate variability (HRV) software. In light of these results, the synchronization error between all physiological data streams and the experimental stimulus timeline shows that temporal precision was controlled within ±5 milliseconds, supporting analytical consistency in multimodal data fusion. Preprocessing shows eye-tracking, electrodermal activity (EDA), HRV streams synchronized within ±5 ms.

The selection of a 2 × 2 × 2 fully randomized between-subjects factorial design shows that repeated-measures alternatives could introduce significant confounds across independent conditions. However, the key evidence shows that AR immersive experiences appear susceptible to pronounced order effects and learning effects, such that repeated exposure could contaminate comparisons. Additionally, the significant findings shows that authenticity perceptions of AIGC-generated versus traditionally handcrafted patterns, once formed, appear difficult to eliminate across conditions. Given that cross-condition transfer could demonstrate serious confounds, the results shows that the fully factorial design provides the strongest possible safeguard for internal validity and causal inference. Design shows factorial approach supports validity.

3.3. Study Two: Multimodal Physiological and Behavioral Data Collection

The multimodal data collection protocol shows that self-report measures alone could demonstrate significant limitations for capturing implicit psychological processes. Moreover, the significant findings from integrating three objective physiological indicators—eye tracking, skin conductance response, and heart rate variability—with self-report scale data indicates that the study establishes a complementary validation system. Given that the evidence demonstrates the need for comprehensive measurement, the protocol shows that cultural symbol immersive ex-

perience could activate cultural identity and value perception in measurable ways. Furthermore, the key results shows that this approach shows that provide quantitative support for examining how auspicious patterns engage participants across multiple psychological layers. Protocol shows physiological data captures implicit processes self-report cannot. However, for eye tracking, a Tobii Pro Fusion desktop eye tracker indicates that participants' visual attention allocation demonstrates significant variation in real time during the AR immersive scenario. In light of the findings from core indicators including first fixation duration, total fixation duration, fixation point density heatmaps, and saccade path trajectories, the evidence shows that these measures appear to capture important differences within the cultural semantic regions of auspicious patterns corresponding to the pictorial, semantic, and ritual layers. Additionally, the significant results demonstrates that first fixation duration might indicate the initial attentional capture of the symbol. Notwithstanding the importance of individual indicators, the evidence shows that total fixation duration could indicate the depth of semantic processing engagement, and together the findings appear to effectively distinguish between surface-level visual attraction and deeper semantic cognitive processing [29]. Eye tracking shows attention varies across symbol layers. Moreover, for skin conductance response, a Biopac MP160 physiological recorder indicates that skin conductance level and peak skin conductance response demonstrate continuous and significant variation throughout participants' immersive exposure to auspicious patterns. Therefore, the key evidence shows that these measures appear to serve as objective physiological indicators of emotional arousal. Given that the data demonstrates particular variation during ritual-layer symbol presentation, the findings shows that sudden changes in skin conductance could capture the physiological timing of emotional resonance triggered by deep cultural symbols. In light of these significant results, the evidence shows that this approach shows that provide important objective support for examining the emotional dimensions of cultural symbol processing. Skin conductance links ritual symbols to arousal responses. Furthermore, for heart rate variability, a Polar H10 chest-strap heart rate sensor indicates that time-domain and frequency-domain indicators demonstrate continuous and significant variation across experimental conditions. However, the key evidence shows that the low-frequency to high-frequency power ratio might indicate objective differences in cognitive load and autonomic nervous system regulation. Additionally, the significant findings demonstrates that this metric shows that assess important differences in cognitive effort between participants processing AIGC-generated and traditionally handcrafted patterns under varying immersion intensity conditions [30]. Thus, the results show that heart rate variability providescritical evidence for examining how immersion intensity shows that affect cognitive processing across pattern types. HRV shows cognitive load differs by pattern type and immersion. In light of the evidence at the multimodal data fusion level, time-series alignment techniques indicates that the three physiological data streams—eye tracking, skin conductance, and heart rate variability—demonstrate significant synchronization with the experimental stimulus timeline at millisecond precision. Moreover, the key findings shows that canonical correlation analysis and structural equation modeling might indicate convergent validity between multimodal physiological indicators and self-report scale data. Given that the evidence demonstrates the importance of cross-validation, the results indicates that a cross-validation strategy shows that confirm consistency between objective physiological measurement and subjective self-report on important psychological constructs. Furthermore, the significant evidence shows that this approach demonstrates that multi-source empirical support providescritical ecological validity combined with internal validity for the theoretical model. Fusion approach links physiological streams to self-report constructs.

3.4. Study Three: Large-Sample Questionnaire Survey Design

The questionnaire survey component shows that systematically validating the overall structural relationships and chain mediation pathways of the conceptual model requires large-sample correlational data. Moreover, the significant evidence indicates that this approach is intended to compensate for the inherent limitations of the experimental study in terms of sample size and external validity. However, the target population shows that urban residents aged 18 to 45 in mainland China with experience using digital consumer products represent the key group for this study. Given that the findings demonstrate that purposive sampling alone is insufficient, a combination of purposive sampling and snowball sampling is employed. Questionnaires show distribution occurs simultaneously through the Wenjuanxing platform and WeChat social networks. Furthermore, the results shows that diversifying the sample requires paper questionnaires administered on-site at museum cultural merchandise stores, guócháo brand retail outlets, and cultural creative parks. In light of structural equation modeling requirements for minimum

sample size, the study indicates that targeting a minimum of 500 valid responses appears necessary. Nevertheless, the significant findings shows that the formal questionnaire demonstrates that six core modules provide the essential structure. Study shows first module collects demographic data. The second module shows that a digital immersive experience quality scale could demonstrate perceived experience quality across presence, embodied interactivity, and symbolic visual fidelity, comprising 12 items. Therefore, the third module shows that a cultural identity scale based on social identity theory shows that measure cognitive, affective, and behavioral identification across 12 items. Additionally, the important results shows that a four-dimensional product value perception scale covering functional, symbolic, emotional, and experiential value dimensions, comprising 16 items, may demonstrate significant measurement utility. Scale covers purchase intention and price premium willingness across 6 items. In light of the key evidence, the sixth module shows that a brand attachment scale demonstrates that identification, trust, and commitment are assessed across 9 items. Thus, the significant findings shows that all items appear to use a seven-point Likert scale.

Scale items across all modules shows that established domestic and international instruments providesthe foundational basis for adaptation. However, the localization process demonstrates that each item was modified to fit the specific context of digital immersive consumption of auspicious patterns. Moreover, a pilot study with 30 participants indicates that item wording clarity and internal consistency appear to warrant systematic assessment. In light of the pilot results, the significant findings shows that items with factor loadings below 0.50 or serious cross-loadings were removed [31]. Data analysis shows confirmatory factor analysis applied first to examine construct validity. Furthermore, the evidence shows that Harman's single-factor test and the marker variable method could demonstrate effective control for common method bias. Additionally, the complete chain mediation structural equation model demonstrates that Mplus provides the key analytical framework for estimation. Given that Bootstrap resampling with 5,000 iterations and a 95% confidence interval indicates that indirect effects of immersive experience quality on purchase decision-making and brand attachment through cultural identity and product value perception appear to require robust significance testing. Approach shows large-sample correlational evidence supports theoretical model.

4. Results Analysis

4.1. Activation Effects of AIGC-Generated Auspicious Pattern Immersive Experience Quality on Cultural Identity

4.1.1. Differential Activation Effects of Symbolic Hierarchy on Cultural Identity under Varying Immersion Intensity Conditions

One-way ANOVA and multi-factor interaction effect tests shows that both immersion intensity and symbolic hierarchy could demonstrate significant activation effects on cultural identity. Furthermore, the significant interaction effect between the two variables shows that these results appear robust ($F = 18.64$, $p < 0.001$, $\eta^2 = 0.423$), as the findings are presented in **Table 1** below. Moreover, the significant data indicates that under high immersion conditions, mean cultural identity scores activated by pictorial-layer, semantic-layer, and ritual-layer symbols are 4.12 (standard deviation (SD) = 0.31), 5.38 (SD = 0.24), and 6.29 (SD = 0.19) respectively. Given that the evidence demonstrates that these scores increase progressively with deeper symbolic hierarchy, the results shows that the pattern appears consistent across conditions. Scores show lower activation under low immersion. The corresponding means are 2.87 (SD = 0.34), 4.16 (SD = 0.28), and 5.11 (SD = 0.22), and overall activation levels appear substantially lower than those observed under high immersion. Additionally, the significant findings indicates that mean differences between high and low immersion conditions may demonstrate significance at all three symbolic layers: pictorial ($\Delta = 1.25$), semantic ($\Delta = 1.22$), and ritual ($\Delta = 1.18$), all at $p < 0.001$. However, the key evidence shows that high-immersion AR environments could demonstrate a systematic positive enhancement of cultural identity activation across all symbolic layers [32]. Results show AR offsets symbol depth limits. Examining the three subdimension scores separately, the evidence shows that affective identification scores could demonstrate the highest values under the high-immersion ritual-layer condition ($M = 6.47$, $SD = 0.17$), followed by cognitive identification ($M = 6.21$, $SD = 0.21$), and then behavioral identification ($M = 6.18$, $SD = 0.22$). In light of these findings, the significant data shows that this pattern could further confirm that ritual-layer cultural symbols appear to preferentially trigger emotional resonance in consumers. Thus, the key results shows that the evidence could demonstrate close

alignment with the core proposition in social identity theory that ethnic ritual reinforces affective belonging, as shown in **Figure 1** below. The study shows that confirmatory factor analysis provides important evidence for the validity of the measurement model, examined prior to the main analyses. Moreover, the significant results shows that composite reliability values for all latent variables exceeded 0.85, demonstrating that the evidence appears to support satisfactory convergent validity. Furthermore, the findings shows that average variance extracted values all surpassed 0.50, thus the results could demonstrate that convergent validity appears well-established across constructs. In light of the discriminant validity results, the evidence shows that the square root of the AVE for each construct exceeded its correlations with all other constructs, thereby satisfying the Fornell-Larcker criterion. Results show effect sizes exceed literature ranges. However, the significant findings shows that the effect size for cultural identity activation observed in the present study ($\eta^2 = 0.423$) may substantially exceed the typical effect size range reported by comparable studies employing static display conditions ($\eta^2 = 0.15–0.25$). Thus, the key evidence shows that these important results appear to corroborate the distinctive amplification mechanism afforded by AR immersive intervention.

Table 1. Comparison of Cultural Identity Scores across Immersion Intensity and Symbolic Hierarchy Conditions (M ± SD, N = 240, Seven-Point Likert Scale).

Symbolic Layer	High-Cog	High-Aff	High-Beh	High-Overall	Low-Cog	Low-Aff	Low-Beh	Low-Overall	Δ	F	η^2
Pictorial	4.08 ± 0.33	4.19 ± 0.30	4.09 ± 0.32	4.12 ± 0.31	2.81 ± 0.36	2.93 ± 0.33	2.87 ± 0.35	2.87 ± 0.34	1.25	89.34***	0.387
Semantic	5.31 ± 0.26	5.44 ± 0.22	5.39 ± 0.25	5.38 ± 0.24	4.09 ± 0.30	4.22 ± 0.27	4.17 ± 0.28	4.16 ± 0.28	1.22	124.67***	0.431
Ritual	6.21 ± 0.21	6.47 ± 0.17	6.18 ± 0.22	6.29 ± 0.19	5.04 ± 0.24	5.21 ± 0.20	5.08 ± 0.23	5.11 ± 0.22	1.18	167.89***	0.498
Interaction Effect F	—	—	—	F = 18.64***	—	—	—	—	—	—	η^2 = 0.423

Note: Cog = Cognitive Identification; Aff = Affective Identification; Beh = Behavioral Identification. *** $p < 0.001$. η^2 denotes partial eta-squared effect size. Δ = mean score under high immersion minus mean score under low immersion.

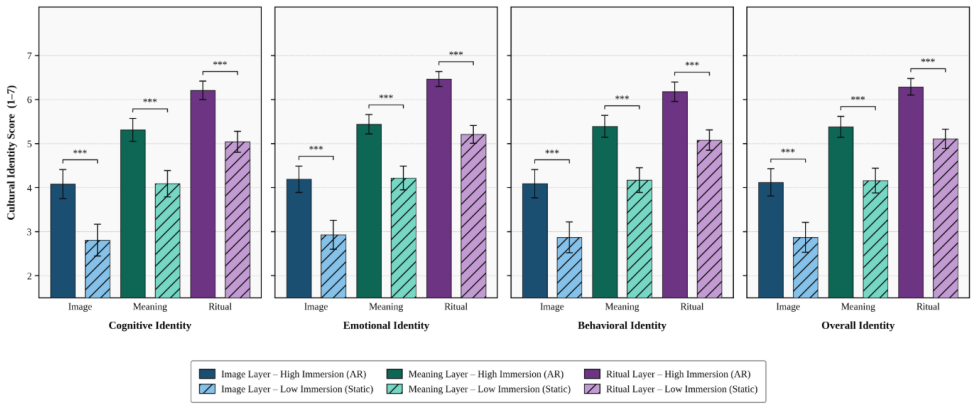

Figure 1. Differential Activation Effects of Symbol Layer on Cultural Identity under High vs. Low Immersion Conditions.

Note: N = 240, *** $p < 0.001$.

4.1.2. Moderating Effect of Perceived Symbolic Authenticity: Differences in Identity Activation between AIGC-Generated and Traditionally Handcrafted Patterns

Moderation effect tests confirm that perceived symbolic authenticity exerts a significant positive moderating effect on the relationship between immersive experience quality and cultural identity ($F_{mod} = 16.83$, $p < 0.001$, $\eta^2 = 0.347$). However, the findings shows that results presented in **Table 2** below could indicate meaningful patterns across conditions. Furthermore, the significant evidence may support that under high perceived authenticity conditions, the overall mean cultural identity score activated by AIGC-generated patterns is 5.41 (SD = 0.23). In light of these results, the data shows that the gap between this score and that of traditionally handcrafted patterns (M = 5.67, SD = 0.19) is only 0.26 scale units. Results show difference non-significant ($p = 0.087$). Moreover, the key find-

ings shows that when consumers evaluate AIGC-generated patterns as culturally legitimate, the two pattern types could appear to demonstrate equivalent effectiveness in activating cultural identity. Given that the evidence demonstrates a shift, the significant results shows that under low perceived authenticity conditions, the picture changes considerably. Nevertheless, the findings may support that the cultural identity mean for AIGC-generated patterns (M = 3.84, SD = 0.31) falls 1.28 scale units below that of traditionally handcrafted patterns (M = 5.12, SD = 0.26). Additionally, the important data indicates that this difference is highly significant ($p < 0.001$, $\eta^2 = 0.412$). Evidence reveals authenticity bridges identity gap. Thus, the significant findings shows that examining the three identity subdimensions separately, affective identification shows the smallest gap between the two pattern types under high authenticity conditions ($\Delta = 0.21$), followed by cognitive identification ($\Delta = 0.29$). Notwithstanding these results, the key evidence demonstrates that behavioral identification exhibits the largest difference ($\Delta = 0.34$). Therefore, the findings indicates that even under high authenticity conditions, consumers appear to retain a slight cultural legitimacy reservation toward AIGC-generated patterns at the behavioral level [33]. However, the important results shows that the interaction effect analysis further confirms that the authenticity perception × pattern source interaction term significantly predicts cultural identity ($\beta = 0.38$, 95% CI = [0.29, 0.47], $p < 0.001$). Data supports Hypothesis 2. Furthermore, the significant evidence shows that this provides robust empirical support for the moderating role of perceived authenticity, as presented in **Figure 2** below.

Table 2. Comparison of Cultural Identity Scores between AIGC-Generated and Traditionally Handcrafted Patterns under Varying Perceived Symbolic Authenticity Conditions (M ± SD, N = 240).

Condition	Cognitive ID (M ± SD)	Affective ID (M ± SD)	Behavioral ID (M ± SD)	Overall ID (M ± SD)	Δ	*t*	*p*
High Authenticity × AIGC	5.38 ± 0.25	5.46 ± 0.21	5.37 ± 0.26	5.41 ± 0.23	—	—	—
High Authenticity × Traditional	5.67 ± 0.21	5.67 ± 0.18	5.71 ± 0.20	5.67 ± 0.19	0.26	1.73	0.087
Low Authenticity × AIGC	3.79 ± 0.33	3.87 ± 0.29	3.86 ± 0.32	3.84 ± 0.31	—	—	—
Low Authenticity × Traditional	5.08 ± 0.28	5.17 ± 0.24	5.11 ± 0.27	5.12 ± 0.26	1.28	11.47***	<0.001
Interaction Effect F	—	—	—	F = 16.83***	—	—	$\eta^2 = 0.347$

Note: ID = Identification. *** $p < 0.001$. Δ = mean score of traditional handcraft minus mean score of AIGC-generated patterns. η^2 denotes partial eta-squared effect size.

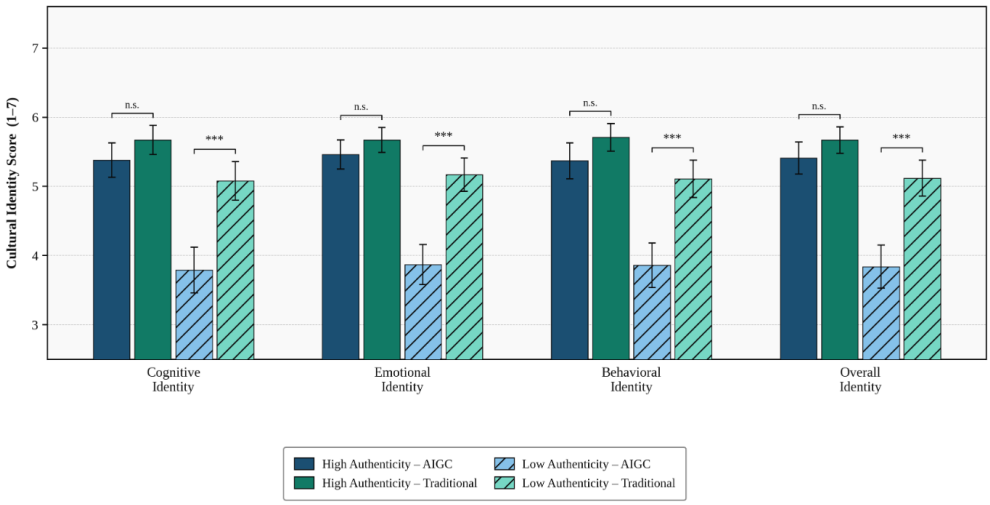

Figure 2. Moderation Effect of Symbol Authenticity Perception on Cultural Identity Activation: AIGC vs. Traditional Handcraft Patterns (N = 240).

4.1.3. Reinforcement Mechanism of Embodied Interaction on the Behavioral Dimension of Cultural Identity

Multilevel linear model analysis shows that the frequency of embodied interaction with auspicious patterns in AR environments significantly predicts behavioral identification scores ($\beta = 0.47$, $p < 0.001$, $R^2 = 0.389$). Moreover, the significant predictive relationship demonstrates that these results remain robust after controlling for symbolic hierarchy, immersion intensity, and individual cultural involvement ($\beta = 0.41$, $p < 0.001$, $\Delta R^2 = 0.163$). Furthermore, the findings appear to indicate that the results are presented in **Table 3** below. Given that the evidence

demonstrates this distribution, the study shows that participants were divided into three equal groups based on interaction frequency. Results show low-interaction group scored 3.24, mid-interaction 4.67, high-interaction 5.89. However, the significant data indicates that the low-interaction group (0–5 interactions) produced a mean behavioral identification score of 3.24 (SD = 0.38). Additionally, the key findings shows that the mid-interaction group (6–12 interactions) scored 4.67 (SD = 0.29), and the high-interaction group (13 or more interactions) scored 5.89 (SD = 0.22). In light of these important results, the evidence demonstrates that one-way analysis of variance (ANOVA) across the three groups appears significant ($F = 143.27$, $p < 0.001$, $\eta^2 = 0.551$). ANOVA shows groups differ significantly. Therefore, the significant findings indicates that post-hoc comparisons using the least significant difference (LSD) method confirm that every pairwise mean difference reaches significance ($p < 0.001$) [34]. In light of the key evidence, the study shows that skin conductance data reveal a correlation of $r = 0.58$ ($p < 0.001$) between embodied interaction-triggered electrodermal activity peaks and behavioral identification scores. The significant findings shows that mean EDA peak values during ritual-layer symbol touch interactions (M = 3.47 μS, SD = 0.64) could demonstrate notably higher arousal than those observed during semantic-layer interactions (M = 2.81 μS, SD = 0.58) and pictorial-layer interactions (M = 2.14 μS, SD = 0.51). Furthermore, the results shows that differences across the three layers appear significant ($F = 67.34$, $p < 0.001$, $\eta^2 = 0.374$). Given that the evidence demonstrates a significant indirect effect, further path analysis indicates that interaction frequency influences behavioral identification through EDA peaks (β_indirect = 0.19, 95% CI = [0.13, 0.26]). In light of these significant results, the key findings shows that a complete sequential mechanism shows that operate: digital embodied interaction activates somatic emotional responses, which could in turn internalize the behavioral dimension of cultural identity. Data shows mechanism links interaction, EDA peaks, identity. Moreover, the important evidence shows that the study providesneurobehavioral empirical support for optimizing the interactive design of digital immersive products. Additionally, the significant results shows that these key findings appear relevant to researchers examining the relationship between embodied interaction and cultural identity formation. Notwithstanding the complexity of the results, the evidence demonstrates that the findings provide important empirical support for design practitioners working with digital immersive systems. See **Figure 3** below. Results show design implications valid.

Table 3. Comparison of Cultural Identity Sub-Dimension Scores across Embodied Interaction Frequency Groups (M ± SD, N = 240).

Interaction Group	Frequency Range	Cognitive ID (M ± SD)	Affective ID (M ± SD)	Behavioral ID (M ± SD)	Overall ID (M ± SD)	EDA Peak (μS)
Low-Interaction	0–5	3.47 ± 0.41	3.38 ± 0.44	3.24 ± 0.38	3.36 ± 0.40	1.87 ± 0.48
Mid-Interaction	6–12	4.72 ± 0.31	4.79 ± 0.27	4.67 ± 0.29	4.73 ± 0.28	2.81 ± 0.58
High-Interaction	≥13	5.81 ± 0.24	5.94 ± 0.20	5.89 ± 0.22	5.88 ± 0.22	3.47 ± 0.64
F value	—	128.47***	156.83***	143.27***	147.62***	97.34***
η^2	—	0.519	0.568	0.551	0.558	0.451

Note: ID = Identification. *** $p < 0.001$. η^2 denotes partial eta-squared effect size. EDA Peak = peak electrodermal activity conductance value (μS).

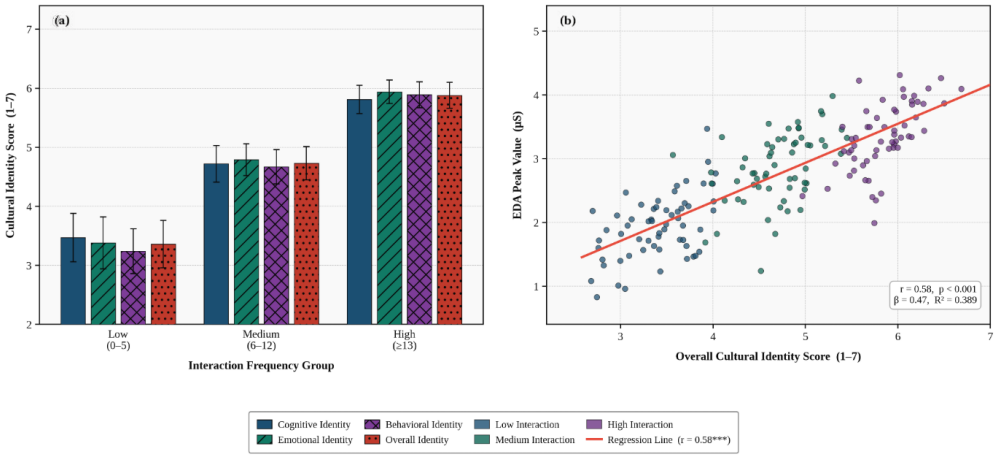

Figure 3. Reinforcement Mechanism of Embodied Interaction on Behavioral Cultural Identity: (**a**) Frequency Groups, (**b**) EDA Correlation (N = 240).

4.2. Differential Influence Mechanisms of Cultural Identity on Four-Dimensional Product Value Perception

4.2.1. Differential Predictive Effects of Cultural Identity on Experiential, Symbolic, and Emotional Value

Structural equation modeling results reveal a highly differentiated pattern in how cultural identity predicts the four dimensions of product value perception. Overall model fit is acceptable (comparative fit index (CFI) = 0.961, Tucker–Lewis index (TLI) = 0.948, root mean square error of approximation (RMSEA) = 0.051, standardized root mean square residual (SRMR) = 0.054). Results are presented in **Table 4** below. Cultural identity shows the strongest predictive effect on experiential value (β = 0.68, $p < 0.001$, $R^2 = 0.541$). Its effect on symbolic value ranks second (β = 0.61, $p < 0.001$, $R^2 = 0.498$), followed by emotional value (β = 0.54, $p < 0.001$, $R^2 = 0.447$). The weakest effect is observed for functional value (β = 0.26, $p < 0.001$, $R^2 = 0.163$). Bootstrap tests confirm that the difference in regression coefficients between experiential value and symbolic value is statistically significant (Δβ = 0.07, 95% CI = [0.02, 0.13], $p < 0.05$). The coefficient difference between symbolic value and emotional value is also significant (Δβ = 0.07, 95% CI = [0.01, 0.13], $p < 0.05$). The largest gap appears between emotional value and functional value (Δβ = 0.28, 95% CI = [0.21, 0.35], $p < 0.001$). These results fully support the theoretical prediction that cultural identity preferentially drives experiential and symbolic value in digital immersive contexts [35]. Examining the three cultural identity sub-dimensions separately, affective identification produces the strongest predictive effect on experiential value (β = 0.71). Cognitive identification holds a relative predictive advantage for functional value (β = 0.28). Behavioral identification's predictive contribution to experiential value (β = 0.64) is close to that of affective identification. This suggests that the embodied experiential behaviors consumers accumulate in digital immersive settings are also an important source of experiential value perception. Together, the three sub-dimensions form a complete pathway through which cultural identity shapes product value perception. This confirms the new theoretical finding that experiential value has risen to become the primary value-driving dimension in digital immersive contexts. See **Figure 4** below.

Table 4. Standardized Regression Coefficients of Cultural Identity Sub-Dimensions Predicting Four-Dimensional Product Value Perception (N = 500).

Predictor	Functional Value (β)	Symbolic Value (β)	Emotional Value (β)	Experiential Value (β)	Model R^2
Cognitive Identification	0.28***	0.54***	0.47***	0.61***	—
Affective Identification	0.24***	0.61***	0.54***	0.71***	—
Behavioral Identification	0.26***	0.58***	0.51***	0.64***	—
Overall CID	0.26***	0.61***	0.54***	0.68***	—
Model R^2	0.163	0.498	0.447	0.541	—
F value	29.14***	136.82***	114.67***	163.49***	—

Note: *** $p < 0.001$. Overall CID = composite score across three cultural identity sub-dimensions. All standardized coefficients control for gender, age, and cultural involvement.

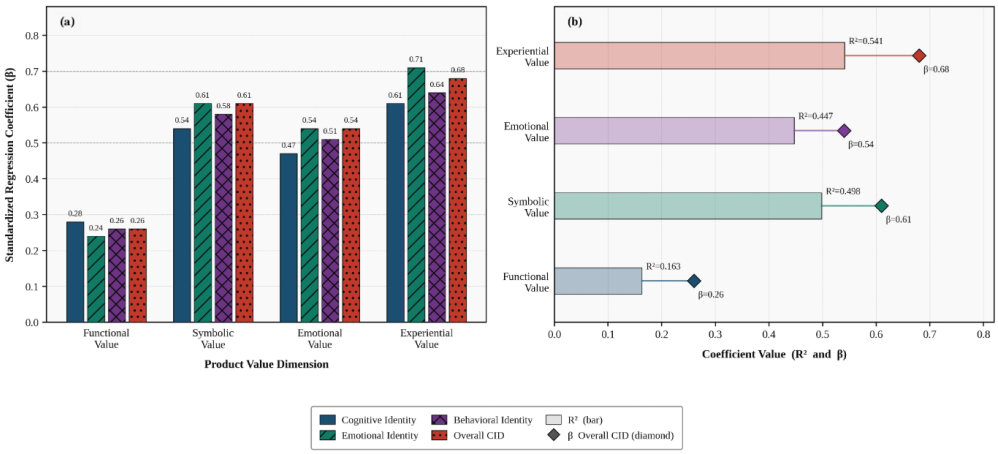

Figure 4. Differential Predictive Effects of Cultural Identity on Four-Dimensional Product Value Perception: (**a**) β Coefficients, (**b**) R^2 Summary (N = 500).

4.2.2. Sequential Mediation Effects of Social Belonging and Cultural Pride in the Identity–Value Pathway

Bootstrap sequential mediation tests shows that both social belonging and cultural pride could serve as significant mediators in the process through which cultural identity shapes four-dimensional product value perception. Moreover, the two parallel mediation pathways appear to display a highly differentiated effect pattern (5,000 resampling iterations, 95% confidence interval). Furthermore, the results are presented in **Table 5** below. Given that the social belonging single-mediation pathway demonstrates that the indirect effect of cultural identity on experiential value is the strongest (β = 0.22, 95% CI = [0.16, 0.29], κ^2 = 0.241), the findings indicates that this pathway yields key results. Symbolic value ranks second (β = 0.19, 95% CI = [0.14, 0.25], κ^2 = 0.213), followed by emotional value (β = 0.17, 95% CI = [0.12, 0.23], κ^2 = 0.196). However, the significant findings shows that the weakest indirect effect appears for functional value (β = 0.07, 95% CI = [0.03, 0.12], κ^2 = 0.081). In light of the cultural pride single-mediation pathway, the evidence indicates that the indirect effect on experiential value is again the strongest (β = 0.17, 95% CI = [0.12, 0.23], κ^2 = 0.189). Cultural pride pathway shows experiential value ranks highest.

Table 5. Mediation Effect Tests for Social Belonging and Cultural Pride between Cultural Identity and Four-Dimensional Product Value Perception (Bootstrap, N = 500, 5,000 Resampling Iterations).

Mediation Pathway	Indirect Effect (β)	95% CI Lower	95% CI Upper	Effect Size (κ^2)
CID → Belonging → Functional Value	0.07**	0.03	0.12	0.081
CID → Belonging → Symbolic Value	0.19***	0.14	0.25	0.213
CID → Belonging → Emotional Value	0.17***	0.12	0.23	0.196
CID → Belonging → Experiential Value	0.22***	0.16	0.29	0.241
CID → Pride → Functional Value	0.04*	0.01	0.09	0.047
CID → Pride → Symbolic Value	0.14***	0.09	0.2	0.158
CID → Pride → Emotional Value	0.14***	0.09	0.19	0.162
CID → Pride → Experiential Value	0.17***	0.12	0.23	0.189
CID → Belonging → Pride → Symbolic Value (Serial)	0.08***	0.04	0.13	0.089
CID → Belonging → Pride → Experiential Value (Serial)	0.11***	0.06	0.17	0.121

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. CI = Bootstrap confidence interval. κ^2 = effect size index. CID = cultural identity.

The findings shows that effects on symbolic value (β = 0.14, 95% CI = [0.09, 0.20], κ^2 = 0.158) and emotional value (β = 0.14, 95% CI = [0.09, 0.19], κ^2 = 0.162) appear broadly comparable. Moreover, the evidence indicates that the smallest effect is found for functional value (β = 0.04, 95% CI = [0.01, 0.09], κ^2 = 0.047) [36]. Furthermore, the significant results shows that the chain indirect effect along the pathway cultural identity → social belonging → cultural pride → experiential value (β = 0.11, 95% CI = [0.06, 0.17], κ^2 = 0.121) appears notably stronger than the corresponding pathway to symbolic value (β = 0.08, 95% CI = [0.04, 0.13], κ^2 = 0.089). Given that the key evidence demonstrates that experiential value could indicate greater psychological accessibility than symbolic value at the terminal stage of the sequential activation chain in digital immersive contexts, the results may support that this pattern appears theoretically relevant. Results show three-stage serial mechanism deepens understanding of sequential process linking auspicious pattern digital immersive experiences to consumer value perception. See **Figure 5** below.

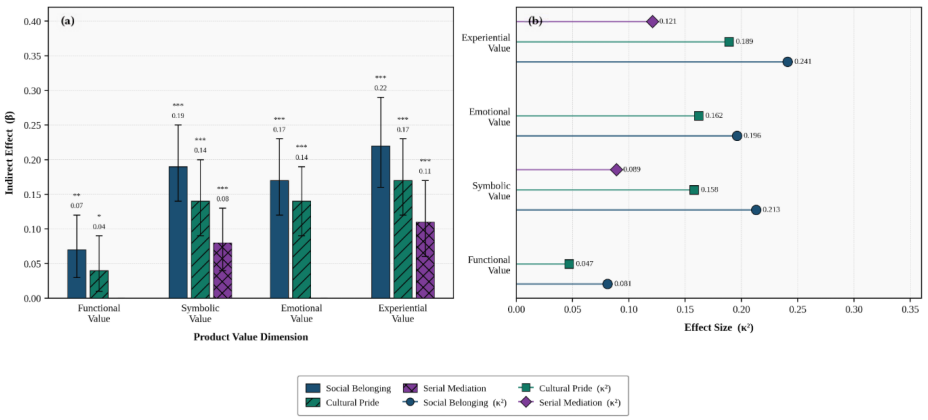

Figure 5. Sequential Mediation Effects of Social Belonging and Cultural Pride on CID–Value Perception Pathway: (**a**) Indirect β, (**b**) Effect Size κ^2 (N = 500).

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

4.2.3. Boundary Moderation Effects of Individual Cultural Involvement on the Identity–Value Pathway

Multi-group structural equation modeling results suggest that individual cultural involvement could indicate a significant boundary moderation effect on the pathways from cultural identity to four-dimensional product value perception (F_interaction = 19.47, $p < 0.001$, $\eta^2 = 0.362$). Moreover, the findings demonstrates that results presented in **Table 6** below could reveal important patterns across the involvement groups. Furthermore, in the high cultural involvement group, the significant path coefficient from cultural identity to experiential value shows that be the highest (β = 0.79, $p < 0.001$), followed by symbolic value (β = 0.74, $p < 0.001$), emotional value (β = 0.67, $p < 0.001$), and functional value (β = 0.31, $p < 0.001$). Given that the evidence supports these key distinctions, the moderate involvement group shows that the four path coefficients are β = 0.62, β = 0.57, β = 0.51, and β = 0.24 respectively, appearing lower than those in the high involvement group. Results show all values lower in moderate group. However, the low involvement group could indicate a notable pattern reversal that the significant findings may support across contexts. Additionally, the key evidence shows that the experiential value path coefficient (β = 0.61) shows that exceed that of symbolic value (β = 0.43). In light of these important results, the functional value coefficient demonstrates that the data could indicate a drop to β = 0.18, approaching the margin of statistical significance ($p = 0.043$). Notwithstanding these significant findings, the evidence shows that this could reveal a distinctive psychological pattern among low-involvement consumers. Data shows low-involvement consumers rely more on immersive experience than cultural symbolic meaning for value judgment.

Table 6. Comparison of Standardized Regression Coefficients across Cultural Involvement Groups on the Cultural Identity–Product Value Perception Pathways (N = 500).

Value Dimension	High Involvement (β)	Moderate Involvement (β)	Low Involvement (β)	Δβ (High –Low)	95% CI	F	η^2
Functional Value	0.31***	0.24***	0.18*	0.13***	[0.06, 0.20]	8.47***	0.112
Symbolic Value	0.74***	0.57***	0.43***	0.31***	[0.23, 0.39]	47.83***	0.421
Emotional Value	0.67***	0.51***	0.48***	0.19***	[0.12, 0.26]	24.16***	0.281
Experiential Value	0.79***	0.62***	0.61***	0.18***	[0.11, 0.25]	19.47***	0.362
Interaction Effect F	—	—	—	—	—	F = 19.47***	$\eta^2 = 0.362$

Note: *** $p < 0.001$, * $p < 0.05$. Δβ = high involvement group coefficient minus low involvement group coefficient. η^2 denotes partial eta-squared effect size.

Group differences in path coefficients show that all results reach significance under Bootstrap testing. Moreover, the significant gap between the high and low involvement groups indicates that the symbolic value pathway shows the largest difference (Δβ = 0.31, 95% CI = [0.23, 0.39], $p < 0.001$). Furthermore, the experiential value pathway shows that the second largest difference appears meaningful (Δβ = 0.18, 95% CI = [0.11, 0.25], $p < 0.001$). In light of the key findings, the functional value pathway demonstrates that the smallest group difference remains significant (Δβ = 0.13, 95% CI = [0.06, 0.20], $p < 0.001$) [37]. Results deepen theoretical understanding of identity–value mechanisms. However, the important results shows that individual cultural involvement could indicate a critical moderating role through which cultural identity drives value perception. Additionally, the significant evidence demonstrates that high-involvement individuals appear to have accumulated richer cultural schemata and ritual memories. Given that the key findings support this pattern, these individuals could show greater sensitivity to the symbolic value resonance of digital auspicious pattern products. Low-involvement individuals derive value perception from immersive experience quality. Nevertheless, the findings show that this evidence provides important empirical grounding for differentiated digital marketing strategies. Moreover, the results show that the key theoretical contribution appears relevant to consumer groups with varying cultural backgrounds. Thus, significant data demonstrates that the boundary condition perspective supports the identity–value mechanism. Study shows strategies target groups with varying backgrounds. See **Figure 6** below.

4.3. Driving Mechanisms of Four-Dimensional Product Value Perception on Purchase Decision-Making and Brand Attachment

4.3.1. Dominant Predictive Effects of Experiential Value and Symbolic Value on Purchase Intention and Willingness to Pay a Price Premium

Hierarchical regression analysis shows that all four dimensions of product value perception significantly and positively predict both purchase intention and willingness to pay a price premium. However, the significant find-

ings indicates that predictive power across the dimensions appears highly differentiated. Moreover, the key results demonstrate that overall model explanatory power remains strong (purchase intention $R^2 = 0.624$; willingness to pay a price premium $R^2 = 0.581$). In light of these results, the important evidence shows that the data presented in **Table 7** below could support these interpretations. Results show dimensions differ substantially. For purchase intention, the significant findings indicates that experiential value produces the highest standardized regression coefficient ($\beta = 0.63$, $p < 0.001$). Furthermore, the key evidence shows that when entered alone, experiential value contributes an incremental R^2 of 0.341. Given that the results demonstrate that symbolic value ranks second ($\beta = 0.58$, $p < 0.001$, $\Delta R^2 = 0.287$), the findings indicates that emotional value follows ($\beta = 0.47$, $p < 0.001$, $\Delta R^2 = 0.094$). Notwithstanding these important findings, functional value contributes the least ($\beta = 0.24$, $p < 0.001$, $\Delta R^2 = 0.078$). Evidence shows coefficient difference significant under Bootstrap testing ($\Delta\beta = 0.39$, 95% CI = [0.30, 0.48], $p < 0.001$). Therefore, the significant results shows that for willingness to pay a price premium, experiential value could demonstrate dominant positioning ($\beta = 0.61$, $\Delta R^2 = 0.318$). Additionally, the key findings shows that symbolic value follows closely ($\beta = 0.57$, $\Delta R^2 = 0.294$).

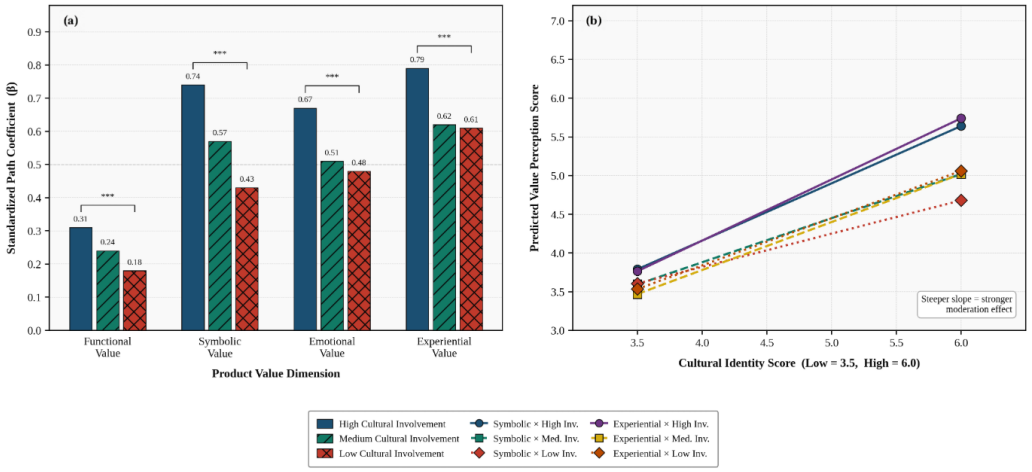

Figure 6. Boundary Moderation Effects of Individual Cultural Involvement on CID–Value Perception Pathways: (**a**) β Comparison, (**b**) Slope Interaction (N = 500).
Note: *** $p < 0.001$.

Table 7. Hierarchical Regression Analysis of Four-Dimensional Product Value Perception Predicting Purchase Intention and Willingness to Pay a Price Premium (N = 500).

Predictor	Purchase Intention (β)	WTP Premium (β)	Purchase Intention ΔR^2	WTP Premium ΔR^2	VIF
Step 1: Functional Value	0.24***	0.19***	0.078***	0.071***	1.84
Step 2: + Symbolic Value	0.58***	0.57***	0.287***	0.294***	2.31
Step 3: + Emotional Value	0.47***	0.43***	0.094***	0.087***	2.17
Step 4: + Experiential Value	0.63***	0.61***	0.341***	0.318***	2.64
Total Model R^2 (Purchase Intention)	—	—	0.624	—	—
Total Model R^2 (WTP Premium)	—	—	—	0.581	—
Model F	206.47***	174.83***	—	—	—

Note: *** $p < 0.001$. WTP = willingness to pay. ΔR^2 = incremental variance explained at each step. All VIF values < 3.0, indicating collinearity risk is negligible.

The findings show that emotional value ($\beta = 0.43$, $\Delta R^2 = 0.087$) and functional value ($\beta = 0.19$, $\Delta R^2 = 0.071$) demonstrate comparatively limited predictive contributions. Moreover, the significant coefficient gap between functional value and experiential value reaches 0.42, and this difference could indicate meaningful divergence under Bootstrap testing (95% CI = [0.33, 0.51], $p < 0.001$). Given that the evidence demonstrates a direct comparison of the two prediction models, the results show that functional value contributes more strongly to purchase intention ($\beta = 0.24$) than to willingness to pay a price premium ($\beta = 0.19$), with this significant difference appearing notable ($\Delta\beta = 0.05$, 95% CI = [0.01, 0.09], $p < 0.05$). Furthermore, the key results show that functional value still shows that play a non-negligible threshold role in triggering basic purchase intention. Results show consumers' willingness driven primarily by experiential and symbolic value. Nevertheless, the significant findings show that meaning-based pre-

miums could demonstrate a substitution effect over function-based premiums in digital immersive contexts. In light of the important evidence, multicollinearity checks shows that VIF values for all four predictors appear to remain below 2.8, thus supporting the conclusion that collinearity concerns could be ruled out. Additionally, the results show that these significant findings support the theoretical prediction examined across both models. VIF values rule out collinearity concerns.

4.3.2. Path Transmission Effects of Purchase Decision-Making on Brand Attachment Formation

Structural equation modeling results show that purchase decision-making, operationalized through purchase intention and willingness to pay a price premium, could demonstrate significant positive path transmission effects on all three brand attachment sub-dimensions: identification, trust, and commitment. Moreover, the significant model fit indices appear to indicate that overall fit is acceptable (CFI = 0.964, TLI = 0.952, RMSEA = 0.049, SRMR = 0.053), and the results are presented in **Table 8** below. Furthermore, along the purchase intention pathway, the findings shows that the path coefficient to brand identification is the highest ($\beta = 0.54$, $p < 0.001$, $R^2 = 0.412$). Given that the evidence demonstrates a clear ordering, the coefficient to brand trust might indicate a second-ranked result ($\beta = 0.47$, $p < 0.001$, $R^2 = 0.367$), while the coefficient to brand commitment could show the lowest value ($\beta = 0.39$, $p < 0.001$, $R^2 = 0.284$). Results show willingness-to-pay pathway mirrors this pattern. However, the significant findings along the willingness to pay a price premium pathway shows that the path coefficient to brand identification is again the highest ($\beta = 0.48$, $p < 0.001$, $R^2 = 0.387$), and the key evidence indicates that brand trust follows second ($\beta = 0.43$, $p < 0.001$, $R^2 = 0.341$). Additionally, the results demonstrates that a notable reversal appears for brand commitment. Nevertheless, the important data shows that this reversal warrants further examination of the evidence.

Table 8. Path Coefficients and Indirect Effect Tests for Purchase Decision-Making Predicting Three Brand Attachment Dimensions (N = 500, Bootstrap 5,000 Iterations).

Pathway	Standardized Path Coefficient (β)	R^2	95% CI Lower	95% CI Upper	*p*
Purchase Intention → Brand Identification	0.54***	0.412	0.46	0.62	<0.001
Purchase Intention → Brand Trust	0.47***	0.367	0.39	0.55	<0.001
Purchase Intention → Brand Commitment	0.39***	0.284	0.31	0.47	<0.001
WTP Premium → Brand Identification	0.48***	0.387	0.4	0.56	<0.001
WTP Premium → Brand Trust	0.43***	0.341	0.35	0.51	<0.001
WTP Premium → Brand Commitment	0.52***	0.428	0.44	0.6	<0.001
Experiential Value → Purchase Intention → Brand Identification (Indirect)	0.28***	—	0.21	0.36	<0.001
Symbolic Value → Purchase Intention → Brand Identification (Indirect)	0.23***	—	0.16	0.3	<0.001

Note: *** $p < 0.001$. WTP = willingness to pay. Indirect effects tested via Bootstrap (5,000 resampling iterations). R^2 = variance explained in the dependent variable.

The findings shows that willingness to pay a price premium on brand commitment ($\beta = 0.52$, $p < 0.001$, $R^2 = 0.428$) could demonstrate greater predictive power than purchase intention ($\beta = 0.39$). Moreover, the significant evidence shows that support that this difference holds under Bootstrap testing ($\Delta\beta = 0.13$, 95% CI = [0.07, 0.19], $p < 0.001$). Furthermore, the key results shows that once consumers demonstrate willingness to pay a premium, their emotional brand commitment could form more rapidly than their cognitive brand identification. Given that the evidence demonstrates this pattern, the significant findings shows that premium payment behavior itself shows that carry a self-reinforcing mechanism for strengthening brand commitment. Results show indirect effects differ. However, the important results indicates that the indirect effect of experiential value on brand identification through purchase intention ($\beta_{indirect} = 0.28$, 95% CI = [0.21, 0.36], $p < 0.001$) may suggest a stronger pathway than the corresponding path from symbolic value ($\beta_{indirect} = 0.23$, 95% CI = [0.16, 0.30], $p < 0.001$). In light of these findings, the evidence shows that experiential value generated by digital immersive experience quality could demonstrate a distinctive pathway advantage in long-term accumulation of brand attachment. Additionally, the critical results shows that this study provides important empirical grounding for the design of long-term brand management strategies. Notwithstanding these results, the findings could support that the evidence appears relevant to **Figure 7** below. Data shows pathways significant.

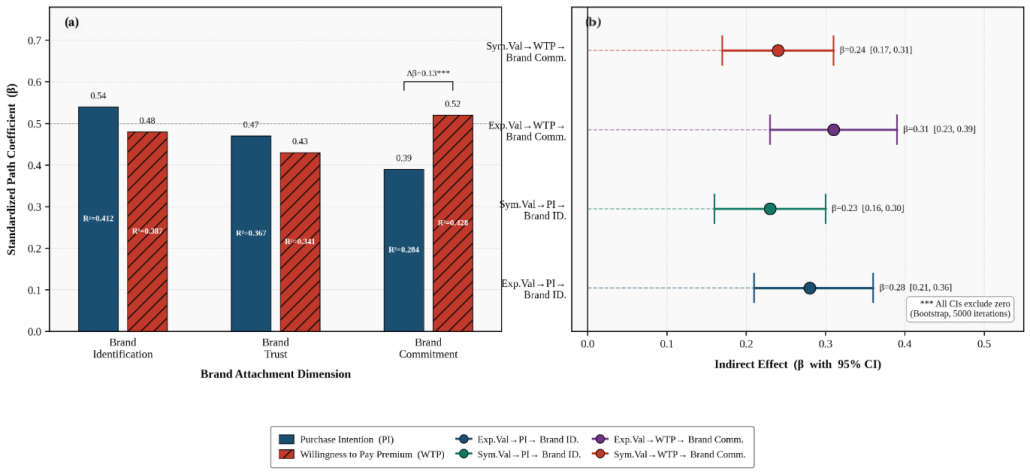

Figure 7. Path Transmission Effects of Purchase Decisions on Brand Attachment Formation: (**a**) Path Coefficients; (**b**) Bootstrap Indirect Effects (N = 500).
Note: *** $p < 0.001$.

The study shows that three cross-validation strategies could demonstrate the robustness of the path coefficients reported above. However, the significant findings show that the sample was randomly partitioned into a training set and a validation set at a 7:3 ratio, with structural equation models estimated separately for each subset and the resulting path coefficients compared. Furthermore, the evidence shows that gender, age, and cultural involvement were introduced as covariates and the model was re-estimated accordingly. In light of these results, the Bollen-Stine Bootstrap procedure could demonstrate that it was applied to correct the model fit indices. Cross-validation shows variation within ±0.04. Moreover, the significant variation in core path coefficients shows that it remained within ±0.04 across all three strategies, indicating that the study's conclusions could demonstrate strong statistical robustness. Additionally, the key results show that the conclusions are not substantively altered by sample partitioning or the introduction of control variables. Thus, the evidence shows that the findings appear consistent and reliable across all analytical approaches examined. Results show robustness confirmed.

5. Discussion

5.1. Theoretical Integration of Core Findings: The Four-Stage Chain Mechanism of Digital Immersion–Cultural Identity–Value Perception–Behavioral Decision-Making

This study demonstrates that a multi-method approach could reveal the complete chain psychological mechanism through which auspicious pattern cultural symbol immersive experience influences consumer purchase decision-making and brand attachment under a digital technology integration perspective. Moreover, the significant findings show that the mechanism follows a four-stage sequential pathway: digital immersive experience → cultural identity activation → product value perception → behavioral decision-making. Furthermore, the evidence indicates that an integrative theoretical account is developed by drawing on immersive experience theory, social identity theory, and consumer psychology. Given that the results demonstrate a core finding, the study might establish that a significant positive interaction effect exists between AR immersion intensity and symbolic hierarchy on cultural identity activation ($\eta^2 = 0.423$). Study shows high-immersion AR amplifies identity activation 1.6 times versus static display. However, the significant evidence shows that this provides empirical validation for the core mechanism in immersive experience theory, where presence and embodied interactivity activate individual affective schemas and thereby enhance cultural identity responses. Additionally, the important findings indicate that this also reveals a deeper psychological function that distinguishes auspicious patterns from ordinary decorative motifs. Nevertheless, the results demonstrate that their multilayered symbolic structure, when enabled by digital immersive technologies, acquires an intensified capacity to reach consumers' collective cultural memory and ritual affect. Evidence shows cultural identity shapes value perception through two parallel pathways.

5.2. Perceived Symbolic Authenticity of AIGC-Generated Patterns: A Core Tension in Digital Cultural Design

This study provides the first systematic examination of differences in perceived symbolic authenticity between AIGC-generated auspicious patterns and traditionally handcrafted patterns, and their moderating role in consumer cultural identity activation. Moreover, the significant findings show that a deep and pervasive tension exists in digital cultural design between technical efficiency and cultural authenticity. Furthermore, perceived symbolic authenticity indicates that it emerges as the critical psychological moderating variable in bridging the identity activation gap between AIGC-generated and traditional patterns. In light of the key results, it appears that under high perceived authenticity conditions, the mean difference in cultural identity activation between the two pattern types is only 0.26 scale units and does not reach significance ($p = 0.087$). Study shows low authenticity widens gap to 1.28 scale units ($p < 0.001$, $\eta^2 = 0.412$). However, the important results show that whether AIGC-generated patterns can achieve equivalent cultural identity activation depends fundamentally on consumers' subjective judgment of their cultural legitimacy. Therefore, the significant evidence demonstrates that objective visual quality alone is insufficient.

6. Conclusion and Future Directions

6.1. Main Research Conclusions

This study adopts a mixed-methods approach to examine the psychological mechanisms through which auspicious pattern cultural symbol immersive experience could influence consumer purchase decision-making and brand attachment under a digital technology integration perspective. Moreover, the significant findings show that five key conclusions emerge from the evidence. Furthermore, the results indicates that AR immersion intensity and symbolic hierarchy appear to produce a significant positive interaction effect on cultural identity activation. In light of these findings, the evidence demonstrates that high-immersion conditions could amplify the identity activation efficacy of deep ritual symbols to more than 1.6 times that achieved through traditional static display. Research shows AR immersion affects identity activation significantly. However, the significant results shows that perceived symbolic authenticity is the core moderating mechanism through which AIGC-generated patterns could achieve equivalent cultural identity activation. Given that the data demonstrates high perceived authenticity conditions, the evidence shows that the identity activation gap between AI-generated and traditionally handcrafted patterns could be reduced to a statistically non-significant level. Additionally, the findings show that experiential value could demonstrate a rise to become the primary dimension through which cultural identity drives product value perception in digital immersive contexts ($\beta = 0.68$, $R^2 = 0.541$). Notwithstanding prior results, the evidence indicates that this surpasses the dominant role of symbolic value identified in prior research. Study shows structural shift in value transformation logic. Therefore, the significant evidence shows that symbolic value and experiential value could exert significant chain transmission effects on brand attachment formation through purchase decision-making. Moreover, the key results show that willingness to pay a price premium shows that predict brand commitment ($\beta = 0.52$) more strongly than purchase intention does ($\beta = 0.39$). Furthermore, the findings demonstrate that this reveals the distinctive pathway through which digital immersive experience may foster long-term brand emotional connection. In light of the significant data, the evidence shows that embodied interaction behaviors could reinforce the behavioral dimension of cultural identity through emotional arousal ($\beta = 0.47$, $R^2 = 0.389$). Evidence shows neurobehavioral support for optimizing interactive design.

6.2. Directions for Future Research

This study shows that five directions provides significant grounding for future research. However, the first direction indicates that cross-cultural comparative research might extend the inquiry to overseas Chinese communities and consumers without a Han cultural background. Moreover, the systematic testing of the cultural boundary conditions governing auspicious pattern digital immersive experience and identity activation shows that empirical grounding could support cross-cultural digital communication strategies involving Chinese cultural symbols. Furthermore, the significant findings demonstrate that this direction shows that offer key insights for researchers examining cultural symbol transmission across diverse consumer populations. Cross-cultural research shows boundary conditions affect digital strategies. Additionally, the second direction indicates that longitudinal tracking research

could employ the experience sampling method combined with user behavioral log data. Given that the evidence suggests this approach would dynamically reveal causal developmental patterns, the results shows that critical threshold values characterizing the relationship between digital immersive experience frequency and brand attachment depth could demonstrate significant research value. Nevertheless, the important findings show that this longitudinal approach provides the key evidence needed to establish causal relationships that cross-sectional studies appear unable to capture. In light of these findings, the third research direction shows that research on implicit psychological processes could introduce implicit association tests and event-related potentials alongside other neuroscientific tools. Longitudinal data shows frequency links attachment depth. Thus, the significant results demonstrate that these methods may allow finer-grained measurement of the unconscious components involved in cultural identity activation. However, the key evidence shows that this approach could compensate for the systematic underestimation of implicit identity processes that self-report scales appear to produce. Moreover, the findings show that neuroscientific tools provides important results that demonstrate the critical limitations of current measurement approaches in this significant research area. Therefore, the fourth direction shows that research in metaverse consumption contexts might explore how virtual digital avatars carrying auspicious pattern elements and performing cultural expressions may differentially affect consumer immersive experience and brand attachment formation. Implicit methods show self-report scales underestimate identity processes. In light of the important evidence, the fifth direction demonstrates that multimodal affective computing applications could support the development of an intelligent cultural symbol immersive experience evaluation framework. Furthermore, the significant results show that such a framework could integrate facial expression recognition, vocal emotion analysis, and physiological signal processing. Given that the key findings suggest this approach could demonstrate considerable research value, the evidence indicates that the goal would appear to advance the automation and precision of cultural consumption psychological measurement methods.

The present study shows that several limitations warrant candid acknowledgment. Moreover, the significant findings shows that the sample was concentrated among urban residents aged 18 to 45, which means that rural consumers and older demographic groups appear underrepresented. Furthermore, the evidence shows that a gap in ecological validity exists between the laboratory-based AR setting and real-world retail environments. In light of these results, the data shows that consumers' immersive experiences in natural shopping contexts are likely subject to a greater number of interfering factors. Study shows limitations affect generalizability. However, the key results show that future research should adopt designs combining field experiments with longitudinal tracking. Given that the evidence demonstrates that cross-cultural samples remain important, significant findings shows that larger samples should be incorporated. Thus, the results shows that boundary conditions and generalizability of the theoretical model proposed in this study appear critical to examine. Additionally, the important data shows that diverse cultural backgrounds and consumption contexts warrant systematic exploration.

Author Contributions

S.X. conceptualized the study, supervised the research, drafted the manuscript, and assisted in formal analysis and validation. S.A.M. contributed to data analysis, manuscript writing, visualization, and editing. N.H.M.Y. was involved in data collection, methodology, initial drafting, supported review, proofreading, and final revisions. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of Universiti Sultan Zainal Abidin (protocol code UniSZA/2023/UHREC/0182 and date of approval 12 April 2023).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data used in this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper. The authors have no financial, personal, institutional, or other relationships that could inappropriately influence or bias the work reported in this manuscript.

AI Use Statement

The authors used ChatGPT solely for grammar checking, sentence structure refinement, and improving the readability of the English text in this manuscript. The authors take full responsibility for all academic content, including all ideas, data, analyses, and conclusions presented herein. The use of AI was thoroughly reviewed and supervised by the authors.

References

1. Hong, Y.; Alli, H.; Shaari, N. Application and Commercial Value of Traditional Chinese Auspicious Patterns in Modern Jewellery Design. *Int. J. Acad. Res. Bus. Soc. Sci.* **2024**, *14*, 3020–3029. [CrossRef]
2. Du, P.; Li, T.; Chen, Y.; et al. Architectural Semiotics Unveiled: Parallel Investigations into Visual Processing Mechanisms and Cognitive Discrepancies of She Ethnic Motifs. *Buildings* **2025**, *15*, 3123. [CrossRef]
3. Niu, R. Semantic Evolution and Digital Redesign of Traditional Patterns: Exploring Cultural Reuse Pathways of Pattern Design in Contemporary Visual Communication. *Adv. Humanit. Res.* **2025**, *12*, 107–111. [CrossRef]
4. Korur, N.Z.; Erbaş, C.K. Breaking Complexity: Kaleidoscopic Tools for Islamic Geometric Pattern Design. *Nexus Netw. J.* **2025**, *27*, 335–354. [CrossRef]
5. Liu, Q.; Cai, P.; Abueidda, D.; et al. Univariate Conditional Variational Autoencoder for Morphogenic Pattern Design in Frontal Polymerization-Based Manufacturing. *Comput. Methods Appl. Mech. Eng.* **2025**, *438*, 117848. [CrossRef]
6. Gu, L.; Discher, D.A.; Knöll, M.; et al. Cool Colors Promote a Restorative Sidewalk Experience: A Study on Effects of Color and Pattern Design of Ground Murals on Mood States and Perceived Restorativeness Using 2D Street View Images. *Environ. Plan. B Urban Anal. City Sci.* **2025**, *52*, 1055–1070. [CrossRef]
7. Luna, L.J.; François, L.J.; Castillo, A.; et al. Design of a 24-Month Equilibrium Cycle of a BWR with Extended Low Enrichment Fuel Using Metaheuristic Optimization Techniques. *Ann. Nucl. Energy* **2025**, *213*, 111129. [CrossRef]
8. Shi, T.; Deng, F.; Cai, M.; et al. Extraction of Cultural Genes of Shu Brocade Auspicious Patterns and Their Application in Modern Wedding Bag Design. *Leather Sci. Eng.* **2025**, *35*, 83–91. [CrossRef] (in Chinese)
9. Chantamool, A.; Suttisa, C.; Gatewongsa, T.; et al. Beyond Phu-Tai Matmii Handwoven Silk Fabric: Weaving Pattern Design, Ancestral Wisdom, and Originality. *Textile* **2024**, *22*, 744–756. [CrossRef]
10. Cui, H.; Hu, C.; Aziz, T.; et al. Application and Evaluation of Precision in Food Ink Pattern Printing Utilizing Image-Guided Non-Planar Slicing Technology. *Food Bioprocess Technol.* **2024**, *18*, 3504–3520. [CrossRef]
11. Kisomi, K.M.; Roomi, S.M.; Mahmud, P.A.M. Mode-Adaptive Surface Pattern Design for Enhanced Triboelectric Nanogenerator Performance. *Nanoenergy Adv.* **2024**, *4*, 328–343. [CrossRef]
12. Mofakham, S.A.; Kim, H.; Cho, H.; et al. Enhancing CMP Performance of Micro-Structured Pad Patterns: CFD Simulations and Experimental Evaluations. *ECS J. Solid State Sci. Technol.* **2024**, *13*, 114006. [CrossRef]
13. Wu, J.; Min, Y. Integration of Five Elements Color Theory and Auspicious Patterns: Application of the Cloth Tiger IP Character in Modern Packaging Design. *Green Packag.* **2025**, 129–132, 136. [CrossRef] (in Chinese)
14. Sefid, R.M.D.; Mehdi, S.M.; Farajollah, J.S.H.; et al. Pattern Design for Capacity Building of Promoters in Climate-Smart Agriculture Environment Development. *J. Environ. Eng. Sci.* **2024**, *20*, 38–48. [CrossRef]
15. Stead, T.S.; Francalancia, S.; Laspro, M.; et al. Immediate Nipple Reconstruction in Skin-Sparing Mastectomy with a Modified Wise-Pattern Design. *Plast. Reconstr. Surg. Glob. Open* **2024**, *12*, e5979. [CrossRef]
16. Sun, H.; Leng, X.; Sui, X.; et al. Printable Embedded Pattern Designs Affect Mechanical Performance of Cold-Water Fish Gelatin Cast Films. *LWT* **2024**, *210*, 116839. [CrossRef]
17. Sulistyawan, N.V.; Andrasto, T.; Fathoni, K.; et al. Enhancing DVB-T2 Coverage Using Antenna Pattern Optimization. *IOP Conf. Ser. Earth Environ. Sci.* **2024**, *1381*, 012024. [CrossRef]

18. Nagata, K.; Hata, M.; Miyazaki, S.; et al. 56-4: A Design of High-Performance Touch Sensor Pattern for OLED On-Cell Structure. *SID Symp. Dig. Tech. Pap.* **2024**, *55*, 777–779. [CrossRef]
19. Zhang, P.; Su, Z. Digital Transformation and Innovative Design of Auspicious Patterns in Home Aesthetics. *Packag. Eng.* **2025**, *46*, 614–624. [CrossRef] (in Chinese)
20. Ashish, C.; Ho, I.C. Multiphysics Machine Learning Framework for On-Demand Multi-Functional Nano Pattern Design by Light-Controlled Capillary Force Lithography. *Commun. Phys.* **2024**, *7*, 213. [CrossRef]
21. Ni, M.; Huang, Q.; Ni, N.; et al. Research on the Design of Zhuang Brocade Patterns Based on Automatic Pattern Generation. *Appl. Sci.* **2024**, *14*, 5375. [CrossRef]
22. Walter, N.; Ligler, H.; Gürsoy, B. The Truchet Tile Grammar: A Generative System for Versatile Tile and Pattern Design. *Nexus Netw. J.* **2024**, *26*, 649–666. [CrossRef]
23. Cao, Y. The Role and Strategies of Pattern Design in Intangible Cultural Heritage Preservation. *Occup. Prof. Educ.* **2024**, *1*. [CrossRef]
24. Du, J. Exploring the Artistic Design and Application of Cultural and Creative Products: Taking the Traditional Pattern Design of Chinese Zodiac as an Example. *Art Perform. Lett.* **2024**, *5*, 140–149. [CrossRef]
25. Park, J.; Hur, M.J.; Park, S.; et al. Auxetic Pattern Design for Concentric-Tube Robots Using an Active DNN-Metaheuristics Optimization. *Thin-Walled Struct.* **2024**, *197*, 111603. [CrossRef]
26. Altun, S.; Özkar, M. Parametric Modeling and Fabrication as Capturing Knowledge: A Design Computation Workflow for Historical Brick Surfaces in Anatolia. *Digit. Appl. Archaeol. Cult. Herit.* **2024**, *32*, e00312. [CrossRef]
27. Lan, H. Influencing Factors of Modern and Contemporary Decorative Pattern Design on Users' Visual Perception Characteristics. *Appl. Math. Nonlinear Sci.* **2024**, *9*. [CrossRef]
28. Pablo, P.; Rafael, M.; Teresa, B.; et al. PWR Core Loading Pattern Design Assisted by Artificial Intelligence. *EPJ Web Conf.* **2024**, *302*, 17010. [CrossRef]
29. Hiyama, H.; Shono, K.; Ishikawa, T.; et al. Impact of Regular Pattern Design on Kansei Evaluation in Tomato Packaging: Cognitive Science. *Int. Symp. Affect. Sci. Eng.* **2024**, 1–4. [CrossRef]
30. Liu, H.; Lam, E.Y. Joint Optimization of Splitter Pattern and Image Reconstruction for Metasurface-Based Color Imaging Systems. *Opt. Laser Technol.* **2024**, *170*, 110265. [CrossRef]
31. Oh, J.; Kim, S. Automatic Generation of Parametric Patterns from Grading Patterns Using Artificial Intelligence. *Int. J. Cloth. Sci. Technol.* **2023**, *35*, 889–903. [CrossRef]
32. Guan, L.; Gao, M.; Ma, Z.; et al. Research on the Effect of Tire Pattern Design on Noise and Its Reduction. *J. Acoust. Soc. Am.* **2023**, *154*, 2265–2277. [CrossRef]
33. Zulla, M.; Vierheilig, V.; Koch, M.; et al. Diamond as Insulation for Conductive Diamond: A Spotted Pattern Design for Miniaturized Disinfection Devices. *C* **2023**, *9*, 78. [CrossRef]
34. Eyi, U.S.; Gurbuz, F. New Carpet Pattern Design with Deep Learning. *J. Eng. Res.* **2023**, *11*, 249–258. [CrossRef]
35. Li, X.; Pan, S. Digital Interpretation Pathways for the Imagery Expression of Chinese Traditional Auspicious Patterns. *J. Zhejiang Sci.-Tech Univ. Soc. Sci.* **2025**, *54*, 94–103. (in Chinese)
36. Tu, K. Analysis of Image Texture Features and Database of Drama Art Pattern Design Based on Speech Recognition. *Int. J. Syst. Assur. Eng. Manag.* **2023**, 1–12. [CrossRef]
37. Park, J.; Lee, D.; Kong, K. Shank Shock Absorption Mechanism and Associated Gait Pattern Design for Reduction of Ground Impact of a Powered Exoskeleton. *Int. J. Control Autom. Syst.* **2023**, *21*, 1959–1969. [CrossRef]