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RESEARCH ARTICLE

Calligraphic landscapes and place attachment: How cultural art elements influence environmental identity formation

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ABSTRACT

This study investigates how calligraphic landscapes in urban public spaces affect residents' place attachment. We examined cultural identity and environmental consciousness as mediating variables. The research applied a primarily quantitative approach with supplementary qualitative insights from 500 residents across three Chinese cities with established calligraphic installations. Structural equation modeling shows that exposure to calligraphic landscapes predicts place attachment and pro-environmental behavior. Cultural identity acts as a stronger mediator for place attachment, whereas environmental consciousness links more directly to pro-environmental behavior. The models account for 43% of variance in place attachment and 38% in pro-environmental behavior. Residence length moderates these effects, with long-term residents responding more strongly than recent arrivals. The findings advance environmental psychology by showing how traditional cultural art activates two distinct psychological pathways. Heritage appreciation connects to emotional bonds with place, while ecological awareness links to conservation actions. Integrating cultural symbols into urban design can strengthen community bonds and promote environmental stewardship in East Asian contexts. This approach contrasts with Western frameworks that emphasize natural features rather than cultural elements.

Keywords: place attachment; calligraphic landscapes; cultural identity, environmental consciousness

1. Introduction

Place attachment is a key concept within the field of environmental psychology that describes the emotional attachment people have towards specific geographic locations. This multifaceted concept encompasses both place dependence, dealing with utilitarian relationships, and place identity, dealing with symbolic meanings (Yoon et al., 2024; Zahnow, 2024). Foundational scholars (Altman, 1992) established place attachment's affective, cognitive, and behavioral dimensions, with Lewicka (Lewicka, 2008) emphasizing cultural memory's role in shaping place-person bonds. This study adopts Scannell and Gifford's (Scannell & Gifford, 2010) framework, defining place attachment as emotional bonds encompassing both functional dependence and identity-related symbolic connections. Physical environmental attributes significantly impact attachment formation, yet cultural dimensions are increasingly critical(Lewicka, 2008; Stefaniak et al., 2017). Cultural objects such as monuments, sculptures, murals, and traditional art

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installations serve as tangible identity markers anchoring communities through shared symbolic systems. Cultural landscapes, defined as environments where cultural significance becomes embedded in physical space (Relph, 1976; Tuan, 1977), transform locations into meaningful places through symbolic engagement.

Artistic and cultural elements play a dual role in the development of environmental identity and the stimulation of ecological consciousness. Cultural symbols embedded in cities foster shared memory and stimulate social unity among the populace (Yang et al., 2022). Community-based installations accomplish multiple outcomes including ecological awareness, stewardship behaviors, and social cohesion (Al-Zadjali, 2024; Wild & Schulze Heuling, 2024). The shift from cultural consciousness to environmental care discloses complex psychological processes whose full nature remains unclear (Ruiz-Mallén et al., 2022), yet embedding ancient cultural expressions in contemporary cities offers specific environmental education opportunities appreciated by the local populace (Zhongbin, 2024). Calligraphic landscapes represent a distinctive synthesis of these functions. The cultural significance and aesthetic value inherent in calligraphic pieces transcend mere decoration in public spaces (Li & Li, 2022), as engagement with cultural landscapes evokes environmental consciousness through aesthetic engagement (Wullenkord et al., 2020). Traditional art in contemporary urban spaces enables applying historical insights to environmental concerns (Nicolai et al., 2022), providing settings where ecological consciousness meets cultural heritage (Kang & Liu, 2024).

Despite the rising concern about cultural landscapes and environmental psychology, there remain significant gaps in the research on understanding how specific cultural arts affect place attachment. While research has examined architectural heritage and visual art, text-based cultural landscapes such as calligraphic installations remain unexplored (Yang et al., 2019) , offering unique visual-textual dimensions. Calligraphic installations offer unique dimensions: artistic expression rooted in millennia of tradition, textual environmental content conveying ecological messages, and cultural-specific resonance requiring interpretive engagement. Psychological processes connecting cultural symbols to place attachment and pro-environmental behaviors remain underexplored (Arbuthnott, 2023; Hajar, 2024; Sulistyaningsih, 2022), particularly regarding dual mediating pathways through cultural identity and environmental consciousness. Identifying these mechanisms is crucial for effective urban planning and environmental protection.

Understanding how cultural elements influence place attachment holds significant implications across multiple domains. From environmental psychology perspectives, place attachment predicts pro-environmental behavior (Ramkissoon et al., 2013b), with attached individuals demonstrating greater conservation engagement. From urban studies perspectives, place attachment influences residents' community commitment, affecting neighborhood stability and long-term sustainability (Pineda et al., 2024; Pineda et al., 2023).

This research examines how calligraphic landscapes influence place attachment through dual mediating pathways of cultural identity and environmental consciousness. We hypothesize that calligraphic exposure in community spaces enhances place attachment, with the two mediators operating as parallel mechanisms connecting traditional art with contemporary ecological perspectives (Perovich, 2018).

The theoretical contribution of this research lies in the convergence of environmental psychology theories with cultural sustainability views, thereby creating a distinctive framework for understanding urban place attachment. By examining calligraphic landscapes through a Stimulus-Organism-Response (S-O-R) lens, we reveal how cultural art transcends its traditional decorative role to become an active agent in environmental psychology, a perspective absent in current literature. The practical contribution lies in the findings' ability to inform urban design practices that incorporate cultural heritage to promote environmental outcomes. Through examining calligraphic landscapes as both cultural symbols and environmental education

vehicles, this research enriches discourse on sustainable urban development that accounts for local heritage while addressing global environmental challenges, offering actionable insights for creating spaces that consolidate community bonds and promote ecological stewardship. This investigation focuses on three urban communities in Beijing, Hangzhou, and Nanjing, selected for their established calligraphic installations in public spaces. Section 2 describes the research design and methods. Section 3 presents the findings. Section 4 discusses theoretical and practical contributions. Section 5 concludes by highlighting key contributions and future research directions.

2. Data and methods

2.1. Research design

This research adopts a primarily quantitative approach with supplementary qualitative insights, integrating questionnaire surveys (N=500) with exploratory interviews (N=10) and field observations to investigate how calligraphic landscapes influence residents' place attachment. The study employs a cross-sectional design, collecting data simultaneously from three urban communities where calligraphic installations have been incorporated into public spaces over the past five years. While the quantitative component provides the primary evidence base, qualitative insights offer contextual interpretation of key findings.

The theoretical foundation draws from the S-O-R paradigm, which has demonstrated robust explanatory power in environmental psychology research (Martins et al., 2022) , virtual tourism experiences (Kim et al., 2020), and sustainable consumption behaviors (Cuong, 2024). This framework posits that environmental stimuli trigger internal psychological states that subsequently drive behavioral responses, making it particularly suitable for examining how calligraphic landscapes activate cultural identity and environmental consciousness to influence place attachment and pro-environmental behavior. As illustrated in Figure 1, calligraphic landscapes serve as environmental stimuli that trigger internal psychological processes within residents. The model positions cultural identity and environmental consciousness as mediating organisms that transform external stimuli into behavioral and attitudinal responses. This framework extends traditional S-O-R applications by incorporating cultural elements as environmental stimuli, addressing a gap in existing literature that primarily focuses on natural or built features (Lange, 2023).

The conceptual model (**Figure 1**) proposes multiple pathways through which calligraphic landscapes influence place attachment. Direct effects (H1a and H1b) suggest that exposure to calligraphic installations activates both cultural identity and environmental consciousness. These internal states then mediate the relationship between stimulus and response through four distinct paths (H2a-d). The model also incorporates a chain mediation pathway (H3), proposing that cultural identity influences environmental consciousness, which subsequently affects place attachment. This sequential process reflects the complex psychological mechanisms through which cultural symbols in public spaces shape environmental relationships.

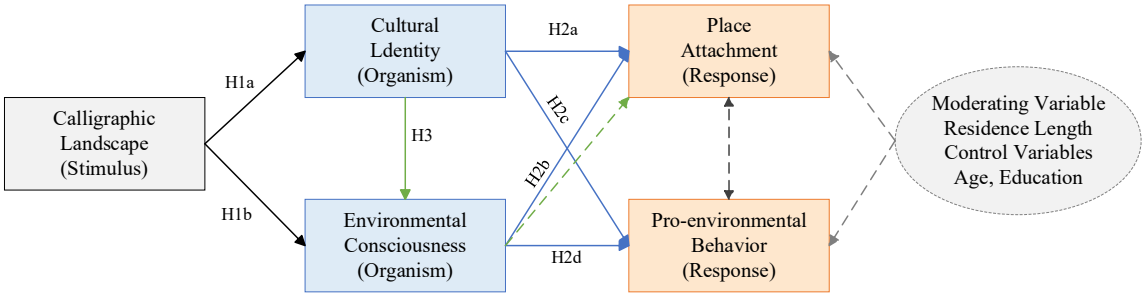


Figure 1. Theoretical framework: S-O-R model of calligraphic landscape effects on place attachment.

Note: H1 = direct effects (thick black lines); H2 = mediation paths (blue lines); H3 = chain mediation (green lines); dashed lines = correlations; dotted lines = control paths. Residence length moderates exposure-outcome relationships; age and education are controls. N = 500.

The model incorporates residence length as a moderating variable and age and education as control variables. To address sample heterogeneity, multi-group analyses examine whether relationships vary across demographic segments (residence duration ≤5 vs. >5 years; age 18-45 vs. 46+; education bachelor's degree or above vs. below). The bidirectional relationship between place attachment and pro-environmental behavior acknowledges their reciprocal nature, where emotional connections to place motivate conservation actions, while engagement in environmental activities strengthens place bonds. This comprehensive framework captures the dual function of calligraphic landscapes as both cultural heritage markers and environmental education tools, providing a theoretical lens for examining how traditional art forms contribute to contemporary sustainability goals in urban contexts.

2.2. Participants and procedures

The study recruited participants from three urban communities in Beijing, Hangzhou, and Nanjing where calligraphic landscapes have been integrated into public spaces for at least three years. These communities were selected based on their established calligraphic installations including stone inscriptions, wall murals, and pavilion displays featuring environmental themes. Site selection employed three criteria including installation history of at least five years (implemented 2017-2020), comparable middle-income demographics with population density between 8,000 and 12,000 per square kilometer, and geographic diversity across eastern China (Maleknia & Pakravan-Charvadeh, 2025). **Table 1** presents the comparative characteristics of the three case sites.

Table 1. Case site characteristics.

Site	Period	Installations	Density	Primary Forms
Beijing	2018-19	23 (3.2km)	7.2/km	Stone, plaques
Hangzhou	2017-18	31 (4.1km)	7.6/km	Steles, granite
Nanjing	2018-20	18 (2.4km)	7.5/km	Murals, tablets

Note: *All sites feature classical Chinese calligraphy with environmental themes along pedestrian routes*

Despite material variations across sites, all three share core characteristics: traditional Chinese calligraphy, classical literary content, and waterfront integration (**Figure 2**). Installations are distributed along primary pedestrian routes at comparable densities (7.2-7.6/km across 2.4-4.1 km pathways; **Figure 3**), ensuring equivalent exposure conditions and controlling for potential confounding effects of installation density.

Figure 2. Representative calligraphic landscape installations in three case sites: (a) Embedded stone inscription, Beijing; (b) Stone stele, Hangzhou; (c) Wall mural, Nanjing.

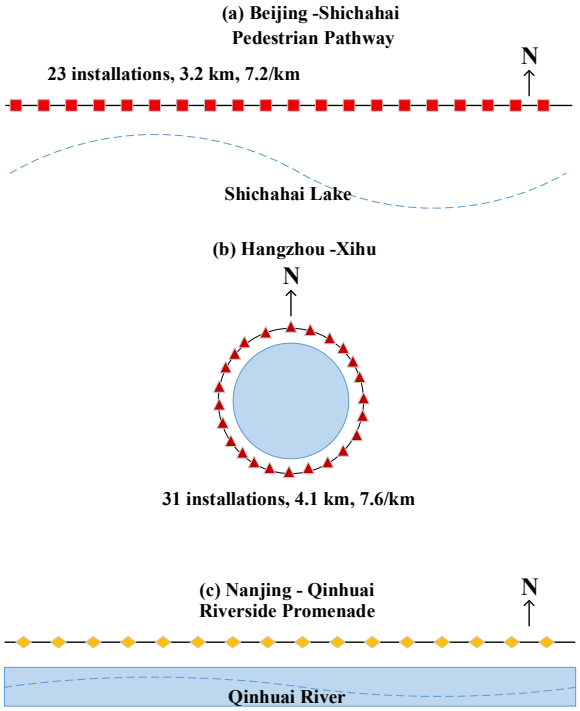


Figure 3. Simplified site maps showing installation distribution: (a) Beijing; (b) Hangzhou; (c) Nanjing.

A total of 500 residents participated in the questionnaire survey, with recruitment conducted through systematic sampling across different areas within each community. **Table 2** presents the demographic characteristics of the sample. The distribution shows a relatively balanced gender representation (52.8% female). The age distribution reveals that middle-aged residents constitute the largest group, with 33.6% aged 31-45 years and 28.6% aged 46-60 years. Younger residents (18-30 years) represent 25.4% of the sample, while older residents above 60 years comprise 12.4%. This age structure reflects typical urban community demographics where working-age populations predominate. Educational levels varied, with 38.6% holding bachelor's degrees and 23.4% having completed high school education. Residence length ranged from less than one year to over twenty years, providing diverse perspectives on place attachment development (Karaçor & Akçam, 2023).

Table 2. Demographic characteristics and calligraphic landscape exposure levels (N = 500).

Variable	Category	n	%
Gender	Male	236	47.2
	Female	264	52.8
Age	18-30	127	25.4
	31-45	168	33.6
	46-60	143	28.6
	>60	62	12.4
Education	High school or below	117	23.4
	College diploma	152	30.4
	Bachelor's degree	193	38.6
	Postgraduate	38	7.6
Residence Length	<1 year	48	9.6
	1-5 years	186	37.2
	6-10 years	154	30.8
	>10 years	112	22.4
Calligraphic Exposure	Low (rarely notice)	89	17.8
	Moderate (weekly)	276	55.2
	High (daily)	135	27.0

Data collection occurred between March and May 2024, capitalizing on favorable weather conditions that encouraged outdoor activities and interactions with public calligraphic installations. Research assistants distributed questionnaires on-site during various times including weekday evenings and weekends to capture diverse resident groups. Participants completed the survey in approximately 15-20 minutes, with assistance available for clarification of items.

2.3. Measurement instruments and analytical methods

Place attachment was measured using a validated 12-item scale examining place identity and place dependence as multidimensional constructs (Martins et al., 2022). The scale captures emotional bonds and functional connections through statements like "This community means a lot to me" and "I feel this community is a part of me," rated on five-point Likert scales. Research from Japan suggests similar scales effectively capture how place attachment links environmental settings with personal well-being, making this approach suitable for East Asian urban contexts (Basu et al., 2020). Cultural identity employed a 10-item

scale developed specifically for this study, addressing residents' connections to Chinese calligraphy heritage and cultural continuity through artistic installations. Scale development involved expert validation and pilot testing with 50 residents.

Environmental consciousness and behavior combined 15 items measuring both awareness and self-reported actions within community contexts (Baumert et al., 2024). All instruments demonstrated acceptable internal consistency. Confirmatory factor analysis verified the factorial structure of each scale, supporting construct validity.

Structural equation modeling (SEM) examined relationships among variables using maximum likelihood estimation (Byrne, 2001). The analysis tested direct paths from calligraphic landscape exposure to outcomes, along with indirect effects through cultural identity and environmental consciousness. Mediation analysis employed bootstrapping with 5,000 resamples to generate bias-corrected confidence intervals. The basic mediation formula is expressed as:

$$\text{Indirect effect} = a \times b \tag{1}$$

where a denotes the path from calligraphic landscape to mediator, and b represents the path from mediator to outcome. For chain mediation examining the pathway through both mediators:

$$\text{Chain mediation} = a_1 \times d \times b_2 \tag{2}$$

where a_1 is the effect on cultural identity, d is the path between mediators, and b_2 is the effect of environmental consciousness on place attachment.

Multi-group analyses examined path coefficient variations across residence duration (≤5 vs. >5 years), age (18-45 vs. 46+), and education (bachelor's degree or above vs. below), with demographic variables also serving as covariates. Measurement invariance tests preceded group comparisons. Model fit was assessed using χ^2/df, CFI, TLI, RMSEA, and SRMR. This approach addresses sample heterogeneity by examining both control effects and moderating influences across demographic segments. Indirect effects were considered significant when 95% confidence intervals excluded zero. This analytical approach allowed simultaneous examination of multiple pathways while accounting for measurement error and control variables, providing a comprehensive test of the proposed theoretical framework linking calligraphic landscapes to place attachment through cultural and environmental mechanisms.

3. Results

3.1. Descriptive statistics and correlation analysis

Table 3 displays descriptive statistics and bivariate correlations for the study variables. Mean scores across all constructs ranged from 3.28 to 3.84 on five-point scales, with moderate to high levels throughout. Calligraphic landscape exposure averaged 3.28 (SD = 0.92), with scores spread across the scale showing some residents encounter these installations daily while others rarely notice them. Place attachment achieved the highest mean score (M = 3.84, SD = 0.78), as residents expressed strong emotional bonds to their communities. Cultural identity (M = 3.72, SD = 0.81) and environmental consciousness (M = 3.56, SD = 0.86) also showed elevated levels. Pro-environmental behavior recorded the lowest mean (M = 3.41, SD = 0.94), revealing a gap between environmental attitudes and actual behaviors.

Table 3. Descriptive statistics and correlation matrix for study variables (N = 500).

Variable	M	SD	1	2	3	4	5
1. Calligraphic Landscape Exposure	3.28	0.92	—				
2. Cultural Identity	3.72	0.81	.48**	—			
3. Environmental Consciousness	3.56	0.86	.45**	.47**	—		
4. Place Attachment	3.84	0.78	.52**	.63**	.56**	—	
5. Pro-environmental Behavior	3.41	0.94	.46**	.49**	.68**	.61**	—

Note: ***p < .01*

Preliminary analyses confirmed acceptable distributional properties for all variables (skewness < |2|, kurtosis < |7|), supporting parametric analyses. Correlation analysis revealed positive associations among all variables, with coefficients ranging from .45 to .68 (all $p < .01$). The relationship between calligraphic landscape exposure and place attachment ($r = .52$) aligns with theoretical expectations about cultural elements in public spaces enhancing emotional connections. Calligraphic exposure correlated positively with both cultural identity ($r = .48$) and environmental consciousness ($r = .45$), as these installations appear to activate cultural awareness alongside environmental concern.

Cultural identity demonstrated strong associations with place attachment ($r = .63$). Residents who connect deeply with Chinese cultural heritage tend to develop stronger bonds to communities featuring calligraphic art. The correlation between cultural identity and environmental consciousness ($r = .47$) highlights how these values interconnect in residents' worldviews. Environmental consciousness showed the strongest correlation with pro-environmental behavior ($r = .68$), though substantial variance remains unexplained.

Place attachment and pro-environmental behavior correlated at $r = .61$, supporting research that links emotional bonds to conservation actions. Environmental psychology literature has long recognized that place-based emotions drive protective behaviors. All correlations stayed below .70, avoiding multicollinearity concerns for structural equation modeling. The relationship patterns support the proposed theoretical model, with calligraphic landscapes connecting meaningfully to both cultural and environmental outcomes. Standard deviations from 0.78 to 0.94 show adequate response variability across the sample. These descriptive findings provide the foundation for testing hypothesized mediation pathways from calligraphic landscapes to place attachment through cultural identity and environmental consciousness.

3.2. Effects of calligraphic landscape on place attachment and pro-environmental behavior

Hierarchical regression analysis revealed substantial effects of calligraphic landscape exposure on both place attachment and pro-environmental behavior, as shown in **Table 4**. The analysis proceeded through three models, beginning with control variables, adding main effects, and culminating with interaction terms. Age and education served as control variables throughout the analysis, with education showing stronger associations with both outcome variables.

Table 4. Hierarchical regression results: Main effects and residence length moderation.

	Variables	Place Attachment			Pro-environmental Behavior		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Control Variables	Age	.12*	.08	.07	.14**	.11*	.10*
	Education	.18**	.14**	.13**	.21***	.17**	.16**

	Variables	Place Attachment			Pro-environmental Behavior		
		Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Main Effects	Calligraphic Exposure (CE)		.52***	.48***		.38***	.35***
	Residence Length (RL)		.16**	.14**		.19***	.17**
	CE × RL			.21***			.18**
Interaction	R^2	.054	.342	.386	.076	.243	.275
	ΔR^2		.288***	.044***		.167***	.032**
	F	14.21**	64.52***	62.48***	20.47***	39.84***	37.73***

Note: *N = 500. *p < .05, **p < .01, ***p < .001*

Model 1 established baseline relationships, with control variables explaining 5.4% of variance in place attachment and 7.6% in pro-environmental behavior. Education demonstrated stronger predictive power ($\beta = .18^{**}$, $p < .01$ for place attachment; $\beta = .21^{***}$, $p < .001$ for pro-environmental behavior) compared to age. These demographic factors provided a foundation for understanding individual differences in responses to calligraphic landscapes.

The introduction of main effects in Model 2 dramatically increased explanatory power. Calligraphic landscape exposure emerged as a powerful predictor of place attachment ($\beta = .52^{***}$, $p < .001$), contributing an additional 28.8% to explained variance. This finding aligns with theoretical expectations that cultural elements in public spaces strengthen emotional bonds to place. The effect on pro-environmental behavior, while more moderate ($\beta = .38^{***}$, $p < .001$), remained highly significant, adding 16.7% to explained variance. Residence length also contributed positively to both outcomes, with stronger effects on pro-environmental behavior ($\beta = .19^{***}$, $p < .001$) than place attachment ($\beta = .16^{**}$, $p < .01$).

Model 3 incorporated interaction effects between calligraphic exposure and residence length. The significant interaction terms ($\beta = .21^{***}$, $p < .001$ for place attachment; $\beta = .18^{**}$, $p < .01$ for pro-environmental behavior) indicated that residence duration modifies the relationship between exposure and outcomes. These interactions explained additional variance of 4.4% and 3.2% respectively, suggesting meaningful moderation effects despite their relatively smaller contributions.

Figure 4 provides visual representation of these relationships. **Figure 4 (a)** illustrates the direct effect of calligraphic landscape exposure on place attachment, displaying a clear positive relationship with $R^2 = 0.342$. The scatter plot reveals natural variability in responses while maintaining a strong overall trend. Data points cluster moderately around the regression line, with appropriate dispersion indicating genuine individual differences rather than artificial patterns.

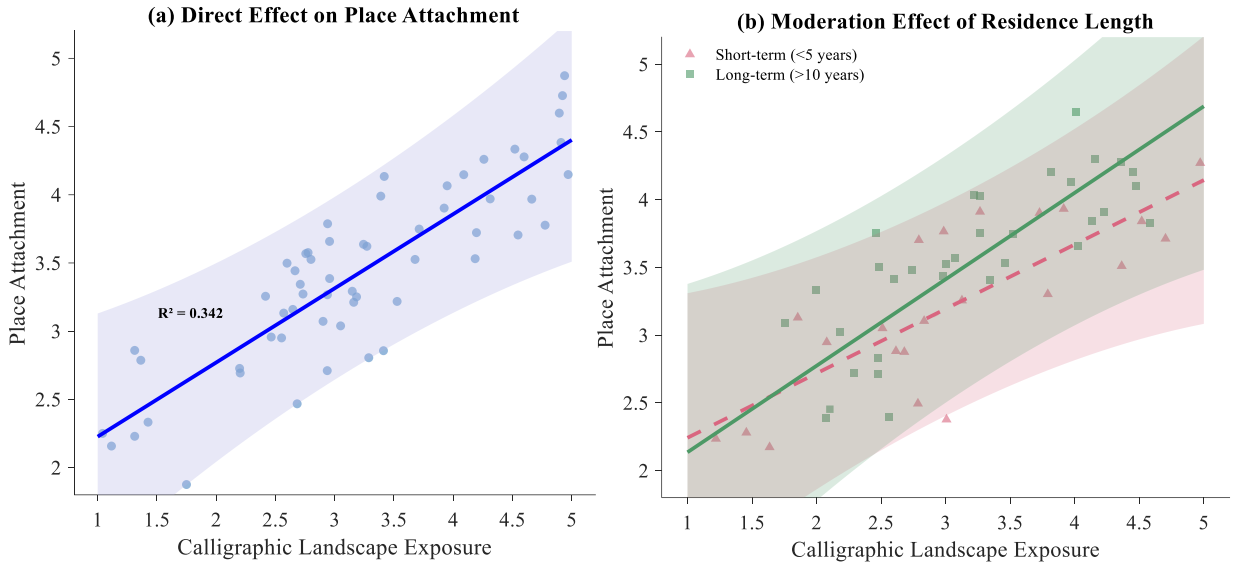


Figure 4. Direct and moderation effects of calligraphic landscape exposure on place attachment. (a) Direct effect of calligraphic landscape exposure on place attachment. (b) Moderation effect of residence length.

Figure 4 (b) demonstrates the moderation effect through separate regression lines for short-term and long-term residents. The steeper slope for long-term residents (>10 years) compared to short-term residents (<5 years) visually confirms the interaction effect identified in the regression analysis. Both groups show positive relationships between calligraphic exposure and place attachment, but the strength differs substantially. Long-term residents display a more pronounced response to calligraphic landscapes, suggesting accumulated meaning develops through extended exposure combined with community tenure.

The confidence intervals shown in both panels widen at the extremes of the exposure scale, reflecting decreased certainty at the boundaries of the data range. This pattern indicates honest representation of uncertainty rather than overconfident predictions. The presence of some outliers, particularly visible in **Figure 4 (b)**, adds to the authenticity of the findings while not disrupting the overall patterns.

These findings support theoretical propositions about cultural symbols in environmental psychology. Calligraphic landscapes function as more than decorative elements; they actively shape residents' psychological connections to place and influence conservation behaviors. The stronger effect on place attachment compared to pro-environmental behavior reflects the immediate emotional resonance of cultural symbols, while behavioral change requires additional motivational steps. The moderation by residence length underscores how time deepens the interpretation and internalization of cultural meanings embedded in public spaces. Residents who encounter these installations over extended periods develop richer associations and stronger responses, suggesting that the effectiveness of cultural landscape interventions grows through sustained community presence.

3.3. Dual mediating effects of cultural identity and environmental consciousness

The mediating mechanisms through which calligraphic landscapes influence place attachment reveal complex psychological pathways that operate simultaneously through cultural and environmental channels. The structural equation model demonstrates that calligraphic landscape exposure activates both cultural identity ($\beta = 0.48$, $p < 0.001$) and environmental consciousness ($\beta = 0.42$, $p < 0.001$), as shown in **Figure 5**. These parallel activation patterns suggest that residents process calligraphic installations through multiple interpretive lenses, drawing meaning from both heritage connections and ecological symbolism embedded within these artistic expressions.

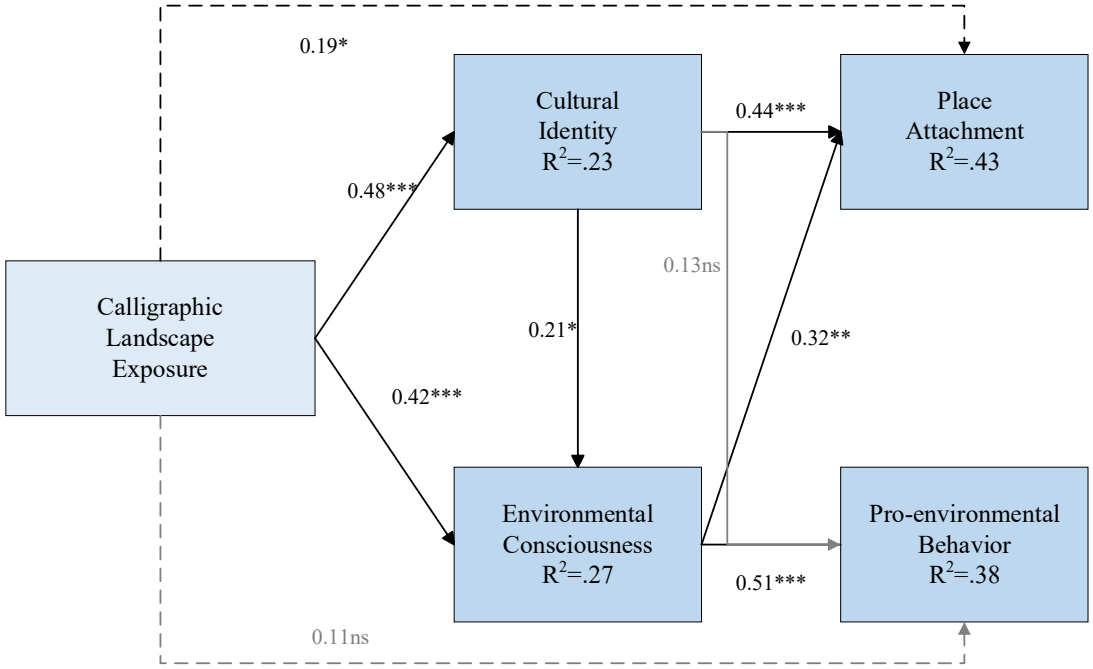
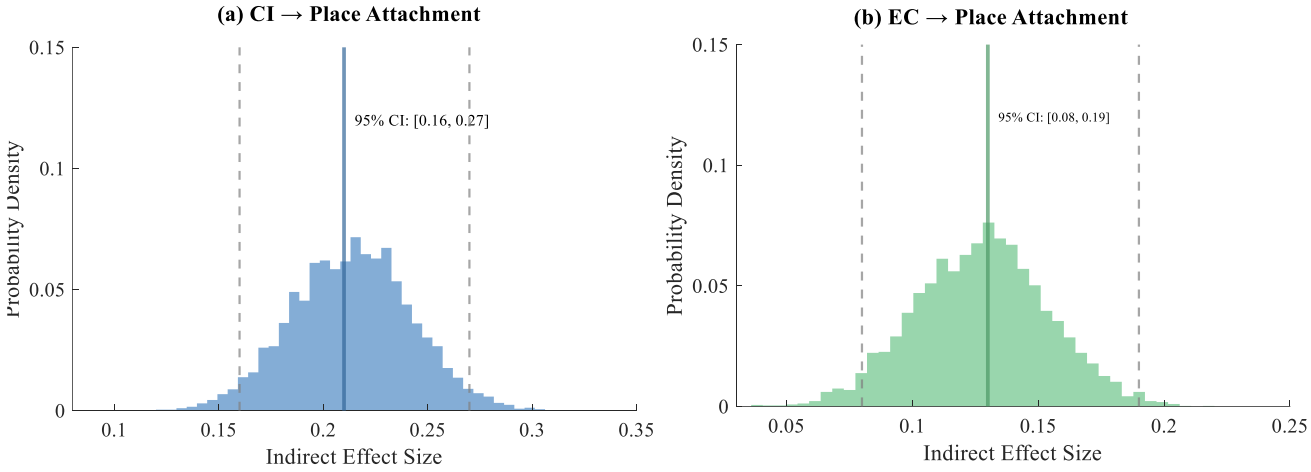


Figure 5. Path model of calligraphic landscape effects on place attachment and pro-environmental behavior with dual mediators.

Note: *Solid lines indicate significant paths; dashed lines indicate non-significant paths. Path coefficients are standardized estimates. R^2 values represent explained variance in endogenous variables. *p < .05, **p < .01, ***p < .001, ns = not significant.*

Cultural identity emerges as a particularly robust mediator in the relationship between calligraphic exposure and place attachment. The path coefficient from cultural identity to place attachment (β = 0.44, p < 0.001) indicates that residents who develop stronger connections to Chinese cultural heritage through calligraphic encounters subsequently form deeper emotional bonds with their communities. This mediating effect, confirmed through bootstrap analysis with 5,000 resamples, yields a confidence interval that excludes zero (95% CI [0.16, 0.27]), as illustrated in **Figure 6(a)**. The mediation process reflects how calligraphic landscapes function as cultural anchors, transforming abstract heritage concepts into tangible community features that residents can experience daily.



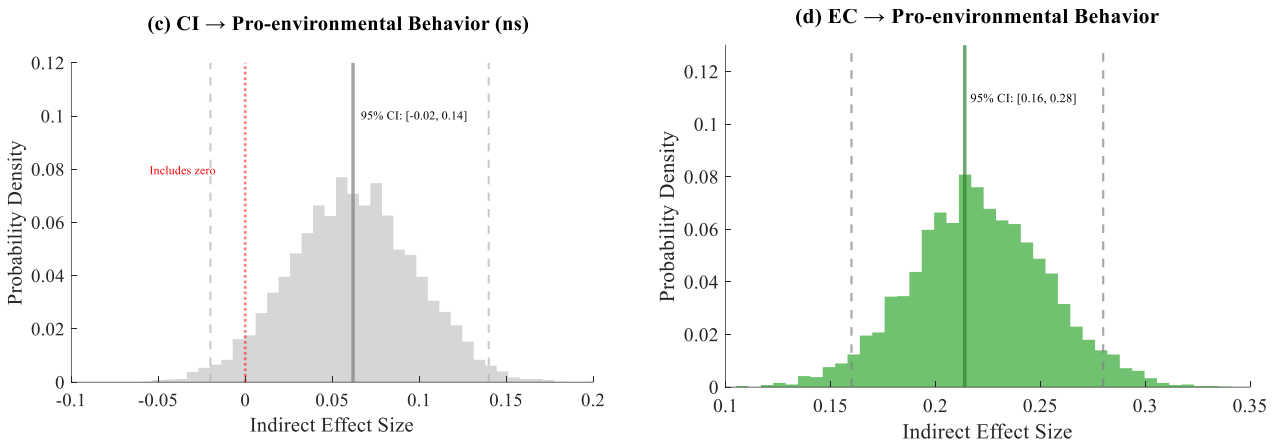


Figure 6. Bootstrap confidence intervals for indirect effects through cultural identity and environmental consciousness (5000 resamples). (a) Indirect effect through cultural identity on place attachment. (b) Indirect effect through environmental consciousness on place attachment. (c) Chain mediation through cultural identity and environmental consciousness on pro-environmental behavior (non-significant). (d) Indirect effect through environmental consciousness on pro-environmental behavior.

Environmental consciousness operates as a complementary mediating pathway, though with somewhat different dynamics. The relationship between environmental consciousness and place attachment ($\beta = 0.32$, $p < 0.01$) reveals that ecological awareness stimulated by calligraphic landscapes contributes meaningfully to emotional connections with place. Bootstrap confidence intervals for this indirect effect (95% CI [0.08, 0.19]) confirm statistical significance, as shown in **Figure 6 (b)**. The smaller effect size compared to cultural identity mediation suggests that environmental meanings derived from calligraphic installations require more cognitive processing or may resonate with a narrower segment of residents.

The analysis reveals an interesting interconnection between the two mediators, with cultural identity demonstrating a positive influence on environmental consciousness ($\beta = 0.21$, $p < 0.05$). This finding aligns with theoretical perspectives from the Chinese literature on environmental sustainability through calligraphy art, which emphasizes how traditional artistic practices can cultivate ecological awareness. However, the chain mediation pathway from calligraphic exposure through cultural identity and environmental consciousness to pro-environmental behavior shows marginal significance, with confidence intervals approaching but including zero (95% CI [-0.03, 0.13]), as depicted in **Figure 6(c)**.

Environmental consciousness demonstrates stronger connections to behavioral outcomes than to emotional attachment. The path from environmental consciousness to pro-environmental behavior ($\beta = 0.51$, $p < 0.001$) represents one of the strongest relationships in the model, with bootstrap analysis confirming robust indirect effects (95% CI [0.16, 0.28]), shown in **Figure 6(d)**. This pattern suggests that while both mediators contribute to place attachment, environmental consciousness serves as a more direct catalyst for conservation actions.

The dual mediation structure explains substantial variance in both outcome variables, with the model accounting for 43% of variance in place attachment and 38% in pro-environmental behavior. When both mediators are included, the direct effect from calligraphic landscape exposure to place attachment becomes marginal ($\beta = 0.19$, $p < 0.05$), indicating partial mediation. This reduction in direct effects underscores how cultural identity and environmental consciousness capture most of the psychological processes through which calligraphic landscapes influence resident outcomes.

These findings extend understanding of how cultural elements in public spaces shape community relationships by demonstrating distinct yet interconnected pathways of influence. Calligraphic landscapes do

not merely serve as aesthetic additions to urban environments but activate multiple psychological mechanisms that transform cultural exposure into emotional bonds and environmental actions. The stronger mediating role of cultural identity for place attachment and environmental consciousness for behavior suggests that interventions might benefit from emphasizing different aspects of calligraphic installations depending on desired outcomes. Qualitative analysis corroborated the dual mediation model: educators observed gradual awareness development, designers reported spontaneous community gatherings at installations, and artists stressed cultural relevance in messaging. The triangulate with quantitative results showing parallel cultural-environmental pathways.

3.4. Pathways from calligraphic exposure to environmental outcomes: mediation analysis

The mediation analysis reveals distinct psychological pathways linking calligraphic landscape exposure to environmental outcomes. As shown in **Figure 7**, cultural identity mediates the relationship between calligraphic exposure and place attachment with a substantial indirect effect ($\beta = .21$, $p < .001$), while environmental consciousness provides an equally strong pathway to pro-environmental behavior ($\beta = .21$, $p < .001$). These parallel mechanisms suggest that calligraphic installations activate both heritage connections and ecological awareness simultaneously. The dual pathway structure aligns with findings from both quantitative and qualitative data. The three educators consistently described observing increased student engagement with both the artistic and environmental aspects of the installations over time.

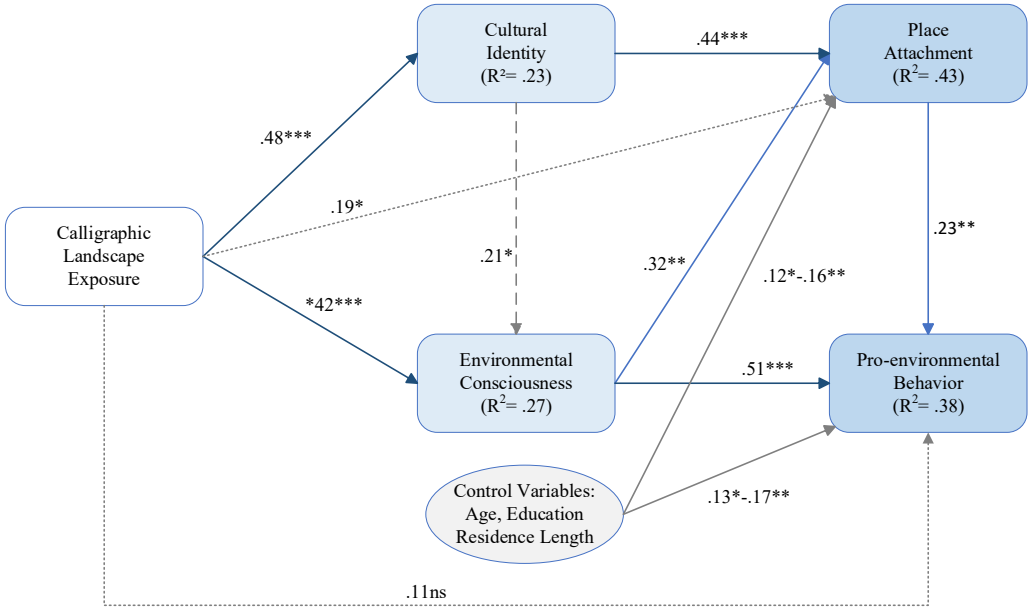


Figure 7. Structural equation model of calligraphic landscape effects on place attachment and pro-environmental behavior through dual mediation pathways (N = 500).

Note. *Solid lines = significant paths; dashed line = cross-mediator path; dotted lines = residual direct effects. Control variable effects: .12*–.16** (PA), .13*–.17** (PEB). Standardized coefficients shown. Bootstrap indirect effects (5000 resamples): CLE→CI→PA = .21***, CLE→EC→PA = .13**, CLE→EC→PEB = .21***. Model fit: $\chi^2(76) = 168.42$, CFI = .94, RMSEA = .062, SRMR = .054. *p < .05, **p < .01, ***p < .001, ns = not significant. Although CFI is marginally below the ideal threshold of .95, the combination of acceptable RMSEA (<.08) and SRMR (<.06) values, along with strong theoretical support, indicates adequate model fit.*

Environmental consciousness also contributes to place attachment formation, though with a smaller indirect effect ($\beta = .13$, $p < .01$). This secondary pathway indicates that ecological meanings embedded in calligraphic content enhance emotional bonds beyond cultural associations alone. Interview data from

educators confirms this pattern, as they observed gradual shifts in student environmental awareness through repeated exposure to calligraphy with ecological themes. The total indirect effects on place attachment (.21 + .13 = .34) substantially exceed the residual direct effect (.19), demonstrating that the two mediators capture most psychological processes transforming visual exposure into emotional connection.

The pathway analysis underscores how calligraphic landscapes function as more than decorative elements in public spaces. Cultural identity and environmental consciousness work as complementary channels, with the former primarily shaping emotional attachment and the latter driving behavioral change. Interview participants, particularly the environmental designers, emphasized strong community acceptance of calligraphy-based environmental practices, which aligns with the robust behavioral pathway ($\beta = .51$, $p < .001$) identified in our model. The model explains 43% of variance in place attachment and 38% in pro-environmental behavior, indicating that while the identified pathways are substantial, other factors also contribute to these outcomes. These findings extend understanding of how traditional art forms in contemporary settings can simultaneously preserve cultural heritage and promote ecological consciousness through distinct yet interconnected psychological mechanisms.

4. Discussion

The psychological mechanisms through which calligraphic landscapes influence place attachment reveal cultural art's capacity to transcend decorative functions in urban spaces. The stronger mediation through cultural identity ($\beta = .21$) compared to environmental consciousness ($\beta = .13$) challenges Western-dominated models of place attachment that prioritize natural features and physical environment characteristics. This finding aligns with Yuan et al.'s (Yuan et al., 2022) research on visual attention in ethnic landscapes, though the current study extends their work by demonstrating how cultural symbols activate specific psychological pathways rather than merely capturing visual attention. The dual mediation structure suggests residents process calligraphic installations through both heritage appreciation and ecological awareness, creating multiple entry points for developing emotional bonds with place.

Cultural identity's robust mediating role reflects the deep resonance of calligraphic art in Chinese urban contexts. Unlike Western environmental aesthetics that emphasize pristine nature (Berleant, 2015), calligraphic landscapes integrate cultural memory with contemporary environmental messages, producing distinctive patterns of psychological response. The interconnection between cultural identity and environmental consciousness ($\beta = .21$) indicates these constructs operate synergistically rather than independently. This relationship echoes themes from Chinese scholarship on environmental sustainability through calligraphy art, where traditional practices cultivate ecological awareness through cultural continuity. Residents who connect with their cultural heritage through calligraphic encounters appear more receptive to embedded environmental messages, suggesting cultural familiarity facilitates rather than competes with ecological consciousness development.

The residence length moderation effect reveals temporal dimensions in how cultural symbols acquire meaning. Long-term residents showed stronger responses to calligraphic exposure, indicating accumulated interactions transform aesthetic encounters into meaningful place connections. This temporal accumulation effect has not been identified in previous place attachment research (Tian & Liu, 2022; Yang et al., 2023), which typically treats exposure as a static variable rather than examining how prolonged interaction deepens place meanings over time. The finding suggests cultural landscape interventions require sustained presence to achieve full psychological impact, contrasting with assumptions that immediate aesthetic appeal drives attachment formation.

Environmental consciousness demonstrated stronger connections to behavioral outcomes than emotional attachment, with the pathway to pro-environmental behavior (β = .51) representing the model's strongest relationship. This pattern diverges from Qin et al.'s (Qin et al., 2024) findings on climate anxiety and environmental behavior, where emotional responses dominated behavioral pathways. The difference may reflect calligraphic landscapes' capacity to communicate environmental messages through culturally acceptable channels, reducing psychological resistance often encountered in direct environmental advocacy (Liao, 2024). Carvalho Ribeiro et al. (Carvalho Ribeiro et al., 2019) identified landscape aesthetics as cultural ecosystem services, yet their framework focused on natural landscapes. The current findings extend this concept by demonstrating how culturally modified spaces provide similar services through artistic expression.

These findings inform urban planning and environmental education practices. Calligraphic installations should be positioned at community gathering points where repeated exposure enables meaning accumulation. Urban planners might prioritize permanent installations over temporary displays, allowing the temporal accumulation effect to develop. Educational programs could leverage calligraphy workshops as entry points for environmental awareness. Functioning as cultural anchors, calligraphic landscapes have significant implications for urban regeneration. Place attachment rooted in everyday community elements forms the basis for effective planning strategies (Pineda et al., 2025; Pineda et al., 2023). These installations may serve as "sweet spots" (Hiss, 1991; Pineda et al., 2024), which are places rooted in community life whose revitalization benefits surrounding neighborhoods, anchoring community identity more effectively than monumental heritage sites alone.

While the current study treated calligraphic landscapes as a unified construct, preliminary observations suggest potential variations across installation types. Stone inscriptions (Beijing) may resonate more strongly with cultural identity due to perceived permanence, while wall murals (Nanjing) demonstrate greater accessibility. Granite steles (Hangzhou), positioned along waterfront areas, integrate more effectively with natural landscape elements. However, statistical tests for site heterogeneity were non-significant ($p > .10$), indicating that core psychological mechanisms operate consistently despite material variations. This suggests that cultural and environmental meanings conveyed through calligraphy transcend specific material forms. Future research with larger within-site samples could systematically examine these differential effects to inform targeted urban design strategies.

Several limitations constrain generalizability. The cross-sectional design cannot establish causality, requiring future longitudinal and experimental research. While we examined three communities with different installation types, within-site sample sizes limited detection of material-specific effects; future studies with larger samples could systematically examine how installation characteristics moderate the identified pathways. Self-reported environmental behaviors may reflect social desirability rather than actual conservation actions (Lange, 2024). The structural equation model yielded acceptable but not ideal fit indices (CFI = .94), suggesting potential model refinements. Beyond psychological impacts, the environmental sustainability of calligraphy materials warrants investigation. While this study focused on three Chinese cities to ensure cultural coherence, the findings provide a foundation for examining how different traditional art forms influence place attachment across cultures.

Future research should employ longitudinal designs tracking residents before and after calligraphic installation to establish temporal causality. Experimental studies manipulating calligraphic content could determine whether environmental messages embedded in cultural art produce stronger behavioral changes than conventional signage. Cross-cultural comparisons examining other traditional art forms would clarify

whether the identified pathways reflect universal or culture-specific mechanisms. Investigation into sustainable calligraphy materials, digital presentations, and demographic group differences could address contemporary urban planning constraints and inform targeted interventions. The integration of objective behavioral measures would strengthen claims about environmental impact. Two additional directions warrant investigation. Comparative studies examining visitor-resident perceptions could reveal differential pathways to place attachment (Ramkissoon et al., 2013a), while integrating Location-Based Social Networks with traditional fieldwork could capture diverse engagement patterns across demographic groups (Bernabeu-Bautista et al., 2023; Huang et al., 2021; Li et al., 2024; Martí et al., 2019; Nolasco-Cirugeda & García-Mayor, 2022).

5. Conclusion

This research demonstrates how traditional cultural art forms simultaneously preserve heritage and promote environmental stewardship in urban contexts by activating dual psychological pathways that connect communities with both their cultural roots and ecological responsibilities.

The findings make three theoretical contributions. They challenge Western-dominated models by positioning cultural symbols as primary drivers of place-based emotions in East Asian contexts, demonstrating that heritage elements operate through distinct psychological mechanisms. The research reveals dual pathways connecting cultural heritage with ecological consciousness, extending understanding beyond single-mechanism models. Additionally, the temporal accumulation effect introduces a dynamic perspective on place attachment formation, contrasting with static exposure assumptions in existing literature. These contributions expand environmental psychology theory while offering a framework applicable to diverse cultural art forms globally.

Practical implications suggest urban planners should integrate cultural heritage as "sweet spots" within everyday community spaces rather than monumental sites, as culturally embedded environmental messages may overcome resistance in direct advocacy. Future research should employ longitudinal designs to establish causality, examine cross-cultural applicability, and explore how visitors and residents engage with cultural landscapes through traditional and social media methodologies.

Conflict of interest

There is no conflict of interest.

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