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Sensory Overload and Sustainable Heritage Tourism: A Neurophenomenological Model of Urban Eco-Preservation

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Abstract

Historic urban centers face a structural paradox: the very sensory richness that draws heritage tourists is also what depletes the attentional resources tourists need to behave in environmentally and culturally respectful ways. Sustainable tourism scholarship continues to show that measured rates of environmentally sustainable tourist behavior depend heavily on whether real behavior, rather than self-reported intention, is what gets measured. Much of this literature has nonetheless treated the tourist's cognitive and perceptual state largely as a black box. This paper addresses that gap by proposing a Sensory–Mindfulness–Stewardship (SMS) model, which draws on recent embodied-cognition research on heritage sites to theorize how the auditory, visual, and spatial atmosphere of a heritage site shapes a tourist's momentary 'mindful state', and how that state, in turn, predicts spontaneous eco-preservation behavior such as litter disposal and boundary-respecting movement. The model further introduces the construct of 'restorative cognitive pathways,' extending recent work applying attention restoration and stress recovery theory to tourism settings to the design of high-stimulus tourist zones. Six theoretical propositions are advanced, followed by a discussion of contributions to environmental psychology and heritage tourism theory, implications for urban heritage design, and an agenda for empirical testing.

1. Introduction

Historic urban centers occupy a peculiar position in the sustainability literature. They are simultaneously fragile ecological-cultural assets and high-density stimulus environments engineered, often inadvertently, to overwhelm the visitor. Cobbled lanes, layered soundscapes, market crowds, and centuries of ornamentation compress an unusual density of sensory information into a small footprint; recent soundscape research on historic districts shows that acoustic design choices directly shape how authentic and coherent a heritage precinct feels to visitors, and that unmanaged acoustic density can undermine rather than reinforce the qualities that make a district feel historic (A. H. Alsharif, 2025; Hu et al., 2024). Tourism scholars have long treated this density as an asset — the 'authenticity' that heritage tourism sells — while conservation researchers have treated the behavioral fallout of that density (littering, disregard for cordoned areas, erosion of protected surfaces) mainly as a problem of insufficient rules or low environmental awareness.

This paper argues that both framings miss a more fundamental mechanism: the sensory atmosphere of a heritage site directly modulates the cognitive and attentional state of the tourist, and that state — not attitude, not awareness, not moral commitment — is the proximate driver of moment-to-moment conservation behavior. Self-control draws on a resource that is depleted by exertion, and recent work confirms that depleted self-regulatory capacity continues to predict reduced prosocial behavior even once mediating and moderating factors such as social self-efficacy are accounted for (Isa & Alsharif, 2026; Li et al., 2022); when tourists are cognitively overloaded, this resource is depleted, and effortful, prosocial behaviors such as carrying litter to a bin or moderating conduct around fragile heritage fabric become less likely, regardless of how much the tourist consciously values the site. Consistent with this logic, empirical work on tourist crowding has found that perceived spatial and human density does not

reduce pro-environmental behavior directly, but does so indirectly — through a state of reduced self-awareness the literature terms deindividuation — while simultaneously and directly provoking deviant, norm-violating conduct (A. H. Alsharif & Isa, 2025; Jo et al., 2024).

To formalize this claim, the paper integrates recent embodied-cognition research on heritage conservation behavior (Cai et al., 2025) with sustainable tourism literature emphasizing real, observed behavior over self-report (Juvan et al., 2025) and with environmental-psychology-informed tourism research on restoration and stress recovery (Zhang et al., 2026). The result is a conceptual model, termed the Sensory–Mindfulness–Stewardship (SMS) model, in which sensory atmosphere shapes mindful state, mindful state shapes eco-preservation behavior, and purpose-built 'restorative cognitive pathways' act as a design-level moderator that can be engineered into high-stimulus tourist zones. The paper closes by deriving testable propositions and outlining an empirical and design research agenda, directly addressing the call for papers' interest in cultural heritage, tourism, and cognitive decision-making.

2. Theoretical Foundations

2.1 Embodied Cognition: Bridging Subjective Experience and Conservation Behavior

A growing body of recent work reframes heritage-tourism experience through embodied cognition, the view that perception, bodily engagement, and cognitive processing are inseparable rather than sequential stages. In a 2025 field study of visitors to the historic buildings of Quanzhou, a World Heritage site, Cai et al., (2025) show that three dimensions of embodied cognition — multisensory perception, physical engagement, and cognitive processing — each positively predict place attachment and, through it, tourists' intentions toward destination-supportive, conservation-oriented behavior; the effect was further shaped by the surrounding social climate of resident identity. Applied to the present model, this reframes the 'visitor experience' from a marketing abstraction into a tractable object of study: the tourist's moment-to-moment experience of a plaza, a nave, or a market street has a describable multisensory and bodily structure that is coupled to measurable environmental input and to downstream conservation-relevant behavior. This is the theoretical backbone of the model proposed here: sensory environments shape embodied experience, and that experience recursively shapes how subsequent sensory input is processed and acted upon.

2.2 Sustainable and Heritage Tourism: The Behavioral Gap

Sustainable tourism scholarship continues to document a persistent gap between tourists' stated environmental values and their actual on-site behavior. Juvan et al., (2025) argue that practical measures to encourage environmentally sustainable tourist behavior are typically tested using survey experiments and self-reported intentions, and demonstrate — drawing on a program of field studies — that conclusions about what actually changes behavior are only trustworthy when real, observed behavior is

measured directly, since self-reported measures are vulnerable to social-desirability bias and often fail to predict what tourists actually do on site. Read together with recent work on tourist decision-making more broadly, which shows that tourists vary substantially in how much deliberate, effortful processing they bring to a given choice and that unhurried conditions promote more deliberate processing (A. H. Alsharif et al., 2025; Lindberg & Stemmer, 2022), these findings suggest that heritage tourism research has a well-developed account of what tourists believe and intend, and a much thinner account of what tourists are cognitively capable of enacting in a given sensory moment — precisely the gap this paper's model is designed to close.

2.3 Mindfulness, Cognitive Load, and Attention Restoration

Tourism research already possesses a construct closely related to the mediator proposed here. In a 2023 field study at the Forbidden City, Eck et al., (2023) show that perceived authenticity significantly shapes heritage tourists' mindfulness — an active, engaged state of processing one's surroundings — and that this mindful state, in turn, shapes the quality of the tourist experience and downstream satisfaction and loyalty. Complementing this tourism-specific account, recent environmental psychology applied directly to tourism settings shows that environmental density affects tourists' behavioral intentions indirectly, through a sequential pathway of perceived safety and emotional experience, and that perceived restorativeness significantly buffers the negative effect of density on perceived safety — extending both attention restoration and stress recovery accounts to real tourism contexts, including night-time and high-density urban settings (Zhang et al., 2026). Because directed-attention and self-regulatory resources appear to draw on a common, depletable capacity, with depletion measurably reducing prosocial behavior (A. Alsharif et al., 2024; Li et al., 2022), a tourist whose attention has been fatigued by an incoherent sensory environment is left with less spare capacity for the effortful, non-automatic behaviors that heritage stewardship requires. Together, these strands justify treating the tourist's momentary cognitive-attentional state, rather than attitude alone, as the proximate variable of interest.

3. The Sensory–Mindfulness–Stewardship (SMS) Model

The SMS model proposes a four-part causal chain: (a) the sensory atmosphere of a heritage precinct acts as the environmental antecedent; (b) this atmosphere shapes the tourist's mindful state, a mediating cognitive-affective construct; (c) mindful state predicts eco-preservation behavior, the outcome of interest; and (d) restorative cognitive pathways — deliberate design interventions embedded in the urban fabric — moderate the relationship between sensory atmosphere and mindful state, buffering tourists against cognitive overload at points of peak stimulus density. Figure 1 summarizes the full structure, including the boundary conditions discussed in Section 3.5.

3.1 Sensory Atmosphere as Antecedent

Sensory atmosphere is conceptualized along three channels. The auditory channel includes ambient noise level, reverberation, overlapping human voices, and intentional soundscaping; recent grounded-

theory work on historic districts identifies the physical and cultural characteristics of soundscapes, and the effects of spatial characteristics on soundscape perception, as key levers for shaping how authentic and coherent a district feels to visitors (A. H. Alsharif et al., 2023; Hu et al., 2024). The visual channel includes density of visual information (signage clutter, crowd density, glare) and legibility of wayfinding. The spatial channel includes street width relative to building height, degree of enclosure, and the presence of thresholds that signal a transition from ordinary to protected space. Each channel can be characterized on a continuum from restorative (coherent, legible, moderately stimulating) to depleting (chaotic, high-density, incoherent), and heritage precincts frequently sit toward the depleting end precisely because historical density and modern tourist infrastructure are layered without coordination.

3.2 Mindful State as Mediator

Mindful state is defined here as a momentary condition of present-focused, non-evaluative attentional engagement with one's immediate surroundings, coupled with lowered cognitive fatigue — an operationalization consistent with recent heritage-tourism findings that authenticity and mindfulness are closely linked drivers of tourist experience quality (Eck et al., 2023), extended here to incorporate the embodied-cognition claim that this state is structurally coupled to, and not merely triggered by, the sensory and bodily environment (Cai et al., 2025). It is treated as a state rather than a trait: the same tourist may be highly mindful when entering a quiet cloister and cognitively depleted twenty minutes later in a congested market lane. This shift matters because it is precisely the resource that self-controlled, prosocial behavior draws upon (Li et al., 2022); a tourist in a depleted, narrow-attention state has less spare capacity to notice a piece of litter, register a boundary marker, or moderate their own conduct around fragile fabric.

3.3 Restorative Cognitive Pathways as Moderator

Restorative cognitive pathways are defined as sequenced spatial and sensory interventions — pocket gardens, sound-dampening thresholds, framed views, shaded pauses, water elements, rhythmic paving changes — inserted at intervals within high-stimulus tourist circuits. Their design logic follows directly from recent tourism research extending attention restoration and stress recovery theory: perceived restorativeness has been shown to significantly buffer the negative effects of environmental density on perceived safety and, through it, on tourists' behavioral intentions (Zhang et al., 2026). Their function is not to reduce the density of heritage stimuli, which would undermine the tourism value of the site, but to punctuate that density with brief restorative opportunities that allow attentional resources to partially recover before the next high-stimulus segment. The model proposes that the presence and placement density of such pathways moderates the relationship between sensory atmosphere and mindful state: at equivalent levels of ambient sensory load, precincts with well-placed restorative pathways will sustain higher average mindful state than precincts without them.

3.4 Eco-Preservation Behavior as Outcome

Eco-preservation behavior is operationalized as a class of low-cost, high-frequency, largely non-verbal conservation behaviors available to any visitor in the moment: carrying litter to a receptacle rather than

discarding it, remaining behind boundary markers, moderating touch and contact with heritage surfaces, and lowering voice or crowd behavior in marked quiet zones. Anti-littering behavior in particular remains highly sensitive to situational cues that make a relevant norm momentarily salient rather than to stable individual attitudes alone; a recent high-powered, pre-registered replication of the classic focus theory of normative conduct confirms that people litter less in visibly clean environments than in littered ones, underscoring that littering is strongly state- and context-dependent rather than a fixed trait of the visitor (A. H. Alsharif et al., 2021; Bergquist et al., 2021). These behaviors are distinguished from higher-commitment sustainable tourism behaviors (donating to conservation funds, choosing certified accommodation) because they are enacted under time pressure, in public, and without deliberation — precisely the conditions under which cognitive state, rather than attitude, is expected to dominate.

3.5 Boundary Conditions and Moderators

The model further proposes several boundary conditions. Crowding density is expected to independently deplete attentional resources and to interact with sensory atmosphere: empirical evidence from a major heritage site shows that both spatial and human crowding significantly increase deviant, norm-violating tourist behavior, and indirectly suppress pro-environmental behavior through the mediating mechanism of deindividuation — a diminished state of self-awareness (Jo et al., 2024). Cultural distance between the tourist and the host heritage context may increase baseline cognitive load, since unfamiliar cues require more effortful interpretation. Time pressure, whether self-imposed or itinerary-driven, is expected to compress the window in which restorative pathways can take effect, weakening their moderating role; this is consistent with recent evidence that unhurried conditions promote more deliberate, effortful cognitive processing among tourists making on-site choices (Lindberg & Stemmer, 2022). These boundary conditions are proposed as directions for empirical refinement rather than as fully specified sub-models.

3.6 Model Summary

Figure 1 summarizes the proposed causal structure. Sensory atmosphere (auditory, visual, spatial) exerts a direct effect on mindful state (P1); mindful state exerts a direct effect on eco-preservation behavior (P2); restorative cognitive pathways moderate the sensory-atmosphere-to-mindful-state path (P3); and crowding density (P4), cultural distance (P5), and time pressure (P6) act as boundary conditions on the overall chain.

4. Theoretical Propositions

P1: The lower the coherence and higher the density of a heritage precinct's sensory atmosphere (auditory, visual, spatial), the lower a tourist's momentary mindful state.

P2: A tourist's momentary mindful state is positively associated with the likelihood of enacting low-cost eco-preservation behaviors (litter disposal, boundary respect, touch moderation, voice moderation).

P3: The presence of restorative cognitive pathways positively moderates the relationship between sensory atmosphere and mindful state, such that the negative effect of high sensory density on mindful state is attenuated in precincts with well-placed restorative pathways.

P4: Crowding density negatively moderates the sensory-atmosphere-to-mindful-state relationship, amplifying the depleting effect of a given sensory load under conditions of high visitor density, consistent with evidence that crowding suppresses pro-environmental behavior via deindividuation (Jo et al., 2024).

P5: Cultural distance between the tourist and the host heritage context is positively associated with baseline cognitive load, reducing the residual attentional capacity available for eco-preservation behavior independent of on-site sensory atmosphere.

P6: The positive effect of restorative cognitive pathways on mindful state is attenuated under high self-imposed or itinerary-driven time pressure, such that the moderating benefit of restorative design is strongest among tourists with unhurried, self-paced visit structures, consistent with evidence that unhurried conditions promote more deliberate cognitive processing (Lindberg & Stemmer, 2022).

5. Theoretical Contributions

The SMS model makes three contributions. First, it repositions the tourist's cognitive-perceptual state, rather than attitude or awareness alone, as the proximate mechanism linking urban heritage design to conservation behavior — extending the real-versus-reported behavior gap identified in the sustainable tourism literature (Juvan et al., 2025) with a state-based rather than purely dispositional explanation. Second, it imports the embodied-cognition insistence on treating multisensory, bodily experience as a legitimate explanatory variable (Cai et al., 2025), giving tourism researchers a principled way to connect heritage-tourism mindfulness findings (Eck et al., 2023) to measurable sensory antecedents rather than treating mindfulness as an unexplained individual difference. Third, by introducing restorative cognitive pathways as a moderator that can be deliberately engineered rather than merely observed, the model bridges cognitive science and urban design practice, translating recently updated attention restoration and stress recovery findings from tourism settings (Li & Wang, 2026) — including high-density, high-stimulus urban contexts — into a design vocabulary for dense historic urban precincts.

6. Implications for Urban Heritage Design and Management

To effectively safeguard both the structural integrity and the cognitive experience of historic environments, heritage site management must shift toward design strategies that actively manage visitor psychology and sensory input. Rather than treating visitor reflection as an afterthought, site managers can audit tourist circuits to identify "sensory density hot spots," strategically inserting intentional restorative pauses—such as shaded thresholds, framed views, and sound-dampened courtyards—at predictable intervals.

A critical component of this environmental curation is acoustic and soundscape design. Far from being a mere visitor-comfort feature, buffering noise at gateways and curating zone-specific sounds should be prioritized as a core conservation intervention, especially given evidence that soundscape design measurably shapes how authentic a historic district is perceived to be (Hu et al., 2024).

Furthermore, traditional crowd flow management techniques like timed entries and one-directional routing should be recontextualized. Beyond simply controlling physical congestion, these tools manage cognitive load; this is vital because crowding has been directly linked to increased deviant behavior and a decline in pro-environmental actions through deindividuation (Jo et al., 2024).

To counteract these high-risk, high-load moments, management should deploy highly specific, localized on-site cues that make anti-littering and boundary-respect norms momentarily salient. Relying on general appeals to environmental attitudes is often ineffective, whereas making norms immediate and keeping environments visibly clean has been shown to drastically reduce littering behavior (Bergquist et al., 2021).

Finally, these immediate behavioral interventions are best supported by encouraging unhurried, self-paced itinerary designs. When tourists operate under less time pressure, they are far more likely to engage in deliberate, effortful cognitive processing, which helps consolidate momentary actions into lasting stewardship behavior (Lindberg & Stemmer, 2022).

7. Future Research Directions

The propositions above are stated at a level suitable for empirical testing using mixed methods. Psychophysiological measures (heart-rate variability, electrodermal activity, eye-tracking for visual scanning patterns) could operationalize mindful state and cognitive fatigue in situ, following mixed-methods protocols already used to link environmental density, perceived restorativeness, and tourist behavioral intention (Zhang et al., 2026). Mobile ethnographic methods, including think-aloud walking interviews and GPS-linked behavioral observation, could capture the moment-to-moment covariation between sensory exposure and eco-preservation behavior as tourists move through real heritage precincts, extending grounded-theory soundscape methodologies already used to characterize historic districts (Hu et al., 2024). Quasi-experimental field studies comparing matched precincts with and without restorative cognitive pathways would allow direct tests of the proposed moderation effect (P3), while diary or experience-sampling methods could test the role of cultural distance and time pressure (P5, P6) across tourist segments. Because measured rates of environmentally sustainable tourist behavior are highly sensitive to method, future tests of this model should prioritize direct behavioral observation over self-report wherever possible, following recent calls for field studies that measure real rather than self-reported tourist behavior (Juvan et al., 2025).

8. Conclusion

This paper has proposed an embodied-cognition account of how the sensory design of historic urban centers shapes tourists' capacity for spontaneous environmental stewardship. By reframing eco-preservation behavior as a function of momentary cognitive and attentional state rather than of attitude alone, and by introducing restorative cognitive pathways as an actionable design construct, the Sensory–Mindfulness–Stewardship model offers heritage tourism scholarship a mechanism that is simultaneously grounded in current cognitive and environmental psychology research and directly translatable into urban design practice. In doing so, it responds to the call for papers' interest in cultural heritage, tourism, and cognitive decision-making by treating the historic city not merely as a backdrop for visitor experience, but as a cognitive environment whose design choices carry direct consequences for conservation outcomes.

Declarations

The current study did not receive any funding.

Data Availability Statement

Not applicable. This is a conceptual/perspective article based on the synthesis of previously published, publicly available peer-reviewed literature; no new datasets were generated or analyzed during the current study.

Clinical trial number

Not applicable

Ethics, Consent to Participate, and Consent to Publish declarations:

Not applicable

Author Contribution

Ali. J and Khan. N conceptualize, wrote and analyzed the manuscript and Amran. M supervise and validate the study.

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During the preparation of this work the author(s) used NotebookLM and napkinai in order to ensure the language development and image development. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

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Figures

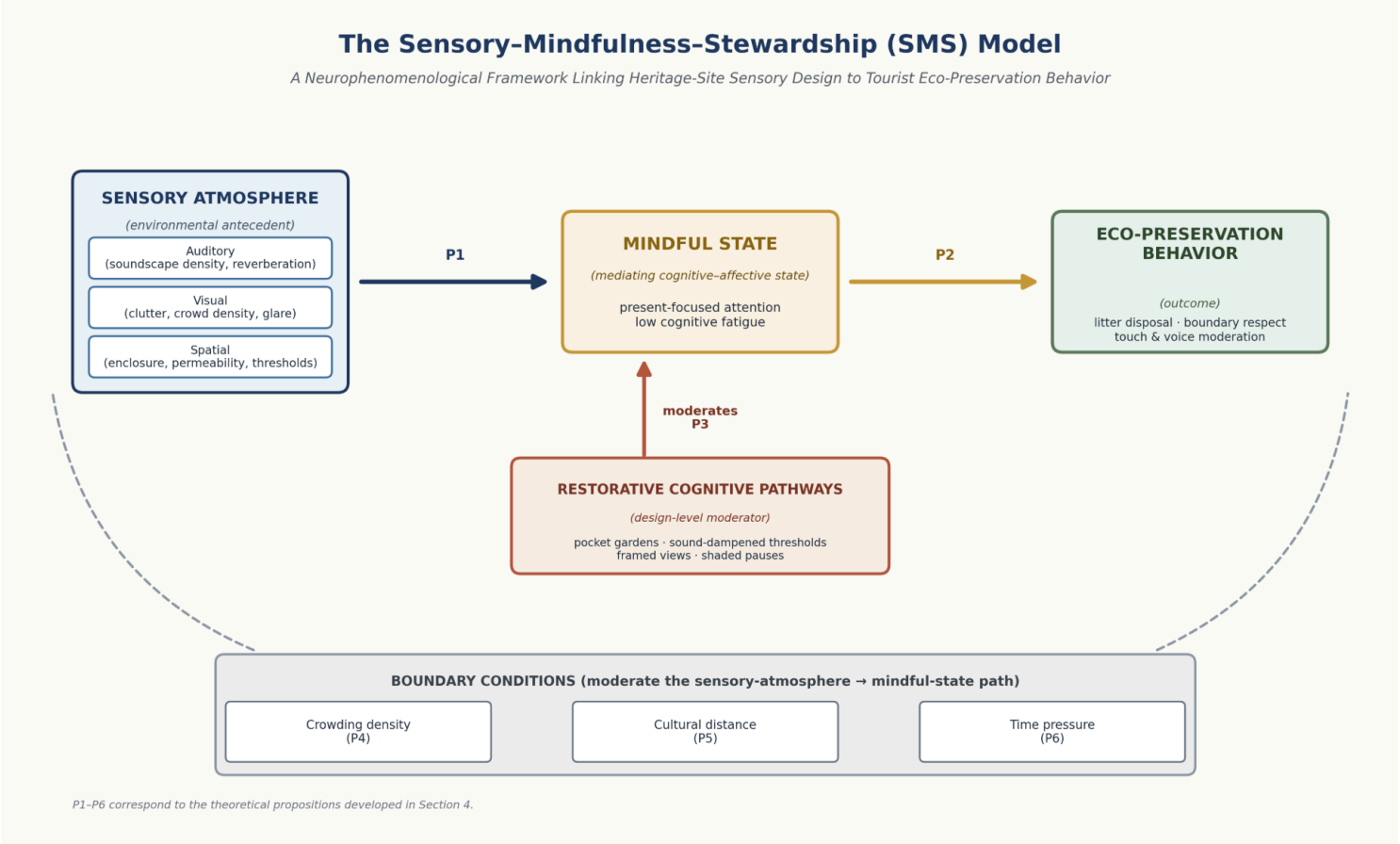

Figure 1

The Sensory–Mindfulness–Stewardship (SMS) model.