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Perceived blue space restorativeness and subjective vitality among coastal tourists: A cross-sectional moderated mediation study

Ziqing Xu[1,2] and Yanjun Luo[1,2]*

[1]The Institute of Digital Economy & Ocean Industry Development, Guangdong Ocean University, Yangjiang, Guangdong, China

[2]Business School, Guangdong Ocean University, Yangjiang, Guangdong, China

Abstract

Background: Blue spaces may support psychological recovery, yet the processes linking perceived restorativeness to subjective vitality and the role of digital engagement remain unclear.

Objective: This study examined the indirect associations between perceived blue space restorativeness and subjective vitality involving psychological detachment and cognitive restoration, and whether online vigilance moderated the restorativeness–detachment association.

Methods: We used a cross-sectional online survey of 384 adult Chinese tourists who had recently visited a coastal site. Latent-variable structural equation modeling was used to estimate the proposed associations. Bias-corrected bootstrap confidence intervals were applied to the indirect effects, and moderation was examined through a product-indicator latent interaction.

Results: Perceived blue space restorativeness was positively associated with psychological detachment (β = 0.466) and cognitive restoration (β = 0.318), while psychological detachment was positively associated with cognitive restoration (β = 0.312). Psychological detachment (β = 0.257) and cognitive restoration (β = 0.316) were both positively associated with subjective vitality. The sequential indirect association was significant (β = 0.046). Online vigilance negatively moderated the restorativeness–detachment association (β = –0.179), and indirect effects involving psychological detachment were not significant at high online vigilance.

Conclusion: The findings suggest that perceived blue space restorativeness is associated with greater subjective vitality through psychological detachment and cognitive restoration, while online vigilance may weaken this restorative process by constraining psychological detachment. These results extend understanding of psychological recovery in blue space environments and highlight the importance of reducing digital attentional demands during restorative leisure experiences.

Keywords: Perceived blue space restorativeness; Psychological detachment; Cognitive restoration; Online vigilance; Subjective vitality

***Corresponding author:**
Yanjun Luo
(luoyj@gdou.edu.cn)

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1. Introduction

Modern society is characterized by increasing cognitive demands arising from

work, study, and continuous engagement with digital information.[1] Continued mental effort places demands on limited attentional resources. Over time, this may produce directed attention fatigue, which is linked to poorer cognition, weaker self-regulation, and lower psychological well-being.[2,3] As a result, environmental and health psychology research has increasingly focused on how depleted cognitive resources can be restored. From a health psychology perspective, such recovery is relevant not only to reducing mental fatigue but also to restoring positive psychological functioning, including individuals' perceived energy and vitality.[4] One widely studied route to recovery is contact with natural environments. Prior studies generally show that such exposure can ease mental fatigue and support cognitive and emotional functioning.[5]

More recently, water-related natural environments, including coasts, beaches, and islands, have received growing research attention. Existing evidence suggests that contact with these settings may be associated with psychological health and well-being.[6-8] In the present study, blue space is considered within the specific context of coastal and seaside tourism. This focus distinguishes the study from broader research on blue spaces that includes inland aquatic environments. Within restoration research, perceived restorativeness provides a way to characterize the restorative qualities of an environment from the perspective of the person experiencing it.[9,10] Accordingly, the present study examines perceived blue space restorativeness as an appraisal of the restorative qualities of coastal and seaside tourism settings. Evidence of associations between blue space and well-being does not by itself explain the psychological processes through which tourists may experience restoration. Understanding these processes is therefore important for clarifying how coastal tourism environments may be associated with psychological recovery and well-being.

Attention restoration theory (ART) is often used to explain why natural environments can be restorative, and it remains a central framework in environmental psychology.[11] ART proposes that people have a limited capacity for directed attention, which may become fatigued after sustained mental effort. Settings that offer a sense of escape, fascination, coherence, and fit with individual needs may support attentional recovery by drawing on effortless attention.[12] Previous evidence broadly supports the assumptions of ART. Spending time in natural settings may help people sustain attention, feel less mentally tired, and perform better on cognitive tasks.[13,14] Research on coastal environments has also shown that perceived restorativeness varies across different coastal settings, suggesting that restorative qualities may differ according to the characteristics of the environment in which they are experienced.[15] Although restorative environments have been widely studied, several issues remain unresolved.

First, a large body of empirical work has focused on the psychological and cognitive outcomes associated with natural environment exposure, including reduced stress, improved affect, and enhanced cognitive functioning.[16-18] However, less attention has been given to how individuals' perceptions of environmental restorativeness relate to the psychological experiences through which recovery may occur. From a health psychology perspective, psychological recovery involves more than being in a potentially restorative environment. It also concerns the ability to disengage from ongoing demands and recover depleted psychological and cognitive resources.[19] Thus, greater attention is needed to the psychological processes linking perceived environmental restorativeness with positive psychological functioning.

Second, ART helps explain how attention can recover in restorative settings. Yet previous studies have mainly examined environmental characteristics and cognitive outcomes, rather than the psychological responses that may link perceived restorativeness to recovery.[9,20] In particular, psychological detachment and cognitive restoration have generally been examined as separate recovery-related processes, and relatively little is known about how they may operate together. Psychological detachment represents disengagement from ongoing everyday demands,[21] whereas cognitive restoration reflects the replenishment of depleted attentional resources. Examining these two processes within a common framework may therefore provide a more differentiated account of psychological recovery. More specifically, the theoretically proposed sequence through which psychological detachment may facilitate cognitive restoration and subsequently relate to subjective vitality remains insufficiently understood.

Third, emerging research in cognitive psychology and media studies suggests that individuals increasingly maintain continuous cognitive engagement with digital information streams even during leisure contexts, a phenomenon often conceptualized as online vigilance or continuous partial attention.[22] This indicates that restoration processes may not only depend on environmental exposure but also be shaped by individuals' ongoing cognitive allocation patterns. However, the role of such cognitive constraints in shaping variability in restorative experiences has not been systematically integrated into existing restoration frameworks. This gap matters for health psychology, as recovery now often takes place while people remain connected to digital information. Digital stress, including online vigilance, has been systematically

associated with poorer psychological outcomes.[23] Even during leisure experiences, sustained cognitive orientation toward online information may compete for attentional resources and interfere with individuals' ability to disengage from everyday demands. Online vigilance may therefore represent an important contemporary boundary condition of environmental restoration.

To address these research gaps, this study examines a moderated sequential mediation framework. It considers how perceived blue space restorativeness is associated with tourists' subjective vitality. The model proposes that perceived blue space restorativeness is positively associated with psychological detachment from daily cognitive and work-related demands, which is hypothesized to facilitate cognitive restoration, and subsequently relate to higher levels of subjective vitality. In addition, this study considers online vigilance as a moderating condition. When vigilance is high, continued attention to digital information may reduce the strength of the positive link between perceived blue space restorativeness and psychological detachment. Accordingly, this study aims to: (i) examine the associations of perceived blue space restorativeness with psychological detachment and cognitive restoration among tourists in coastal and seaside tourism settings; (ii) investigate the associations among psychological detachment, cognitive restoration, and subjective vitality; (iii) test the indirect associations of perceived blue space restorativeness with subjective vitality through psychological detachment and cognitive restoration; and (iv) examine the moderating effect of online vigilance on the association between perceived blue space restorativeness and psychological detachment.

This study brings perceived environmental restorativeness and recovery-related psychological processes together in a coastal tourism context. It makes three contributions. First, it extends the application of restoration research to coastal tourism by examining perceived restorativeness in relation to psychological detachment and cognitive restoration. ART provides a framework for understanding the restorative qualities of the environment, while recovery experience theory helps conceptualize psychological detachment as a recovery-related experience. Second, by linking these recovery-related processes with subjective vitality, the study connects environmental restoration with a positive indicator of psychological functioning rather than focusing solely on the reduction of stress or fatigue. Third, it introduces online vigilance as a contemporary digital boundary condition that may shape the association between perceived environmental restorativeness and psychological detachment.

2. Literature review and hypothesis development

2.1. Perceived blue space restorativeness, psychological detachment, and cognitive restoration

Attention restoration theory suggests that certain environments can help people recover after sustained mental effort. Such settings may support the renewal of attentional resources that have been reduced by prolonged cognitive demands.[24] Within this framework, perceived restorativeness has been widely recognized as a key psychological mechanism through which natural environments exert their restorative effects on individuals.[10,25] Prior empirical studies have consistently demonstrated that environments perceived as highly restorative are associated with improved cognitive functioning, including enhanced attentional control, reduced mental fatigue, and improved cognitive clarity.[26]

Restorative environments are relevant not only to cognitive recovery but also to psychological detachment. This concept describes the experience of temporarily putting work and routine stressors out of mind during leisure.[27] Research suggests that exposure to recovery-supportive environments can facilitate psychological detachment by reducing exposure to cognitive demands and promoting a shift in attentional focus away from task-related concerns.[28,29] In natural and leisure contexts, environments characterized by restorative qualities have been found to support this disengagement process, thereby enabling individuals to experience a sense of mental separation from routine obligations.

Psychological detachment should be separated conceptually from the being-away dimension of perceived restorativeness. In ART, being away describes the sense of leaving familiar places, routines, and daily demands behind. Psychological detachment, by contrast, concerns mentally switching off from work and other ongoing concerns. Thus, being away characterizes how the environmental experience is perceived, while psychological detachment characterizes the individual's recovery-related cognitive state. Psychological detachment is also distinct from cognitive restoration. The former concerns disengagement from ongoing demands, whereas the latter concerns the perceived recovery of attentional capacity, cognitive clarity, and mental functioning.[24,30]

These distinctions also separate psychological detachment from other adjacent recovery concepts. Recovery experience theory treats psychological detachment and relaxation as related but distinct recovery experiences, with detachment referring to mentally

switching off from demands and relaxation referring primarily to reduced activation and increased calmness.[30] Mindfulness likewise concerns present-moment, non-judgmental awareness rather than disengagement from a particular domain of demands; empirical research has examined mindfulness and psychological detachment as related but distinguishable recovery experiences.[31] Mental-fatigue reduction, in turn, is more appropriately understood as a potential recovery outcome, whereas psychological detachment refers to the disengagement experience itself.

Furthermore, psychological detachment has been linked to cognitive restoration in previous research. Empirical research has associated psychological detachment from work-related cognition with better cognitive functioning and lower mental fatigue.[32] Building on this evidence, the present study considers whether psychological detachment is associated with cognitive restoration in the context of perceived environmental restorativeness. Accordingly, the following three hypotheses were tested:

Hypothesis 1 (H1): Perceived blue space restorativeness is positively associated with tourists' cognitive restoration.

Hypothesis 2 (H2): Perceived blue space restorativeness is positively associated with tourists' psychological detachment.

Hypothesis 3 (H3): Psychological detachment is positively associated with cognitive restoration.

2.2. Psychological detachment, cognitive restoration, and subjective vitality

Subjective vitality reflects the feeling of having energy and being fully alive. It is viewed as a sign of positive psychological functioning, not just the absence of fatigue.[33] Subjective vitality describes the inner energy that supports effective functioning. People with greater vitality are more able to stay active and involved in their surroundings.[34] Previous research has demonstrated that subjective vitality is associated with a range of positive psychological outcomes, including well-being and mental health, making it an important indicator for evaluating the effectiveness of restorative experiences.[35] Accordingly, subjective vitality is a meaningful outcome in this study because it captures positive psychological functioning rather than only the reduction of fatigue, stress, or psychological strain. From a health psychology perspective, this distinction is important because psychological recovery may involve not only relief from depleted states but also the restoration of energy and a sense of aliveness.[33,35]

Mental disengagement plays an important role in the recovery process. It enables people to leave work concerns and routine pressures behind while they are at leisure.[32] By interrupting continued cognitive and emotional activation associated with stressors, psychological detachment allows individuals to recover from resource depletion and facilitates subsequent psychological functioning.[29] Earlier research has linked stronger psychological detachment with less fatigue and lower psychological strain. It has also been associated with better well-being after leisure activities and vacations.[36,37] Given that subjective vitality reflects individuals' perceived availability of psychological energy, tourists who are better able to psychologically detach from everyday demands during blue space experiences are expected to experience higher levels of subjective vitality. Beyond psychological detachment, ART suggests that natural settings can support the recovery of attention after prolonged mental effort. This process may reduce mental fatigue and help restore cognitive functioning.[38] Research has linked contact with natural settings to better cognitive performance. These benefits include stronger attention and working memory, especially after extended mental effort.[39,40]

Recent research further supports distinguishing cognitive restoration from subjective vitality rather than treating both as interchangeable indicators of feeling "refreshed." Cognitive or attention restoration is primarily concerned with the recovery of depleted attentional and cognitive resources. A recent systematic review and meta-analysis found that the restorative cognitive benefits of nature are particularly evident in domains such as attentional control and working memory, reinforcing the cognitive-resource basis of restoration.[38] Subjective vitality, in contrast, reflects a broader affective and motivational experience of feeling energetic, alive, and psychologically invigorated. Accordingly, recent environmental psychology studies have assessed restoration or perceived restorativeness and subjective vitality as separate constructs within the same models and have reported meaningful associations between them.[41]

This distinction has also been supported in tourism-related research. Recent tourism research has examined mental restoration and subjective vitality as distinct psychological outcomes and found that perceived restorative quality was linked to both outcomes in the context of religious tourism.[42] Collectively, these findings suggest that cognitive restoration and subjective vitality are related but conceptually non-equivalent: the former concerns the recovery of attentional and cognitive functioning, whereas the latter reflects the broader subjective experience of psychological energy and aliveness. Accordingly, the following hypotheses were tested:

Hypothesis 4 (H4): Psychological detachment is positively

associated with subjective vitality.

Hypothesis 5 (H5): Cognitive restoration is positively associated with subjective vitality.

2.3. Mediation effects

According to ART, restorative settings may help renew directed attention after it has been heavily used. This recovery may occur because restorative environments engage attention with relatively little effort, reducing the need for sustained directed attention.[43,44] Restoration should not be assumed to occur automatically following exposure to a natural environment. Instead, cognitive recovery depends on how individuals engage with restorative features such as being away, fascination, extent, and compatibility. This perspective implies that psychological restoration involves a gradual process through which depleted cognitive resources are replenished. From this perspective, cognitive restoration refers specifically to the recovery of attentional capacity rather than to disengagement from ongoing demands itself.

Recovery experience theory emphasizes the need to mentally step away from work and daily demands during leisure time.[45] This process is known as psychological detachment. It involves reducing continued attention to ongoing concerns and stress-related thoughts.[46,47] A recent systematic review highlights psychological detachment as an important part of recovery that is related to employee health and well-being. It also shows that both work and non-work conditions can shape how easily individuals mentally disengage.[21] Moreover, recent meta-analytic evidence from vacation research indicates that psychological detachment during vacations is positively associated with well-being, further supporting its relevance to recovery during leisure experiences.[19]

Although recovery experience theory does not explicitly address cognitive restoration in natural environments, temporarily disengaging from ongoing cognitive demands may reduce continued demand-related cognitive activation and provide greater opportunity for engagement with restorative environmental experiences. The integration of the two theoretical perspectives therefore provides a complementary account of recovery. Recovery experience theory explains the disengagement from continuing demands, whereas ART explains the replenishment of directed attentional resources in restorative environments. Psychological detachment and cognitive restoration are thus theoretically related but conceptually distinct recovery experiences rather than interchangeable indicators of the same process.

On this basis, psychological detachment may constitute one condition under which perceived environmental restorativeness is associated with cognitive restoration. When individuals are less cognitively occupied by work-related or everyday demands, they may be more able to engage with environmental characteristics that support attentional recovery. However, existing research has not established that psychological detachment necessarily precedes cognitive restoration in natural or tourism settings. The proposed ordering should therefore be understood as a theoretically motivated sequence rather than as an established temporal process.

Building upon these complementary theoretical perspectives, the present study proposes that psychological detachment and cognitive restoration represent two linked recovery processes in a sequential pathway connecting perceived blue space restorativeness with subjective vitality. Specifically, greater psychological detachment may be associated with more favorable conditions for cognitive restoration, while restored attentional capacity may, in turn, be associated with greater psychological energy and vitality. Importantly, the proposed sequential pathway does not imply that the reverse ordering is theoretically impossible. Rather, it represents one plausible configuration derived from integrating the disengagement perspective of recovery experience theory with the attentional recovery perspective of ART. Accordingly, the following hypothesis was tested:

Hypothesis 6 (H6): Psychological detachment and cognitive restoration sequentially mediate the relationship between perceived blue space restorativeness and subjective vitality.

2.4. Moderation effects

In contemporary digital environments, individuals often maintain continuous access to and engagement with mobile communication technologies, even during leisure and tourism experiences. This ongoing connectivity is described as online vigilance. It refers to a mental tendency to stay alert to digital information, including messages and social media updates. Because the present study measures this orientation with reference to a specific trip, online vigilance is treated throughout as a trip-specific state rather than as a stable trait.[48,49]

Online vigilance should be distinguished from several related but conceptually different forms of digital engagement. Screen time and notification frequency primarily represent behavioral indicators of the amount or frequency of digital exposure, whereas problematic smartphone use concerns maladaptive or excessive patterns of smartphone use.[50] Fear of missing out involves concern about missing experiences that others may be enjoying. It is often linked to a stronger desire to remain connected to ongoing social information.[51] Media multitasking,

by contrast, concerns engagement with multiple media streams or tasks, often simultaneously.[22] Online vigilance differs from these constructs in referring specifically to a persistent cognitive orientation towards the salience, monitoring, and reactivity of online information.[48] Thus, individuals may remain cognitively oriented towards online information even when they are not actively using a digital device.

Prior research suggests that online vigilance reflects a form of sustained attentional readiness that continuously allocates part of individuals' cognitive resources to potential digital stimuli.[52,53] This state of partial attention may compete with the attentional resources available for ongoing environmental experiences, thereby making psychological disengagement from everyday cognitive demands more difficult.

Building on this perspective, the extent to which perceived restorative environments are associated with psychological detachment may depend partly on individuals' available attentional capacity for engagement with the immediate environment.[54,55] When online vigilance is high, a portion of attentional resources remains oriented toward external digital cues, which may limit the extent to which individuals can fully disengage from routine cognitive concerns even in environments characterized by high perceived restorativeness. In contrast, when online vigilance is low, individuals may have greater attentional capacity available for engagement with the immediate environment, thereby supporting psychological detachment. Accordingly, the following hypothesis was tested:

Hypothesis 7 (H7): Online vigilance negatively moderates the association between perceived blue space restorativeness and psychological detachment, such that the positive association is weaker at higher levels of online vigilance.

The proposed research model and hypothesized relationships are illustrated in Figure 1.

3. Methods

3.1. Participants

The study used a quantitative cross-sectional survey. It examined whether perceived blue space restorativeness related to subjective vitality through psychological detachment and cognitive restoration, and whether online vigilance changed these associations. The target population comprised adult tourists who had recently undertaken a coastal or seaside (blue space) leisure trip in China. The study focus was conveyed by the instruction introducing the measurement section, which asked respondents to evaluate each statement "according to your genuine feelings about this blue space (seaside/coastal) trip", so that all items referred to a single focal trip.

A total of 412 questionnaires were collected. Ten were removed before analysis: three judged on inspection to have been completed implausibly quickly, and seven showing complete straight-lining, defined as the identical response option selected across all items of every construct. A further 18 questionnaires (4.5%) were excluded on ethical grounds: the lowest category of the age item read "18 years or below," which does not exclude respondents beneath the age of majority, and no guardian-consent procedure was in place. The analyzed sample comprises 384 respondents. The analyzed sample was then screened against the response patterns conventionally used as careless-responding indicators.

Sample-size adequacy was evaluated in two ways. The

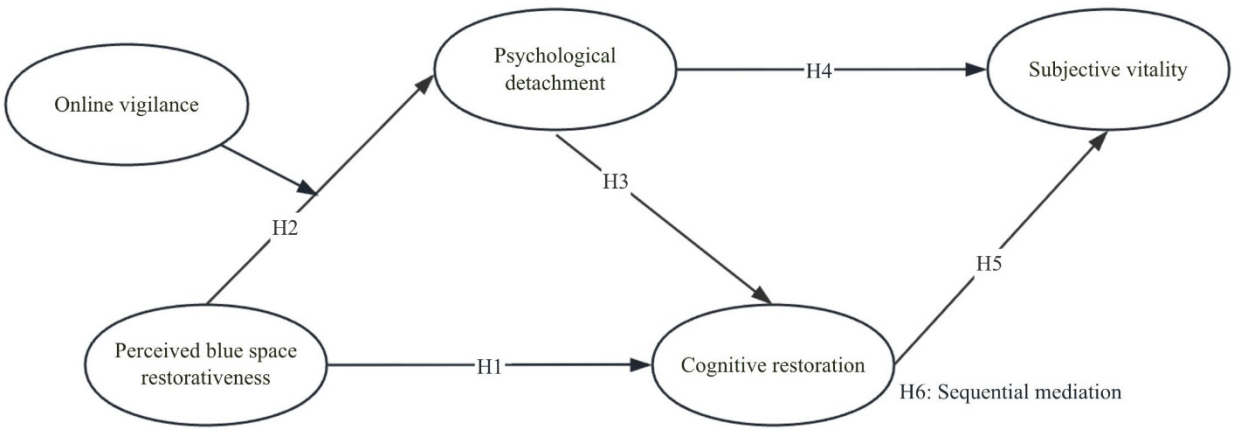


Figure 1. Proposed research model

measurement and structural models estimate 76 and 59 free parameters, giving 5.1 and 6.5 observations per estimated parameter, which meet the 5:1 minimum recommended for covariance-based structural equation modeling although not the 10:1 ideal. Parameter–count ratios and the root mean square error of approximation (RMSEA) test of close fit, which was reported previously, however, concern the model as a whole and say nothing about the power to detect a latent interaction or a sequential indirect effect. They have therefore been replaced by a Monte Carlo simulation conducted at the design and parameter values of the present study. Completion time had a median of 117 s (interquartile range 103–132 s; range 49–226 s), with 29 responses (7.6%) under 90 s.

The analyzed sample consisted of 207 women (53.9%) and 177 men (46.1%). Participants were distributed across age groups, with the largest proportions aged 26–35 years (34.9%) and 36–45 years (24.0%). Most participants held a bachelor's degree (44.5%), and the most common travel companionship was with family (45.8%). Respondents were located in 31 provincial-level administrative regions, with 50.8% residing in coastal and 49.2% in inland provinces; the five most represented regions were Shandong (10.9%), Henan (8.6%), Guangdong (8.3%), Jiangsu (7.8%), and Hebei (7.0%). The full demographic profile is presented in Table 1.

3.2. Measures

Perceived blue space restorativeness was assessed using 12 context-adapted items developed with reference to the restorative components specified in ART and the Perceived Restorativeness Scale tradition, namely being away, fascination, extent, and compatibility.[9,56] The items were adapted or developed to refer specifically to the focal blue-space tourism experience. The 12 items covered being away (3 items), fascination (3 items), extent (3 items), and compatibility (3 items). Within the extent component, the items reflected both extent–scope and extent–coherence. Item development also drew on subsequent applications and contextual adaptations of perceived restorativeness measures, including the Perceived Restorativeness Soundscape Scale.[57,58] Although perceived restorativeness is theoretically multidimensional, the present study operationalized perceived blue space restorativeness as a unidimensional reflective construct representing tourists' overall perception of the restorative quality of the focal blue-space environment. Because this specification aggregates theoretically distinguishable restorative components, a one-factor model was formally compared with a correlated multi-factor specification, and an additional robustness analysis was conducted after removing the being-away items. The results of these analyses are reported in the measurement-model and robustness sections.

Table 1. Demographic characteristics of the participants (*N* = 384)

Characteristic	Frequency	Percentage (%)
Gender		
Male	177	46.1
Female	207	53.9
Age (years)		
19–25	39	10.2
26–35	134	34.9
36–45	92	24.0
46–55	79	20.6
56 or above	40	10.4
Education		
Junior high school or below	7	1.8
Senior/vocational high school	56	14.6
Junior college	123	32.0
Bachelor's degree	171	44.5
Master's degree or above	27	7.0
Monthly personal income (Chinese yuan, RMB)		
3,000 or below	16	4.2
3,001–6,000	98	25.5
6,001–10,000	132	34.4
10,001–15,000	100	26
15,001 or above	38	9.9
Annual travel frequency		
Once or fewer	71	18.5
2–3 times	155	40.4
4–6 times	121	31.5
7 times or more	37	9.6
Travel companionship		
Alone	35	9.1
Family	176	45.8
Friends	112	29.2
Organized tour group	61	15.9

Psychological detachment was measured using the psychological detachment dimension of the Recovery Experience Questionnaire developed by Sonnentag and

Fritz.[30] The original dimension consists of four items assessing mental disengagement from work, including forgetting about work, not thinking about work, distancing oneself from work, and obtaining a break from work demands. In the present study, these items were contextually adapted to the blue-space tourism setting (e.g., the original item "I forgot about work" was adapted to "During this blue space tourism experience, I was able to completely forget about work-related matters"). Consistent with the recovery literature, psychological detachment is defined throughout this study as mental disengagement from work and other routine obligations, and this definition is applied consistently in the theoretical development, measurement, and interpretation of the construct.

Cognitive restoration was assessed using five context-adapted items developed with reference to the cognitive restoration dimension of the Restoration Scale[59] and the restorative-outcome literature, particularly the Restoration Outcome Scale.[60] Han[59] conceptualizes restoration across emotional, physiological, cognitive, and behavioral dimensions, with its cognitive dimension addressing aspects such as mental fatigue and cognitive functioning. The Restoration Outcome Scale, in turn, captures restorative outcomes including attention restoration, clarity of thoughts, relaxation, and renewed energy. Drawing on these complementary measurement traditions, the present study developed five items to capture tourists' perceived cognitive recovery during the focal blue-space tourism experience, including reductions in mental fatigue, restoration of attentional capacity, improved cognitive clarity, and a renewed sense of cognitive energy. The items were contextually adapted to the coastal tourism setting rather than treated as direct translations of the original instruments.

Online vigilance was measured using a shortened, contextually adapted version of the Online Vigilance Scale developed by Reinecke *et al.*[48] The original Online Vigilance Scale conceptualizes online vigilance as a persistent cognitive orientation toward online content and communication and comprises three dimensions: salience, reactibility, and monitoring. The original scale contains four items for each dimension. In the present study, two items were used to represent each dimension, resulting in six items. The wording was contextually adapted so that each item referred specifically to the focal blue-space tourism experience. Accordingly, the adapted measure captures trip-specific online vigilance rather than assuming that the original general or person-level orientation is invariant across contexts. The psychometric properties of this six-item adapted version were therefore evaluated in the present sample rather than assumed from the original instrument.

All constructs in this study were measured using multi-item reflective scales. Respondents indicated their level of agreement with each statement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). No items were reverse-coded, and no items were removed following confirmatory factor analysis.

3.3. Procedure

Data were collected through an online self-administered questionnaire distributed via the Wenjuanxing platform in May 2026. A combination of convenience and snowball sampling was used: the survey link was disseminated through social media channels and tourism-related online communities, and initial respondents were encouraged to forward the link to eligible acquaintances. Prior to administration, participants were informed that participation was voluntary and anonymous and that the data would be used solely for academic research. To reduce response bias, participants were assured of confidentiality and instructed to respond honestly based on their actual experiences, and the questionnaire required all items to be answered before submission. The study was conducted in accordance with the Declaration of Helsinki and was approved by the institutional ethics committee.

3.4. Common method bias

Harman's single-factor test was conducted as a preliminary screen. The first factor accounted for 38.10% of the total variance. This figure is reported for completeness only; because Harman's test is a weak diagnostic, it is not interpreted as evidence that method variance is absent. The common latent factor test provides a more informative assessment and is reported here in full rather than as a single percentage. The measurement model containing a method factor loading on all 33 indicators fit the data well, $\chi^2(452) = 455.93$, $p = 0.439$; $\chi^2/df = 1.01$; comparative fit index (CFI) = 0.999; Tucker–Lewis index (TLI) = 0.999; RMSEA = 0.005; standardized root mean square residual (SRMR) = 0.027. Standardized method-factor loadings ranged from −0.295 to 0.434 (mean absolute value 0.210) and are reported for every indicator in Table A1; the loadings of the six online vigilance items were uniformly negative, consistent with the negative correlation of that construct with the remaining four. The average variance attributable to the method factor was 5.23%, compared with 56.15% attributable to the substantive factors. Substantive standardized loadings fell from 0.745–0.854 to 0.643–0.841 when the method factor was retained; the mean absolute change was 0.033, the largest change was 0.105, and no loading fell below 0.60 or changed its significance. When the method factor was retained in the structural model

itself, the model fit the data well, $\chi^2(291) = 284.99$, $p = 0.588$; CFI = 1.000; RMSEA = 0.000; SRMR = 0.026, and no standardized structural coefficient changed by more than 0.044 (the largest change was the association of perceived blue space restorativeness with psychological detachment, 0.466 to 0.422); all six paths remained significant. Common method variance is therefore present, as would be expected in a single-source design, and it attenuates rather than manufactures the reported associations.

To further examine the pattern of correlations and the residuals of the measurement model, two diagnostic analyses were conducted. Within-construct inter-item correlations ranged from 0.546 to 0.700, and between-construct absolute correlations from 0.179 to 0.535, and the standardized residual correlations of the five-factor measurement model had a mean absolute value of 0.024, with a maximum of 0.115 and only one of the 528 residuals exceeding 0.10 in absolute value. The analyzed data set, the codebook, and a script that reproduces every statistic reported in this article from the raw responses have been deposited so that these figures can be verified independently.

3.5. Statistical analysis

Data were analyzed using Statistical Package for Social Sciences software (version 26.0, IBM Corp., United States of America) and AMOS (version 23.0, IBM Corp., United States of America) following a two-step analytical strategy. In the first step, the measurement model was evaluated through confirmatory factor analysis to assess the reliability and validity of the constructs. Internal consistency reliability was examined using Cronbach's α and composite reliability (CR), with values of 0.70 or above considered acceptable. Convergent validity was assessed via standardized factor loadings and the average variance extracted (AVE; ≥ 0.50). Discriminant validity was evaluated by comparing the square root of each construct's AVE with its inter-construct correlations, supplemented by the full heterotrait–monotrait (HTMT) ratio matrix. Prior to estimation, item-level skewness and kurtosis were inspected to confirm the appropriateness of maximum likelihood estimation, and univariate outliers (standardized scores) and multivariate outliers (Mahalanobis distance) were screened.

In the second step, the structural model was estimated using maximum likelihood estimation to test the hypothesized paths (H1–H5). This model does not contain online vigilance and therefore comprises four latent constructs and 27 indicators, which is why its degrees of freedom differ from those of the measurement model. In addition to the five hypothesized paths, a direct path from perceived blue space restorativeness to subjective vitality was specified, because the mediation hypotheses are partial rather than complete; the specifications with and without this path were compared by chi-square difference test. Model fit was evaluated using the ratio of the chi-square statistic to its degrees of freedom ($\chi^2/df < 3$), CFI (≥ 0.90), TLI (≥ 0.90), RMSEA (≤ 0.08), and SRMR (≤ 0.08). All five indices are reported for every estimated model. The specific and sequential indirect effects of psychological detachment and cognitive restoration (H6) were estimated within this model using the bias-corrected percentile bootstrap procedure with 5,000 resamples; unstandardized (*B*) and standardized (β) estimates are reported together with bootstrap standard errors and confidence intervals (CIs), and an indirect effect was considered statistically significant when its 95% CI did not include zero.

In the third step, the moderating role of online vigilance (H7) was tested in a single integrated latent moderated mediation model that contains perceived blue space restorativeness, online vigilance, their latent product, psychological detachment, cognitive restoration, and subjective vitality simultaneously. The latent interaction was specified using the unconstrained matched-pair product-indicator approach: perceived blue space restorativeness and online vigilance were each represented by three parcels formed from their respective items, parcel scores were mean-centered and multiplied in matched pairs so that each product indicator drew on a distinct set of items, and psychological detachment, cognitive restoration, and subjective vitality retained their original item indicators. Because online vigilance was negatively associated with every other construct, its direct paths to cognitive restoration and subjective vitality were estimated alongside its main effect on psychological detachment rather than being fixed to zero; the specification with and without these two paths was compared by chi-square difference test. Conditional indirect effects at one standard deviation below the mean, at the mean, and at one standard deviation above the mean of online vigilance, the index of moderated mediation for each psychological-detachment pathway, and the simple slopes were all computed within this model, with bias-corrected bootstrap CIs based on 5,000 resamples. The region of significance of the conditional association was identified using the Johnson–Neyman technique applied to the bootstrap covariance matrix of the first-stage coefficients. Finally, a Monte Carlo simulation of 1,000 replications was conducted to evaluate statistical power: data were generated at $N = 384$ from the estimated population values of the integrated model, with the product indicators formed from the generated parcels rather than drawn as normal variates, and each replication was re-estimated and tested using its own model-based

standard errors. Relative bias, CI coverage, and empirical power are reported for every structural path, indirect effect, and index of moderated mediation.

4. Results

4.1. Common method bias and measurement model

Harman's single-factor test was conducted as a preliminary screen. The first factor accounted for 38.10% of the total variance. This percentage is reported for completeness only; because Harman's test is a weak diagnostic, it is not interpreted as evidence that method variance is absent. The common latent factor test provides a more informative assessment. When a method factor loading on all 33 indicators was added to the measurement model, the average variance attributable to the method factor was 5.23%, compared with 56.15% attributable to the substantive factors, a ratio of approximately 10.7 to 1. The mean absolute change in standardized substantive loadings between the models with and without the method factor was 0.033, and no indicator changed its significance. Common method variance was therefore present, as would be expected in a single-source design, but its magnitude was small relative to the variance attributable to the substantive factors, and accounting for the method factor produced only minor changes in the substantive loadings.

The measurement model comprising five latent constructs and 33 indicators fit the data well: $\chi^2(485) = 509.95$, $p = 0.209$; $\chi^2/df = 1.05$; CFI = 0.997; TLI = 0.997; RMSEA = 0.012; SRMR = 0.030. As shown in Table 2**,** all standardized factor loadings ranged from 0.745 to 0.854 and were significant ($p < 0.001$). Cronbach's α and CR values ranged from 0.848 to 0.947, exceeding the 0.70 criterion. The AVE values ranged from 0.582 to 0.637, exceeding the 0.50 threshold and supporting convergent validity. Item-level distributions were suitable for maximum likelihood estimation, with absolute skewness not exceeding 0.29 and absolute kurtosis not exceeding 1.30 across all 33 indicators. No univariate outliers were identified (no standardized score exceeded |3.29|), and no multivariate outliers were identified (maximum Mahalanobis $D^2 = 52.88$, below the critical value of 63.87 at $p < 0.001$ with 33 degrees of freedom); no cases were removed on these grounds.

Discriminant validity was assessed using the Fornell–Larcker criterion. As reported in Table 3, the square root of the AVE for each construct exceeded its correlations with all other constructs. This conclusion was corroborated by the HTMT ratios, all of which were well below the 0.85 threshold; the ten ratios ranged from 0.435 to 0.523, the highest being that between cognitive restoration and subjective vitality. The full HTMT matrix, together with construct-level means, standard deviations, and correlations, is provided in Table A1. Online vigilance was significantly and negatively correlated with all other constructs, consistent with its hypothesized inhibitory role.

Table 2. Reliability and convergent validity

Construct	Factor loading	Cronbach's α	CR	AVE
PBSR (12 items)	0.745–0.805	0.947	0.947	0.599
PD (4 items)	0.752–0.770	0.848	0.848	0.582
CRR (5 items)	0.759–0.805	0.888	0.889	0.615
SV (6 items)	0.749–0.811	0.898	0.898	0.595
OV (6 items)	0.768–0.854	0.913	0.913	0.637

Notes: All factor loadings are significant at $p < 0.001$.
Abbreviations: AVE: Average variance extracted; CR: Composite reliability; CRR: Cognitive restoration; OV: Online vigilance; PBSR: Perceived blue space restorativeness; PD: Psychological detachment; SV: Subjective vitality.

Table 3. Inter-construct correlations and discriminant validity

Construct	1	2	3	4	5
1. PBSR	(0.774)				
2. PD	0.466	(0.763)			
3. *CRR*	0.464	0.460	(0.784)		
4. SV	0.454	0.490	0.521	(0.771)	
5. OV	−0.515	−0.437	−0.509	−0.510	(0.798)

Notes: The square root of the AVE is shown in parentheses on the diagonal; off-diagonal values are inter-construct correlations, all significant at $p < 0.01$.
Abbreviations: AVE: Average variance extracted; CRR: Cognitive restoration; OV: Online vigilance; PBSR: Perceived blue space restorativeness; PD: Psychological detachment; SV: Subjective vitality.

4.2. Structural model and direct effects

After confirming the adequacy of the measurement model, the structural model was estimated. Three specifications are reported in this article, and every fit statistic below belongs to one of them. Model 1 contains only the five hypothesized paths and fits the data well, $\chi^2(319) = 345.09$, $p = 0.151$; $\chi^2/df = 1.08$; CFI = 0.996; TLI = 0.995; RMSEA = 0.015; SRMR = 0.043. Model 2 adds the direct path from perceived blue space restorativeness to subjective vitality; this produced a significant improvement in fit, $\Delta\chi^2(1) = 10.92$, $p < 0.001$, and a better-fitting model overall, $\chi^2(318) = 334.17$, $p = 0.256$; $\chi^2/df = 1.05$; CFI = 0.997; TLI = 0.997; RMSEA = 0.012; SRMR = 0.029. Neither Model 1 nor Model 2 contains online vigilance, which is why their degrees of freedom differ from those of the measurement model. Model 3, reported in Section 4.4, adds online vigilance, its latent product with perceived blue space restorativeness, and its direct associations with the endogenous constructs. Tables 4 and 5 and Figure 2 report Model 2; Tables 6 and 7 report Model 3.

Perceived blue space restorativeness was positively associated with cognitive restoration (β = 0.318, 95% CI [0.214, 0.421]) and with psychological detachment (β = 0.466, 95% CI [0.368, 0.549]), supporting H1 and H2. Psychological detachment was positively associated with cognitive restoration (β = 0.312, 95% CI [0.203, 0.414]), supporting H3. Both psychological detachment (β = 0.257, 95% CI [0.133, 0.383]) and cognitive restoration (β = 0.316, 95% CI [0.204, 0.421]) were positively associated with subjective vitality, supporting H4 and H5. The direct association between perceived blue space restorativeness and subjective vitality also remained positive and significant (β = 0.188, 95% CI [0.074, 0.299]). The model accounted for 21.7% of the variance in psychological detachment, 29.1% in cognitive restoration, and 37.6% in subjective vitality. Because the design is cross-sectional, these coefficients describe associations among simultaneously measured variables and do not establish the direction of influence.

The standardized coefficients of Model 2, including the direct association between perceived blue space restorativeness and subjective vitality and the explained variance in the endogenous constructs, are presented in Figure 2.

4.3. Mediation analysis

H6 was tested in the latent structural model. Indirect effects were assessed with bias-corrected percentile bootstrapping based on 5,000 resamples. As reported in Table 5, the specific indirect effects of perceived blue space restorativeness on subjective vitality through psychological detachment ($B = 0.127$, β = 0.120, 95% CI [0.064, 0.199]) and through cognitive restoration ($B = 0.107$, β = 0.101, 95% CI [0.060, 0.162]) were both significant. The sequential indirect effect through psychological detachment and then cognitive restoration (PBSR → PD → CRR → SV) was also significant ($B = 0.049$, β = 0.046, 95% CI [0.026, 0.077]), supporting H6. The total indirect effect was $B = 0.283$ (β = 0.266, 95% CI [0.210, 0.369]), the direct effect was $B = 0.200$ (β = 0.188, 95% CI [0.080, 0.319]) and the total effect was $B = 0.483$ (β = 0.454, 95% CI [0.391, 0.580]). Because the direct effect remained significant with the mediators in the model, the

Table 4. Standardized path coefficients for the latent structural model

Hypothesis	Path	β	Boot SE	95% CI	Result
H1	PBSR →CRR	0.318***	0.052	0.214, 0.421	Supported
H2	PBSR → PD	0.466***	0.047	0.368, 0.549	Supported
H3	PD →CRR	0.312***	0.055	0.203, 0.414	Supported
H4	PD → SV	0.257***	0.063	0.133, 0.383	Supported
H5	CRR → SV	0.316***	0.056	0.204, 0.421	Supported
–	PBSR → SV	0.188***	0.058	0.074, 0.299	Estimated

Notes: β denotes the standardized path coefficient from the latent structural model, including the direct path from PBSR to SV. Boot SE and 95% CIs are bias-corrected bootstrap estimates based on 5,000 resamples and correspond to the standardized coefficient. Unstandardized estimates are PBSR → CRR 0.327, PBSR → PD 0.455, PD → CRR 0.328, PD → SV 0.280, CRR → SV 0.327, PBSR → SV 0.200. *** $p < 0.001$.

Abbreviations: CI: Confidence interval; CRR: Cognitive restoration; PBSR: Perceived blue space restorativeness; PD: Psychological detachment; SE: Standard error; SV: Subjective vitality.

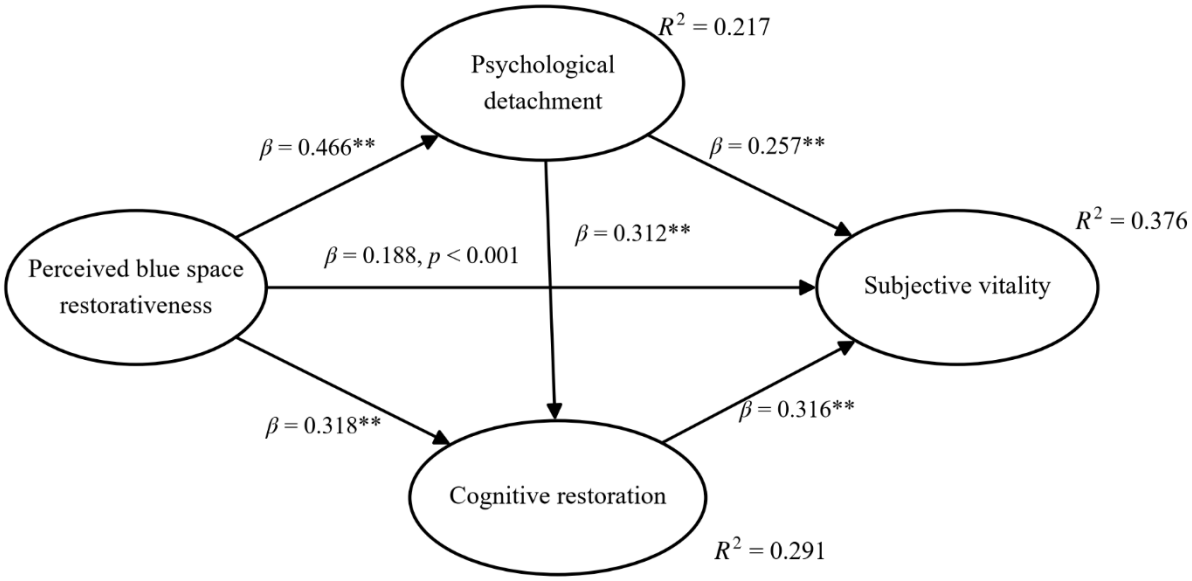


Figure 2. Structural model (Model 2). Standardized path coefficients and explained variance (R^2) are shown for the endogenous constructs. ** $p < 0.01$.

pattern was one of partial rather than complete mediation. The sequential indirect effect was the smallest of the three, accounting for 17.2% of the total indirect effect, whereas the two single-mediator pathways accounted for 45.0% and 37.8%, respectively.

4.4. Moderation analysis

H7 proposed that online vigilance negatively moderates the relationship between perceived blue space restorativeness and psychological detachment. To avoid relying on coefficients estimated from separate models, the moderation effect, mediation pathways, and direct associations involving online vigilance were estimated simultaneously in a single integrated latent moderated mediation model (Model 3). Because online vigilance correlated negatively with every other construct (−0.437 to −0.515; Table 3), the specification containing only its main effect on psychological detachment was compared with the specification that also estimates its direct paths to cognitive restoration and subjective vitality. The former fit less well, $\chi^2(241) = 278.78$, $p = 0.048$; CFI = 0.993; TLI = 0.992; RMSEA = 0.020; SRMR = 0.052, and adding the two direct paths produced a substantial improvement in fit, $\Delta\chi^2(2) = 41.87$, $p < 0.001$, yielding a model that fit the data well, $\chi^2(239) = 236.92$, $p = 0.526$; $\chi^2/df = 0.99$; CFI = 1.000; TLI = 1.000; RMSEA = 0.000; SRMR = 0.028. All results reported in this section and in Tables 6 and 7 come from this integrated model. As shown in Table 6, the latent interaction of perceived blue space restorativeness and online vigilance was negatively and significantly associated with psychological detachment ($B = -0.170$, $\beta = -0.179$, 95% CI [−0.293, −0.073]), supporting H7. Online vigilance was itself negatively associated with psychological detachment (β = −0.259), cognitive restoration (β = −0.308), and subjective vitality (β = −0.229). The model accounted for 30.0% of the variance in psychological detachment, 35.7% in cognitive restoration, and 40.9% in subjective vitality.

Simple-slope analyses further clarified the interaction. At low levels of online vigilance (−1 SD), perceived blue space restorativeness was strongly and positively associated with psychological detachment (simple slope = 0.511, 95% CI [0.356, 0.659]). At the mean, the association remained significant (0.311, 95% CI [0.180, 0.436]), and at high levels (+1 SD) it was substantially attenuated and no longer statistically significant (0.125, 95% CI [−0.076, 0.322]). Applying the Johnson–Neyman technique to the bootstrap covariance matrix of the first-stage coefficients, the conditional association ceased to be significant at values of online vigilance above 3.37 on the five-point scale, a region containing 104 respondents, or 27.1% of the analyzed sample. The interaction pattern is depicted in Figure 3.

Because online vigilance moderates the first stage of the pathways that run through psychological detachment, conditional indirect effects and the index of moderated mediation were estimated within the same model and are reported in full in Table 7. The index of moderated mediation was significant both for the pathway through psychological detachment alone (−0.040, 95% CI

Table 5. Bootstrapped direct, indirect, and total effects (5,000 resamples)

Effect	*B*	Boot SE	β	95% CI
PBSR → PD → SV	0.127	0.034	0.120	[0.064, 0.199]
PBSR → CRR → SV	0.107	0.026	0.101	[0.060, 0.162]
PBSR → PD → CRR → SV	0.049	0.013	0.046	[0.026, 0.077]
Total indirect effect	0.283	0.040	0.266	[0.210, 0.369]
Direct effect (PBSR → SV)	0.200	0.061	0.188	[0.080, 0.319]
Total effect (PBSR → SV)	0.483	0.048	0.454	[0.391, 0.580]

Notes: *B* = Unstandardized coefficient; β = Standardized coefficient. Bootstrap confidence intervals are bias-corrected and based on 5,000 resamples; intervals that exclude zero indicate statistically significant effects.
Abbreviations: CI: Confidence interval; CRR: Cognitive restoration; PBSR: Perceived blue space restorativeness; PD: Psychological detachment; SE: Standard error; SV: Subjective vitality.

[−0.083, −0.013]) and for the sequential pathway through psychological detachment and cognitive restoration (−0.011, 95% CI [−0.026, −0.004]). Both conditional indirect effects were significant at low and mean levels of online vigilance but not at high levels, whereas the pathway through cognitive restoration alone (0.050, 95% CI [0.018, 0.099]) is not moderated. One consequence of estimating all associations within one model should be stated explicitly. With the direct associations of online vigilance included, the direct association between perceived blue space restorativeness and subjective vitality was no longer statistically significant (β = 0.118, 95% CI [−0.002, 0.238]), although it was significant in Model 2, which does not contain online vigilance (β = 0.188, 95% CI [0.074, 0.299]), and remained so in the specification containing only the main effect of online vigilance (β = 0.190).

4.5. Robustness analyses

Five sets of robustness analyses were conducted. First, because the screening of unusually fast responses was based on inspection rather than on a pre-specified threshold, the model was re-estimated under a range of time-based exclusion rules. Excluding the fastest 10% of responses (n = 39, threshold 92 s) yielded standardized structural coefficients of 0.449, 0.310, 0.316, 0.265, 0.304, and 0.196; excluding all responses under 90 s (n = 29) yielded 0.446, 0.320, 0.317, 0.271, 0.297, and 0.197; and excluding all responses under 100 s (n = 70, 18.2% of the sample) yielded 0.440, 0.325, 0.304, 0.284, 0.301, and 0.173. Every coefficient remained within 0.03 of its full-sample value, and all paths remained significant. The findings are therefore not attributable to rapidly completed questionnaires, and this analysis is offered in place of a single reproducible cut-off.

Second, the model was re-estimated with gender, age, education, monthly personal income, annual travel frequency, and travel companionship included as covariates. No standardized structural coefficient changed by more than 0.006, and the interaction estimate remained substantively unchanged after the inclusion of the covariates. The covariate block was jointly non-significant, $F(6, 374) = 1.58$, $p = 0.150$. These results indicate that the substantive pattern of associations was robust to adjustment for the measured demographic and travel-related characteristics.

Third, three theoretically plausible alternative structural orderings were estimated. A model specifying subjective vitality as the antecedent of perceived blue space restorativeness fit worse ($\chi^2(319) = 362.33$), as did a parallel-mediation model omitting the path from psychological detachment to cognitive restoration ($\chi^2(319) = 360.60$). However, a model reversing the order of the two mediators, in which cognitive restoration precedes psychological detachment, produced fit statistics identical to those of the hypothesized model ($\chi^2(318) = 334.17$; CFI = 0.997; RMSEA = 0.012; SRMR = 0.029). These two orderings are statistically equivalent and cannot be distinguished by the present data. The ordering adopted here therefore rests on theoretical grounds, and the sequential interpretation is offered as one plausible account rather than as an empirically established temporal sequence.

Fourth, the specification of perceived blue space restorativeness was examined. A correlated four-factor model corresponding to the four original ART components fit marginally better than the one-factor model ($\Delta\chi^2(6) = 12.90$, $p = 0.045$), but the four factors correlated between 0.95 and 1.00 with one another, indicating that they are not

Table 6. Structural path coefficients of the integrated latent moderated mediation model (Model 3; *N* = 384)

Path	*B*	Boot SE	β	95% CI
PBSR → PD	0.311	0.066	0.311***	[0.181, 0.437]
OV → PD	−0.242	0.068	−0.259***	[−0.393, −0.123]
PBSR × OV → PD	−0.170	0.056	−0.179**	[−0.293, −0.073]
PBSR → CRR	0.200	0.061	0.193**	[0.071, 0.307]
PD → CRR	0.249	0.058	0.239***	[0.123, 0.350]
OV → CRR	−0.300	0.065	−0.308***	[−0.440, −0.187]
PBSR → SV	0.124	0.062	0.118	[−0.002, 0.238]
PD → SV	0.235	0.063	0.224***	[0.098, 0.345]
CRR → SV	0.248	0.059	0.246***	[0.129, 0.360]
OV → SV	−0.224	0.063	−0.229***	[−0.350, −0.105]

Notes: B = Unstandardized coefficient; β = Standardized coefficient. Boot SE and 95% CIs are bias-corrected bootstrap estimates based on 5,000 resamples. ** $p < 0.01$, *** $p < 0.001$.
Abbreviations: CI: Confidence interval; CRR: Cognitive restoration; OV: Online vigilance; PBSR: Perceived blue space restorativeness; PD: Psychological detachment; SE: Standard error; SV: Subjective vitality.

Table 7. Conditional indirect effects and indices of moderated mediation from the integrated model (*N* = 384)

Effect	Online vigilance	*B*	Boot SE	95% CI
PBSR → PD → SV	−1 SD	0.114	0.038	[0.049, 0.197]
	Mean	0.073	0.027	[0.030, 0.135]
	+1 SD	0.032	0.026	[−0.010, 0.093]
PBSR → PD → CRR → SV	−1 SD	0.030	0.012	[0.013, 0.063]
	Mean	0.019	0.008	[0.008, 0.043]
	+1 SD	0.008	0.007	[−0.002, 0.028]
Index of moderated mediation (PBSR → PD → SV)	–	−0.040	0.017	[−0.083, −0.013]
Index of moderated mediation (PBSR → PD → CRR → SV)	–	−0.011	0.005	[−0.026, −0.004]

Notes: All quantities were estimated within the integrated model reported in Table 6. *B* = Unstandardized effect; CIs are bias-corrected bootstrap intervals based on 5,000 resamples; an effect is significant when its interval excludes zero. Conditional values are evaluated at one SD below the mean, at the mean, and at one standard deviation above the mean of online vigilance.
Abbreviations: CI: Confidence interval; CRR: Cognitive restoration; PBSR: Perceived blue space restorativeness; PD: Psychological detachment; SD: Standard deviation; SE: Standard error; SV: Subjective vitality.

empirically distinguishable in this sample and supporting the unidimensional specification. Because being away overlaps conceptually with psychological detachment, the model was also re-estimated after removing the three being-away items. The standardized association between perceived blue space restorativeness and psychological detachment changed only marginally, from 0.466 to 0.451, indicating that this association is not an artifact of overlapping item content.

Fifth, the model was re-estimated after removing each group of responses flagged by the careless-responding checks described in Section 3.1, both for Model 2 and for the integrated model. Removing the six later responses from duplicated IP addresses (N = 378) or all twelve responses

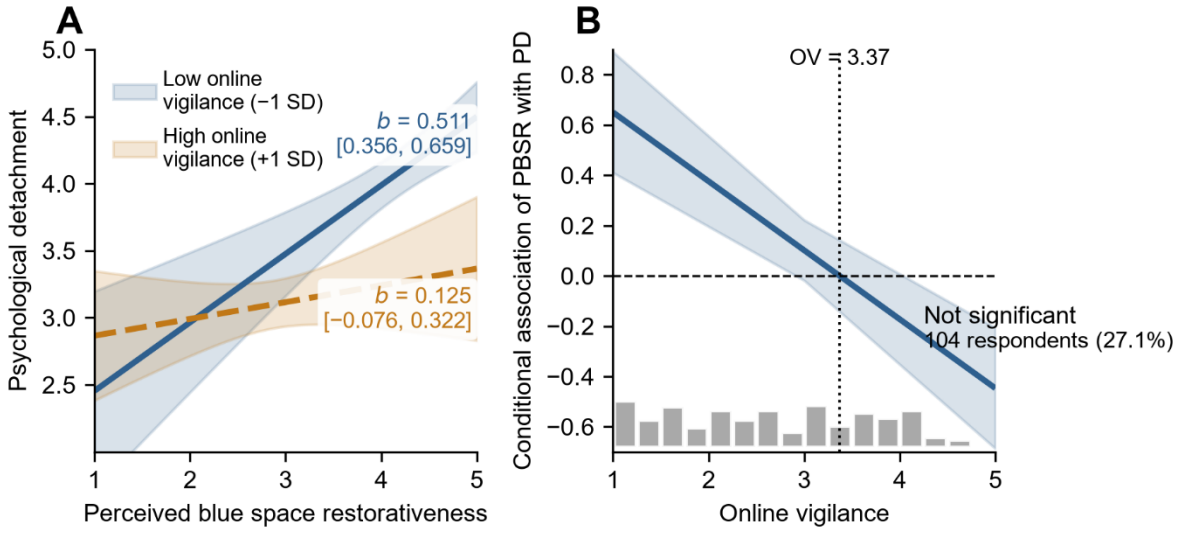


Figure 3. Moderating effect of online vigilance (OV) in the association between perceived blue space restorativeness (PBSR) and psychological detachment (PD). (A) Simple slopes at low (−1 SD) and high (+1 SD) levels of OV, with 95% bootstrap confidence bands. (B) Johnson–Neyman analysis showing the conditional association between PBSR and PD across the observed range of OV, with a 95% bootstrap confidence band. The vertical dotted line indicates the Johnson–Neyman threshold (OV = 3.37), above which the confidence band includes zero, and the association is no longer statistically significant at the 0.05 level. A total of 104 respondents (27.1%) had OV scores above this threshold. The grey bars represent the observed distribution of OV. All estimates were derived from the integrated latent moderated mediation model (Model 3; Table 6; $N = 384$). Confidence bands represent 95% bias-corrected bootstrap confidence intervals based on 5,000 resamples

involved (N = 372) changed no standardized coefficient by more than 0.010. Removing the 28 respondents with a long-string run of ten or more (N = 356) changed no coefficient by more than 0.059 in Model 2 and 0.035 in the integrated model; removing the 19 respondents with zero variance on two or more constructs (N = 365) changed none by more than 0.036 and 0.031 respectively; and removing the union of all three flagged groups (N = 334) changed none by more than 0.076 and 0.054. In every case, all paths retained their sign and significance, and the latent interaction remained significant. A deliberately extreme rule, removing all 115 respondents with zero variance on any single construct (N = 269, 29.9% of the sample), is also reported because it is the most demanding test available: here the association between perceived blue space restorativeness and psychological detachment attenuated from 0.466 to 0.347 in Model 2 and from 0.311 to 0.180 in the integrated model, while the latent interaction strengthened from −0.179 to −0.257 and every path retained its sign and significance. This rule removes a substantial part of the sample largely because zero variance across the four items of the psychological detachment scale is not by itself evidence of careless responding, but the attenuation it produces is reported rather than set aside.

4.6. Statistical power

A Monte Carlo simulation was used to evaluate whether the present design is adequately powered for the specific effects tested, in place of the parameter-count ratio and the RMSEA test of close fit reported previously. One thousand data sets of N = 384 were generated from the estimated population values of the integrated model, with the product indicators formed from the generated parcels rather than drawn as normal variates, and each replication was re-estimated and tested against its own model-based standard errors. The estimator behaved well: relative bias was below 2% for every structural path, indirect effect, and index of moderated mediation, and 95% confidence-interval coverage ranged from 0.908 to 0.967. Power was adequate for most effects: 0.999 for the association of perceived blue space restorativeness with psychological detachment, 0.976 for the latent interaction, 0.982 for the path from psychological detachment to cognitive restoration, 0.955 and 0.987 for the two paths to subjective vitality, 0.940 for the indirect effect through psychological detachment, and 0.870 for the sequential indirect effect. Three quantities were underpowered at this sample size: the indirect effect through cognitive restoration alone (0.790), the index of moderated mediation for the sequential pathway (0.724), and, most notably, the direct association between perceived blue space restorativeness and subjective vitality (0.508). Extrapolating from the simulated standard errors, approximately 490, 570, and 720 respondents, respectively, would be required for 0.80

power for these three quantities.

5. Discussion

5.1. Theoretical contributions

This study contributes to research on environmental restoration, tourism experiences, and psychological recovery by examining how perceived restorativeness is associated with recovery-related psychological processes and subjective vitality among tourists in coastal and seaside tourism settings.

First, this study applies restoration research to a defined coastal tourism context by focusing on perceived blue space restorativeness as tourists' appraisal of the restorative qualities of the setting. Tourism research has examined perceived destination restorative qualities as a way to understand how tourists experience the restorative characteristics of vacation environments.[61] Recent tourism research has linked perceived destination restorative qualities with tourists' well-being and other tourism-related outcomes, highlighting the relevance of restorative destination environments to tourists' psychological experiences.[62] The present study extends this line of research by examining perceived restorativeness together with psychological detachment, cognitive restoration, and subjective vitality within a common framework. This approach places the emphasis on tourists' restorative perceptions and associated recovery experiences, while the coastal and seaside setting defines the empirical context in which these relationships are examined.

Second, this study brings ART and recovery experience theory together to examine complementary aspects of psychological recovery. ART focuses on how environmental qualities can support the recovery of directed attention, whereas recovery experience theory emphasizes psychological detachment from ongoing demands during non-work time.[9,30] By examining psychological detachment and cognitive restoration within the same model, this study shows that these constructs are empirically distinguishable and are each associated with subjective vitality through separate indirect associations. The serial indirect association from perceived blue space restorativeness through psychological detachment and cognitive restoration was also significant, but it was smaller than the two single-mediator associations. Moreover, the equivalent fit of the reverse mediator ordering indicates that the proposed PD → CRR ordering should be understood as a theory-guided proposition rather than an empirically established temporal sequence. The theoretical contribution therefore lies primarily in connecting environmental restorative appraisal with two related but distinguishable recovery experiences.

Third, this study contributes to research on subjective vitality by linking environmental restoration with a positive indicator of psychological functioning. Subjective vitality refers to a positive experience of energy and aliveness and provides an outcome that differs from measures focused mainly on stress, fatigue, or psychological distress.[33] The findings indicate that perceived blue space restorativeness was indirectly associated with subjective vitality through psychological detachment and cognitive restoration. The stronger single-mediator associations, compared with the serial association, further suggest that psychological detachment and cognitive restoration may each provide a distinct route through which restorative environmental experiences are related to positive psychological functioning.

Finally, this study introduces online vigilance as a digital boundary condition of the association between perceived environmental restorativeness and psychological detachment. Existing restoration research has largely considered environmental qualities and individual recovery experiences, whereas contemporary leisure experiences increasingly occur alongside continued attention to digital information.[48] In the present study, the negative interaction between perceived blue space restorativeness and online vigilance indicates that the positive association between perceived restorativeness and psychological detachment was weaker at higher levels of online vigilance. This finding extends the restoration framework by considering digital attentional orientation as a condition that may shape how restorative environmental perceptions are related to psychological detachment.

5.2. Practical implications

The findings of this study provide several implications for restorative experiences in blue space tourism.

First, the positive associations between perceived blue space restorativeness, psychological detachment, cognitive restoration, and subjective vitality highlight the importance of visitors' perceptions when considering the psychological quality of coastal tourism experiences. For destination managers and tourism providers, perceived restorativeness may therefore be a useful dimension for understanding and evaluating the recovery-related value of coastal and seaside tourism. Attention to whether visitors experience a setting as conducive to relaxation, disengagement from everyday demands, and cognitive recovery may help broaden the evaluation of tourism experiences beyond conventional indicators such as satisfaction and destination attractiveness.

Second, psychological detachment was positively associated with cognitive restoration and subjective vitality,

highlighting the relevance of psychological disengagement in restorative tourism experiences. This finding suggests that tourism experiences that allow visitors to temporarily step away from work-related and everyday concerns may be particularly relevant to psychological recovery. From a management perspective, this may encourage greater attention to the overall experience of leisure and to opportunities for visitors to shift their attention away from routine demands. Such a perspective can complement existing tourism approaches that focus primarily on entertainment, destination appeal, or service quality.

Third, cognitive restoration was positively associated with subjective vitality and represented an important indirect pathway linking perceived blue space restorativeness with subjective vitality. This finding highlights cognitive recovery as an important dimension of restorative tourism experiences. For tourism managers and researchers, considering visitors' perceived cognitive recovery may provide an additional way to understand the psychological value of coastal tourism. In particular, restorative tourism experiences may be considered not only in terms of relaxation or stress reduction, but also in terms of whether visitors experience renewed mental clarity, attentional capacity, and psychological energy.

Fourth, subjective vitality provides a meaningful indicator for evaluating the positive psychological value of restorative tourism experiences. Unlike outcomes that focus mainly on fatigue, stress, or psychological strain, subjective vitality reflects a person's experience of energy and aliveness. Incorporating this perspective may help tourism researchers and practitioners better understand the positive psychological outcomes associated with leisure and recovery. It also broadens the assessment of restorative tourism from the reduction of negative states to the experience of positive psychological functioning.

Finally, the moderating role of online vigilance highlights the relevance of digital attentional orientation in contemporary leisure experiences. Higher online vigilance was associated with a weaker positive association between perceived blue space restorativeness and psychological detachment. This finding suggests that continued attention to online information may be an important consideration when examining tourists' ability to disengage from everyday concerns during leisure. For tourists and tourism providers, greater awareness of digital attentional patterns may therefore be relevant when considering the quality of restorative leisure experiences, particularly as mobile connectivity becomes increasingly integrated into travel and everyday life.

Overall, these findings suggest that restorative coastal tourism can be understood through several interconnected dimensions, including perceived environmental restorativeness, psychological detachment, cognitive restoration, subjective vitality, and digital attentional orientation. Considering these dimensions together may provide tourism managers and researchers with a broader perspective on the psychological value of coastal and seaside tourism experiences.

5.3. Limitations and future research

Several limitations of this study should be considered when interpreting the findings and identifying the directions for future research.

First, the cross-sectional design limits the ability to draw firm causal conclusions regarding the relationships among perceived blue space restorativeness, psychological detachment, cognitive restoration, and subjective vitality. Robustness checks indicate that a model specifying the reverse serial ordering fits the data equally well, suggesting that the adopted sequence rests on theoretical reasoning rather than empirical adjudication, and reciprocal influences cannot be ruled out. Future research could adopt longitudinal vacation designs with measurements before, during, and after a blue space experience, or employ experience sampling, to better capture changes in recovery-related experiences and clarify temporal ordering.

Second, respondents were recruited online through non-probability sampling, and because the moderator itself concerns digital engagement, self-selection may have shaped the distribution of online vigilance in ways that constrain generalizability. The findings are therefore best interpreted as applying primarily to online-recruited tourists with the demographic profile described in this study. Future studies could employ probability-based or on-site sampling, together with predefined eligibility criteria and a specified recall window, to strengthen external validity.

Third, the reliance on self-reported data from a single source may introduce common method bias and subjective perception bias, and the absence of a pre-trip baseline means that the study captures perceived restorative experiences rather than changes from a documented starting point. Future studies could complement survey data with physiological measures, device-use records, or behavioral measures of sustained attention to provide additional sources of evidence.

Fourth, several unmeasured individual differences, including trait anxiety and neuroticism, may partly account for the observed associations involving online vigilance. In addition, the conceptual proximity between the being-away dimension of perceived restorativeness and psychological detachment warrants further scrutiny,

although robustness analyses indicate that the observed association is not driven by overlapping item content. Future studies could incorporate relevant dispositional measures and further examine the discriminant validity of these theoretically related constructs.

Fifth, the study did not collect objective or detailed indicators of the tourism and environmental context, such as time spent near water, specific environmental features, destination conditions, activity type, weather, or perceived crowding. The study also did not include a non-blue comparison condition. As a result, the findings describe associations within coastal and seaside tourism settings but cannot determine whether these associations are specific to particular blue space characteristics or would also be observed in other restorative tourism environments. Future research could incorporate objective measures of environmental exposure and trip characteristics, and compare coastal blue space settings with green or other tourism environments. Experimental designs could further manipulate environmental exposure and smartphone availability to examine the conditions under which restorative associations emerge.

6. Conclusion

Using ART as a foundation, this study examined a moderated sequential mediation model of the association between perceived blue space restorativeness and tourists' subjective vitality. Based on survey data from 384 coastal tourists, perceived blue space restorativeness was associated with subjective vitality both directly and indirectly through psychological detachment and cognitive restoration considered separately and in sequence. The two single-mediator pathways accounted for a larger share of the total indirect association, whereas the sequential pathway, although statistically significant, was the smallest of the three. The strength of the associations involving psychological detachment varied according to online vigilance: at higher levels of online vigilance, the indirect pathways involving psychological detachment were no longer statistically distinguishable from zero. Because the evidence is cross-sectional and an alternative ordering of the two mediators fits the data equally well, these results are best interpreted as covariance patterns consistent with the proposed recovery framework rather than as evidence of a temporal or causal sequence. Therefore, the findings suggest that online vigilance may represent a condition under which the association between perceived blue space restorativeness and psychological detachment is weaker. Longitudinal and experimental research is needed to clarify the temporal and causal processes underlying these associations.

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Conflict of interest

The authors declare no conflicts of interest.

Author contributions

Conceptualization: All authors
Formal analysis: All authors
Investigation: All authors
Methodology: Yanjun Luo
Writing–original draft: All authors
Writing–review & editing: All authors

Ethics approval and consent to participate

This study was reviewed and approved by the Academic Committee of the Business School, Guangdong Ocean University. No formal approval reference number was issued by the committee. The study was conducted in accordance with local legislation, institutional requirements, and the principles of the Declaration of Helsinki. Informed consent was obtained from all participants before their participation in the study.

Consent for publication

Not applicable. All survey data were collected anonymously, and participation was voluntary.

Availability of data

The data supporting the findings of this study are publicly available in an online repository and can be accessed at https://doi.org/10.7910/DVN/N4PBDC.

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Appendix

Table A1. Standardized loadings with and without the common latent factor (*N* = 384)

Item	Standardized loading (no method factor)	Standardized loading (method factor retained)	Method-factor loading
PBSR1	0.787	0.777	0.131
PBSR2	0.773	0.750	0.186
PBSR3	0.759	0.750	0.124
PBSR4	0.764	0.775	0.045
PBSR5	0.759	0.746	0.143
PBSR6	0.781	0.781	0.094
PBSR7	0.774	0.753	0.176
PBSR8	0.768	0.763	0.107
PBSR9	0.780	0.724	0.349
PBSR10	0.805	0.775	0.223
PBSR11	0.786	0.763	0.189
PBSR12	0.745	0.720	0.191
PD1	0.768	0.740	0.211
PD2	0.763	0.762	0.150
PD3	0.770	0.706	0.314
PD4	0.752	0.697	0.271
CRR1	0.759	0.721	0.242
CRR2	0.778	0.722	0.289
CRR3	0.805	0.734	0.335
CRR4	0.793	0.769	0.213
CRR5	0.784	0.753	0.226
SV1	0.790	0.836	0.056
SV2	0.752	0.718	0.215
SV3	0.811	0.793	0.192
SV4	0.763	0.682	0.345
SV5	0.749	0.643	0.434
SV6	0.761	0.686	0.350
OV1	0.768	0.718	-0.295
OV2	0.791	0.782	-0.138
OV3	0.772	0.740	-0.221
OV4	0.798	0.779	-0.173
OV5	0.804	0.791	-0.154
OV6	0.854	0.841	-0.162

Notes: The measurement model with a common latent factor loading on all 33 indicators fit the data well, $\chi^2(452) = 455.93$, $p = 0.439$; $\chi^2/df = 1.01$; comparative fit index (CFI) = 0.999; Tucker–Lewis index = 0.999; root mean square error of approximation (RMSEA) = 0.005; standardized root mean square residual (SRMR) = 0.027. Method-factor loadings ranged from −0.295 to 0.434 (mean absolute value 0.210); the loadings of the six online vigilance items are uniformly negative, consistent with the negative correlation of that construct with the remaining four. The average variance attributable to the method factor was 5.23%, compared with 56.15% attributable to the substantive factors. The mean absolute change in substantive standardized loadings was 0.033 and the largest change 0.105; no loading fell below 0.60 or changed its significance. When the method factor was retained in the structural model, $\chi^2(291) = 284.99$, $p = 0.588$; CFI = 1.000; RMSEA = 0.000; SRMR = 0.026, and no standardized structural coefficient changed by more than 0.044.

Abbreviations: CRR: Cognitive restoration; OV: Online vigilance; PBSR: Perceived blue space restorativeness; PD: Psychological detachment; SV: Subjective vitality.