forests

MDPI

Article

How Does the Urban Forest Environment Affect the Psychological Restoration of Residents? A Natural Experiment in Environmental Perception from Beijing

Sixian Li, Tianyu Chen, Feiying Chen and Feng Mi *

School of Economics and Management, Beijing Forestry University, Beijing 100083, China; keer_li@163.com (S.L.); chentianyu@bjfu.edu.cn (T.C.); yuzuphillm@gmail.com (F.C.)
* Correspondence: mifengsun@163.com; Tel.: +86-010-62338464

Abstract: The urban forest is not only an essential part of maintaining the security of the urban ecosystem but also an important restorative environmental site that benefits the physical and mental health of residents. In this research, a natural experiment was designed in Beijing in order to evaluate the urban forest environment in terms of visual, auditory, and olfactory senses, and the effects of psychosocial restoration in urban forest environments were tested. On this basis, a Partial Least Squares-Structural Equation Model was structured to verify the "environment-perception-restoration mechanism". The findings showed that the urban forest environment was the main cause of the differences in residents' psychological restoration and the natural environment perception, while the natural environment perception directly impacted residents' psychological restoration and mediated the relationship between the urban forest environment and psychological restoration. Therefore, Beijing needs to further optimize the landscape, sound, smell, and other environmental elements of urban forests and create a peaceful and spacious urban forest open space, considering the environmental perception preferences of urban residents, to improve the psychological restoration effect of urban forests.

Keywords: urban forest environment; psychological restoration; environmental perception; natural experiment

Citation: Li, S.; Chen, T.; Chen, F.; Mi, F. How Does the Urban Forest Environment Affect the Psychological Restoration of Residents? A Natural Experiment in Environmental Perception from Beijing. *Forests* **2023**, *14*, 1986. https://doi.org/10.3390/f14101986

Academic Editors: Patrik Grahn, Anna Maria Palsdottir and Jonathan Stoltz

Received: 24 August 2023
Revised: 25 September 2023
Accepted: 29 September 2023
Published: 2 October 2023

1. Introduction

As an ecosystem with human society as the main body and territorial space and various facilities as the environment, the city is the sum of the natural and social environments. While the accelerated pace of global urbanization in recent years has largely improved medical conditions and thus human health, it has been accompanied by a growing number of urban problems, including environmental pollution, changes in the types of work and lifestyle, and changes in diet and daily activities, which pose significant challenges to the health of urban residents [1]. Currently, nature-based solutions are an important concept in building sustainable cities internationally [2]. The urban forest is a green infrastructure for sustainable urban construction [3]. As an important component of modern cities and a cornerstone for maintaining the security of urban ecosystems, urban forests play an important ecological function in carbon sequestration and oxygen release, landscape beautification, noise reduction, urban heat island effect reduction, and pollutant absorption [4]. At the same time, the urban forest, as an important restorative environment, is close to urban residents and is an indispensable place for people to get close to nature in their daily lives, playing a special role in promoting healthy bodies for residents, especially in alleviating people's bad moods, reducing mental fatigue, and providing other psychological recoveries [5]. In recent years, urban forests in China have developed rapidly. According to The People's Republic of China Yearbook, 2022, the green space rate of the urban built district across China reached 38.70% in 2021 [6]. However, against the background of the rapid

growth of the urban forest "quantity", whether its spatial distribution can meet the needs of the sustainable socio-economic development, and whether its environmental quality can act to improve the physical and mental health of residents, have become the key constraints for the scientific construction and governance of urban forests.

The urban forest environment, as an important space for environmental restoration and an important place for residents to engage with nature, improves human well-being in a variety of ways [7]. Vision, hearing, and smell are the three senses through which people most directly perceive their environment, and urban forests also positively affect residents' psyche primarily through these perceptible environmental elements, i.e., landscape, sound, and odor. Though several researchers have proven the importance of urban forest environments for residents' mental health, environmental elements and resident perceptions have led to the variability in psychological restoration in urban forest environments. If we focus on increasing the quantity without improving the quality and do not focus on the residents' sense of experience in the urban forest environment, the psychological restoration effect that the urban forest environment has on residents will not achieve the expected effect. Some studies have collected the evaluation and preferences of experiencers in terms of visual, auditory, and olfactory senses, respectively, through methods such as Scenic Beauty Evaluation (SBE) [8–10]. Other studies have focused on the overall sensory evaluation of the environment [11–13]. On the whole, the variations in the psychological restoration of urban forest environments are derived from the "top-down" planning and design of environmental elements and the "bottom-up" perceptual evaluation of residents. In order to achieve environmental restoration in urban forests, governmental departments should not only plan for the formation of near-natural or semi-natural urban forest communities [14] based on the concepts of ecosystem services [15] and near-nature [16], but also focus on the perceptible attributes of the environment and aim to effectively enhance people's s well-being [17].

In this study, we constructed the analytical framework of the "environment-perception-restoration mechanism" for urban forests, and corresponding hypotheses were proposed. Then, a Partial Least Squares-Structural Equation Model (PLS-SEM) was constructed to analyze the effect mechanism of the urban forest environment on residents' psychological restoration based on the experimental data of Beijing, China. Finally, the role of natural environment perception in influencing residents' psychological restoration was investigated by examining the mediating effects of natural environment perception. Accordingly, planning and design measures in the perception dimension of the urban forest environment were proposed to enhance the restoration effect of Beijing's urban forests, thereby improving the residents' mental health.

2. Theoretical Analysis and Hypotheses

2.1. Restorative Environment

In the mid-19th century, Olmsted, a master of urban landscape design, discovered that the natural landscape of cities positively affected the psychological health of city dwellers. Since then, the theoretical concept of restoration has gradually received the attention of researchers in environmental psychology [18]. The concept of a "restorative environment" was first introduced in the 1980s by Kaplan and Talbot at the University of Michigan, who found that wilderness life had a restorative function for most people [19]. Kaplan thus defines "restorative environment" as an environmental setting that helps people recover and renew from physical and mental exhaustion and the negative emotions associated with stress [20]. The recovery processes that can be observed, such as positive shifts in mood, decreased levels of voluntary arousal, improvements in the completion of directed attention tasks, and other changes, are dependent on the individual's use of needed resources [21]. Subsequently, Kaplan and Ulrich et al. conducted a series of further theoretical and empirical studies on restorative environments and proposed the Attention Recovery Theory (ART) and Stress Reduction Theory (SRT) [20,22]. These two fundamental theories have been widely applied in the environmental psychology field.

At present, studies have demonstrated that human contact with nature is expected to promote mental health, improve mood, and even improve physical health [23,24]. Nature can be effective in helping people recover from stress or attention fatigue [25–27]. In the initial studies, experiments were biased toward comparing the differences between natural and artificial spaces (urban environments) as a way to emphasize the restorative nature of the natural environment [21,28,29]. In fact, any environment that is restorative can be restorative [20]. Urban environments, which are designed, have the same stress-reducing and mood-elevating abilities as natural environments [30,31]. Therefore, it is necessary to pay attention to areas with natural elements in the city, such as parks and street green spaces in cities, which have a more direct relevance to people's daily use and thus act in the healthy life of people, compensating for the health problems caused by the lack of nature in cities [32–34].

2.2. Urban Forest Environment and Psychological Restoration

As a significant component of the urban environment, the urban forest has a close relationship with the health and well-being of city dwellers, and the effect of the urban forest environment on psychological restoration is impacted by a variety of factors in a combined manner (Figure 1). On the one hand, urban forest environments can have psychological benefits. A growing number of studies from different perspectives such as plant volatiles, ecological product services, and horticultural therapy have shown that urban forest environments can provide relaxation and leisure for urban residents; improve people's quality of life and thus reduce depression and anxiety levels; alleviate mental stress and mood disorders; and contribute to positive emotions [22,35–37]. In recent years, some studies have further measured psychological responses using stress perception scales and self-assessment based on SRT to increase the reliability of the findings [38,39]. According to a summary analysis of current studies, urban green spaces, including urban forests, could affect the mental health of residents by affecting people's emotions, stress, social interactions, and neighborhood satisfaction [40]. In addition, urban green spaces can also improve residents' happiness in living and working [41,42]. On the other hand, urban forest environments can also produce cognitive benefits. Kaplan hypothesized that exposure to nature could reduce mental fatigue by stimulating non-physically demanding unconscious cognitive processes [26]. Subsequently, studies have further confirmed that green spaces such as urban forests not only help people to recover energy [20] and eliminate visual fatigue but also help to stimulate creativity [43]. Even casual contact with nature can help people to relax and improve cognitive functions [44,45]. In addition, it has been proved that the urban forest environment can help improve the cognitive function and academic performance of children and adolescents, enhance memory ability, and improve life skills [44,46]. At the same time, some scholars have developed the Perceived Restorative Scale, Restoration Outcome Scale, and other scales in order to evaluate the restorative effect of the environment [47,48]. In general, most studies have shown that there is a positive correlation between urban green space and residents' psychological well-being, but the existing research lacks the causal relationship between these two, especially in terms of the mechanisms of influence. Combined with the above analysis, Hypothesis 1 is proposed.

Hypothesis 1 (H1). *The urban forest environment has a significant positive effect on psychological restoration.*

2.3. Environmental Perception and Psychological Restoration in Urban Forests

The ways in which forest environments improve human physical and mental health are many [7], and even small stimuli can have some positive impact. Currently, the recognized beneficial environmental factors include a more comfortable microclimate, cleaner air, softer light, quieter acoustics, and certain types of Biogenic Volatile Organic Compounds (BVOCs) [49]. In addition, some studies have gradually recognized the importance of subjectivity as much as objectivity. Studies have been conducted in several research areas

using the Semantic Differential (SD) method to extensively explore residents' perceptions of the forest environment in terms of the composition, function, and design [50,51].

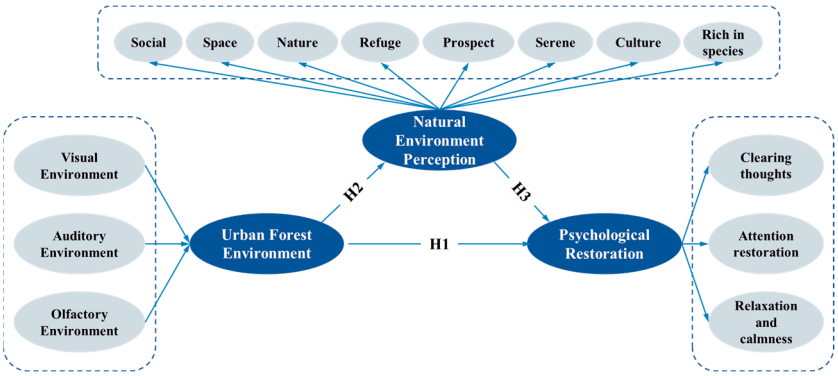

Figure 1. The analytical framework of the "environment-perception-restoration mechanism".

Differences in forest environments also influence people's evaluation and selection preferences. Forest landscapes, sounds, and smells, as influences affecting physical and mental states, can be intuitively perceived, and studies evaluating their quality through subject feedback are becoming deeper and more refined [52]. Therefore, the Perceived Sensory Dimensions (PSD), a bottom-up approach to environmental evaluation, is widely used [11–13]. Some scholars have further identified eight different natural-environment perception dimensions based on theories such as ART, SRT, and Biodiversity Theory [53], which apply to a variety of landscape types [12], such as urban parks [54], urban forests [55], natural forests [56], etc. The following hypotheses are proposed according to the above analysis.

Hypothesis 2 (H2). *The urban forest environment has a significant positive effect on natural environment perception.*

Hypothesis 3 (H3). *Natural environment perception has a significant positive effect on psychological restoration.*

In summary, although newly built or renovated urban forest environments can meet residents' daily needs to be close to nature and restore their psychological health, there is great heterogeneity in the psychological recovery effects of urban forests because of the differences in residents' natural environment perception. Based on the above analysis, the urban forest environment influences residents' psychological restoration through natural environment perception. Accordingly, Hypothesis 4 is proposed.

Hypothesis 4 (H4). *Natural environment perception mediates the effect of the urban forest environment on residents' psychological restoration.*

3. Materials and Methods

3.1. Experimental Sites

The western region of Beijing is mountainous, rich in forest resources and diverse landscape types. The local government announced a number of urban forests that have potential for therapeutic recreation in the Western Hills area of Beijing after inspections. Based on this, we further investigated and considered the geographic location, air quality, landscape configuration, vegetation types, and other factors of the urban forests. Three urban forest parks with dense forests and different landscapes from the list announced by the local government were chosen for the study: Fenghuangling Forest Park, Yangtai Mountain Forest Park, and Baiwang Mountain Forest Park. Among them, Fenghuangling Forest Park is rich in natural landscapes, and the park is mainly planted with pines, cypresses, ginkgoes, and mountain apricots. Yangtai Mountain Forest Park has many old

and famous trees, mainly cypresses, ginkgoes, and maples. Baiwang Mountain Forest Park is rich in vegetation levels, with many greasy pines and cypresses, as well as colorful foliage species such as Cotinus coggygria. Figure 2 shows the actual views of the three experimental sites on the morning of the experimental days.

Figure 2. Actual views of the three experimental sites on the morning of the experimental day.

The physical environment of the forest changes dynamically throughout the day, and the air anion content of the forest is higher in the morning and evening than at other times of the day during the spring in Beijing [57]. Considering the distance between the three experimental sites, it was not possible to complete the experiment in the morning of the experimental day. Therefore, we selected the mornings of 25 March, 26 March, and 28 March 2023, respectively. Meanwhile, we reminded participants to try to maintain a regular life during the experimental days to avoid affecting the results. While participants were undergoing the urban forest experience, two of our researchers used a temperature and humidity anemometer (NK-5500, Kestrel, Albuquerque, NM, USA) to measure air temperature, relative humidity, and wind speed at the experimental sites, a digital noise meter (TES-1350R, TES, Taiwan, China) with an A-weighting gear to measure the average sound pressure level at the experimental sites, and a forest atmospheric ion meter (DLY-5G, Kilter, Fujian, China) to measure air anion. As shown in Table 1, the urban forest environment experience on the experimental days felt comfortable, with good weather conditions and relatively stable atmospheric states.

Table 1. Objective physical environment indicators between three experimental sites.

Date	Experimental Site	Temperature/°C	Humidity/%	Wind Speed/(m·s^{-1})	Noise/dB	Air Anion/cm^{-3}
25 March 2023	Fenghuangling Forest Park	13.40	33.90	0.72	45.48	561.00
26 March 2023	Yangtai Mountain Forest Park	14.10	17.75	0.67	43.11	508.50
28 March 2023	Baiwang Mountain Forest Park	13.80	34.80	0.80	37.16	53.50

3.2. Participants

We recruited 41 participants (including 22 university student volunteers and 19 social volunteers) to complete three experimental tests through online and offline recruitments in

Beijing. The inclusion criteria were people aged 18 and above, and enrollees who thought it was difficult to walk in the forest park were excluded. All participants had normal vision and color vision, hearing and smell were at normal levels, and none of them had cognitive or psychiatric disorders. There were 21 males (51.22%) and 20 females (48.78%) who participated in the study, with a wide distribution of subjects in terms of age, occupation, and income, making the study somewhat generalizable. In addition, all participants had prior forest experiences but had not visited an urban forest in the last six months (i.e., October 2022 to March 2023). Participation in the study was voluntary, and every subject signed the informed consent document.

3.3. Measures

The full questionnaire, presented in Appendix A, consists of four parts, including the Demographic Information, the Urban Forest Environment Semantic Evaluation Scale, the Perceived Sensory Dimension Scale [55], and the Restoration Outcome Scale [39]. The language of all questions was Chinese, with the Perceived Sensory Dimension Scale and the Restoration Outcome Scale using Chinese versions developed by Chinese researchers to enable better understanding and use by participants.

3.3.1. Environmental Indices

The perceptible urban forest environment can be measured in three dimensions: visual, auditory, and olfactory. We set up six pairs of adjectives reflecting the visual environment, six pairs of adjectives reflecting the auditory environment, and five pairs of adjectives reflecting the olfactory environment, and each set of descriptions was adjusted to meet the purpose of the study. Each item was measured using a 5-point Likert scale which ranged from −2 (closer to the left side description) to 2 (closer to the right-side description). Based on this scale, the participants evaluated the urban forest environment in different experimental areas.

3.3.2. Perceptual Indices

The PSD scale was used to examine the participants' perceptions of how they perceive different natural environments. The scale consists of eight different dimensions with recognized reliability [53,55,58]. Each dimension was followed by additional descriptions to facilitate participants' understanding. The 5-point Likert scale (1 = completely disagree, 5 = completely agree) was used for all questions.

3.3.3. Psychological Indices

The Restoration Outcome Scale (ROS) is a valid scale for studying the effects of recovery. This scale reflects the outcome of subjective environmental resilience and includes three dimensions of clearing thoughts, attention restoration, relaxation and calmness. There are six items in total [39,48,59,60]. All questions were asked on a 5-point Likert scale (1 = completely disagree, 5 = completely agree).

3.4. Experimental Design and Survey Procedure

3.4.1. Preparation and Introduction

Before conducting the experiment, all participants were informed regarding the purpose and process of this research, the confidentiality of the experimental data, and how to reach the investigators. Participants declared that they volunteered to participate and understood that they could discontinue participating at any time and with no consequences. In addition, we randomly divided 41 subjects into three groups, and they filled out the Demographic Information.

3.4.2. Going to the Experimental Site and Stress Induction

On the morning of each of the three urban forest experience days, three guides led the subjects to the experimental site together by car. On the way, all subjects were not allowed

to use electronic devices, such as mobile phones, and the guides played the same music to create a uniform environment for subjects, keeping them as undisturbed as possible by the outside environment. Upon arrival at the experimental site, participants gathered in the designated open area at 9:15 a.m. A stress induction before the urban forest experience was necessary to ensure, as much as possible, that all 41 subjects were under stress at the same time. Existing research practices include asking subjects to visualize mentally exhausting scenarios [61], the Stroop test [62], going through an exam [63], etc. Considering the convenience and comprehensibility of stress induction outdoors, we finally used the Stroop test, also known as the "Color Word Conflict Test", which requires subjects to restrain the brain's inherent habit and quickly identify colors in the presence of word meaning interference [62]. The use of the Stroop test in this experiment could generate a certain amount of stress by allowing all participants to focus their attention and task their brains quickly for a short period of time.

3.4.3. Experience and Restoration

Three groups of subjects were led by three guides and entered the experimental area at 9:30. They were not allowed to carry cell phones and were asked not to talk to each other during the experiment. Forest walking and forest meditation are often used as essential activities for forest therapy [64,65]. Walking in a forest environment can increase vitality and reduce fatigue [66]. Forest meditation can reduce unnecessary attention [67] and has a significant stress-reducing effect [68]. Furthermore, it has been shown that staying in a natural environment for more than 15 min produces the best recovery effect [69]. Therefore, in this study, the subjects first walked freely on the designated trail for 30 min, avoiding fast walking, running, and other behaviors that might affect the results of the experiment, and then they sat quietly in the designated area for 30 min. Throughout the experience, all subjects carefully observed the sights in the forest, listened to insects and birds, and breathed in the fresh air and smells of the forest. During the second half of the meditation, the subjects further mobilized the three senses of sight, sound, and smell by referring to the questions on the Urban Forest Environment Semantic Evaluation Scale and the PSD scale, and they completed the questionnaire. Finally, after two stages of experience in the urban forest environment, the subjects completed the ROS within two minutes with their feelings. Figure 3 takes Baiwang Mountain Forest Park as an example and represents the experimental procedure which is divided into four stages in total: Gather, Stroop Test, Forest Walking, and Forest Meditation.

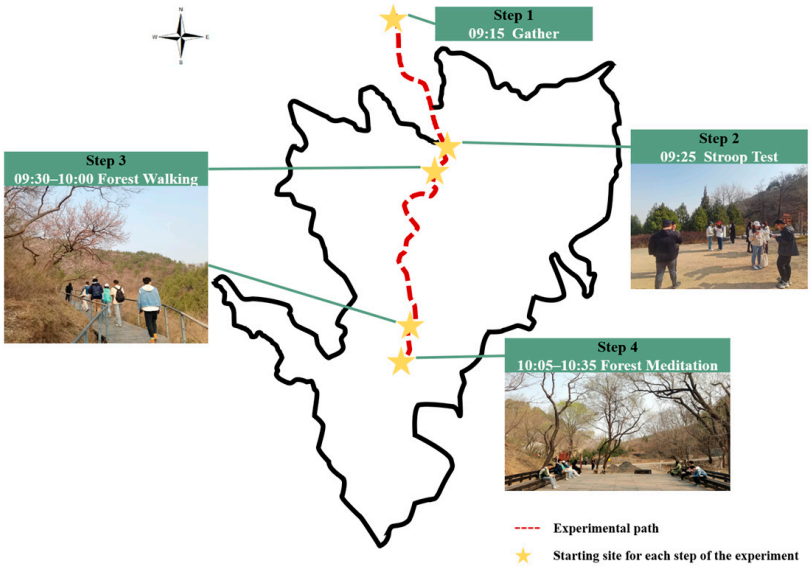

Figure 3. Schematic diagram of the experimental procedure in Baiwang Mountain Forest Park.

3.5. Data Analysis Strategy

3.5.1. Missing Data and Outliers Checking

We first estimated the missing data and subsequently used them in the data analysis. Missing values of the Urban Forest Environment Semantic Evaluation were imputed using the median value (0 or 1). Missing values of the PSD and the Sensory Dimensional ROS were estimated using the median value (4). In addition, we identified data that were extreme outliers, purposely wrong, or had typos, and then we dropped them.

3.5.2. Model Construction

PLS-SEM was utilized to analyze causal relationships and impact pathways between the urban forest environment, natural environment perception, and psychological restoration, providing an expanded space for the study of urban forests as a restorative environment. PLS-SEM is suitable for this study because PLS path modeling avoids the issue of a small sample size [70,71]; additionally, the aim of this research is to discover and test a proposed research model [72]. In addition, PLS-SEM applies to models including second-order constructs [73], and mediating effects could be analyzed better using PLS-SEM [74]. A complete PLS-SEM is composed of the outer model, which characterizes the association between latent and manifest variables, and the inner model, which describes the association among unobserved or latent variables [75]. The outer models are typically composed of two equations that are expressed as shown in Equations (1) and (2).

$$X = \Lambda_\chi \xi + \delta \tag{1}$$

$$Y = \Lambda_y \eta + \varepsilon \tag{2}$$

In Equation (1), ξ is an exogenous latent variable that describes the urban forest environment. Λ_χ denotes the factor loading matrix of the exogenously observed variable on the exogenous latent variable. X stands for the exogenously observed variable, and δ denotes the error term of the observed variable. In Equation (2), η is an endogenous latent variable that describes natural environment perception and psychological restoration. Λ_y denotes the factor loading matrix of the endogenously observed variable on the endogenous latent variable. Y stands for the endogenously observed variable, and ε denotes the error term of the observed variable.

Using internal models, we analyzed the causal relationships between three latent variables: urban forest environment, natural environment perception, and psychological restoration. Equation (3) shows the expression of the structural model.

$$\eta = B\eta + \Gamma\xi + \zeta \tag{3}$$

In Equation (3), B denotes the matrix of coefficients for natural environment perception and psychological restoration. Γ represents the effect of exogenous latent variables on endogenous latent variables, while ζ denotes the residual vectors, which represent the unexplained part of the equation.

The parameters of the outer and inner models were estimated using the Smart PLS software (version 3.2.9, SmartPLS GmbH, Oststeinbek, Schleswig-Holstein, Germany) using PLS path modeling and a path weighting scheme for the inner approximation [76,77]. Moreover, a nonparametric bootstrap implemented in Smart PLS 3.2.9 was used to obtain the standard errors of the estimates through 1000 replications and constructed level change preprocessing [76,77]. In addition, we modeled the hierarchical structure through the three steps shown in Figure 4.

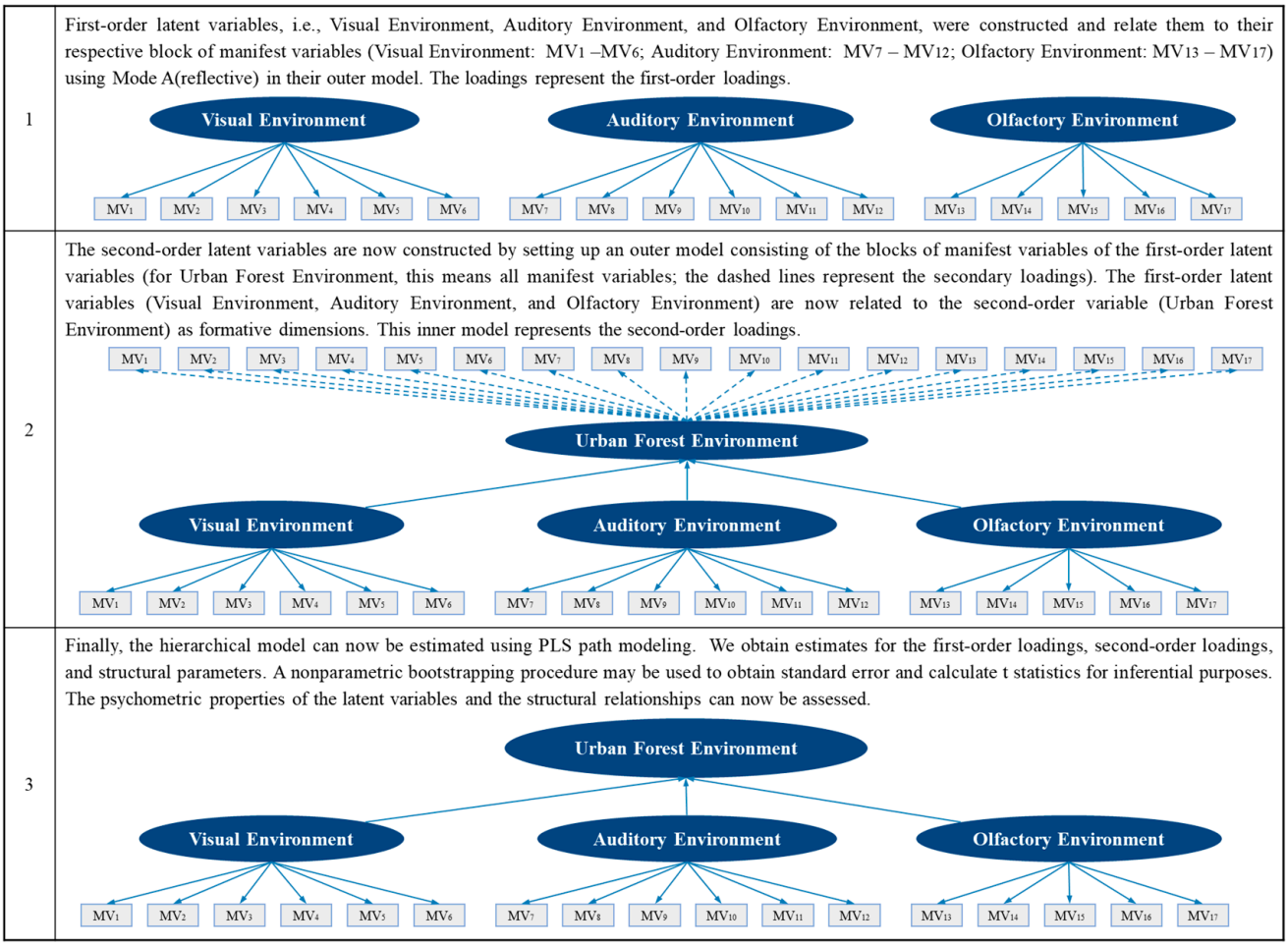

Figure 4. Steps for Constructing a Hierarchical Latent Variable Model Using PLS Path Modeling. The numbers (1, 2, 3) indicate the order of steps.

4. Results

4.1. Overall Evaluation across the Three Experimental Sites

The results of the environmental indices are presented in Figure 5. As for the visual environment, the three experimental sites were considered to have high and well-organized tree covers, creating a spatial sense of tree clusters but at an average level in terms of landscape match. The experimental process was in the spring, the colors of the forests were more diverse, and under the sunlight, the understory was bright but not blinding. In terms of the auditory environment, the participants heard more sounds from nature, which were soft and accompanied by the chirping of insects and birds. Experiencers were able to immerse themselves better. Regarding the olfactory environment, the participants found the odors of all three urban forests to be relatively fragrant and integrated but not very special, and the aromatic odors had a short retention time. Overall, however, the participants were satisfied with the current olfactory environment.

The results of the participants' perceptions of PSD are presented in Figure 6. At first, all three experimental sites (4.171 ± 0.115, 4.220 ± 0.108, and 4.171 ± 0.115) were perceived in the social dimension. For space, Yangtai Mountain Forest Park (4.415 ± 0.105) was the highest, while Fenghuangling Forest Park (4.220 ± 0.108) was the lowest. In the nature dimension, all three experimental sites had a high degree of nature, with Baiwang Mountain Forest Park having the highest (4.707 ± 0.087). In terms of refuge and culture, none of the three experimental sites scored more than 4.1, indicating that these two dimensions are not obviously perceived. For the prospect dimension, all experimental sites scored more than 4, with Yangtai Mountain Forest Park (4.463 ± 0.093) being considered the experimental

site with the most expansive view. In the serene dimension, Yangtai Mountain Forest Park (4.341 ± 0.119) and Baiwang Mountain Forest Park (4.341 ± 0.114) scored higher, and Fenghuangling Forest Park (4.220 ± 0.089) scored slightly lower than the former. In addition, only Fenghuangling Forest Park (4.122 ± 0.112) and Yangtai Mountain Forest Park (4.146 ± 0.124) scored more than 4 in the rich-in-species dimension, suggesting that participants were unable to clearly perceive this environmental attribute at Baiwang Mountain Forest Park.

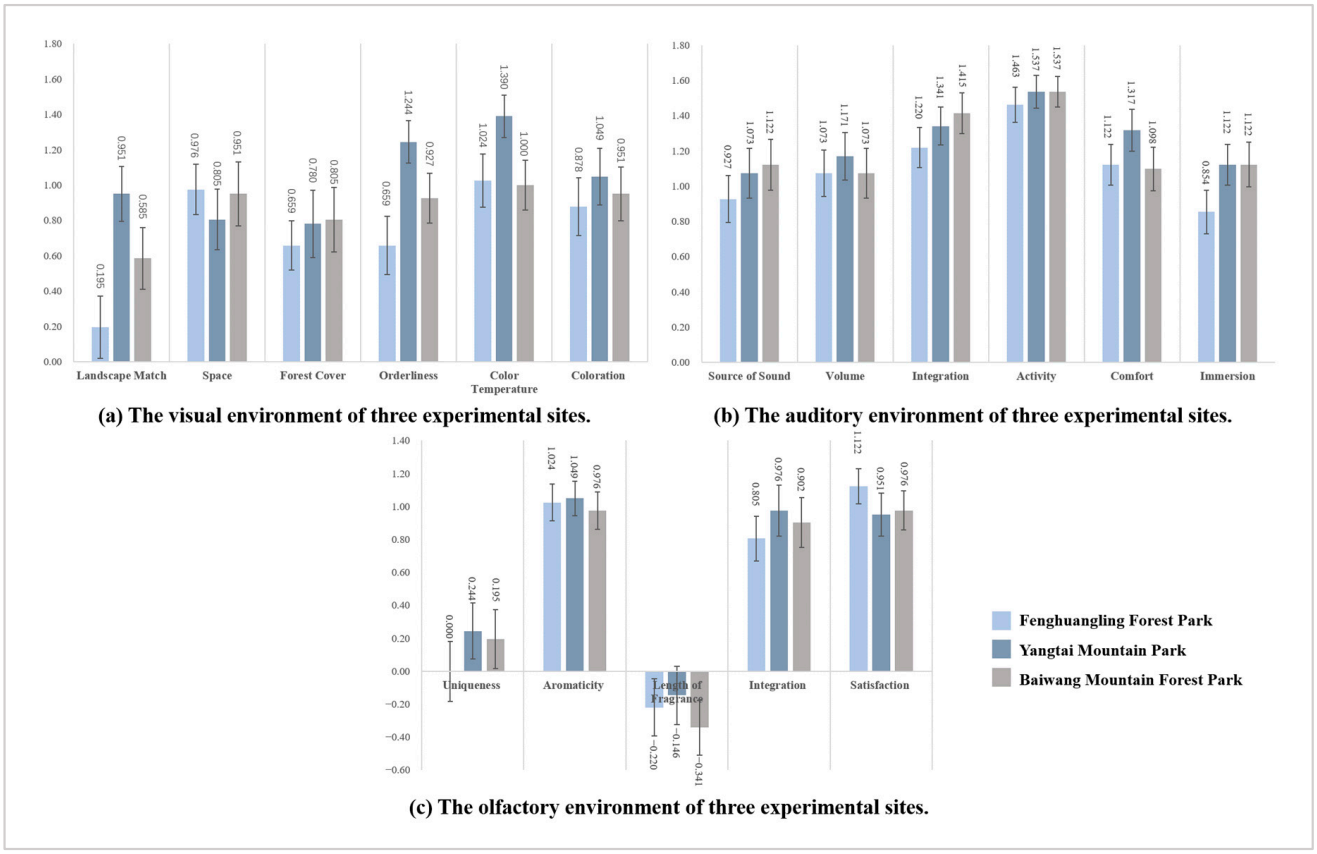

Figure 5. The urban forest environment of three experimental sites. n = 41; Mean ± Standard error.

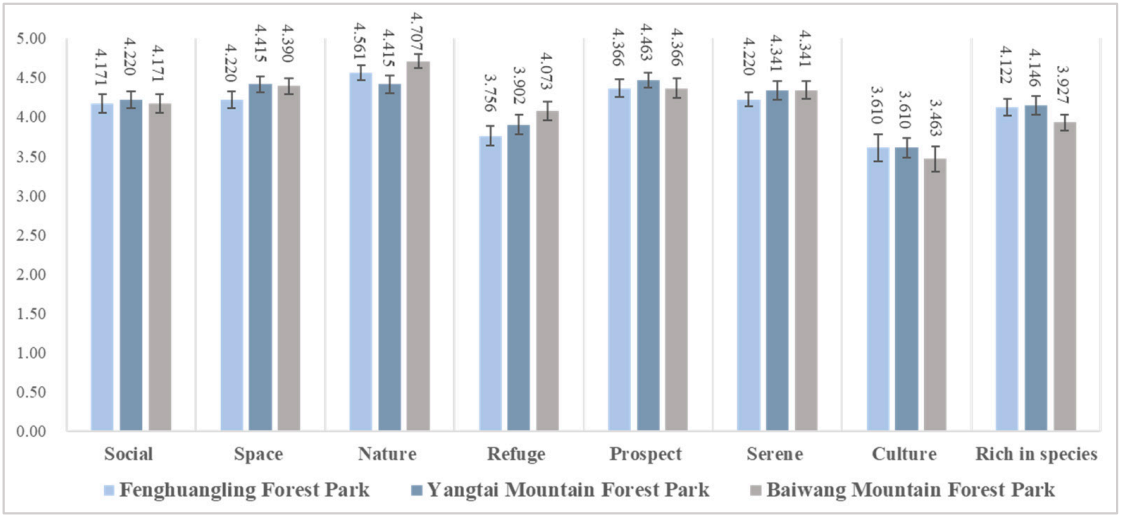

Figure 6. The PSD evaluation of three experimental sites. n = 41; Mean ± Standard error.

As shown in Figure 7, as for the psychological restoration, relaxation and calmness had high scores in all three experimental sites (3.724 ± 0.082, 4.046 ± 0.063, and 3.943 ± 0.074) from three dimensions. In terms of the experimental sites, Yangtai Mountain Forest Park had the highest scores in all three dimensions of clearing thoughts (3.902 ± 0.088), attention restoration (3.780 ± 0.102), and relaxation and calmness (4.046 ± 0.063), indicating a strong level of restoration. In addition, Fenghuangling Forest Park (3.171 ± 0.140) had the lowest score for attention restoration. However, all scores of psychological restoration were above 3, which indicates that the most participants positively evaluated the three restoration experiences.

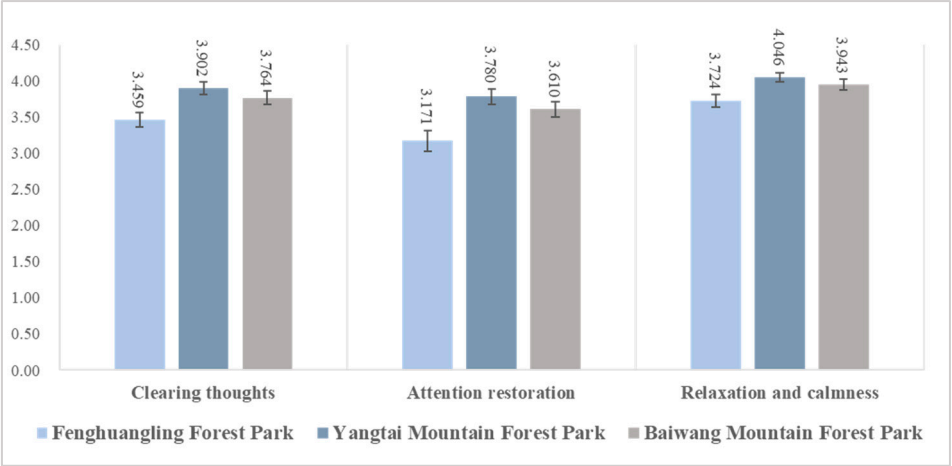

Figure 7. The psychological restoration of three experimental sites. n = 41; Mean ± Standard error.

4.2. Reliability and Validity Analyses

We used Cronbach's alpha (CA) to examine the reliability of the findings. The results are shown in Table 2; every observed variable in the questionnaire had a CA that was greater than 0.7, which means good reliability [78,79]. In addition, composite scale reliability (CR) [80,81] and average variance extracted (AVE) [81] were calculated to assess the reliability of the questionnaire. All AVE exceeded the critical value of 0.40 when the CR was greater than 0.80 [81], which indicated that both reliability and convergent validity were acceptable. Moreover, as shown in Table 3, the results further confirmed the discriminant validity of the Heterotrait-Monotrait ratio (HTMT) [82]. The HTMT values were all below 0.90 [83], thus supporting the discriminant validity.

Table 2. Reliability and validity test results.

Latent Variable	Manifest Variable	Loading	CA	CR	AVE
Urban Forest Environmental Assessment					
Visual Environment	Landscape Match [MV1]	0.807	0.833	0.879	0.551
	Space [MV2]	0.769			
	Forest Cover [MV3]	0.828			
	Orderliness [MV4]	0.655			
	Color Temperature [MV5]	0.568			
	Coloration [MV6]	0.793			
Auditory Environment	Source of Sound [MV7]	0.722	0.794	0.854	0.495
	Volume [MV8]	0.682			
	Integration [MV9]	0.733			
	Activity [MV10]	0.607			
	Comfort [MV11]	0.732			
	Immersion [MV12]	0.737			

Table 2. *Cont.*

Latent Variable	Manifest Variable	Loading	CA	CR	AVE
Olfactory Environment	Uniqueness [MV13]	0.772	0.813	0.870	0.573
	Aromaticity [MV14]	0.787			
	Length of Fragrance [MV15]	0.702			
	Integration [MV16]	0.810			
	Satisfaction [MV17]	0.709			
Urban Forest Environmental Perceptiveness					
Natural Environment Perception	Social [MV18]	0.594	0.784	0.840	0.403
	Space [MV19]	0.684			
	Nature [MV20]	0.745			
	Refuge [MV21]	0.621			
	Prospect [MV22]	0.518			
	Serene [MV23]	0.774			
	Culture [MV24]	0.440			
	Rich in species [MV25]	0.634			
Urban Forest Environmental Restorative					
Psychological Restoration	Clearing thoughts [MV26]	0.933	0.870	0.9120	0.793
	Attention restoration [MV27]	0.830			
	Relaxation and calmness [MV28]	0.905			

CA, Cronbach's alpha; CR, Composite reliability; AVE, Average variance extracted.

Table 3. Discriminant validity assessment: Heterotrait-Monotrait (HTMT) ratios.

Construct	Visual Environment	Auditory Environment	Olfactory Environment	Natural Environment Perception	Psychological Restoration
Visual Environment					
Auditory Environment	0.6992				
Olfactory Environment	0.8975	0.6438			
Natural Environment Perception	0.5328	0.4503	0.3611		
Psychological Restoration	0.6142	0.5777	0.5722	0.7391	

4.3. Model Path Analysis

PLS-SEM uses the R^2 values (explained variance) in the causal structure for assessing the explanatory strength of the structural model. Among them, the construct of the urban forest environment accounted for 19.5% of the variance in natural environment perception. A total of 52.1% of the variance in psychological restoration was accounted for by urban forest environment and natural environment perceptions. It shows that, for this study, the theoretical model constructed has a moderate level of explanatory ability that allows for path regression analysis [82].

The pathways through which the urban forest environment affected residents' psychological restoration were analyzed using the PLS-SEM constructed above (Figure 8). Regarding the second-order factor of the urban forest environment, the path coefficients from the basic first-order factors of the visual environment, auditory environment, and olfactory environment to the urban forest environment were 0.443, 0.344, and 0.369, respectively (Table 4), and all of them were significantly positive at the 1% level. Among them, compared with auditory environment and olfactory environment, the path coefficient of the visual environment was the largest, and its contribution to the urban forest environment was the most prominent. This indicates that, for residents, the landscape state of an urban forest, such as landscape match, forest cover, and coloration, more prominently reflects the environmental characteristics of the urban forest, as well as being an essential dimension for residents to evaluate the urban forest environment. The CR and CA of the urban forest environment were 0.918 and 0.904, both of which were higher than the recommended

threshold value of 0.70. Moreover, the correlations among the first-order factors were high, which ranged from 0.527 to 0.743. The correlations between the first-order factors and the path coefficients from the first-order factors to the urban forest environment implied that the urban forest environment was influenced by these first-order factors, and they were thus formative dimensions of the urban forest environment [81,84]. In summary, the findings supported the formative measurement model of the urban forest environment as a second-order factor and its three dimensions as first-order indicators.

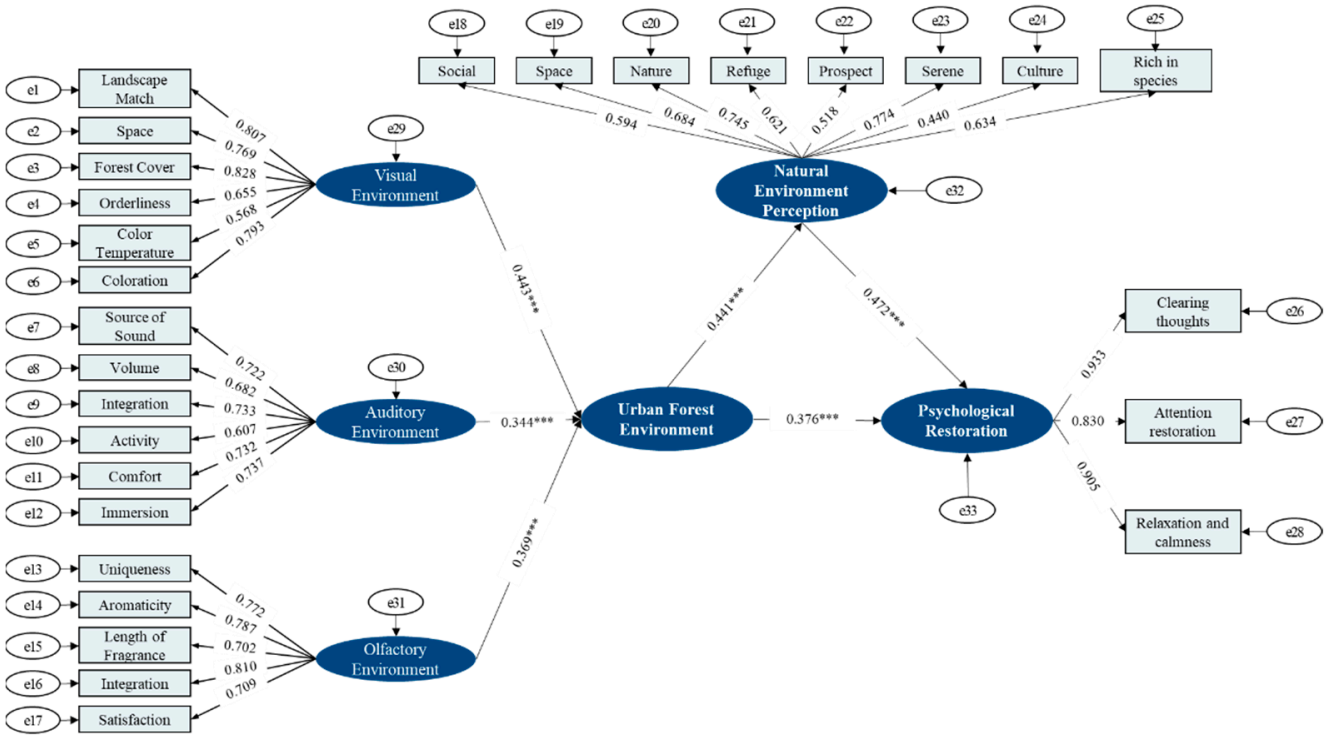

Figure 8. PLS-SEM of psychological restoration of urban forests. *** indicate 1% significance levels.

Table 4. Model path results and explanatory ability of constructs relationships.

Constructs	Path Coefficients	SE	*p*-Value	Boot LLCI	Boot ULCI	R^2 Value	Hypotheses
VE to UFE	0.443 ***	0.026	0.000	0.397	0.501	-	-
AE to UFE	0.344 ***	0.030	0.000	0.280	0.400	-	-
OE to UFE	0.369 ***	0.020	0.000	0.327	0.408	-	-
UFE to PRL	0.376 ***	0.062	0.000	0.252	0.493	-	Supported
UFE to NEP	0.441 ***	0.088	0.000	0.282	0.624	-	Supported
NEP to PRL	0.472 ***	0.069	0.000	0.327	0.592	-	Supported
NEP	-	-	0.017	0.080	0.390	0.195 **	-
PRL	-	-	0.000	0.422	0.643	0.521 ***	-

*** and ** indicate 1% and 5% significance levels, respectively. VE, Visual environment; AE, Auditory environment; OE, Olfactory environment; UFE, Urban forest environment; PRL, Psychological restoration; NEP, Natural environment perception.

Meanwhile, we tested all hypotheses according to the outcomes of the model path coefficients. As indicated in Table 4, hypotheses H1, H2, and H3 were supported by the standardized path coefficients of the model. The standardized path coefficient between the urban forest environment and psychological restoration was 0.376 (significant and positive at 1% level), which indicated that each 1-unit increase in the urban forest environment increased the residents' psychological restoration by 0.376 units, validating H1. It demonstrated that enhancing the environmental setting of the urban forest (including the sights, sounds, and smells), especially the visual environment, can attract residents to experiences, which in turn makes them feel the forest, relax, and relieve stress, ultimately

restoring their mental state [85]. The standardized path coefficient between the urban forest environment and natural environment perceptions was 0.441 (significant and positive at 1% level), which showed that each 1-unit increase in the urban forest environment led to an increase of 0.441 units in residents' natural environment perception, validating H2. It indicated that as the environment is optimized in the urban forest, the strength of the residents' perceptions of the natural environment here will increase accordingly. The standardized path coefficient between the natural environment perception and psychological restoration was 0.472 (significant and positive at 1% level), which implied that each 1-unit increase in natural environment perception was associated with an increase of 0.472 units of residents' psychological restoration, validating H3. It reflected that the higher the residents' perceived senses of the natural environment here, the more deeply they can feel the uniqueness of the urban forest environment and have a better restorative experience, resulting in a more pronounced psychological recovery effect [13].

In addition, among the eight dimensions of natural environment perception, the standardized path coefficients of serene (0.774) and nature (0.745) were larger than those of other dimensions, and both were higher than 0.7, which not only indicated that the urban forest environment influenced the residents' perception of serenity and naturalness to a greater extent, but also indicated that the residents' perception of serenity and naturalness also played a more significant role in the psychological restoration. Regarding psychological restoration, the standardized path coefficient of attention restoration (0.830) was relatively low compared to clearing thoughts and relaxation and calmness. This may be due to the fact that residents, when they are in the urban forest environment, are more concerned with relaxing and clearing their minds in the short term, whereas attention restoration will be reflected in their commitment to work and study after the experience.

4.4. Intermediary Effect Analysis

We supplemented the analysis by examining whether the effect of the urban forest environment on psychological restoration was mediated by natural environment perception. The results showed a positive relationship between the urban forest environment and psychological restoration without the natural environment perception variable, with a significant direct path from the urban forest environment to the psychological restoration in the model ($\beta = 0.583$, $p < 0.01$). In addition, natural environment perception was included as a mediating variable in the model. It was found that the effect of the urban forest environment on the psychological restoration was still significant ($\beta = 0.376$, $p < 0.01$). However, the absolute value of the path coefficient from the urban forest environment to the psychological restoration was much smaller than the former.

To discover the pathways by which the urban forest environment affects residents' psychological restoration, we further analyzed its mediating effects. Table 5 shows the results. None of the confidence intervals for the direct, indirect, and total effects of the urban forest environment on residents' psychological restoration with natural environment perception as a mediating variable contained 0, demonstrating a partial rather than a full mediating effect of the urban forest environment on residents' psychological restoration. This suggests that differences in urban forests' psychological restoration between residents are generated by the residents' natural environment perception.

Table 5. Standardized test results between latent variables.

Hypothesis Effect	Test Item	β	SE	*p*-Value	Boot LLCI	Boot ULCI
Direct effect	UFE ⇒ PRL	0.376 ***	0.062	0.000	0.252	0.493
Indirect effect	UFE ⇒ NEP	0.441 ***	0.088	0.000	0.282	0.624
	NEP ⇒ PRL	0.472 ***	0.069	0.000	0.327	0.592
Total effect	UFE ⇒ PRL	0.584 ***	0.058	0.000	0.470	0.696

*** indicates 1% level of significance. UFE, Urban forest environment; PRL, Psychological restoration; NEP, Natural environment perception.

The resulting PLS-SEM showed that the urban forest environment had an impact on residents' psychological restoration via a mechanism (Table 6). The mediating effect of natural environment perception (i.e., "environmental perception mechanism") was 0.208 (significant and positive at 1% level). It suggests that the urban forest environment significantly increased residents' psychological restoration through the "environmental perception mechanism", further revealing the profound impact of residents' natural environment perception on psychological restoration [13] and validating H4.

Table 6. Results of mediated path tests between latent variables.

Mediation Analysis	β	SE	*p*-Value	Boot LLCI	Boot ULCI
UFE ⇒ NEP ⇒ PRL	0.208 ***	0.040	0.000	0.142	0.302

*** indicates 1% level of significance. UFE, Urban forest environment; PRL, Psychological restoration; NEP, Natural environment perception.

5. Discussion

The impact of forests on psychological well-being is a research topic that has received a great deal of attention. However, relatively few studies have explored the association between urban forests and psychological restoration with respect to the visual, auditory, and olfactory environmental characteristics of urban forests, and few have investigated the mediating effect variables that explain how urban forests affect recovery outcomes. This study aimed to test the theoretically established "environment-perception-restoration mechanism" through the effects of urban forest environment and natural environment perceptions. In addition, it was hypothesized that natural environment perception positively mediated the relationship between urban forest environment and psychological restoration. Using PLS-SEM modeling techniques, the direct and indirect relationships were examined, and we proved significant associations between urban forest environment and natural environment perceptions with psychological restoration. Through this modeling, we were able to characterize nearly 55% of the variance in psychological restoration and show that urban forest environments can provide a psychologically restorative experience. The exploration of the "environment-perception-restoration mechanism" of urban forests provides an empirical evidence basis for the promotion of residents' mental health in urban forest environments, as well as a direction for the development of forest therapy in Beijing.

5.1. Environmental Features and Psychological Restoration in Urban Forests

The PLS-SEM results indicated a significant positive effect between the urban forest environment and psychological restoration. The experience of the urban forest involves the perceptual sensory system [53], which reflects the feelings of the experiencers. Subjective feelings are different from objective measurements, which directly contribute to human well-being by measuring indicators such as temperature, humidity, and negative ion content in urban forests. In practice, the subjective perception of residents is equally important, and residents can only achieve better physical and mental relaxation if they personally feel the uniqueness of the urban forest environment. In contrast to existing research, this study reinforced the observations through scoring the experience of the visual, auditory, and olfactory environments of urban forests. Significant differences in the effects of the visual, auditory, and olfactory environments of urban forests on residents' psychological restoration were demonstrated. Urban forest environments with a high percentage of forest cover, a unique landscape match, soft and immersive sounds in the forest, and aromatic odors in the forest can have a notable impact on residents' psychological restoration. Notably, of the three types of environments: visual, auditory, and olfactory, the visual environment has a more prominent restorative effect and exerts a greater influence. This indicates that the landscape state of urban forests more directly reflects the environmental features of forests, and the visual impact of urban forests on residents can produce more significant psychological restoration. Therefore, it is important for Beijing's urban forests to focus on relying on richer landscape resources, shaping a superior visual recreation

environment, enhancing people's visual experience, and thus improving the healing effect of forests in China's capital city.

5.2. Environmental Perception and Psychological Restoration in Urban Forests

Understanding which environmental qualities have a major influence on the psychological restoration of residents is important for optimizing and managing urban forest environments [53,56]. It has been shown in several studies that the PSD scale can offer reliable outcomes in evaluating the sensory perceptions of environments such as urban green spaces [13,54,55]. Therefore, in this study, we incorporated PSD as a natural environment perception into the "environment-perception-restoration mechanism" analytical framework of urban forests, and we collected subjects' perceptual evaluations of eight dimensions at three experimental sites. This approach not only helped us to explore the influence of environmental perception on psychological restoration but also helped us to identify the important environmental qualities that contribute to psychological restoration. The PLS-SEM results showed that the perception of the natural environment had a direct influence on the psychological restoration of the residents [86,87], and among the eight dimensions, the serene and nature dimensions had the highest contribution, and the influence on the psychological restoration was higher than that on the other dimensions. Overall, the depth perception of the urban forest is a key factor in promoting psychological restoration. Urban forest environments that gave a stronger sense of serenity and nature had higher psychological recovery effects. In addition, it was found that natural environment perception played a partial mediating role in the relationship between the urban forest environment and psychological restoration. This suggests that natural environment perception is a mechanism that enables experiencers to perceive the unique beauty of the urban forest and, in turn, gain positive psychological restoration. This provides evidence that positive forest experiences and restorative effects are realized through the multisensory perception of the urban forest environment. Therefore, Beijing's urban forests should pay more attention to the noise reduction effect of forests and actively create natural spaces to promote the effective utilization of the therapy function of forests.

5.3. Suggestions

Accordingly, it is necessary to further optimize and enhance the urban forest environment in terms of residents' perception of the natural environment, combined with the visual, auditory, olfactory, and other environmental characteristics of urban forests, to promote the development of a synergistic enhancement of urban forest and residents' mental health [88].

First, the landscape design of the urban forest should be optimized. We discovered that the visual environment is the environmental dimension that has the most significant impact on the residents' environmental perception and psychological restoration. Therefore, the focus should be on relying on the existing rich landscape resources and continuously improving the forest coverage, enriching plant species and vegetation colors, shaping a more superior visual environment, and guaranteeing the uniqueness and restorative nature of the urban forest landscape. Second, a pleasant sound environment of the urban forest should be created. Different sounds through the human auditory function will bring different feelings. Our study found that a serene environment can promote the psychological restoration of residents. For this reason, plants with noise-reducing functions should be planted, and the sounds of nature should be used more to create a comfortable auditory landscape, thus enhancing the sense of belonging of those who experience it and bringing inner peace. Third, the olfactory environment of urban forests should not be ignored. In this study, although odor did not play a major role in psychological restoration, clean air and aromatic and volatile substances emitted by plants are beneficial to the human body [49]. Therefore, flowers and trees with a light fragrance and which are beneficial to the human body can be planted to create a healthy, clean, and restorative scent environment.

5.4. Limitations and Future Research

In spite of the contribution of this study, several limitations should be noted. First, the experiments of this research were all focused on the spring, and no follow-up experiments were conducted for all seasons. In the future, researchers can conduct long-term experiments while maintaining the consistency of the experimental design to explore changes in the urban forest environment under seasonal changes, including the changes in vegetation, temperature, humidity, and other important factors, and the impacts on psychological restoration effects. Second, this experiment mainly used psychological scales to collect relevant data and lacked the collection of objective data. In the future, researchers can incorporate relevant physiological indicators on this basis and obtain objective data such as heart rate, blood pressure, finger temperature, etc. through professional medical equipment to enhance the accuracy of the data. Finally, to obtain the subjective real feelings of the subjects, this study adopted the field natural experiment method, which lacks controllability to a certain extent. Subsequently, 3S technology, VR equipment, and eye trackers can be introduced to conduct virtual experiments to achieve real-time monitoring and convenient data collection of the urban forest environment and human behaviors based on comprehensive consideration and setting of multi-sensory perception.

6. Conclusions

Urban forests play an important role in enhancing residents' physical and mental health. A framework of psychological restoration in the urban forest environment was analyzed in this study based on ART and SRT. Using the experimental data in Beijing, China, we constructed a PLS-SEM to quantify the mechanisms of psychological restoration of the urban forest environment. The major conclusions in this research include: (1) Urban forest environments should be designed to take into account people's sensory experience and create a more restorative environment in terms of landscape, sound, and smell, especially from the visual perspective, thereby ensuring that residents are restored within the urban forest. (2) The effect coefficient of the urban forest environment on natural environment perception was 0.441, while that on residents' psychological restoration was 0.376, indicating that an overall environmental setting for urban forests enhances the intensity of residents' perception of the environment here, especially the sense of serenity and nature. This may further attract residents to experience it in-depth and thus promote the recovery of mental health. (3) The impact coefficient of natural environment perception on residents' psychological restoration was 0.472, indicating a significant positive influence of residents' perceived senses on restorative experience. By optimizing the factors of the perceptual sensory dimension of urban forests, residents' psychological recovery can be improved. (4) The urban forest environment can significantly affect residents' psychological restoration through the "environment-perception-restoration mechanism". Residents with a relatively low perception of the natural environment may not have a better psychological recovery. With the aim of further improving the perceptibility of the urban forest environment and residents' mental health, Beijing must optimize the environmental elements of urban forests to make sure that the health benefits of urban forests are truly realized.

Author Contributions: Conceptualization, S.L. and T.C.; methodology, S.L. and F.C.; software, S.L. and F.C.; validation, S.L., T.C. and F.C.; formal analysis, S.L., T.C. and F.C.; resources, S.L. and T.C.; data curation, S.L., F.C. and T.C.; writing—original draft preparation, S.L. and T.C.; writing—review and editing, F.M.; visualization, S.L. and T.C.; supervision, F.M.; project administration, F.M.; funding acquisition, F.M.; all authors corrected the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Fundamental Research Funds for the Central Universities, Grant No. 2021SJZ01.

Data Availability Statement: Data will be made available on request.

Acknowledgments: We are grateful for the assistance of other members of the subject group in gathering the data. We would also like to thank the researchers of Beijing Forestry University for their technical guidance.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Appendix A.1. Demographic Information

(1) Your gender is:

A. Male B. Female

(2) Your age is:

A. 18–30 years old B. 31–40 years old C. 41–50 years old D. 51–65 years old E. >65 years old

(3) Your occupation is:

A. student B. Famer C. Retiree D. Freelancer E. Worker
F. Business manager G. Professional H. Public official I. Self-employed

(4) Your average monthly income is:

A. <3500 ¥ B. 3501–5000 ¥ C. 5001–8000 ¥
D. 8001–15,000 ¥ E. 15,001–20,000 ¥ F. >20,000 ¥

Table A1. Urban Forest Environment Semantic Evaluation Scale.

Sensory Dimension	Item	−2	−1	0	1	2	
Visual Environment	Landscape Match	Common					Unique
	Space	Spacious					Clustered
	Forest Cover	Sparse					Lush
	Orderliness	Scattered					Staggered
	Color Temperature	Shady					Bright
	Coloration	Single					Multicolored
Auditory Environment	Source of Sound	Man-Made					Natural
	Volume	Loud					Softly
	Integration	Clamorous					Coordinated
	Activity	Dull					Energetic
	Comfort	Harsh					Gentle
	Immersion	Estranged					Immersed
Olfactory Environment	Uniqueness	General					Special
	Aromaticity	Pungent					Fragrant
	Length of Fragrance	Short-Lived					Ongoing
	Integration	Adulterated					Converged
	Satisfaction	Disgusted					Obsessed

Table A2. Perceived Sensory Dimension Scale.

Dimension	Description	Scale				
Social	Here is an environment suitable for social activities.	1	2	3	4	5
Space	This is a spacious and undisturbed environment.	1	2	3	4	5
Nature	The sensation of wilderness and nature.	1	2	3	4	5
Refuge	Here is an enclosed and safe environment.	1	2	3	4	5
Prospect	Here is an open space with a wide view.	1	2	3	4	5
Serene	Here is a silent and peaceful environment.	1	2	3	4	5
Culture	Many artificial elements are decorated here.	1	2	3	4	5
Rich in species	Many animals and plants around here.	1	2	3	4	5

Table A3. Restoration Outcome Scale.

Dimension	Item	Scale
Clearing thoughts	I can forget everyday worries here.	1 2 3 4 5
	Visiting here is a way of clearing and clarifying my thoughts.	1 2 3 4 5
Attention restoration	My concentration and alertness clearly increase here.	1 2 3 4 5
Relaxation and calmness	I feel calmer after being here.	1 2 3 4 5
	After visiting this place I always feel restored and relaxed.	1 2 3 4 5
	I get new enthusiasm and energy for my everyday routines from here.	1 2 3 4 5

References

1. Zhao, Z.; Hou, Y.; Wen, Y. Research on Citizens' Spatial Image Perception of Urban Forest in Beijing. *J. Arid Land Resour. Environ.* **2019**, *33*, 57–63. (In Chinese)
2. Tayefi Nasrabadi, M. How Do Nature-Based Solutions Contribute to Urban Landscape Sustainability? *Environ. Dev. Sustain.* **2021**, *24*, 576–591. [CrossRef]
3. Castellar, J.A.C.; Popartan, L.A.; Pueyo-Ros, J.; Atanasova, N.; Langergraber, G.; Säumel, I.; Corominas, L.; Comas, J.; Acuña, V. Nature-Based Solutions in the Urban Context: Terminology, Classification and Scoring for Urban Challenges and Ecosystem Services. *Sci. Total Environ.* **2021**, *779*, 146237. [CrossRef]
4. Torralba, M.; Lovrić, M.; Roux, J.-L.; Budniok, M.-A.; Mulier, A.-S.; Winkel, G.; Plieninger, T. Examining the Relevance of Cultural Ecosystem Services in Forest Management in Europe. *Ecol. Soc.* **2020**, *25*, 2. [CrossRef]
5. Kotera, Y.; Richardson, M.; Sheffield, D. Effects of Shinrin-Yoku (Forest Bathing) and Nature Therapy on Mental Health: A Systematic Review and Meta-Analysis. *Int. J. Ment. Health Addict.* **2020**, *20*, 337–361. [CrossRef]
6. The People's Republic of China Yearbook Publishing House. *The People's Republic of China Yearbook, 2022*; Wang, Y., Shi, G., Eds.; The People's Republic of China Yearbook Publishing House: Beijing, China, 2022; pp. 491–494. ISBN 10009647. (In Chinese)
7. Karjalainen, E.; Sarjala, T.; Raitio, H. Promoting Human Health through Forests: Overview and Major Challenges. *Environ. Health Prev. Med.* **2009**, *15*, 1–8. [CrossRef]
8. Yu, K. *Landscape: Culture, Ecology and Perception*; Science Press: Beijing, China, 1998; ISBN 7030067118. (In Chinese)
9. Chen, F.; Liao, W. Construction of an Evaluation Index System on the Forest Soundscape. *Sci. Silvae Sin.* **2012**, *48*, 56–60. (In Chinese)
10. Chen, Y.; Yuan, X. Research Progress on Smellscape. *Chin. Landsc. Archit.* **2017**, *33*, 107–112. (In Chinese)
11. Yakınlar, N.; Akpınar, A. How Perceived Sensory Dimensions of Urban Green Spaces Are Associated with Adults' Perceived Restoration, Stress, and Mental Health? *Urban For. Urban Green.* **2022**, *72*, 127572. [CrossRef]
12. Memari, S.; Pazhouhanfar, M.; Grahn, P. Perceived Sensory Dimensions of Green Areas: An Experimental Study on Stress Recovery. *Sustainability* **2021**, *13*, 5419. [CrossRef]
13. Malekinezhad, F.; Courtney, P.; bin Lamit, H.; Vigani, M. Investigating the Mental Health Impacts of University Campus Green Space through Perceived Sensory Dimensions and the Mediation Effects of Perceived Restorativeness on Restoration Experience. *Front. Public Health* **2020**, *8*, 578241. [CrossRef]
14. Voigt, A.; Wurster, D. Does Diversity Matter? The Experience of Urban Nature's Diversity: Case Study and Cultural Concept. *Ecosyst. Serv.* **2015**, *12*, 200–208. [CrossRef]
15. Tammi, I.; Mustajärvi, K.; Rasinmäki, J. Integrating Spatial Valuation of Ecosystem Services into Regional Planning and Development. *Ecosyst. Serv.* **2017**, *26*, 329–344. [CrossRef]
16. Gavrilidis, A.A.; Niță, M.R.; Onose, D.A.; Badiu, D.L.; Năstase, I.I. Methodological Framework for Urban Sprawl Control through Sustainable Planning of Urban Green Infrastructure. *Ecol. Indic.* **2019**, *96*, 67–78. [CrossRef]
17. Tomao, A.; Secondi, L.; Carrus, G.; Corona, P.; Portoghesi, L.; Agrimi, M. Restorative Urban Forests: Exploring the Relationships between Forest Stand Structure, Perceived Restorativeness and Benefits Gained by Visitors to Coastal Pinus Pinea Forests. *Ecol. Indic.* **2018**, *90*, 594–605. [CrossRef]
18. Ulrich, R.S. Visual Landscapes and Psychological Well-Being. *Landsc. Res.* **1979**, *4*, 17–23. [CrossRef]
19. Kaplan, S.; Talbot, J.F. Psychological Benefits of a Wilderness Experience. In *Behavior and the Natural Environment*; Springer: Boston, MA, USA, 1983; pp. 163–203.
20. Kaplan, S. The Restorative Benefits of Nature: Toward an Integrative Framework. *J. Environ. Psychol.* **1995**, *15*, 169–182. [CrossRef]
21. Hartig, T.; Staats, H. Guest Editors' Introduction: Restorative Environments. *J. Environ. Psychol.* **2003**, *23*, 103–107. [CrossRef]
22. Ulrich, R.S.; Simons, R.F.; Losito, B.D.; Fiorito, E.; Miles, M.A.; Zelson, M. Stress Recovery during Exposure to Natural and Urban Environments. *J. Environ. Psychol.* **1991**, *11*, 201–230. [CrossRef]
23. Pietilä, M.; Neuvonen, M.; Borodulin, K.; Korpela, K.; Sievänen, T.; Tyrväinen, L. Relationships between Exposure to Urban Green Spaces, Physical Activity and Self-Rated Health. *J. Outdoor Recreat. Tour.* **2015**, *10*, 44–54. [CrossRef]

24. Roviello, V.; Gilhen-Baker, M.; Vicidomini, C.; Roviello, G.N. Forest-Bathing and Physical Activity as Weapons against COVID-19: A Review. *Environ. Chem. Lett.* **2022**, *20*, 131–140. [CrossRef] [PubMed]
25. Meyer, K.; Bürger-Arndt, R. How Forests Foster Human Health—Present State of Research-Based Knowledge (in the Field of Forests and Human Health). *Int. For. Rev.* **2014**, *16*, 421–446. [CrossRef]
26. Kaplan, R.; Kaplan, S. *The Experience of Nature: A Psychological Perspective*; Ulrich's Bookstore, Cop: Ann Arbor, Mi, USA, 1989; ISBN 9780914004516.
27. Ulrich, R. View through a Window May Influence Recovery from Surgery. *Science* **1984**, *224*, 420–421. [CrossRef]
28. Berto, R. Exposure to Restorative Environments Helps Restore Attentional Capacity. *J. Environ. Psychol.* **2005**, *25*, 249–259. [CrossRef]
29. Laumann, K.; Gärling, T.; Stormark, K.M. Selective Attention and Heart Rate Responses to Natural and Urban Environments. *J. Environ. Psychol.* **2003**, *23*, 125–134. [CrossRef]
30. Graves, R.A.; Pearson, S.M.; Turner, M.G. Species Richness Alone Does Not Predict Cultural Ecosystem Service Value. *Proc. Natl. Acad. Sci. USA* **2017**, *114*, 3774–3779. [CrossRef]
31. Jiang, B.; Chang, C.-Y.; Sullivan, W.C. A Dose of Nature: Tree Cover, Stress Reduction, and Gender Differences. *Landsc. Urban Plan.* **2014**, *132*, 26–36. [CrossRef]
32. Grahn, P.; Stigsdotter, U.A. Landscape Planning and Stress. *Urban For. Urban Green.* **2003**, *2*, 1–18. [CrossRef]
33. Levinger, P.; Cerin, E.; Milner, C.; Hill, K.D. Older People and Nature: The Benefits of Outdoors, Parks and Nature in Light of COVID-19 and Beyond– Where to from Here? *Int. J. Environ. Health Res.* **2021**, *32*, 1329–1336. [CrossRef]
34. Stock, S.; Bu, F.; Fancourt, D.; Mak, H.W. Longitudinal Associations between Going Outdoors and Mental Health and Wellbeing during a COVID-19 Lockdown in the UK. *Sci. Rep.* **2022**, *12*, 10580. [CrossRef]
35. Kaplan, R.; Kaplan, S. Well-Being, Reasonableness, and the Natural Environment. *Appl. Psychol. Health Well-Being* **2011**, *3*, 304–321. [CrossRef]
36. Coldwell, D.F.; Evans, K.L. Visits to Urban Green-Space and the Countryside Associate with Different Components of Mental Well-Being and Are Better Predictors than Perceived or Actual Local Urbanisation Intensity. *Landsc. Urban Plan.* **2018**, *175*, 114–122. [CrossRef]
37. Kong, L.; Liu, Z.; Pan, X.; Wang, Y.; Guo, X.; Wu, J. How Do Different Types and Landscape Attributes of Urban Parks Affect Visitors' Positive Emotions? *Landsc. Urban Plan.* **2022**, *226*, 104482. [CrossRef]
38. Wang, X.; Wu, C.; Yan, J. Experimental Study of the Perceived Restorative Scale (PRS) in Chinese by Evaluating the Restorative Qualities of Urban Park Scenes. *Chin. Landsc. Archit.* **2019**, *35*, 45–48. (In Chinese)
39. Zhou, W.; Nie, X.; Chi, M.; Zhan, Y.; Yan, C.; Xiu, X.; Lan, S. Influence of the Emotional State of Forest Therapy Consumers on the Recovery of Physical and Mental Health. *For. Econ.* **2020**, *42*, 53–62. (In Chinese)
40. Zhang, Y.; Shi, H.; Cheng, B. A Review of the Impact of Urban Green Space on Residents' Mental Health. *World For. Res.* **2021**, *34*, 8–13. (In Chinese)
41. Hartig, T.; Mang, M.; Evans, G.W. Restorative Effects of Natural Environment Experiences. *Environ. Behav.* **1991**, *23*, 3–26. [CrossRef]
42. Yang, H.; Chen, T.; Zeng, Z.; Mi, F. Does Urban Green Space Justly Improve Public Health and Well-Being? A Case Study of Tianjin, a Megacity in China. *J. Clean. Prod.* **2022**, *380*, 134920. [CrossRef]
43. Yu, C.P.S.; Hsieh, H. Beyond Restorative Benefits: Evaluating the Effect of Forest Therapy on Creativity. *Urban For. Urban Green.* **2020**, *51*, 126670. [CrossRef]
44. Keniger, L.; Gaston, K.; Irvine, K.; Fuller, R. What Are the Benefits of Interacting with Nature? *Int. J. Environ. Res. Public Health* **2013**, *10*, 913–935. [CrossRef]
45. Berman, M.G.; Jonides, J.; Kaplan, S. The Cognitive Benefits of Interacting with Nature. *Psychol. Sci.* **2008**, *19*, 1207–1212. [CrossRef] [PubMed]
46. O'Brien, L. Learning Outdoors: The Forest School Approach. In *Outdoor Learning Research*; Routledge: London, UK, 2009; Volume 37, pp. 45–60.
47. Hartig, T.; Korpela, K.; Evans, G.W.; Gärling, T. A Measure of Restorative Quality in Environments. *Scand. Hous. Plan. Res.* **1997**, *14*, 175–194. [CrossRef]
48. Korpela, K.M.; Ylén, M.; Tyrväinen, L.; Silvennoinen, H. Determinants of Restorative Experiences in Everyday Favorite Places. *Health Place* **2008**, *14*, 636–652. [CrossRef] [PubMed]
49. Zhang, Z.; Ye, B.; Yang, J.; He, Q.; Dong, J. Research Progress in Studies of Health Functions of Urban Forests. *World For. Res.* **2014**, *27*, 27–33. (In Chinese)
50. Llinares, C.; Page, A. Application of Product Differential Semantics to Quantify Purchaser Perceptions in Housing Assessment. *Build. Environ.* **2007**, *42*, 2488–2497. [CrossRef]
51. Hansmann, R.; Hug, S.-M.; Seeland, K. Restoration and Stress Relief through Physical Activities in Forests and Parks. *Urban For. Urban Green.* **2007**, *6*, 213–225. [CrossRef]
52. Schirpke, U.; Tasser, E.; Tappeiner, U. Predicting Scenic Beauty of Mountain Regions. *Landsc. Urban Plan.* **2013**, *111*, 1–12. [CrossRef]
53. Grahn, P.; Stigsdotter, U.K. The Relation between Perceived Sensory Dimensions of Urban Green Space and Stress Restoration. *Landsc. Urban Plan.* **2010**, *94*, 264–275. [CrossRef]

54. Qiu, L.; Nielsen, A.B. Are Perceived Sensory Dimensions a Reliable Tool for Urban Green Space Assessment and Planning? *Landsc. Res.* **2015**, *40*, 834–854. [CrossRef]
55. Chen, H.; Qiu, L.; Gao, T. Application of the Eight Perceived Sensory Dimensions as a Tool for Urban Green Space Assessment and Planning in China. *Urban For. Urban Green.* **2019**, *40*, 224–235. [CrossRef]
56. Stigsdotter, U.K.; Corazon, S.S.; Sidenius, U.; Refshauge, A.D.; Grahn, P. Forest Design for Mental Health Promotion—Using Perceived Sensory Dimensions to Elicit Restorative Responses. *Landsc. Urban Plan.* **2017**, *160*, 1–15. [CrossRef]
57. Zhang, J. *Effect of Forest Therapy Based on Environmental and Perceptual Factors*; Beijing Forestry University: Beijing, China, 2018. (In Chinese)
58. Peschardt, K.K.; Stigsdotter, U.K. Associations between Park Characteristics and Perceived Restorativeness of Small Public Urban Green Spaces. *Landsc. Urban Plan.* **2013**, *112*, 26–39. [CrossRef]
59. Kaplan, S.; Bardwell, L.V.; Slakter, D.B. The Museum as a Restorative Environment. *Environ. Behav.* **1993**, *25*, 725–742. [CrossRef]
60. Hartig, T.; Lindblom, K.; Ovefelt, K. The Home and Near-Home Area Offer Restoration Opportunities Differentiated by Gender. *Scand. Hous. Plan. Res.* **1998**, *15*, 283–296. [CrossRef]
61. Tress, B.; Tres, G.; Fry, G.; Opdam, P. *From Landscape Research to Landscape Planning*; Springer Science & Business Media: Berlin/Heidelberg, Germany, 2005; ISBN 9781402039782.
62. Stroop, J.R. Studies of Interference in Serial Verbal Reactions. *J. Exp. Psychol. Gen.* **1992**, *121*, 15–23. [CrossRef]
63. Hartig, T.; Evans, G.W.; Jamner, L.D.; Davis, D.S.; Gärling, T. Tracking Restoration in Natural and Urban Field Settings. *J. Environ. Psychol.* **2003**, *23*, 109–123. [CrossRef]
64. Song, C.; Ikei, H.; Park, B.-J.; Lee, J.; Kagawa, T.; Miyazaki, Y. Psychological Benefits of Walking through Forest Areas. *Int. J. Environ. Res. Public Health* **2018**, *15*, 2804. [CrossRef]
65. Lee, H.J.; Son, Y.-H.; Kim, S.; Lee, D.K. Healing Experiences of Middle-Aged Women through an Urban Forest Therapy Program. *Urban For. Urban Green.* **2019**, *38*, 383–391. [CrossRef]
66. Kobayashi, H.; Ikei, H.; Song, C.; Kagawa, T.; Miyazaki, Y. Comparing the Impact of Forest Walking and Forest Viewing on Psychological States. *Urban For. Urban Green.* **2021**, *57*, 126920. [CrossRef]
67. Peterson, L.G.; Pbert, L. Effectiveness of a Meditation-Based Stress Reduction Program in the Treatment of Anxiety Disorders. *Am. J. Psychiatry* **1992**, *149*, 936–943.
68. Wang, X.; Shi, Y.; Zhang, B.; Chiang, Y. The Influence of Forest Resting Environments on Stress Using Virtual Reality. *Int. J. Environ. Res. Public Health* **2019**, *16*, 3263. [CrossRef] [PubMed]
69. Tyrväinen, L.; Ojala, A.; Korpela, K.; Lanki, T.; Tsunetsugu, Y.; Kagawa, T. The Influence of Urban Green Environments on Stress Relief Measures: A Field Experiment. *J. Environ. Psychol.* **2014**, *38*, 1–9. [CrossRef]
70. Birkinshaw, J.; Morrison, A.; Hulland, J. Structural and Competitive Determinants of a Global Integration Strategy. *Strateg. Manag. J.* **1995**, *16*, 637–655. [CrossRef]
71. Ringle, C.M.; Sarstedt, M.; Straub, D.W. Editor's Comments: A Critical Look at the Use of PLS-SEM in "MIS Quarterly. " *MIS Q.* **2012**, *36*, iii–xiv. [CrossRef]
72. Sarstedt, M.; Cheah, J.-H. Partial Least Squares Structural Equation Modeling Using SmartPLS: A Software Review. *J. Mark. Anal.* **2019**, *7*, 196–202. [CrossRef]
73. Venaik, S.; Midgley, D.F.; Devinney, T.M. Dual Paths to Performance: The Impact of Global Pressures on MNC Subsidiary Conduct and Performance. *J. Int. Bus. Stud.* **2005**, *36*, 655–675. [CrossRef]
74. Nitzl, C.; Roldan, J.L.; Cepeda, G. Mediation Analysis in Partial Least Squares Path Modeling. *Ind. Manag. Data Syst.* **2016**, *116*, 1849–1864. [CrossRef]
75. Henseler, J.; Ringle, C.M.; Sinkovics, R.R. The Use of Partial Least Squares Path Modeling in International Marketing. *Adv. Int. Mark.* **2009**, *20*, 277–319.
76. Chin, W.W. Issues and Opinion on Structural Equation Modeling. *Manag. Inf. Syst. Q.* **1998**, *22*, 7–16.
77. Tenenhaus, M.; Vinzi, V.E.; Chatelin, Y.-M.; Lauro, C. PLS Path Modeling. *Comput. Stat. Data Anal.* **2005**, *48*, 159–205. [CrossRef]
78. Cronbach, L.J. Coefficient Alpha and the Internal Structure of Tests. *Psychometrika* **1951**, *16*, 297–334. [CrossRef]
79. Nunnally, J.C.; Bernstein, I.H. *Psychometric Theory*, 3rd ed.; Tata Mcgraw-Hill Ed: New Delhi, India, 1994; ISBN 9780071070881.
80. Chin, W.W. *The Partial Least Squares Approach for Structural Equation Modeling*; Lawrence Erlbaum Associates: Mahwah, NJ, USA, 1998; pp. 295–336.
81. Fornell, C.; Larcker, D.F. Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *J. Mark. Res.* **1981**, *18*, 39–50. [CrossRef]
82. Hair, J.F. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*; Sage: Los Angeles, CA, USA, 2017; ISBN 9781483377445.
83. Gold, A.H.; Malhotra, A.; Segars, A.H. Knowledge Management: An Organizational Capabilities Perspective. *J. Manag. Inf. Syst.* **2001**, *18*, 185–214. [CrossRef]
84. Bollen, K.; Lennox, R. Conventional Wisdom on Measurement: A Structural Equation Perspective. *Psychol. Bull.* **1991**, *110*, 305–314. [CrossRef]
85. Deng, L.; Li, X.; Luo, H.; Fu, E.-K.; Ma, J.; Sun, L.-X.; Huang, Z.; Cai, S.-Z.; Jia, Y. Empirical Study of Landscape Types, Landscape Elements and Landscape Components of the Urban Park Promoting Physiological and Psychological Restoration. *Urban For. Urban Green.* **2020**, *48*, 126488. [CrossRef]

86. Lu, M.; Fu, J. Attention Restoration Space on a University Campus: Exploring Restorative Campus Design Based on Environmental Preferences of Students. *Int. J. Environ. Res. Public Health* **2019**, *16*, 2629. [CrossRef]
87. Hipp, J.A.; Gulwadi, G.B.; Alves, S.; Sequeira, S. The Relationship between Perceived Greenness and Perceived Restorativeness of University Campuses and Student-Reported Quality of Life. *Environ. Behav.* **2016**, *48*, 1292–1308. [CrossRef]
88. Hsu, Y.-Y.; Hawken, S.; Sepasgozar, S.; Lin, Z.-H. Beyond the Backyard: GIS Analysis of Public Green Space Accessibility in Australian Metropolitan Areas. *Sustainability* **2022**, *14*, 4694. [CrossRef]