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White Spaces Unveiled: Investigating the Restorative Potential of Environmentally Perceived Characteristics in Urban Parks during Winter

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Abstract: Creating attractive urban green spaces in severely cold and harsh climates is significant for promoting peoples' health and perceived restoration. However, there is little evidence regarding the urban green spaces in wintery and cold climates and its restorative benefits. This study utilized a pixel grid approach to quantify winter landscape characteristics and a self-reporting method to assess the restorative benefits of audiovisual interactions. The results show the following: (1) Different types of roads in urban parks have significant differences in their level of restorativeness, and the restorativeness benefits of the primary path in winter parks are the strongest. (2) The presence of snowy elements in winter landscapes can enhance park users' potential to experience restorative characteristics in relation to "being away". Moreover, there exists a noteworthy positive correlation between deciduous trees and their restoration benefits. (3) People's perceptions of the tranquility of the soundscape and the duration of environmental exposure are critical mediators in the impact of the restorative path effect. (4) Compared with women, men have a higher restorative level in both the landscape and soundscape. This elucidates the restorative role of white space landscapes and soundscapes in public psychological perception when proposing appropriate forest-based healthcare strategies. It also provides theoretical guidance and optimization schemes for the overall planning, health planning, and design of white spaces shaped by cold urban green spaces.

Keywords: urban green space; restorative environment; soundscape; winter season; white space

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1. Introduction

The concept of urban planning for healthy cities has attracted the attention of all countries [1], especially since the outbreak of COVID-19. At the same time, with the spread of COVID-19, lockdowns were implemented, and outdoor activities subsequently declined. This led to an increase in psychological stress and suicide mortality [2] and a surge in the number of patients with depression [3]. In addition, the public's demand for entertainment and activities in outdoor spaces is increasing, especially in high-density cities. Urban green space is an important part of urban green infrastructure and a natural place to provide relaxation, entertainment, and perceived recovery for the public [4,5]. The sustainable construction of cities is increasingly emphasizing social sustainability. The design of urban open space supports social sustainability [6]. This design should be combined with the promotion of and support for social life, cultural life, entertainment, recovery, and sports activities [7]. Well-designed green spaces are critical to the health of residents [8] and have

been recognized as one of the potential environmental determinants that regulate mental health [9].

Considering closeness to nature, social interactions, and leisure activities [10], urban green spaces are necessary to maintain the well-being of urban residents in the winter [11]. However, the harsh climatic conditions in winter not only easily cause environmental stress but also limit the occurrence of other outdoor activities [12,13]. Furthermore, they exacerbate common mental health problems such as depression and anxiety [14]. In order to prevent this from happening, a restorative environment that can restore our bodies and minds is required. Research on restorative environments focuses on the physical and mental benefits of exposure to nature, emphasizing the opportunities for individuals to mitigate negative impacts through their interactions with the natural world [15]. A restorative environment has the following four essential characteristics: fascination, being away, compatibility, and extent [16]. Kaplan's attention restoration theory (ART) [16,17] and Ulrich's stress recovery theory (SRT) [18] provide theoretical support for the study of environmental perception characteristics and recovery potential. The view of these two theories is that the driving force of the recovery effect comes from people's immediate emotional response to the natural environment and the potential cognitive benefits of their interaction with the natural environment. At the same time, many studies have proposed a scale to measure the restorative qualities of an environment, such as the widely accepted Perceived Restorativeness Scale (PRS) [19]; its shorter version is PRS-11 [20], and the Restorative Component Scale (RCS) can also be used [21].

Moreover, the restorative effect of the natural element environment is greater than that of the built environment [22,23], and it promotes health from different psychological and physiological perspectives [24]. Therefore, the benefits of exposure to green space include improving mood [25,26], regulating psychological stress [27], enhancing the intensity of physical activity while reducing levels of social anxiety [10,28], and even improving lowered immunity [29]. In addition to green and design elements, the literature points out other factors that affect users' evaluation of green space, namely social demography and space use. First, people found that social/demographical factors such as health status, age, gender, and ethnic group affected users' experience in green spaces [30]. For example, people in good health are twice as likely to exercise in urban green spaces as those in poor health [31]. The gender differences in the effects of the natural environment on stress relief have been documented in previous research. For instance, studies have shown that women are more inclined to experience stress recovery benefits from various environmental settings compared to men [32]. Compared with women, men use urban green spaces more frequently [33], and several large-scale social surveys reveal gender differences in the link between green space and physical/mental health [34,35]. Therefore, it is imperative to investigate potential gender-based disparities for restorative benefits within a winter environment.

The restorative relationship between road types in urban parks has also been confirmed; paths with water edges have better restorative benefits than paths in forests [36]. Therefore, it is urgent to explore the relationship between the spatial characteristics and restorative effects of roads in winter parks. At the same time, there is still limited research on how these benefits can be extended to different seasons, especially regarding the restorative qualities of white space in winter [37]. Forest bathing in winter urban parks can be considered a rational and welcome intervention because it may produce psychological relaxation [38], delivering more sustainable healthcare [39]. In winter, when the elements in many urban green spaces are covered with snow and ice, the landscape may exhibit a limited color palette [40]—forming a "white space" that exists only during a long winter. At the same time, long-term exposure to a cold outdoor environment may cause differences in restorative benefits [41,42]. Consequently, the restorative benefits of winter environments within urban green spaces might be underestimated.

Urban green space may play a key role in building a healthy city [43]. This topic includes various studies that explore physiological and psychological relationships, in-

cluding smell [44], vision [45], hearing [5], and other senses [46]. Generally speaking, vision is considered to be the most important driving factor of sensory and cognitive effects in environmental exposure [5]. Among these aspects, the landscape results from the interaction and influence between people and the environment and is dominated by visual characteristics [23,47]. Some studies have revealed the impact of the continuity of visual landscape features on improving an urban environment's restorative potential [48]. Hearing is the perceptual approach that is second only to vision. It also plays a crucial role in cognition and behavior. Soundscape is described by the International Organization for Standardization (ISO) as an "acoustic environment as perceived or experienced and understood by a person or people, in context" [49]. The soundscape also positively impacts physiological stress recovery [50]; in particular, a natural sound landscape provides more recovery functions [51]. Soundscape perception is mainly related to the perceptions of pleasure or the preference of sound [52] and the familiarity and spatial impression of the sound [53]. Moreover, auditory perception is closely related to visual perception [54]. Therefore, in addition to the adaptive PRS and the Perceived Restorative Component Scale (PRC), the Perceived Restorative Soundscape Scale (PRSS) [55] has been proposed to evaluate soundscape perception recovery. Moreover, the Perceived Restorative Sound Scale for Children (PRSS-C) has been developed [56].

However, most previous studies on the restorative benefits of urban green spaces have not investigated winter conditions, and the effects of audiovisual elements may differ during the winter months due to significant landscape transformations. There is a scarcity of evidence related to winter settings. Therefore, it is essential to contemplate the influence of audiovisual interactions on the psychological restoration of park users within winter environments [57,58].

The relationship between the characteristics of urban green space and perceived recovery has been confirmed [59], which is also the most natural element of the space [60]. However, for urban parks that lose their "green" in winter, the evidence of the relationship between white space characteristics and public mental restoration benefits is still insufficient. This study aims to explore the perceived restorative benefits of urban green space in the winter. It starts from the exposure that the public experiences to outdoor spaces and environments, takes the urban park space environment as closely related to public health and welfare benefits and as the research core, and focuses on the landscape and soundscape characteristics of white space in winter. Specifically, our goal is to explore the impact that the perspective of white space environment design has on restorative benefits in winter by quantifying the public's mental recovery under the winter conditions of urban green space. This provides a design reference and theoretical basis for improving the restorative environment of white spaces in cold cities.

In this work, we asked the following research questions:

Research question 1 (RQ1): Is there a significant difference in the perceived recovery benefits of different path space types in urban parks in winter?

Research question 2 (RQ2): Do the winter landscape and soundscape characteristics significantly affect the perceived recovery benefits? Is environmental exposure related to recoverability? What is the path of impact?

Research question 3 (RQ3): Do demographic characteristics affect the observed patterns?

2. Materials and Methods

2.1. Study Sites

In this study, in severely cold cities in Northeast China, the winter climate is defined as the average daily temperature being below 0 °C (32° F) for more than six consecutive months and the average temperature in January being below −10 °C [61,62]. Changchun, Jilin Province, has a typical cold urban climate [63] and is the only urban park green space in Northeast China that won the ASLA 2019 Honorary Award for Comprehensive Design. This area was selected as the study site. The site's location analysis is shown in Figure 1. The Changchun Culture of Water Ecology Park is an urban brown land reconstruction

project with 300,000 square meters of scarce ecological green land in the urban hinterland. The vegetation community of this site is rich and growing well, with high species diversity; it is adjacent to residential areas, and public recognition is high.

Figure 1. Location map of the research site.

Based on the preliminary field survey findings, it was evident that walking along park pathways is the most prevalent and virtually the sole activity during the winter season. Consequently, we selected 12 specific pathways within the green park area. The selection process was guided by the design requirements outlined in the "Park Design Specifications (GB51192-2016)", which encompass the following three distinct types of pathways: primary path (PP), secondary path (SP), and walking path (WP). These chosen pathways collectively span the entirety of the park, ensuring comprehensive coverage.

2.2. Measuring Tool

2.2.1. Landscape

To quantify the landscape characteristics of winter parks, we employed a method similar to that used by H. Nordh [64] to quantify and summarize the spatial landscape characteristics of each park path element. Each image was consistently framed, maintaining the same angle and focusing on a uniform height (approximately 1.6 m above ground) without the utilization of flash. Working in Photoshop, a grid pattern measuring (42 × 75) square units was laid over each photograph. Each square corresponding to a specific variable was delineated and tallied. Distinct colors were applied for element differentiation within the images, and notations were added to facilitate pixel counting and the computation of variable percentages in relation to the entire image. The quantified variables encompassed the evaluation of sky, snow, trees, and facilities.

The Perceived Restorativeness Scale developed by Hartig et al. was adopted to assess environmental restorativeness. The PRS is a tool to measure the psychological recovery effect of the recovery environment [19]. It has good reliability and validity [36]. This scale was developed based on the attention restoration theory (ART) proposed by Kaplan and his wife [16,17], which includes the following four aspects: fascination, being away, compatibility, and extent. Fascination represents the attractiveness of the environment, measuring how attracted individuals are to their surrounding environment and their ability to stimulate happy and positive emotions. Being away represents stability in the environment and is intended to measure the degree of relaxation in the environment. Compatibility represents environmental tolerance and is intended to measure the comfort of the surrounding environment. The extent represents the spatial connection in the environment, aiming to measure the scale of the environment. Each aspect was measured using a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree).

2.2.2. Soundscape

Drawing from the study concerning the correlation between sound perception within urban parks and the public's visiting experience [65,66], we employed metrics commonly utilized in the research conducted by Hong, J. Y. et al., 2015 [52] and Liu, J. et al., 2019 [67] for soundscape perception. The soundscape was evaluated using the following perceptions of pleasure and tranquility of sound: cheerful, satisfied, happy, and comfortable [52]. The soundscape tranquility was measured as relaxed, soothed, calm, and sober. These items were evaluated using a seven-point scale from "strongly disagree (1)" to "strongly agree (7)".

The assessment of soundscape perception recovery is in line with the previous research design [68] and utilizes the previously developed Perceived Restored Soundscape Scale (PRSS), as shown in Table 1, which was originally introduced by the researcher Sarah R. Payne [69] for an urban park environment based on Perceived Restored Scales.

Table 1. Assessment of items of soundscape restorativeness in urban parks [68].

Components	Restorative Experience with the Soundscape	Items
Fascination	The appeal of the environment	I find this acoustic environment appealing. In this place my attention is drawn by many interesting sounds. I am engrossed in this acoustic environment.
Being away	A sense of relaxation	When I hear these sounds, I can do something different than usual. This acoustic environment is different to what I usually hear. This acoustic environment is a refuge from unwanted distractions. I feel free from routine and responsibility in this acoustic environment.
Compatibility	Exploration of characteristics	This acoustic environment fits with my preference. I can quickly get used to this type of acoustic environment. Hearing these sounds hinders what I want to do here.
Extent	An intoxicating environment	All the sounds I am hearing belong here. All the sounds merge to form a coherent sonic environment. The acoustic environment suggests that the size of this place is limitless.

2.2.3. Nature Exposure

For exposure to the outdoor natural environment, more attention is paid to the duration of park users in this white space. The purpose is to explore whether the duration of exposure is related to recovery and, moreover, whether it plays an intermediary role in the path of the impact of the landscape and soundscape on restoration. One aspect to consider is whether demographic variables (gender) have differences in their duration of environmental exposure. Therefore, the exposure time of the natural environment in the white space in winter was evaluated using a Likert scale of 7 points. The entries were set to "about 10 min", "about 20 min", "about 30 min", "about 40 min", "about 50 min", "about 1 h", and "about 2 h".

2.3. Procedure of the Experiment

In the winter urban park setting, we conducted an on-site experiment following the procedure illustrated in Figure 2. Within the park, we carefully selected 12 pathways to invite park visitors to participate in a questionnaire survey. The process began with researchers providing an introduction to the questionnaire, and participants were asked to respond to inquiries regarding their personal backgrounds and recent stressful experiences. Furthermore, an arithmetic test was employed to elevate their subconscious stress levels. Specifically, participants were required to verbally respond within 5 s of hearing a question and answer a total of 20 arithmetic questions within 2 min to complete the task. Subsequently, participants were prompted to complete the Perceived Restorativeness Scale (PRS) assessment based on their perceptions of the winter environment. Following this,

participants engaged in the evaluation of the Perceived Restorativeness Soundscape Scale (PRSS) while on the park pathways. The aim of this assessment was to gain deeper insights into people's perceptions of the winter soundscape. Between these two assessments, a brief intermission was incorporated to alleviate the cognitive burden on the participants. This measure ensured the accuracy and reliability of the evaluations, allowing participants to relax and focus when transitioning between different assessments. Ultimately, we reported the participants' current stress levels, which added a valuable context to our study.

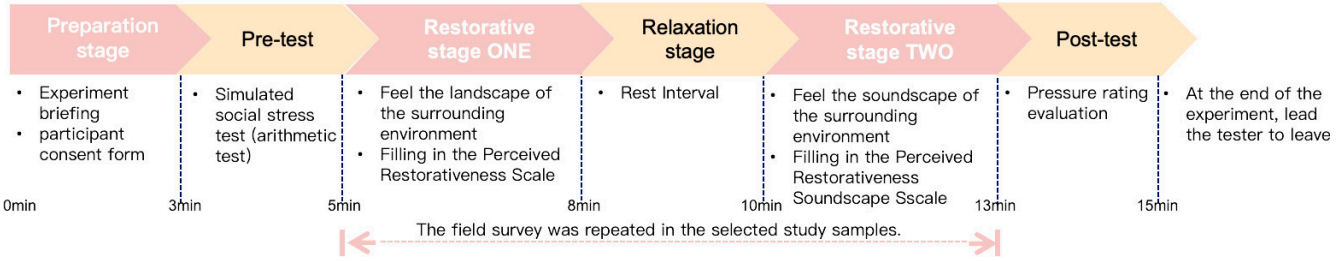

Figure 2. Field experiment process.

2.4. Data Analysis

The statistical parameters were calculated using the data collected from the survey and the software SPSS 26.0 (IBM, Armonk, NY, USA). Through the analysis of variance, the differences in the PRS and soundscape perception on different types of paths were obtained. A *t*-test at $p < 0.01$ and $p < 0.05$ was used to test significant differences. Through the paired *t*-test, the restoration of the landscape and soundscape and the differences in different paths were compared.

Pearson correlation analysis was used to assess the correlation between the sky index, snow, service facilities, trees, and PRS of different landscape elements. In addition, a simple intermediary model prepared by Hayes was utilized to test the intermediary effect of perceived recovery benefits. Intermediary effect analysis was used to analyze the intermediary role of the two soundscape perception variables and the duration of exposure in the restorative generation mechanism in order to further explore the internal mechanism of the impact of the soundscape and exposure on the PRSS when using the park path in winter and decompose the complex impact path. Finally, based on the nonparametric test method, the recovery characteristics and environmental exposure preferences of the urban park among different population groups were investigated through kernel density estimation.

2.5. Selection of Subjects

Participants were recruited during the February statutory holiday and randomly selected from the 12 pathways in the park. Consent was obtained from each subject, and they were informed that the information they provided in the questionnaire would be used for academic research. They were also made aware that their personal information would not be disclosed in any way. A total of 200 questionnaires were distributed during the field survey. A total of 180 valid questionnaires were returned, excluding incomplete information. According to the data statistics, women accounted for 51%, and men represented 49% of the sample. The participants were divided into five age groups. The most prominent group was 20–29-year-olds, accounting for 41.6%. In addition, regarding the frequency of park use in winter, the participants who were surveyed visited the park almost every week, and they were all local people. In addition, participants were surveyed to assess their stress levels in the past month, with the majority experiencing moderate stress, exceeding 50%. Furthermore, at the conclusion of the experiment, all participants reported their current stress levels, as shown in Figure 3.

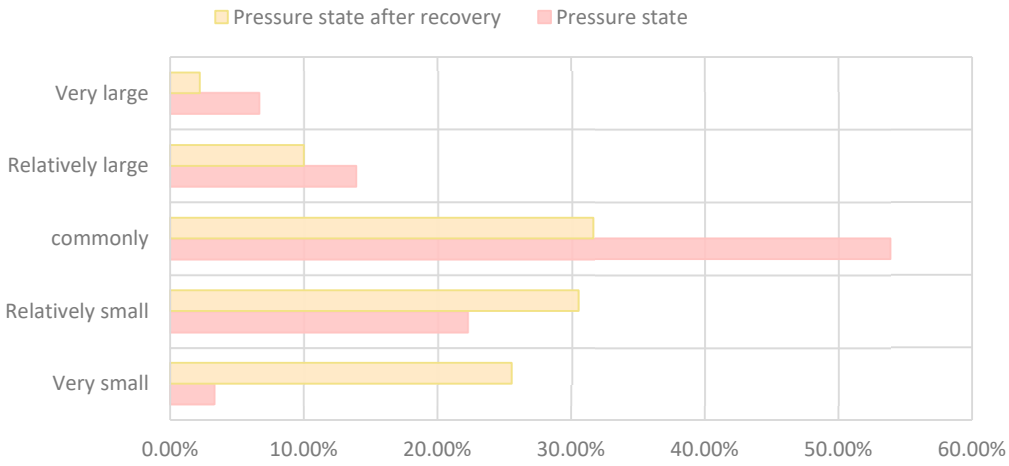

Figure 3. Stress level comparison results before and after recovery.

3. Results

3.1. Reliability and Validity

The reliability and validity of the questionnaire were tested. The PRS Cronbach's α coefficient was 0.938, and the PRS PRSS Cronbach's α coefficient was 0.841, which reflects the scale's high reliability and the research structure's consistency. Concerning validity, the Kaiser–Meyer–Olkin values of the PRS and PRSS were both greater than 0.7, and Bartlett's sphericity test was significant, indicating that the research questionnaire was valid.

3.2. Perceived Recovery Benefit Results for Different Path Types

3.2.1. Descriptive Statistics of Landscape Characteristics

Research question 1 (RQ1) focused on the spatial structure restorative benefits of different path types. A single-factor analysis of variance was used to study the differences in path types across the following five items: fascination, being away, extent, compatibility, and PRS. According to Supplementary Materials S1, the different types of paths were all significant ($p < 0.05$) in terms of the beneficial indicators of perceived recovery.

Although the types of paths were different, the same trend was seen in the scores of restorative characteristics shown in Figure 4. In general, primary path 4 (PP4) exhibits higher scores, characterized by a lower presence of sky elements and the presence of evergreen trees. By contrast, secondary path 1 (SP1) shows lower scores, with a landscape featuring open skies and denser evergreen tree coverage.

3.2.2. Descriptive Statistics of Soundscape Characteristics

The score for soundscape perception was the average of the scores measured on different path types. In order to explore the difference in perception of the soundscape for different road types, a statistical variance analysis was conducted, as shown in Supplementary Materials S2. As shown in Figure 5, the results show that the scores for tranquility were higher than for pleasantness.

(1) Regarding tranquility, secondary path 4 (SP4) and primary path 4 (PP4) scored 5.58 and 5.52, respectively. On these two paths, landscape elements such as snow and sky make up a higher proportion, and the tranquility of the soundscape can be related to the presence of these landscape elements.

(2) Regarding pleasantness, secondary path 4 (SP4) scored the highest at 5.50, which is possibly attributed to the presence of birdsong on this path; secondary path 1 (SP1) scored the lowest at 3.87.

Figure 4. Differences in landscape restoration across various path types within the park.

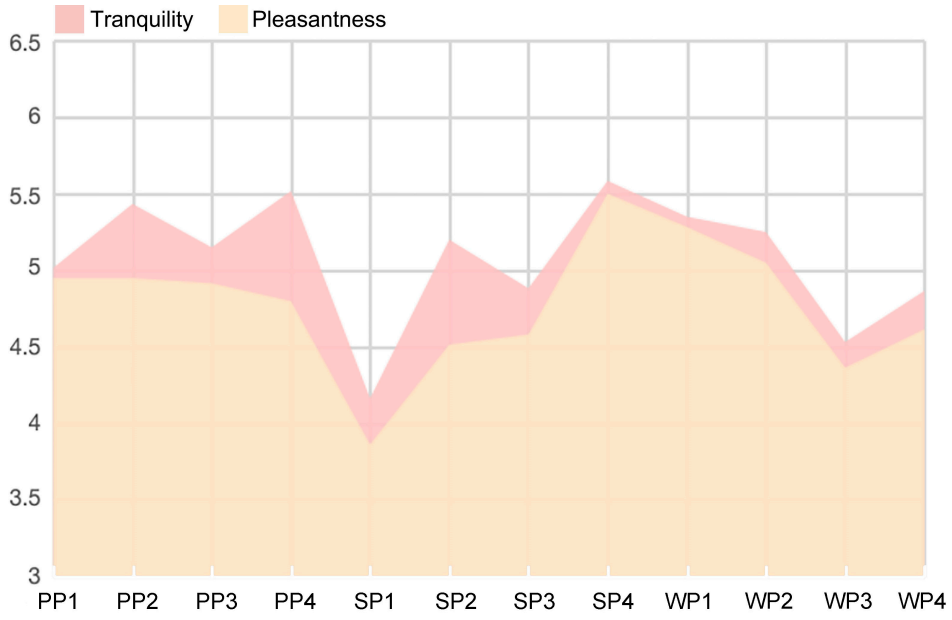

Figure 5. Differences in soundscape restoration across various path types within the park.

We used one-way ANOVA and determined if there was a significant difference in soundscape recovery between each path, as shown in Supplementary Materials S3.

Furthermore, the results comparing the soundscape and landscape that perceived recovery are presented in Figure 6. The perceptions of soundscape exhibited a higher extent of experiences, but it shows a decreased perception of fascination in the SP type and reduced being-away experiences in the WP type.

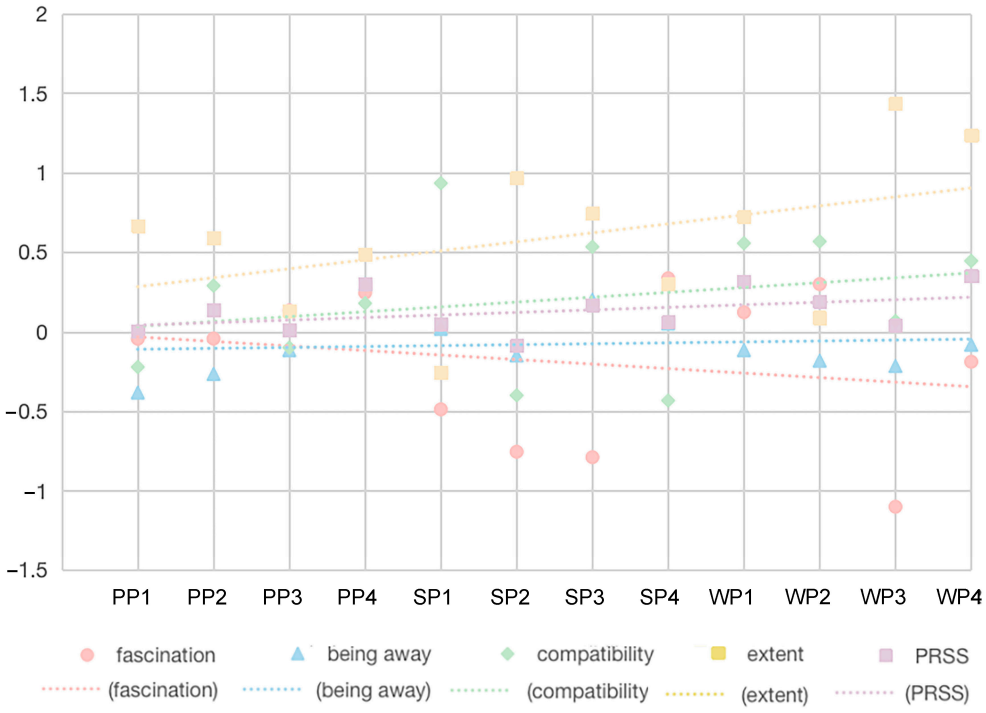

Figure 6. Variations in soundscape restoration in the park.

3.3. Restorative Results for Landscape and Soundscapes

3.3.1. Restorative Comparison Results

Using the paired *t*-test to analyze the difference between landscape and soundscape restoration, it can be seen from Figure 7 that a total of five data pairs show differences ($p < 0.05$). In terms of their restorative characteristics, the scores of landscape restorativeness were higher than those of soundscape restorativeness for both charm and escapism, showing a significance level of 0.05. In terms of compatibility, extension, and overall recovery, soundscape restorativeness was higher, showing a significance level of 0.01. This shows that, compared with the landscape, the soundscape had higher benefits in terms of its compatibility and extension for restorativeness. By experiencing the soundscape in urban winter parks, the potential for psychological recovery in the public can be heightened. Additionally, the landscape is more likely to evoke a sense of fascination and escapism among the public, enabling them to become more immersed and relaxed within the current environment.

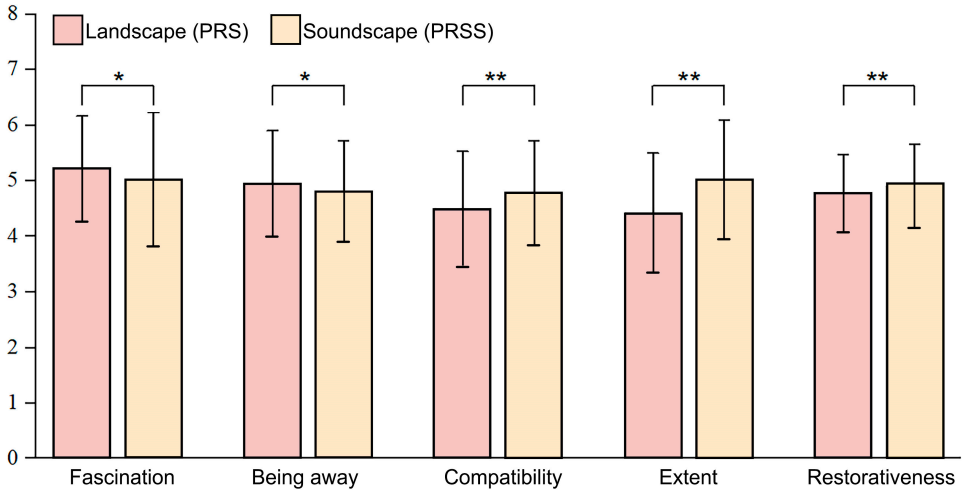

Figure 7. Comparison of restorative characteristics in audiovisual interaction (* $p < 0.05$, ** $p < 0.01$).

3.3.2. Restorative Differences with Different Paths

As shown in Figure 8, the 12 paths studied can be divided into the following three types of paths: primary path, secondary path, and walking path, in contrast to the restorative effect of the landscape and soundscape. We found significant differences in the restorative benefits of the landscape and soundscape with different paths, showing a significance level of 0.01. Overall, compared with the secondary path, the spatial environment of the primary path in the park had a better recovery score (PRS = 5.18 ± 0.53, PRSS = 5.29 ± 0.62). This also means that leisure activities on the park's primary path in winter are easier to obtain with better restorative benefits. In addition, the scores of soundscape restoration on different path types were higher than those of landscape restoration benefits, and there was a significant difference between the two ($p < 0.01$). From the experimental results, the soundscape recovery benefits of urban parks in winter can improve the public's psychological recovery experience. This is the complete answer to research question 1 (RQ1).

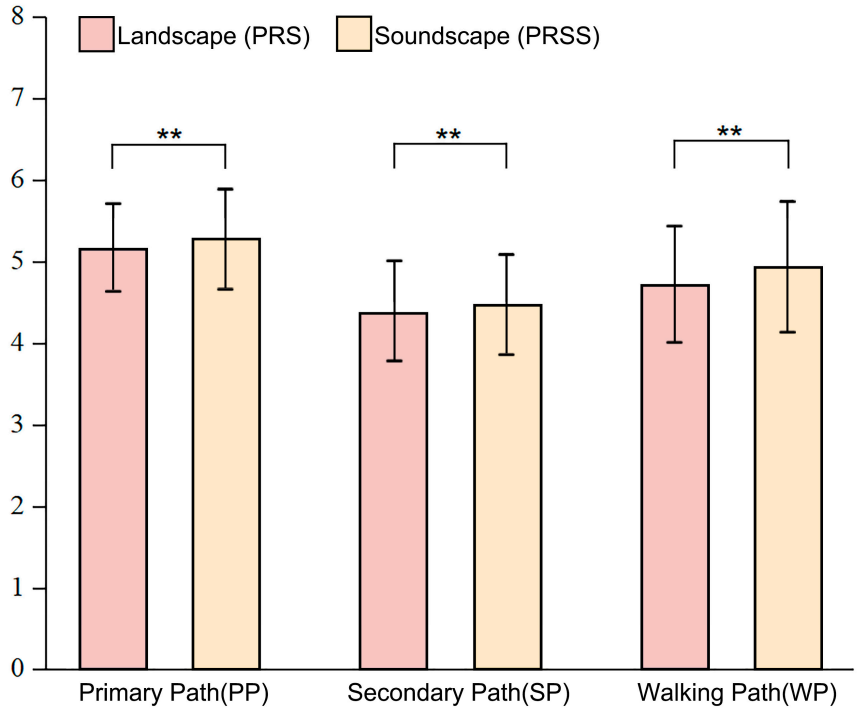

Figure 8. Comparison of recovery for different road types (* $p < 0.05$, ** $p < 0.01$).

3.4. Perceived Recovery Correlation Analysis

3.4.1. Landscape Elements and Restorative

To answer research question 2 (RQ2), we used correlation analysis to study the relationship between the landscape characteristics of path and restoration. As shown in Table 2, two landscape characteristics, snow, and tree branches, had a significant and positive relationship with the characteristics of restoration ($p < 0.01$). On the other hand, three landscape characteristics, the sky index, service facilities, and evergreen plants, showed a negative relationship with restorative characteristics.

(1) The sky index had a negative relationship with restorative characteristics; the relationship with being away was the most significant, followed by the PRS.

(2) There was a significantly positive relationship between snow and restoration. The effects of restorative characteristics were ranked as follows: being away > fascination > extent > compatibility.

(3) There was a negative relationship between service facilities and restorative characteristics, that is, the relationship between service facilities and fascination; being away was the most significant result.

(4) There was a negative relationship between evergreen plants and restorative characteristics. Restorative characteristic effects were ranked as follows: compatibility > being away > fascination > extent.

(5) Tree branches had a significant positive correlation with each property. The effects of restorative characteristics were ranked as follows: being away > compatibility > fascination > extent.

(6) Each landscape element had a different degree of relationship with the PRS. There was a positive relationship between landscape elements and the PRS; the correlation degree was tree branches > snow. Regarding the negative relationship with the PRS, the correlation degree was evergreen plants > service facilities > sky index.

Table 2. Pearson correlation between landscape characteristics and restorativeness.

Variable Name	Fascination	Being Away	Compatibility	Extent	PRS
Sky index	−0.126	−0.206 **	−0.080	−0.044	−0.165 *
Snow	0.303 **	0.353 **	0.206 **	0.236 **	0.428 **
Service facilities	−0.281 **	−0.264 **	−0.104	−0.127	−0.281 **
Evergreen plants	−0.250 **	−0.285 **	−0.286 **	−0.223 **	−0.382 **
Tree branches	0.286 **	0.349 **	0.326 **	0.212 **	0.400 **

* $p < 0.05$, ** $p < 0.01$.

3.4.2. Soundscape Elements and Restorativeness

Furthermore, the impact of the environment soundscape on recoverability was explored. Table 3 shows the restorative relationship and compactness of the acoustic environment through its tranquility and pleasantness. Both the degree of tranquility and the degree of pleasure were positively correlated with the characteristics of sensory recovery ($p < 0.01$). The influence degree of tranquility and restorative characteristics was as follows: fascination > being away > compatibility > extent. The degree of the relationship between pleasantness and restorative characteristics was as follows: fascination > being away, compatibility > extent. In comparison to pleasantness, the influence of tranquility on perceived recovery is notably more pronounced.

Table 3. Pearson correlation between soundscape characteristics and restorativeness.

Variable Name	Fascination	Being Away	Compatibility	Extent	PRS
Tranquility	0.370 **	0.344 **	0.320 **	0.256 **	0.415 **
Pleasantness	0.336 **	0.249 **	0.249 **	0.248 **	0.353 **

* $p < 0.05$, ** $p < 0.01$.

3.5. Relationship between Exposure Duration and Restorativeness

Research question 2 (RQ2) questioned the relationship between environmental exposure and restorativeness and used correlation analysis to explore the relationship between the user's duration of exposure in winter white space and landscape and the perceived restorativeness of the soundscape. As shown in Table 4, it can be seen that the exposure time of white space has a positive correlation with perceptual recovery and shows significance at the level of $p < 0.01$. Specifically, the correlation coefficient between environmental exposure time and the soundscape in terms of attractiveness and escapism is higher than that of landscape restoration. This also shows that with the increase in exposure duration at any time, the public is more likely to experience the tranquility and pleasure of the sound scene in white space, enhancing the perceived recovery benefits of the attraction and escapism for park users. In addition, the impact of the duration of environmental exposure and landscape restoration is higher than that of the soundscape in terms of overall recovery, compatibility, and extent. Therefore, in terms of exposure duration, the landscape's restorative benefit is greater than the soundscape.

Table 4. Results of correlation between the duration of environmental exposure and the mental restoration of landscape and soundscapes.

Variable Name		Fascination	Being Away	Compatibility	Extent	PRS/PRSS
Environmental exposure duration	Correlation coefficient (Soundscape)	0.477 **	0.490 **	0.277 **	0.354 **	0.551 **
	Correlation coefficient (Landscape)	0.388 **	0.466 **	0.454 **	0.422 **	0.623 **

* $p < 0.05$, ** $p < 0.01$.

3.6. The Mediating Role of Soundscape Perceived Recovery

After the influence and effect of white space were obtained via correlation analysis, the intermediary effect test of soundscape restoration was conducted to further explore the impact path of winter landscape characteristics on restorativeness. The complex impact path between winter landscape characteristics, soundscape, and restorativeness was decomposed. The simple mediation model shows the results in Table 5. Snow, tree branches, and evergreen plants affect the PRS through soundscape perception. In the impact effect, soundscape tranquility has a good intermediary effect on the impact path of restorativeness.

Table 5. Mediation effect results.

Term	c Total Effect	a × b Intermediary Effect Value	a × b (Boot SE)	a × b (*p* Value)	a × b (95% BootCI)	c′ Direct Effect	Inspection Conclusion	Effect Proportion
Sky ≥ Tranquility ≥ PRS	−8.195 **	−4.119	0.126	0.000	−0.805~−0.310	−3.233 *	Partial mediation	50.267%
Sky ≥ Pleasantness ≥ PRS	−8.195 **	−0.109	0.047	0.021	−0.110~0.079	−3.233 *	No significant mediating effect	0%
Sky ≥ time ≥ PRS	−8.195 **	−0.734	0.048	0.000	−0.206~−0.018	−3.233 *	Partial mediation	8.957%
Snow ≥ Tranquility ≥ PRS	−5.548 **	−0.416	0.037	0.000	−0.145~−0.002	−3.292 **	Partial mediation	7.503%
Snow ≥ Pleasantness ≥ PRS	−5.548 **	−0.057	0.027	0.038	−0.063~0.050	−3.292 **	No significant mediating effect	0%
Snow ≥ time ≥ PRS	−5.548 **	−1.782	0.096	0.000	−0.447~−0.064	−3.292 **	Partial mediation	32.124%
Service facilities ≥ Tranquility ≥ PRS	−125.743 **	−5.177	0.046	0.000	−0.182~−0.004	−108.644 **	Partial mediation	4.117%
Service facilities ≥ Pleasantness ≥ PRS	−125.743 **	−0.646	0.030	0.000	−0.069~0.055	−108.644 **	No significant mediating effect	0%
Service facilities ≥ time ≥ PRS	−125.743 **	−11.276	0.117	0.000	−0.392~0.068	−108.644 **	No significant mediating effect	0%
Evergreen plants ≥ Tranquility ≥ PRS	−9.713 **	−0.743	0.153	0.000	−0.652~−0.054	−5.487 **	Partial mediation	7.649%
Evergreen plants ≥ Pleasantness ≥ PRS	−9.713 **	−0.098	0.131	0.453	−0.310~0.224	−5.487 **	No significant mediating effect	0%
Evergreen plants ≥ time ≥ PRS	−9.713 **	−3.385	0.349	0.000	−2.078~−0.713	−5.487 **	Partial mediation	34.851%
Tree branches ≥ Tranquility ≥ PRS	−8.715 **	−0.742	0.109	0.000	−0.466~−0.036	−5.445 **	Partial mediation	8.515%
Tree branches ≥ Pleasantness ≥ PRS	−8.715 **	−0.095	0.089	0.287	−0.213~0.152	−5.445 **	No significant mediating effect	0%
Tree branches ≥ time ≥ PRS	−8.715 **	−2.433	0.259	0.000	−1.229~−0.207	−5.445 **	Partial mediation	27.911%

* $p < 0.05$, ** $p < 0.01$.

In addition to the facility elements, the exposure time to the outdoor environment in winter has a significant intermediary effect in the influence path of natural factors such as sky, snow, evergreen plants, and branches and trunks on the restorativeness. Among the influence paths of the sky on the PRS, soundscape tranquility is the largest effect, accounting for 50.26%. Secondly, the effect of environmental exposure duration on the path of mental restoration of evergreen plants accounted for 34.85%. This is the complete answer to research question 2 (RQ2).

3.7. Comparison of Results for Different Genders

In order to answer research question 3 (RQ3), based on the nonparametric test method, the kernel density estimation is shown in Figure 9 under the conditions of different gender samples, spatial exposure duration, and distribution characteristics of the PRS and PRSS. In winter, women are exposed to the outdoors for a relatively short time, focusing more on short-term visits to the park, for example, about 20 to 40 min. On the contrary, men's outdoor exposure time is more concentrated at about 45 min to 1 h and even more than 2 h. Gender differences have the same trend as landscape and soundscape restoration. For women, the assessment of soundscape restorativeness is higher.

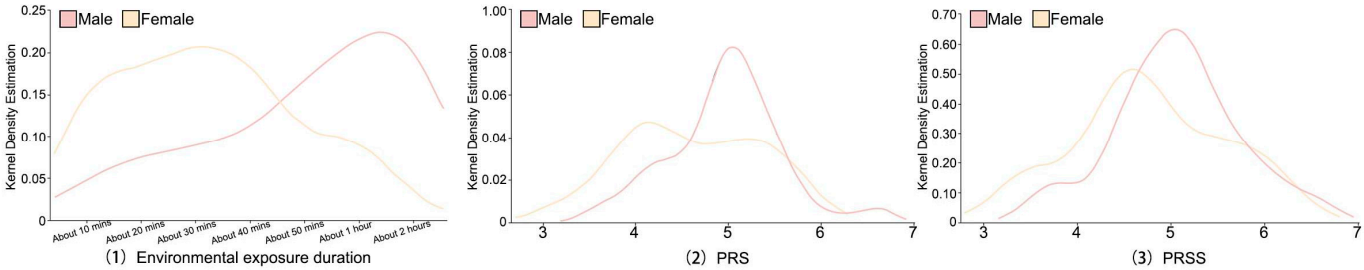

Figure 9. Comparison of exposure duration, PRS and PRSS for different genders.

The purpose of RQ3 is to compare whether there are differences between gender and perceived restorativeness in socio-demographic variables. First, through ANOVA, the gender differences in landscape and soundscape restoration were explored. In both the PRS and PRSS, men scored higher than women in their assessment of perceived restorativeness. As shown in Table 6, compared with the PRSS, the PRS was more significant in the case of gender differences ($p < 0.01$). In order to further explore the impact of landscape and soundscape restoration on the public due to gender differences, through the paired *t*-tests, as shown in Figure 10, we explored the differences between men and women. Contrasting the difference between landscape and soundscape restoration from the male perspective, there was a significant difference between the PRS and PRSS at the 0.01 level ($t = -4.678$, $p < 0.001$), and this specific comparison difference showed that the average value of the PRS (4.96) was significantly lower than the average value of the PRSS (5.05). From the perspective of women, there is a significant difference between the PRS and PRSS at the 0.01 level ($t = -7.843$, $p < 0.001$), and the specific comparison difference shows that the average value of the PRS (4.59) is significantly lower than the average value of the PRSS (4.77).

Table 6. Variance analysis of the landscape and soundscape's mental restoration for different genders.

	Gender (Mean ± Standard Deviation)		**F**	***p***
	Male (*n* = 89)	**Female (*n* = 91)**		
PRS	4.96 ± 0.61	4.59 ± 0.73	13.687	0.000 **
PRSS	5.05 ± 0.67	4.77 ± 0.80	6.540	0.011 *

* $p < 0.05$ ** $p < 0.01$.

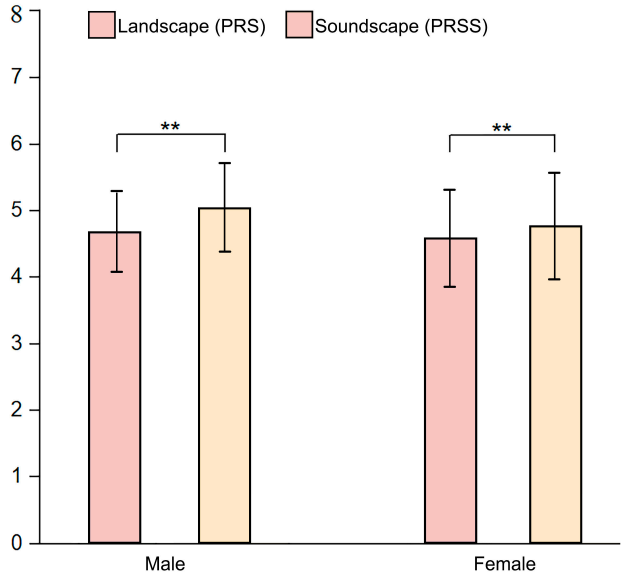

Figure 10. Paired *t*-test of gender difference for landscape and soundscape restoration (* $p < 0.05$, ** $p < 0.01$).

4. Discussion

4.1. Snow Is a Restorative Landscape Element

This study's main contribution is to provide further confirmation of the stronger restorative relationship between people's restorativeness in snow-covered winter landscapes [38,70]. Unlike the previous exploration of the restoration of environmental elements, this study expands on natural elements such as snow. The forests covered by snow also have restorative properties. Furthermore, they have a significant positive relationship with the benefit of stress recovery. The snow element is most closely related to being away among the four restorative characteristics. This may be because the winter snow element can help people experience the environment, activities, and work away from daily life.

At the same time, the snow element is more potent than the evergreen plant element in winter at improving restoration. There was a positive comment on the winter landscape of forests with snow [71], which may be because snow is an enjoyable element in the winter atmosphere [37]. Therefore, this can provide decision makers and designers with insightful findings to help construct a positive place that can promote psychological recovery in the winter environment of cold cities. It also confirms that, in addition to green spaces, "white space", mainly composed of snow elements, has strong restorative benefits.

4.2. Differences in Winter Plant Restorative Benefits

The research results further confirmed that, in winter landscapes, tree elements are beneficial to perceptual restoration [37]. Urban society is under stress all year round. In cold cities, the plant-growing season usually does not exceed half a year; that is, the seasonality of winter leads to the difference in plant forms—evergreen and deciduous plants. Therefore, the restorative environment of winter may also be in effect when the temperature is low and the trees have no leaves. Deciduous plants may provide perceptual recovery in winter because trees without leaves also positively impact humans [38].

The difference between the results of this study and previous studies is that the evergreen tree landscape does not promote psychological recovery in winter, as expected [72,73]. In previous studies, researchers used the photographic content technique method of adding evergreen plants to images. This research was carried out in the laboratory using photographs, indicating that evergreen plants impact perceptual recovery [74]. However, outdoor measurement provides a more realistic experience, which may lead to a difference in the role of evergreen and deciduous plants in perceptual recovery. It is precisely in this outdoor winter space environment that the withering of plant leaves results in bare tree

branches with better restorative benefits [37], which has a positive psychological impact on mood [38,75].

4.3. Audiovisual Integration of White Space Is More Restorative

Both the pleasantness and tranquility of soundscape indicators had a positive impact on the PRS of urban park visitors in winter, but the tranquility of the soundscape was a more influential perception indicator. Our results are consistent with the previous evidence that a pleasant and calm soundscape contributes more to restoring and reducing perceived stress [76]. This shows that, in parks with a good soundscape environment, especially in the sound scene after snow, the soundscape is more closely related to being away in terms of the features of restorativeness. This shows that the soundscape can help people to psychologically escape from unpleasant or irrelevant stimuli in their daily lives, such as an urban noise problem [77]. Thus, it can relieve mental fatigue and restore consumed attention [78].

This study confirms that the soundscape plays a good intermediary role in the process of landscape characteristics affecting restoration in audiovisual interactions [79]. The types of plants in different path types are usually different, resulting in a different soundscape [80]. Moreover, deciduous trees have a better level of restorativeness in terms of harmony between sound and scenery [81]. Among the effects of the soundscape on recoverability, the tranquility of the soundscape is the closest to the degree of perceptual recovery, supporting the impact that the perception of tranquility has in audiovisual interactions [82], playing an intermediary role in the impact of partial restorativeness. In this case, the soundscape needs to be considered as an integral part of urban park planning and design [83], which may be a more effective way to promote a reduction in stress. At the same time, it also provides a new idea for the restorative design of soundscapes in winter in cold cities. It helps support urban biodiversity, health, and quality of life in winter depression and directly or indirectly promotes the achievement of sustainable development goals on different scales [84].

4.4. Impact of Demographic Characteristics on Restorativeness

Our findings indicate that there are significant gender differences in terms of restorativeness. The tranquil soundscape can benefit the public and have a more positive impact on recovery from a male perspective. People with a more profound understanding of life experience often have higher requirements for soundscape content [85]. During environmental perception, while women generally pay more attention to visual stimuli than men [86], it is men who experience a higher level of restoration through visual landscape features compared to women. This shows that in addition to the basic requirements of psychological perception, men usually need the restoration of outdoor natural environments more. This may also be why men use urban green spaces more frequently [33]. It is worth noting that the current results may also be related to the length of exposure to the natural environment because the exposure time of the natural environment in winter plays a significant intermediary effect in the path of affecting the public's restoration. In the future, we aim to further explore the causes and basic mechanisms.

4.5. Limitations and Prospects

Several limitations exist in this study. First, there are no objective measurements of physical environmental factors, including the quantification of ambient sound. Physical environmental factors may induce positive effects in green spaces [87]. Second, it is worth noting that the current results cannot be generalized to different age groups of the population or even in terms of gender differences. Further research on larger, more diverse groups should be conducted in the future. However, our study serves as a first step toward exploring the effects of winter urban park landscapes and soundscapes on perceived restorative benefits.

5. Conclusions

This study is centered around winter urban parks and investigates the relationship between "white space" and restoration, considering both landscape and soundscape elements. The findings of this research shed light on the restorative potential of winter urban parks, and we can draw the following conclusions: Firstly, the strength of winter park paths can be ranked as follows, from strongest to weakest: primary path > walking path > secondary path. Notably, the connection between winter landscape elements and their impact on the efficiency of restoration is not universally positive. Only deciduous tree branches and snow contribute to enhanced perceived recovery benefits. Secondly, concerning restorative aspects, the extent and compatibility of the soundscape play a crucial role in deepening the connections between park visitors and the natural environment. This harmonizes the surrounding soundscape with the winter landscape, thus amplifying restorative benefits. Within the context of the soundscape and its impact on restoration, tranquility appears to be more significant than pleasantness. Lastly, in the realm of audiovisual interactions that influence recovery, the tranquility of the soundscape and the duration of outdoor exposure serve as effective mediators, constituting essential elements in the recovery process. Furthermore, notable differences exist in the evaluation of soundscape recovery based on gender, with men exhibiting a higher appreciation of landscape and soundscape restoration compared to women. Hence, future research on recovery and environmental perception benefits must pay greater attention to the winter environment, especially the contribution of the natural environment under varying climatic conditions.

Given the potential influence of urban green space design on human health and well-being, it is imperative to create a restorative environment that is capable of revitalizing both the body and mind during the winter season. As such, the impact of "white space", shaped by the winter landscape in green areas, on restorativeness should be a focal point for urban planning authorities and policymakers.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/f14122329/s1. Supplementary Materials S1: Results of ANOVA for Different Road Types and Landscape Perception Restorativeness; Supplementary Materials S2: Results of ANOVA for Different Road Types of Soundscape; Supplementary Materials S3: Results of ANOVA for Different Road Types and Soundscape Restorativeness.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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