Case Study

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Effects of Landscape Types and Complexity Along Path on Mental Restoration

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Abstract

Aim: This study checked the effects of landscape types and complexity along path in urban green spaces on perceived restorativeness, so as to provide guidance for path landscape design. **Background:** Paths in urban green spaces are not only the connections between places but also places for visitors reducing mental stress and seeking psychological well-being. However, there is a lack of evidence-based research on the effects of landscape composition along the path on restorative quality, failing to provide a cohesive guideline for practice. **Methods:** Fourteen videos representing the popular path landscapes in urban green spaces were produced using computer software by adding or/and deleting elements and controlling environmental components. The restorative quality of these videos was measured by Short-version Revised Restoration Scale (SRRS). Statistical analysis was employed to treat the data and checked the effects of different landscape types and complexity on restorative quality. **Results:** (1) A significant difference in restorative quality between 14 path landscapes was found, comparatively, the path containing lawn or(and) forest was much better than that containing bamboo and waterscape, and bamboo was a negative predictor of restorative quality; (2) waterscape generally reduced the restorative quality of vegetated path landscape, especially when the landscape possessed higher restorative quality; (3) path landscape complexity had a weak influence on restorative quality. **Conclusions:** This study explains how path landscapes affect mental restoration of users, and these findings contribute to enhancing the restorative quality of urban green spaces and have applications for path landscape design.

Keywords

mental health, path landscape, vegetation type, waterscape, landscape complexity

Poor mental health is a growing problem due to psychological stress of the public caused by fierce competition (Zhao et al., 2018) and dramatic changes in living environment over a very short period caused by the rapid urbanization, including increased traffic, polluted air and water, and anthropogenic climate change. Furthermore, the rapid spread of information technology in modern society has led to an increase in stress which is

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associated with poor psychological health (Misra & Stokols, 2012). Steel et al. (2014) indicated that approximately 1 billion people on a global scale met the criteria for a common mental disorder. On the other hand, COVID-19 pandemic started in the end of 2019 further worsens mental health problems due to fear of future infection, and governments' policies of quarantine and keeping social distance to prevent the spread of the virus in many countries (McGinty et al., 2020; Pierce et al., 2020; Vindegaard & Benros, 2020). Although mental disorder is linked to many factors and some clinical preventions are effective, mental health can be achieved by surrounding environments (Han, 2003; Nikunen et al., 2014; Velarde et al., 2007; Wang et al., 2018; Xu et al., 2018; Zhao et al., 2018).

Attention Restoration Theory (ART; Kaplan and Kaplan, 1989) and Stress Recovery Theory (SRT; Ulrich, 1983) are widely used to explain relationships between a specific environment and psychological well-being. The first emphasizes the importance of cognitive functioning such as restoration from attentional fatigue in the environment. The second focuses on the properties of an environment that support affective and physiological recovery from acute stress. In latest decade, there is a growing body of evidence suggesting that contact with natural environments can promote well-being and psychological restoration from stress and fatigue (Park et al., 2011; van den Bosch & Ode Sang, 2017; Wang et al., 2018; Zhao et al., 2018), because natural environments are the cradle of mankind, they can provide various resources for human survival and reproduction. Psychological restoration can be achieved through human perception of adequate resources (Kaplan, 1995). However, not all natural environments are equally restorative (Herzog et al., 2003). Some experts have paid their talents to investigate the effects of different natural features on the level of restorativeness. For example, Kaplan (1995) proposed that the capacity of an environment to facilitate the feeling of being away, extent, fascination, and compatibility was crucial if restoration was to occur. Memari (2017) indicated that among the eight perceived sensory dimensions (social, prospect, rich in species, serene, culture, space, nature, and refuge) perceived serene, nature, and refuge were the three most important dimensions resulting in stress restoration. Specifically, Jiang et al. (2014) suggested that water and plants were the most important elements for individuals' mental restoration, but Van den Berg et al. (2003) claimed that water was not a reliable promoter of mental restoration. Bagot et al. (2015) demonstrated that perceived restorativeness among children was positively associated with the amount of vegetation and percentage of grass coverage on playgrounds. Zhao et al. (2018) concluded that easy accessibility to waterscape and flat topography could promote restorative quality. Obviously, previous literature does not reach a general agreement on the effects of some landscape features on perceived restorativeness, such as water, and fails to reflect on the differences within a landscape feature, such as vegetation which typically includes several types: trees, bushes, grass, climbing plants, and so on. Therefore, we still have a limited understanding about which type of the natural environment promotes mental health.

Urban green spaces are the closest common places for urban residents to experience nature. Existing literature suggested that exposure to urban green spaces reduced disease: obesity and mental disorder through mechanisms including the promotion of physical exercise (Schipperijn et al., 2017), stress reduction through opportunities of psychological restoration (Velarde et al., 2007; Zhao et al., 2018), and the improvement of urban environments through influencing temperature, wind, humidity, rainfall, air quality, and sound quality (Song et al., 2015). Paths stretch to every corner of urban green spaces. Most active uses such as walking, the most sustainable form of physical activity in our daily lives, to hold on paths (Ignatieva et al., 2017; Korpilo et al., 2017). Visitors usually spend considerable time on paths, and they can rarely choose whether they want to use a path or not. Therefore, path landscapes become the most common visual landscapes when a person visits urban green spaces. Paths are no longer seen as simple connections between places but as places for seeking mental stress relief. The restorative quality of walking environments has an essential influence on visitors' mental health (Paydar et al., 2020). Walking in greenness contributes to the decrease of

depression (Barton et al., 2009) through both exposure to nature in which the pedestrian perceives adequate resources and physical exercise, and pedestrians who walk in urban green spaces or in forest possess significantly lower levels of negative emotions (Song et al., 2015, 2018). However, natural or green environment has a complex composition which can be divided into many elements, including water, vegetation, topography, and so on, and each of them has an essential influence on pedestrian's well-being (Völker & Kistemann, 2015; Wang et al., 2018; Zhao et al., 2018). To the authors' knowledge, no literature has focused on the specific elements in walking environments, especially in urban green spaces, and we have a limited understanding of the issues. Inappropriate path landscape may cause negative emotions, for example, natural growth of vegetation and close view can cause feelings of insecurity (Zhao & Huang, 2021). Safety is a prerequisite for people's well-being (Green et al., 2002). Thus it is necessary to add to fine-scaled understanding on the effects of specific features of path landscapes on psychological restoration, as Paydar et al. (2020, p. 14) suggested: "future studies should carry out further investigation into the composition of visual sequences (of path landscapes) and their inclusive elements in relation to mental and physical health."

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Aims and Overall Framework of the Study

The main purpose of the present study is to find reliable evidence to guide path landscape design, then contributing to users' health. To reach this goal, an experiment was conducted to compare the restorative quality of 14 path landscapes which contain different natural elements (three vegetation types and a water form) and their combinations (Table 1). The following research questions guided this study:

1. Which vegetation type or combination of different vegetation types has higher restorative quality?

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2. What are the impacts of adding waterscape into vegetated path landscapes on restorative quality?

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3. Does landscape complexity (the number of landscape elements along the path) impact the restorative quality?

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Method

Stimuli

Videos produced by computer software (Lumion Version 6.0) were used to represent real landscapes. This method allows researchers to create different videos by varying only the elements under study through controlling environmental components to limit the influence of confounding variables (Waldheim et al., 2014). A considerable proportion of previous literature used photographs as surrogates for real landscapes (e.g., van den Berg et al., 2003; Wang et al., 2018; Xu et al., 2018; Zhao et al., 2018) to reduce cost, increase efficiency, and facilitate comparative evaluation in controlled conditions (Zhao et al., 2013a). Hartig et al. (1996) found no statistically significant differences in restorative evaluations between onsite visits and simulations using photographic slides. Compared to photographs, videos are much closer to the experience of users in a real world (Wang & Zhao, 2019) and they have been evidenced to evoke similar reactions to those occurring when viewing real landscapes (Uzzell and Muckle, 2005). After a survey of path

Table 1. Path Landscape Components of 14 Videos Used in This Study.

Video Number	Landscape Component(s)	Named	Video Number	Landscape Component(s)	Named
1	Lawn (2 min long) on both sides of the path	Lawn	8	Waterscape (2 min long) on the left side, and the same landscape as Video 1 on the right side of the path	Waterscape + lawn
2	Forest (2 min long) on both sides of the path	Forest	9	Waterscape (2 min long) on the left side, and the same landscape as Video 2 on the right side of the path	Waterscape + forest
3	Bamboo (2 min long) on both sides of the path	Bamboo	10	Waterscape (2 min long) on the left side, and the same landscape as Video 3 on the right side of the path	Waterscape + bamboo
4	Lawn (1 min long) and forest (1 min long) on both sides of the path	Lawn + forest	11	Waterscape (2 min long) on the left side, and the same landscape as Video 4 on the right side of the path	Waterscape + lawn + forest
5	Lawn (1 min long) and bamboo (1 min long) on both sides of the path	Lawn + bamboo	12	Waterscape (2 min long) on the left side, and the same landscape as Video 5 on the right side of the path	Waterscape + lawn + bamboo
6	Forest (1 min long) and bamboo (1 min long) on both sides of the path	Forest + bamboo	13	Waterscape (2 min long) on the left side, and the same landscape as Video 6 on the right side of the path	Waterscape + forest + bamboo
7	Lawn (40s long), forest (40s long) and bamboo (40s long) on both sides of the path	Lawn + forest + bamboo	14	Waterscape (2 min long) on the left side, and The same landscape as Video 7 on the right side of the path	Waterscape + lawn + forest + bamboo

landscapes in urban green spaces in Xuzhou, a medium-sized city in eastern China, four natural elements were picked out, including three vegetation types (lawn, forest and bamboo) and water feature, since they are popular used on the sides of paths. Although bamboo can be classified as forest, this study treated it as an identified vegetation type because bamboo has a profound cultural connotation, for example, it symbolizes some merits of a person, such as fearless and modest in Chinese cultural background, thus it is used widely in urban green spaces in eastern China. Totally, 14 videos containing different natural elements and their combinations were produced to represent the common path landscapes in urban green spaces during a growing season (see Table 1 and Figure 1). All videos were 2 min long, and the videos simulated the view of a pedestrian, therefore, the pedestrian traveled about 150 m in each of video. Except for the landscapes along the paths, other variables including path and sky were created exactly same. A video that included waterscape solely was not used because water bodies had to be set on the two sides of the paved path in the video. It was very strange and rarely seen in urban green spaces when we conducted the survey. The unreal scene may distort the evaluations of restorative quality.

Measurement of Respondents' Mental Restorative Quality

Short-version Revised Restoration Scale (SRRS) developed by Han (2003) was employed to measure restorative quality. SRRS has been demonstrated as a reliable and efficient method to

Figure 1. Representative cuts of 14 videos.

Table 2. Short-Version Revised Restoration Scale (1 = *Totally Disagree*, 9 = *Totally Agree*).

Dimensions	Items	Scales
Emotional	Good natured	1___; 2___; 3___; 4___; 5___; 6___; 7___; 8___; 9___
	Relaxed	1___; 2___; 3___; 4___; 5___; 6___; 7___; 8___; 9___
Psychological	My breathing is becoming faster	1___; 2___; 3___; 4___; 5___; 6___; 7___; 8___; 9___
	My hands are sweating	1___; 2___; 3___; 4___; 5___; 6___; 7___; 8___; 9___
Cognitive	I am interesting in the presented scene	1___; 2___; 3___; 4___; 5___; 6___; 7___; 8___; 9___
	I feel attentive to the presented scene	1___; 2___; 3___; 4___; 5___; 6___; 7___; 8___; 9___
Behavioral	I would like to visit here more often	1___; 2___; 3___; 4___; 5___; 6___; 7___; 8___; 9___
	I would like to stay here longer	1___; 2___; 3___; 4___; 5___; 6___; 7___; 8___; 9___

measure restorative quality of various types of environments (Memari et al., 2017; Nordh et al., 2017; Paddle & Gilliland, 2016; Wang & Zhao, 2020; Xu et al., 2018; Zhao et al., 2018). It consists of eight items spread equally across the four dimensions, including emotion, cognition, physiology, and behavior (Table 2). Respondents were asked to imagine that they were in the projected scene and select a scale for each item according to their perception on a 9-point Likert-type scale for how much they agreed with the item, ranging from 1 *totally disagree* to 9 *totally agree*. All items of SRRS were accurately translated into Chinese and have been validated in a previous study conducted by the authors' research team (Zhao et al., 2018). The composite score of physiological response was reversed, because this dimension measures physiological arousal, which is the opposite of perceived restorativeness. The mean value of each item listed in the restoration scale within respondents was calculated. The mean value of eight items was used as the restorative quality of a video.

To relieve possible fatigue of respondents, 14 videos were divided into three groups in which Video 1–4 were treated as the first group, Video 5–9 were the second group, and Video 10–14 the third group. The surveys were conducted in a classroom in March to April 2021. The videos within a group were randomly projected on a 1.6 m × 1.2 m white screen. All videos were played one by one. After a video was played, the respondents were asked to complete the restoration survey. The average time for evaluating a video was about 216s.

For the three vegetation types, the viewing order of natural elements complied with the name of a video. For example, the video of "lawn + forest," participants first saw lawn and then forest, and the time to view lawn is equal to the time to view forest. For the videos including waterscape, since water was set on one side, and vegetation was set on the other side of the path, participants saw water and vegetation simultaneously. For example, the video of "waterscape + lawn + forest," the participants first saw lawn and water, then forest and water, and the time to view lawn and water is equal to the time to view forest and water.

Undergraduate students with self-reported normal eyesight from a wide discipline background within China University of Mining and Technology were invited to participate in these surveys to increase efficiency and reduce costs. Students are widely used as respondents in existing literature on experience-based assessment (e.g., Raanaas et al., 2011; Wang & Zhao, 2019; Zhao et al., 2018), and their reliability has been evidenced (Yao et al., 2012). The number of respondents for 1–3 groups was 71 (male 28, female 43; 66 valid questionnaires), 52 (male 21, female 31; 49 valid questionnaires), and 56 (male 19, female 37; 51 valid questionnaires), respectively. Invalid questionnaires included two or more choice for an item or uncompleted questionnaires.

Data Analysis

SPSS Version 17.0 was employed to analyze the data. The interclass reliability of videos' restorative scores of three groups was tested, and the

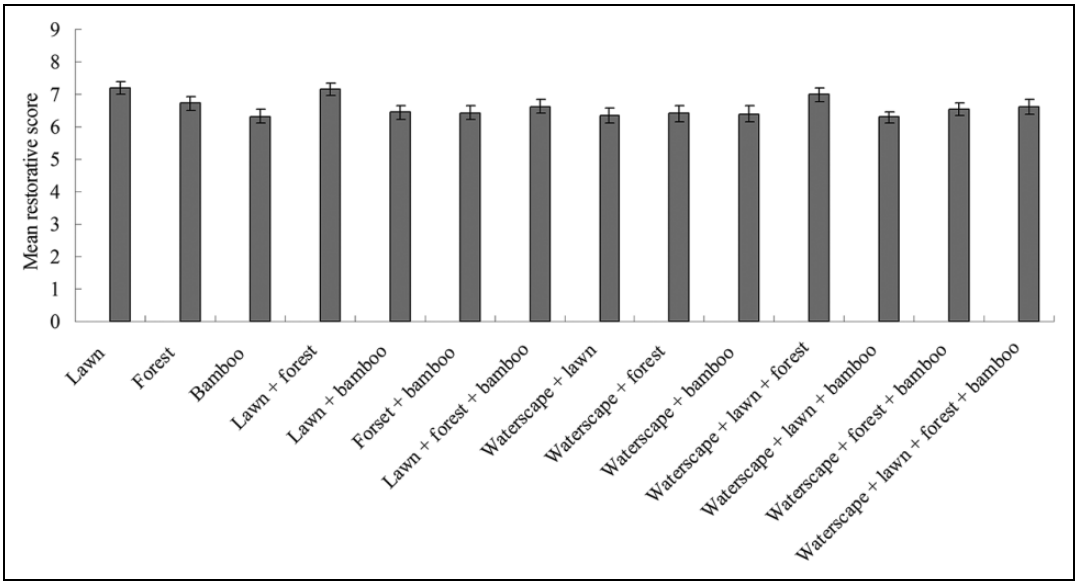

Figure 2. Mean restorative scores (± standard error) within respondents for 14 videos.

one-way analysis of variance (ANOVA) was conducted to explore the differences in restorative quality between videos. Then, the regression analysis was used to explore the effects of different landscape compositions along the path on restorative quality, and correlation analysis was performed to check the relationship between waterscape's effects on restorative quality and the restorative quality of vegetated landscapes.

Results

Reliability

The interclass reliabilities of mental restoration of three groups of videos were calculated, respectively. Cronbach's alpha was 0.944 (the first group), 0.927 (the second group), and 0.941(the third group). According to the criteria built by Landis & Koch (1977) who suggested that if the Cronbach's alpha > 0.801, it was almost perfect, the results showed very good internal reliabilities of restorative score for all groups.

Overall Evaluation of Restorative Quality

The restorative scores of 14 videos were shown in Figure 2. The videos with lawn, lawn + forest, and waterscape + lawn +forest were rated as the highest three restorations. While the videos with bamboo, waterscape + lawn, and waterscape + lawn + bamboo were rated as the lowest. The one-way ANOVA showed that there was a significant difference in restorative quality between 14 videos ($F = 2.237$, $p = .007$), which implies that the features of the path landscape are an essential factor affecting the restorative quality of environments.

Effects of Landscape Types along the Path on Restorative Quality

Fourteen videos was regrouped according to the different landscape types: videos containing lawn (lawn, lawn + forest, lawn + bamboo, waterscape + lawn, lawn + forest + bamboo, waterscape + lawn + forest, waterscape + lawn + bamboo, waterscape + lawn + forest + bamboo), videos containing forest (forest, lawn + forest, forest + bamboo, waterscape + forest, lawn + forest + bamboo, waterscape + lawn + forest, waterscape + forest +bamboo, waterscape + lawn + forest + bamboo), videos containing bamboo (bamboo, lawn + bamboo, forest + bamboo, waterscape + bamboo, waterscape + lawn + bamboo, waterscape + forest +bamboo, waterscape + lawn + forest + bamboo), and videos

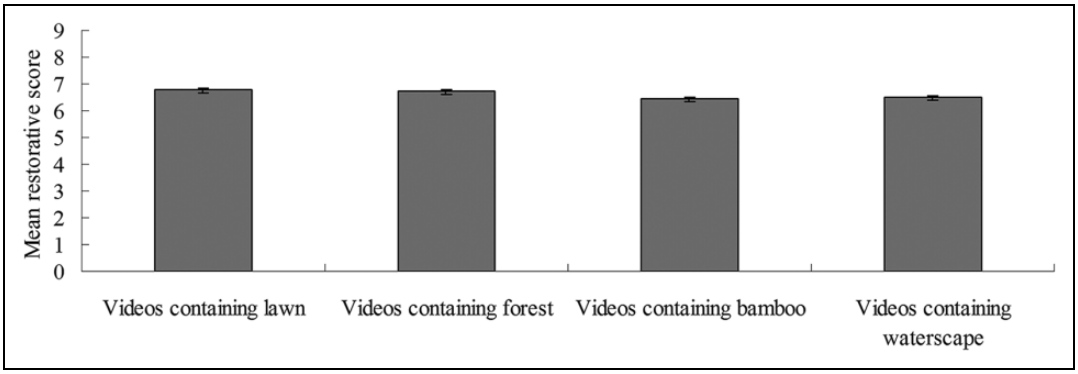

Figure 3. Mean restorative scores (± standard error) for four groups of videos that contain different landscape elements.

Table 3. Significant Predictors for the Perceived Restorativeness From Stepwise Multiple Linear Regression Analysis.

Dependent	Independent	Unstandardized Beta	Standardized Beta	*t*	Significance
Restorative quality	(Constant)	6.829		79.815	.000
($R^2 = 0.416$; adjusted $R^2 = 0.384$)	Bamboo	−0.382	−0.119	−3.293	.001

containing waterscape (waterscape + lawn, waterscape + forest, waterscape + bamboo, waterscape + lawn + forest, waterscape + lawn + bamboo, waterscape + forest +bamboo, waterscape + lawn + forest + bamboo). The mean restorative scores of four groups were presented in Figure 3 which indicated that the videos containing lawn and forest were better than the videos containing bamboo and waterscape in terms of restorative quality. The one-way ANOVA noted that there were significant differences in restorative quality between four groups ($F = 3.853$, $p = .009$), which shows that landscape type is a critical factor to determine the restorative quality of environments. Pairwise comparison indicated that there were significant differences in three of the six comparisons, including lawn VS bamboo ($p = .004$), lawn VS waterscape ($p = .026$), and forest VS bamboo ($p = .015$).

In order to conduct regression analysis, the dummy-coding method was employed to quantify four types referring to previous literature (e.g., Arriaza et al., 2004; Wang et al., 2019): *without lawn* = 0, *with lawn* = 1; *without forest* = 0, *with forest* = 1; *without bamboos* = 0, *with bamboos* = 1; and *without water* = 0, *with water* = 1. The result indicated that bamboo was a negative predicator of restorative quality (Table 3), which generally implies that the bamboo along the path in urban green spaces reduces the restorative quality of walking environment.

Effects of Complexity of Path Landscape Elements on Restorative Quality

Fourteen videos were regrouped according to the number of natural elements along the path: videos with one element (lawn, forest, and bamboo), videos with two elements (lawn + forest, lawn + bamboo, forest + bamboo, waterscape + lawn, waterscape + forest, waterscape + bamboo), videos with three elements (lawn + forest + bamboo, waterscape + lawn + forest, waterscape + forest + bamboo, waterscape + forest + bamboo), and videos with four elements (waterscape + lawn + forest + bamboo). The mean restorative scores of these four groups were presented in Figure 4 which indicated that the restorative quality of path landscape with one element was the

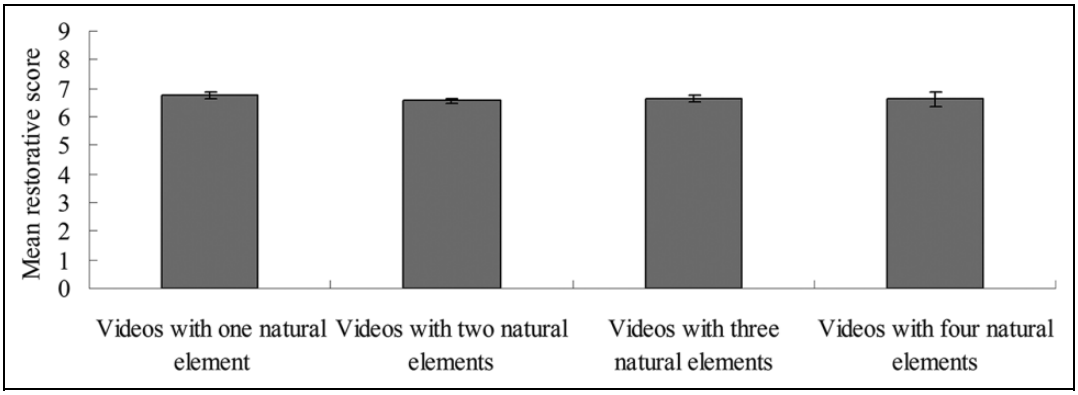

Figure 4. Mean restorative scores (± standard error) for four groups of videos that include different numbers of landscape elements.

highest. The one-way ANOVA demonstrated that there were no significant differences in restorative quality between the four groups ($F = 0.532$, $p = .661$), and all the pairwise comparisons also indicated no significant difference in restorative quality. The Curve Estimate analysis did not find the significantly relationship between landscape complexity and the restorative quality. The results clearly indicated that the landscape complexity had a weak influence on the restorative quality of environments.

Effects of Waterscape on Restorative Quality

Figure 1 suggested that the restorative score of vegetated path landscape was changed by adding waterscape. These changes were defined as waterscape's effects on restorative quality, which were calculated by the following formula:

$$E_i = R_{iw} - R_i$$

where E_i = the effect of waterscape on the restorative quality of *i*th vegetated video; R_{iw} = the restorative quality of the counterpart of *i*th vegetated video, which was created by adding waterscape; and R_i = the restorative quality of *i*th vegetated video.

The waterscape's effects on restorative quality of seven vegetated videos were presented in Table 4, which indicated that waterscape reduced the restorative quality of five of the seven vegetated videos, and only slightly improved the restorative quality of two vegetated videos. The correlation analyses suggested that there was a significantly negative relationship between waterscape's effects and the restorative quality of vegetated videos (Pearson's coefficient = −0.757; $p = 0.049$). The results imply that the higher the restorative quality of vegetated landscape, the greater the damage of waterscape to it, and adding waterscape to the vegetated landscape with low restorative quality is slightly beneficial to restorative quality.

Table 4. Waterscape's Effects on Restorative Quality of Vegetated Videos.

Vegetated Video	Waterscape's Effect	Vegetated Video	Waterscape's Effect
Lawn	−.855	Lawn + forest	−.175
Forest	−.304	Lawn + bamboo	−.157
Bamboo	.075	Forest + bamboo	.113
		Lawn + forest + bamboo	−.020

Discussion

Vegetation Type Along Path in Relation to Restorative Quality

Appleton (1975) proposed the "prospect-refuge" theory which stressed the importance of human self-protection instinct in the process of environmental evaluation. Stamps (2005) provided a

detailed explanation of the physical properties that affect permeability could predict perceived safety. Nikunen et al. (2014) suggested that the presence of a potentially uncontrollable source of danger could damage the restorative quality of a setting. Safety is a key factor in the decision-making process regarding walking and a successful pedestrian network (Southworth, 2005). Lawn in the videos produces open spaces, while forest and bamboo build close spaces (see Figure 1). Open spaces lead to greater mobility and perceived ability (Stamps, 2013), allowing a person to find the potential hazards in the distance, getting more opportunities for escape from the hazards, which means that less directed attention is needed to identify possible dangers, inducing higher perceived restorativeness according to ART (Kaplan & Kaplan, 1989). Also, open spaces provided by lawn may evoke positive feelings, because they provide an opportunity for the respondents to forget about daily living environment where is usually crowded with a dense population on a campus, producing the sense of "being away." The environments inducing immediate, instinctive positive emotional responses would possess higher restorativeness according to SRT (Ulrich, 1983).

On the other hand, although previous works suggest that more green views are better performance on stress recovery (Li & Sullivan, 2016; Wang et al., 2018), these studies use pictures or window views as stimuli, the respondents just view the greenery, not entering it. The videos used in this study are created to simulate a visitor's walking on the path (walking 150 m in 2 min). It is possible that when a visitor moves inside an environment, the perceived safety is much more important than the green view for the improvement of mental restoration. Therefore, it can make sense that the lawn beside the path possesses the highest restorative quality (Figure 3). Furthermore, lawn provides the place for visitors to play, enhancing compatibility of the environment, which was identified as one of four factors promoting restoration (Kaplan, 1995).

Comparatively, permeability of forest is higher than that of bamboo (see Figure 1), and, in the growing season, forest may provide more and abundant food for human being than bamboo. Kaplan (1995) indicated that mental stress could be caused by the human perception of inadequate resources. More resources and higher safety produce the fact that forest is better than bamboo in term of restorative quality.

Landscape Complexity in Relation to Restorative Quality

Most of the existing literature hold the view that biodiversity can predict restorative benefits (e.g., Carrus et al., 2015; Southon et al., 2018; Wood et al., 2018; Zhang et al., 2017). However, "biodiversity" in existing literature mainly refers to species-level biodiversity, that is, species richness, and even perceived biodiversity, not actual biodiversity (Southon et al., 2018). Perceived biodiversity possibly differs from the actual biodiversity, especially at very high or low diversity level (Lindemann-Matthies et al., 2010). In fact, biodiversity includes genetic, species, and ecosystem diversity. In this study, the term "landscape complexity" is equivalent to ecosystem diversity, and the result proves to be no statistically significant relationship between landscape complexity and restorative quality. Maybe, the reason for this is the different definitions of biodiversity. However, this conjecture needs further investigation in future studies.

Another explanation for this result may be that moderate complexity is most preferred (Ulrich, 1986), low complexity is perceived as monotonous and boring, while high complexity confusing (van den Berg & van Winsum-Westra, 2010). Moderate complexity correspondingly induces psychological restorative benefits because of the close ties between preference and mental restoration (Qiu et al., 2021; Wang & Zhao, 2020). Although no literature concretely defines moderate complexity, the videos with two or more landscape elements used in this study may have a high complexity due to the fact that respondents experience a path landscape within 2 min or 150 m travel, and the videos with one element possess a low complexity. That is to say, no video has moderate landscape complexity.

Water in Relation to Restorative Quality

Water is the dependent source of all life in the world. Waterscape is considered to be "peaceful," "traditional," "worth-preserving," and "preferable" (Wang & Zhao, 2019), and the significance of waterscape for heath has been demonstrated by many previous works (Völker & Kistemann, 2013, 2015; Xu et al., 2018; Zhao et al., 2018). However, this is not always the case. Some researchers claim that no significant association between waterscape and mental health is found (Dzhambov et al., 2018; Gascon et al., 2018; Triguero-Mas et al., 2015). For example, Rogerson et al. (2016) observed that there were no significant differences in self-esteem, perceived stress, or mood between runners running along riverside routes compared to those running along grass routes before and after the running. The present study concludes that waterscape generally reduces the restorative quality of vegetated path landscape. This is very significant and can be explained by the following facts. First, Zhao et al. (2013b) indicated that water had not always been conducive to human survival which not only needs water but also other elements such as land for dwelling, plants and animals for food, and shelter for safety. It means that there is a threshold for the proportion of water in a landscape. Waterscape in the videos used in this study spreads on one side of the path (Figure 1). Too much water can reduce the ability of a landscape to afford access to subsistence resources, thereby reducing the restorative quality, especially when the path landscape possesses high restorative quality (Table 4). Second, waterscape possibly causes a range of threats to humans, including an estimated 370,000 drownings globally per year (World Health Organization, 2018) and water-borne diseases (Ali et al., 2015). Zhao & Huang (2021) suggested that easy accessibility of waterscape increased perceived risk of falling into the water. In the videos, there are no protective facilities between waterscape and the path, inducing the worry to fall into the water, in turn reducing restorative quality of path landscape. Third, inland waterscape and green environment are similar for improving the well-being of users (MacKerron & Mourato, 2013). The water used in the videos is not suitable for water-based physical activity such as swimming, boating (see Figure 1), the presence of water along the path reduces the area for conducting physical activity which has been identified as one of the four dimensions of appropriation related to the way blue spaces being perceived to achieve salutogenic potential (Völker & Kistemann, 2011), especially when the landscape types that suitable for physical activity, such as lawn, is removed by water, causing more degradation of restorative quality (Table 4). Fourth, to increase the representativeness of the videos for real landscapes, the water in the videos is not very clear and flows slowly (Figure 1). Water quality is vitally important for a range of health and well-being outcomes (Landrigan et al., 2018; Xu et al. 2018), and Pflüger et al. (2010) suggested that high flows were preferred in small rivers. It is reasonable to assume that perceived poor water quality and small flow speed are the factors reducing the restorative quality of path landscapes. Fifth, Fairchild et al. (2018) indicated that visitors had a greater interest in blue spaces with higher biodiversity, and greater perceived stress reduction from more biodiverse settings. Obviously, the waterscape in our videos has very low biodiversity, which possibly reduces the restorative quality.

In summary, the risks caused by water are generally far better documented than the benefits of waterscape (Borja et al., 2020), and water environments are generally named "blue spaces" in most previous literature (e.g., Garrett et al., 2019; Pearson et al., 2019; White et al., 2013) but do not consider the specific features of water. In fact, water is characterized by variability and sensitivity to environmental forms (Völker & Kistemann, 2015). The polymorphic structure and metamorphic properties as well as reversibility are the qualities of water (Strang, 2004). Therefore, it is inaccurate to generally say that water can lead to positive or negative health outcomes, because the features of water maybe play a major role in the determination of restorative quality. It is just as suggested by Völker and Kistemann (2015) that the waterscape in urban areas which

usually has various qualities needs more detailed and accurate examination of its health-enhancing effects.

Limitations and Future Research

Compared with real walking on paths, 2-min videos used in this study are very short, which possibly weaken our results. Although 14 path landscapes which include three vegetation types and their combinations with or without waterscape were created, they still cannot fully represent the complex path landscapes in urban green spaces. Furthermore, this study does not consider the qualities of each landscape type, just only controls them as constants. In fact, each type has various qualities such as the flow speeds of water, which have been evidenced to be an essential factor influencing visitors' experience (Pflüger et al., 2010). Therefore, this study just provides partial clues to design practice. More evidence is still needed to guide the path landscape design.

Previous studies have been demonstrated that seasonal changes had a profound impact on the landscape (Zhao et al., 2017), thereby affecting visitors' experience (Brooks et al., 2017; Paddle & Gilliland, 2016; Xu et al., 2022; Wang & Zhao, 2020), especially in the temperate regions where usually have distinctively seasonal changes. Song et al. (2015) indicated that the effects of walking in urban parks on mental health were apparently different between the seasons. However, the videos used in this study only represent the growing seasons, in other seasons such as winter, how do the types and complexity of natural elements along path impact visitors' mental health? This question calls for a new research in the future.

Friendship and social cohesion are positively associated with mental health and psychological well-being (O'Campo et al., 2009). A person who walks with others feels less anxiety and severe depression (Paydar et al., 2020). In this study, we evaluate restorative quality in the absence of other people on the path. Although the effects of companions on restorative quality are not the aim of this study, understanding this issue can provide practical evidence for path landscape design.

Conclusions

Paths are most frequently used facilities in urban green spaces, and visitors spend a large proportion of their visiting time on them. Therefore, path landscapes are an essential factor influencing the restorative quality of urban green spaces. This study measures the restorative quality of 14 path landscapes using computer-created videos as stimuli and undergraduates as respondents. The three questions raised in this study are exactly answered by the results. For the first question (which vegetation type or combination of different vegetation types has higher restorative quality?), the answer is that the path containing lawn or(and) forest is much better than that containing bamboo and waterscape in terms of restorative quality. For the second question (what are the impacts of introducing waterscape into vegetated path landscapes on restorative quality), the answer is that, generally speaking, waterscape reduces the restorative quality of vegetated path landscape, the higher the restorative quality of vegetated path landscape, the greater the damage of waterscape to restorative quality. For the third question (does landscape complexity impact the restorative quality of path landscapes?), the answer is that path landscape complexity has a weak influence on the restorative quality of environments. In practice, although bamboo has a cultural connotation in Chinese cultural background, this study suggests the landscape of dense bamboo along the path should be avoided, and lawn and trees along the path are encouraged. If we want to add waterscape to the path, the features of waterscape such as flow, clarity, size, form, and so on should be considered carefully.

. . . the path containing lawn or(and) forest is much better than that containing bamboo and waterscape in terms of restorative quality.

. . . generally speaking, waterscape reduces the restorative quality of vegetated path landscape, the higher the restorative quality of vegetated path landscape, the greater the damage of waterscape to restorative quality

. . . path landscape complexity has a weak influence on the restorative quality of environments

Implications for Practice

- The vegetation along the path should be carefully selected. Lawn and forest or their combination on the sides of the path are encouraged, but bamboo should be restricted in the path landscape.
- If we want to add waterscape to a path, the features of water, such as flow, clarity, size, form, and proportion, should be considered carefully. Maybe, planting some trees on the areas between path and waterscape to decrease the perceived risk of falling into the water is recommended.
- The landscapes along a path do not change frequently, for instance, within 150 m length of path, a constant landscape is much better than changeable landscapes in terms of restorative quality.

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