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How restorative landscapes can benefit psychological and physiological responses: a pilot study of human–nature relationships in Sweden and Taiwan

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ABSTRACT

Restorative landscapes provide people with the opportunity to experience nature. This pilot study aimed to determine whether cultural differences affect psychological and physiological responses to restorative landscapes. Two populations, one in Taiwan and one in Sweden, were experimentally compared by showing them photos of restorative landscapes from each country. The results showed that restorativeness was affected more by photos of the restorative landscape in Sweden than in Taiwan. The results showed that restorativeness in terms of psychological and physiological responses was affected. A significant variation in heart rate was observed between the populations: Taiwanese participants experienced higher heart rates when viewing unfamiliar and novel scenery when compared to Swedish participants. No significant differences between the populations were observed regarding attention capacity, working memory, and muscle tension. The psychological and physiological responses to the two countries' distinctive restorative landscapes may have implications for designing such landscapes in urban green spaces.

KEYWORDS

Culture difference; restorativeness; nature-based intervention; biofeedback

Introduction

Over the past few decades of research on nature and the environment, consistent results have supported the argument that connecting to nature can restore one's physiological and psychological health (Frumkin et al., 2017). Nature-based interventions, such as attending green activities or viewing nature photos, can be used by urban residents to experience nature, which could provide health benefits and improve well-being (Shanahan et al., 2019; Stigsdotter et al., 2011). Natural settings can be considered a 'healing place or therapeutic landscape' that can promote physical, mental, and spiritual health (Gesler, 2003). Different spaces and places, although reflecting local cultural characteristics and geographical features, can similarly impact human

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health (Bell, Foley, Houghton, Maddrell, & Williams, 2018; Foley, 2011; Foley & Kistemann, 2015). In addition, immersion in 'restorative places,' including green and blue landscapes, plays an essential role in restoring psychological health (Kaplan & Kaplan, 1989). The results of research on the relationship between natural environments and positive psychological responses have been consistent (Ulrich, Kellert, & Wilson, 1993). Despite their variety, landscapes have been shown to elicit similar psychological and physiological responses and can thus potentially improve well-being to various degrees (Elsadek, Sun, Sugiyama, & Fujii, 2019; Petrova et al., 2015; Yang & Brown, 1992). However, few studies have explored the universal restorative benefits of natural landscapes by combining different populations and landscape types from different countries.

Nature–human experience and psychological and physiological outcomes

Receiving too much information from one's environment can cause attention fatigue. Connecting with nature, on the other hand, seems to consistently alleviate attention fatigue and improve health more generally (Kaplan & Kaplan, 1989). The relationship between the environment and humans is a dynamic, interactive process that involves human perceptions, experiences, and landscape preferences. Savanna-like biomes have been shown to promote a sense of familiarity with and connection to nature (Balling & Falk, 1982), as these biomes were once the primary setting within which early humans sought shelter and survival (Appleton, 1975). However, the universal preference for savannas has recently been investigated in a study involving university students and indigenous groups in Asia and Latin America (Hägerhäll et al., 2018). The findings of the study showed that the preference for savannas was only present among university students; the indigenous groups, on the other hand, preferred landscapes with denser vegetation (Hägerhäll et al., 2018). Meanwhile, habitat theory argues that animals and plants evolved to adapt to different types of landscapes and available resources (e.g. flowering or fruiting plants, water), whereas human activities are focussed more on directing the evolution and shaping the ecological conditions of these landscapes (Orians & Heerwagen, 1992). Habitat selection theory (Heerwagen & Orians, 1993) states that flowers attract people as they are a survival resource. Kaplan and Kaplan (1989) proposed that restorative environments, including attributes of being away, fascination, extent, and compatibility, can alleviate attention fatigue more than urban environments. Ulrich (1984), in contrast, suggested that, according to psycho-evolutionary theory, connecting with nature can relieve stress. Hence, connecting with unthreatening natural elements and settings (e.g. restorative environments, vegetation, savanna-like conditions, or park-like features) can help individuals recover from stress faster than connections made within urban environments, which might be attributable to the evolutionary assumption of 'adaption and survival' in supporting restorative responses (Joye & van den Berg, 2011).

Natural or urban settings that have restorative effects on psychology and physiology are called restorative environments (Joye & van den Berg, 2018). Studies have pointed out that a variety of restorative environments (e.g. forests, waterscapes, mountains, wilderness, urban parks) have aesthetic value, restore attention, and lower physiological tension and heart rate (Chang, Hammitt, Chen, Machnik, & Su, 2008; Hartig, Mang, & Evans, 1991; Staats, Kieviet, & Hartig, 2003; van den Berg, Koole, & Van der Wulp, 2003). Moreover, natural elements, such as water, plants, and form topography are considered essential to restorative urban landscapes (Deng et al., 2020). A study evaluating human preferences for manicured, romantic, and wild gardens found that those who have a strong demand for a personal structure to assist them in understanding and exploring the environment prefer gardens (van den Berg & van Winsum-Westra, 2010). Other studies have highlighted that rural landscapes (agritourism farms, forests, mountains) with pronounced natural features can serve as a refuge for urban residents to release stress and

restore their direct attention (Hung et al., 2022; Simkin, Ojala, & Tyrväinen, 2020). In addition, therapeutic landscapes for health care, such as the Alnarp Rehabilitation Garden in Sweden and Dannerhuset's Crisis Garden in Copenhagen, Denmark, include restorative components designed to assist patients in connecting with nature and establishing social connections with others in outdoor environments through sensory experiences (Marques et al., 2021a). Previous research has demonstrated that natural environments generate enhanced restorative effects, including reduced physiological stress. In the present study, differences in restorative environments between eastern and western countries and whether—and if so, how—these differences affect psychological and physiological responses were examined.

Cultural differences in human–nature experiences and landscapes

Culture can affect physiological and mental health. Studies have pointed out that therapeutic landscapes designed with specific cultural orientations in mind have health benefits related to the shared meanings these landscapes evoke (Marques et al., 2021b). In addition, therapeutic landscapes elicit the sense of feeling 'at home,' thereby also cultivating a sense of comfort (Wendt & Gone, 2012). Most people today, especially in eastern countries, live in urban areas, with nature experienced almost solely through vacations. However, the experience of nature differs for those living in western countries. Thus, it is important to understand the different roles played by nature for people living in western and eastern countries and the extent to which these differences are based on cultural differences.

Confucianism, Taoism, and Buddhism of Chinese thought view 'Nature and I' as a holistic unit. In stark contrast, throughout the Industrial Revolution, the western world considered human beings as having the power to control nature. That said, all societies, east or west, recognise nature as vital to health. More specifically, regardless of the attitudes of those living in the East and the West towards nature, there is a universal acknowledgment that the human bond with nature is instinctive and consistent across all cultures (Wilson, 1984). Accordingly, natural environments are universally regarded as having a higher aesthetic value than urban environments (Ulrich et al., 1993). Yet, research suggests that cultural variations influence perceptions of aesthetics (Lehman, Chiu, & Schaller, 2004) and affective reactions to landscapes (Ulrich, 1983).

An evolutionary perspective might be useful for predicting landscape preferences (Kaplan, 1987). Partially supporting this argument, in one evidence-based study, humans were shown to prefer flowering over fruit-bearing plants. The study indicated that this preference could be related to a sense of familiarity with the landscape and knowledge of the shapes and colours of plants, etc., with cultural inferences (Hůla & Flegr, 2021). Another study found that three different types of gardens evoke varying types of affection. The first Botanical gardens in UBC dominated by vegetation but with fewer other natural elements were shown to increase relaxation and promote the sense of being in tune with nature. Japanese gardens, on the other hand, provide more types of vegetation, as well as other natural elements, like stones and ponds, whereas architectural gardens featuring roses were shown to evoke culture-specific differences in attention among Japanese and Canadian participants (Elsadek et al., 2019). Another study conducted in Japan and Russia found that the natural landscapes typical of these countries elicited a sense of familiarity and belonging among participants from these countries; however, mountains, waterfalls, lakes, and landscapes with or without water generated consistent levels of attraction and similar preferences for landscape aesthetics (Petrova et al., 2015). Likewise, research on landscape preferences among American, Irish, and Senegalese populations, although demonstrating culture-based distinctions, also revealed a similar sense of belonging and strong attachment attributable to universal cross-cultural landscape preferences (Newell, 1997). Based on the above discussion, we might view 'natural' landscapes that are aesthetically pleasing as a way to restore

health. That is to say, the large open grasslands, flowers, scattered trees, or garden landscapes in western countries easily allow for connections with nature—in contrast to eastern countries, where most people reside in urban centres.

Research framework

According to theories about and research on landscapes, the various restorative qualities of unthreatening natural landscapes may promote human health. Consequently, in the present study, we investigated the extent to which 'restorative natural landscapes' could represent a kind of universal landscape preference in both eastern and western countries. Moreover, we sought to determine whether such landscapes might be employed as a nature-based intervention to help restore psychological and physiological health.

Methods

Participants

This pilot study collected at least 40 samples in two counties, i.e. Sweden and Taiwan, to test the effect of different countries' restorative environments and psychological and physiological responses. Towards this end, biofeedback instruments with a high standard of measurement were employed, which based on the study sample ranges from 40 to 120 participants (Chang et al., 2008; Gao, Zhang, Zhu, Gao, & Qiu, 2019; Lin et al., 2020; Liu, Qu, Ma, Wang, & Qu, 2022).

Sample recruitment was performed separately in Sweden and Taiwan. Those between the age of 20 and 65 were invited to participate in the study. The inclusion criteria used for participant selection were good physiological and psychological health, no history of neurological disease, and no current use of central nervous system medications (e.g. antidepressants). All staff, students, and others at the Swedish University of Agricultural Sciences (SLU) received an email invitation, were asked to attend different classes/lectures with oral presentations, and were presented with flyers and posters with information about the study design and procedures. All participants received two tickets to the cinema for their participation. All but two participants were Swedish natives; these two participants, however, were still from western cultures. In Taiwan, students, staff, and others at the National Taiwan University (NTU) in Taipei were invited to participate via an online social media platform. All participants were native Chinese (Taiwanese) and received a gift card (100NTD $=$ 3.35 dollars) for their participation. The researchers confirmed their willingness to participate and determined the proper time at which they would arrive at the research site.

Experimental settings

This study compared visual attraction and psychological and physiological responses to restorative landscapes in Sweden and Taiwan. We focussed on two critical hypotheses: H1: There is a significant cultural difference between Taiwan and Sweden concerning psychological responses to restorative landscapes and H2: There is a significant cultural difference between Taiwan and Sweden concerning physiological responses to restorative landscapes (see Figure 1). Sweden and Taiwan have varying relations to nature based on cultural differences: Sweden has large natural expanses, and it is therefore much easier for Swedes to experience the natural environment; in contrast, Taiwan is densely populated, and it is thus not so easy for Taiwanese residents to encounter nature, as most live in urban centres. Sweden has a long history of supporting outdoor activities via the Right of Public Access, permitting easy access to natural environments, as

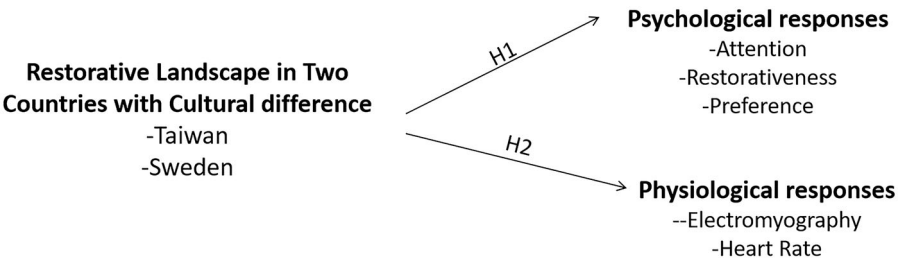

Figure 1. The research framework of the hypothesised model concerning psychological and physiological responses by the two groups to two restorative landscapes.

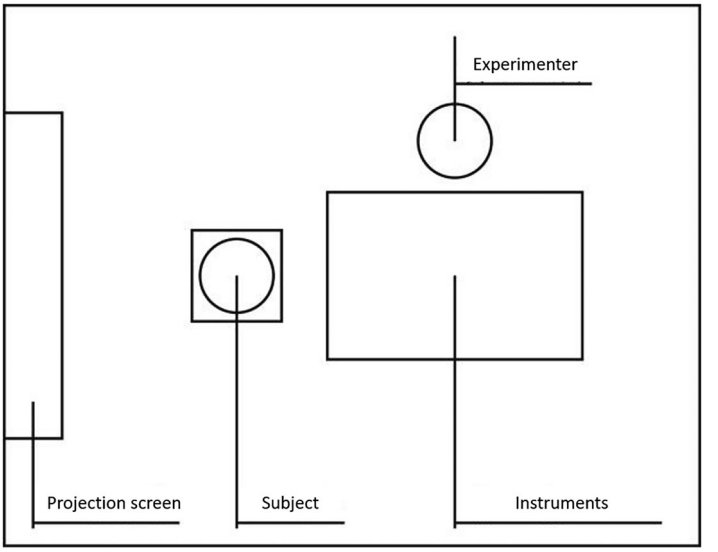

Figure 2. The same relative configurations were set up at SLU and NTU to measure physiological and psychological responses when viewing restorative landscapes.

well as a long tradition of outdoor organisations, such as the Swedish Outdoor Association (*Friluftsfrämjandet*), founded in 1892 and currently boasting over 100 000 members (Frilufts främjandet, 2022). These policies and organisations provide Swedes with many opportunities to explore nature and engage in recreational activities. Access to nature in Taiwan, in contrast, is far more restricted.

Both experiments in this study were conducted at universities. In Sweden, research was conducted in the Alnarp building at SLU. In Taiwan, research was performed in the landscape and gardening building on the main campus of NTU. The relative configuration of the experimental research rooms is depicted in Figure 2.

The restorative images in the experiments

The experimental sites chosen in each country included vast grasslands, flowers, plants, water features, mountain views, etc., away from daily life that were considered to be 'restorative landscapes.' We collaborated with the Swedish University of Agricultural Sciences, which is located in a temperate zone, different from the subtropical zone in which Taiwan is situated. These stark differences in climate, vegetation, and culture provided a good opportunity to build knowledge concerning the effects of culture on nature-based health interventions focussed on aesthetic experiences, restorativeness, and physiological and psychological responses. Experimental photos

Figure 3. An example of different sets of restorative landscapes examined in this study.

of restorative landscapes were taken onsite at the Alnarp Rehabilitation Garden, located in southern Sweden. These photos were selected based on the client's choice and experience in the garden (Pálsdóttir, Stigsdotter, Persson, Thorpert, & Grahn, 2018). In Taiwan, on the other hand, part of the experimental photos of restorative landscapes was taken of mountains, trees, and plants in rural parts of the country (Hung et al., 2022, Tung, Hung, Chang, & Tang, 2023). In total, 25 photos were taken, all representing restorative environments in each country (Figure 3 shows examples of the restorative images).

Measurements

Digit span backward test (DSBT)

Before exposing the participants to environmental stimuli, we used the digit span backward test (DSBT), conducted in two trials of 2–8 digits, to measure their short-term memory. The researchers clearly read the digits aloud at a rate of one per second. The participants were then asked to repeat the digits in reverse order; for example, for the digit sequence 3-7-4, the participants should have responded 4-7-3. Each digit sequence was presented only once. Spontaneous changes to responses were permitted. Testing was stopped after two consecutive failures of the same span length. For each participant, the number of correct responses on the DSBT was divided by the total number of questions. The larger the number of correct responses, the better the attentional performance of the participant at the moment.

Perceived restorativeness scale (PRS)

The study also relied on the shorter version (five questions) of the perceived restorativeness scale (PRS), developed by Berto (2005), to measure the restorative quality of environmental stimuli. The PRS assesses *being away*, *fascination*, *coherence*, *scope*, and *compatibility* on a 5-point Likert scale. Higher scores indicate higher degrees of restorativeness based on perceptions of the experimental environment.

Landscape preferences

Preferences for restorative environments vary among people. Thus, in this research, one statement ('In this environment, I like the setting very much') was evaluated to measure the participants' preferences for restorative environments on a 5-point Likert scale. A higher score indicated a greater preference for a given restorative environment.

Physiological responses

Environmental stimuli affect the physiological status, causing a variety of sympathetic nervous system (SNS) and parasympathetic nervous system (PNS) responses. These can be detected through biofeedback instruments aimed at obtaining an objective value of the relationship between humans and the environment. This study employed the ProComp Infiniti from Thought Technology with Biograph Infiniti 6.1.0 software, a medical device approved by the US Food and Drug Administration (FDA), to record high standards of EMG and HR data as physiological health response indicators resulting from viewing restorative landscapes.

The prefrontal muscle directly expresses physiological responses since feedback from visual stimuli directly reflects emotions and stress via the relaxation and contraction of the brow muscles. When brow muscles are relaxed, it is implied that other parts of the body are relaxed

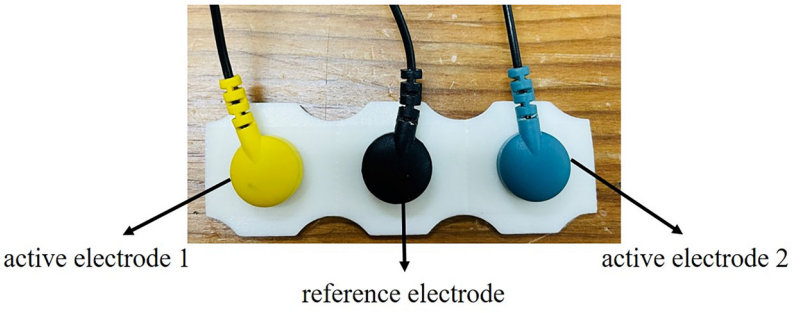

Figure 4. The relative position of the EMG electrode patches.

as well. In the experiment, electrodes were placed about 4 cm above the participants' eyebrows. The middle electrode was the reference electrode, i.e. the path for the other two electrodes (active electrode one and active electrode two) (see Figure 4).

A blood volume pulse (BVP) measurement tool produced by Thought Technology was used to measure the BVP at the tip of the participants' finger using a light source and a light receiver. When the BVP increased, a red light was produced that absorbed the other light colours. By measuring the change in blood flow generated between each heartbeat, changes in the heart rate (HR) can be estimated, from which the state of the SNS receiving and responding to the stimuli can be inferred. However, as peripheral blood flow is not a direct measurement of HR, the results had to be converted into HR by measuring the number of beats per minute (BPM) as a unit of measure. In healthy adults, the HR ranges from 60 to 100 BPM.

Experimental process

The Research Ethics Committee approved this study (approval number 201703HS024). Each participant signed an informed consent form to confirm their willingness to voluntarily participate in the study. The experimental process was divided into (1) a physiological experiment, which employed a biofeedback instrument to test direct stimulation by restorative images, and (2) a psychological assessment, which was based on participant responses on a self-reported questionnaire.

The experimental process was completed in five steps: (1) the experimental process and research purpose were explained to the participants, followed by an introduction to the experimental tools; (2) an exfoliating cream was used to clean the participants' foreheads before attaching the electrodes to ensure the quality of the signals generated by the biofeedback instrument; (3) a neurodiagnostic electrode paste was used to attach the electrodes to the participants' foreheads to confirm the quality of the electromyogram (EMG); another instrument was placed on the left finger of each participant to measure HR; Biograph Infiniti 6.1.0 software was used to confirm the bio-signals, with values below 5 being regarded as standard signals; (4) the physiological experiment was performed, lasting 8 min. The collection of biological data was divided into three stages. In the first stage, the participants' short-term memory and attentional performance were tested by asking them to remember number sequences from the DSBT. After the sequences were read aloud, the participants were asked to recite them in reverse order, with the researchers adding a numeric character for every two questions. This test lasted for 3 min. In the second stage, five sets of images (of 25 images in total) of restorative landscapes in Sweden and Taiwan were shown to the participants, who were then asked to immerse themselves in the images for 15 s. The photos were randomly assigned to the participants. In a related study, Berto (2005) stated that at least 15 s is required to gauge the effect of environmental stimuli on attention. Likewise, in another study, Hartig and Staats (2006) argued that 15 s is sufficient for a participant to distinguish spatial scale based on preference. Therefore, the current study used 15 s as the experimental stimulus for each image of a restorative landscape. The third stage involved performing the DSBT a second time (see Figure 5). In this stage, the aim was to determine whether viewing photos of restorative landscapes improved the short-term memory or attention among the participants. (5) In the last step of the experimental process, the researchers removed the electrodes from the participants' foreheads. In total, the experiment lasted 40 min per participant. Afterward, the psychological questionnaires, which included restorativeness and preference items, were distributed to each participant.

After the participants completed the psychological questionnaires, the data were coded in Excel and checked for incomplete information. The Biograph Infiniti 6.1.0 software was employed to read and export the physiological data, after which outlier data, which included values of the number of original EMG biosignals over 30 and irregular heartbeat waves as a bias, were deleted.

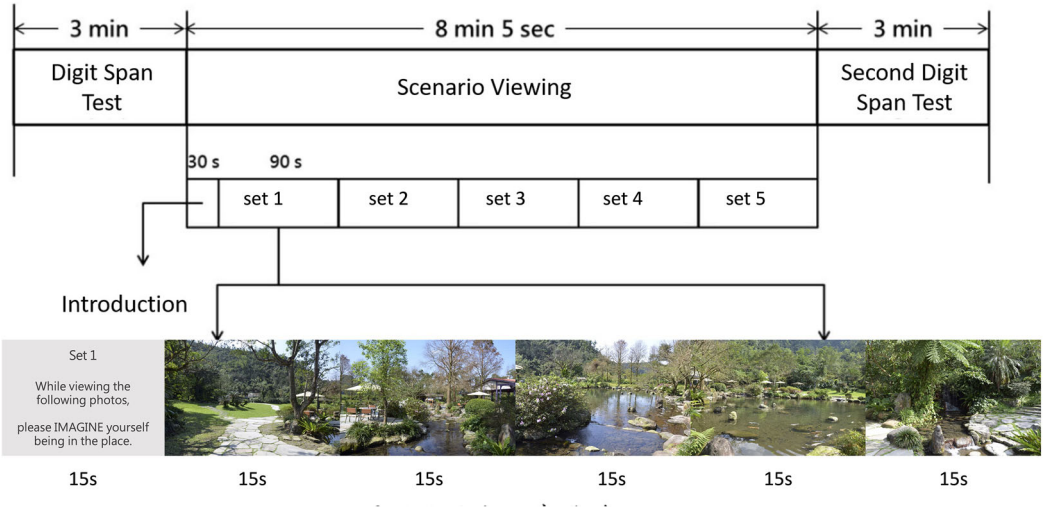

Figure 5. The experimental process was used to collect the physiological and psychological data in the study.

Next, Excel was used to output the physiological data. All data were analysed by IBM SPSS 25 with ANOVA.

Data analysis

To determine whether significant differences existed between the two groups concerning psychological responses, we conducted a general linear model (GLM) of ANOVA tests to describe the statistical relationship between restorative landscapes in the two countries based on participants' overall psychological feelings. Moreover, to determine whether significant differences existed between the groups in terms of physiological responses, we evaluated the participants' electromyographic responses and HR while viewing photos of restorative landscapes in the two countries.

Results

A total of 113 valid data points for psychological responses were included in this study, of which 67 were from participants from Taiwan, and 46 were from participants from Sweden, including 47 males (41.6%) and 66 females (58.4%). For the physiological responses, there was a total of 85 valid data points, of which 48 were from participants from Taiwan, and 37 were from participants from Sweden, including 33 males (38.8%) and 52 females (61.2%). The participants were mostly students. The average age of participants was 25.31 years old in Taiwan and 34.57 years old in Sweden.

Psychological responses to restorative landscapes based on culture

We examined differences in attention, restorativeness, and preference concerning restorative landscapes in the two countries based on participants' overall psychological feelings. The percentage of correct responses before and after the DSBT was 5.11%, indicating an improvement in attention (Table 1). However, the results showed no significant effects of attention based on culture [$F(1, 109) = 1.597$, $p = 0.209$] or restorative landscapes [$F(1, 109) = 0.001$, $p = 0.973$].

The results of the descriptive analysis of restorativeness among the two groups are shown in the Supplementary Material. The GLM revealed significant differences in culture [$F(1,$

Table 1. A description of the percentage of correct responses before and after the DSBT on culture and restorative landscapes.

	Restorative landscapes in Taiwan		Restorative landscapes in Sweden			
Culture	*n*	*M* (*SD*) (%)	*n*	*M* (*SD*) (%)	*n*	Margin *M* (%)
Taiwan	33	4.98 (9.86)	34	3.36 (9.51)	67	4.16 (9.64)
Sweden	27	5.88 (10.03)	19	7.36 (11.22)	46	6.49 (10.44)
Margi *M* (%)	60	5.38 (9.86)	53	4.80 (10.23)	113	5.11 (10.00)

Note: The percentage of attention was calculated by subtracting the rate of correct responses to the first DSBT from the rate of correct responses to the second DSBT after viewing the restorative natural landscapes.

Table 2. The general linear model (GLM) shows the significance of the effect of culture and restorative landscapes on restorativeness.

	SS	*df*	*F*	*p*	η^2
Culture	2.043	1	8.254	0.005	0.070
Restorative landscape	1.323	1	5.347	0.023	0.047
Culture*Restorative landscape	0.198	1	0.802	0.372	0.007
Error	26.972	109			
Corrected total	30.86	112			

$N = 113$, $p < 0.05$.
Note: (1) $R^2 = 0.126$ (Adjusted $R^2 = 0.102$); (2) All variables are equal variances assumed by Levene's test.

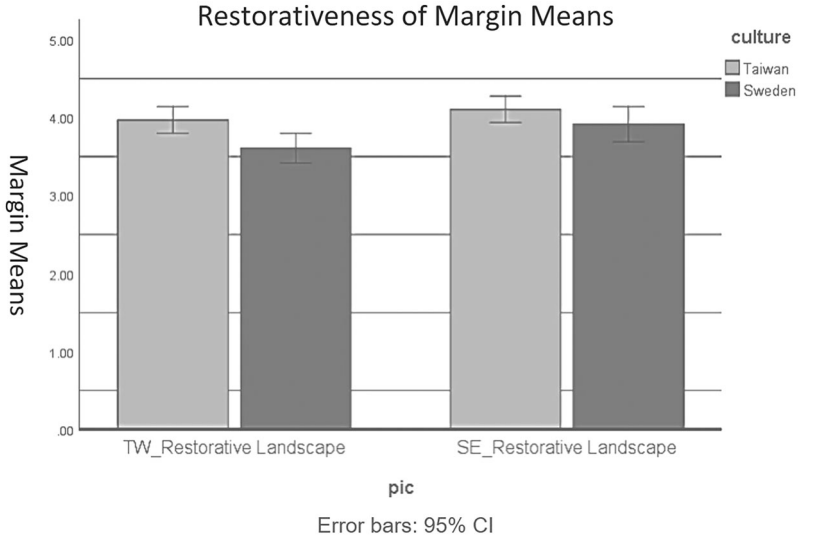

Figure 6. The generalised linear mixed model of the effect of culture and restorative landscapes on restorativeness.

109) = 8.254, $p = 0.005$, $\eta^2 = 0.070$] and restorative landscapes [$F(1, 109) = 5.3474$, $p = 0.023$, $\eta^2 = 0.047$] with respect to restorativeness (Table 2, Figure 6). The results also showed that the Taiwanese participants ($M = 4.04$, $SD = 0.45$) perceived higher restorativeness than the Swedish participants ($M = 3.73$, $SD = 0.57$). Specifically, the results demonstrated that restorative landscapes in Sweden provided a higher restorativeness score rating ($M = 4.04$, $SD = 0.46$) than those in Taiwan ($M = 3.81$, $SD = 0.56$). There was no significant interaction between culture and restorative landscapes [$F(1, 109) = 0.802$, $p = 0.372$]. Both Taiwanese ($M = 4.11$, $SD = 0.42$) and Swedish ($M = 3.92$, $SD = 0.52$) participants reported high restorativeness scores after viewing the restorative landscapes in Sweden compared with those in Taiwan [Taiwanese ($M = 3.97$, $SD = 0.48$) and Swedish ($M = 3.61$, $SD = 0.58$)].

The results of the descriptive analysis of landscape preferences among the two groups are illustrated in the Supplementary Material. The GLM revealed significant differences in culture

Table 3. The general linear model (GLM) shows the significance of the effect of culture on landscape preferences.

	SS	*df*	*F*	*p*	η^2
Culture	2.350	1	4.689	0.033	0.041
Restorative landscape	1.112	1	2.218	0.139	0.020
Culture*Restorative landscape	0.001	1	0.002	0.961	0.000
Error	54.63	109			
Corrected total	58.50	112			

$N = 113$, $p < 0.05$.
Note: (1) $R^2 = 0.066$ (Adjusted $R^2 = 0.040$); (2) All variables are equal variances assumed by Levene's test.

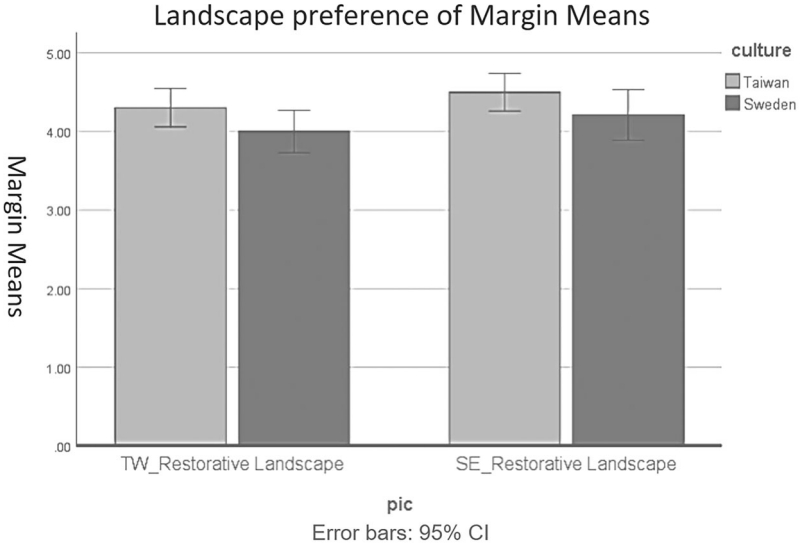

Figure 7. The generalised linear mixed model of the effect of culture and restorative landscapes on landscape preferences.

Table 4. The general linear model (GLM) shows the significance of the effect of culture in terms of heart rate (HR).

	SS	*df*	*F*	*p*	η^2
Culture	2599.454	1	31.554	0.000	0.280
Restorative landscape	48.956	1	0.594	0.443	0.007
Culture*Restorative landscape	20.753	1	0.252	0.617	0.003
Error	6672.843	81			
Corrected total	9396.70	84			

$N = 85$, $p < 0.05$.
Note: (1) $R^2 = 0.290$ (Adjusted $R^2 = 0.264$); (2) All variables are equal variances assumed by Levene's test.

[$F(1, 109) = 4.689$, $p = 0.033$, $\eta^2 = 0.041$] regarding landscape preferences (Table 3, Figure 7). Taiwanese participants ($M = 4.40$, $SD = 0.60$) had a higher preference score than Swedish participants ($M = 4.09$, $SD = 0.84$) concerning restorative landscapes.

Physiological responses to restorative landscapes based on culture

Differences in EMG and HR based on participants' physiological responses to restorative landscapes in the two countries were found. The results showed no significant difference in EMG because of culture [$F(1, 81) = 0.021$, $p = 0.884$] and restorative landscapes [$F(1, 81) = 0.004$, $p = 0.950$]. The results of the descriptive analysis of landscape preferences among the two groups are outlined in the Supplementary Material. A significant difference was found between HR and cultural differences [$F(1, 81) = 31.554$, $p = 0.000$, $\eta^2 = 0.280$] (Table 4, Figure 8). HR was

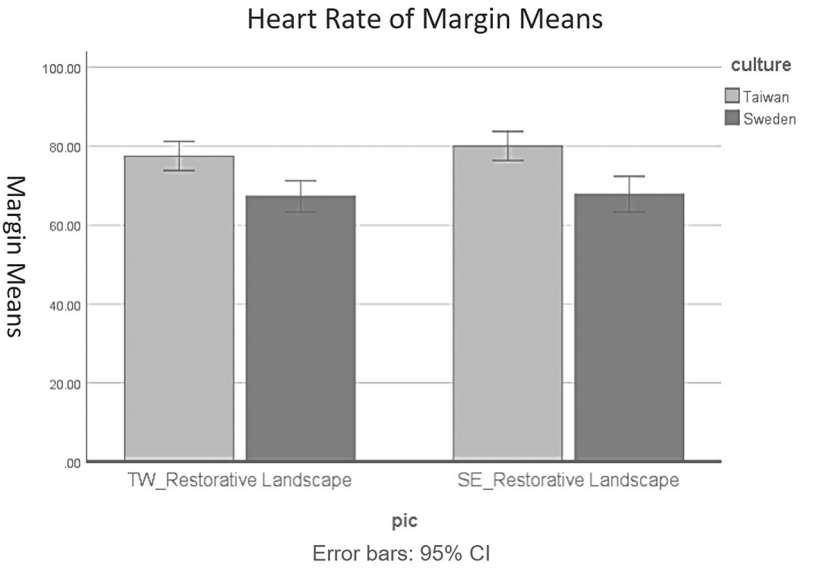

Figure 8. The generalised linear mixed model of the effect of culture and restorative landscapes on heart rate (HR).

shown to be faster when viewing restorative landscapes among Taiwanese participants ($M = 78.80$, $SD = 9.81$) than among Swedish participants ($M = 67.56$, $SD = 7.87$). In the GLM, no significant interaction between cultural differences and viewing different restorative landscapes were found in terms of HR (Table 4, Figure 8).

Discussion

The main finding of the present study was that cultural differences affect restorativeness, landscape preferences, and individual HR. Consequently, cultural understandings of connecting with nature from the western and eastern worlds could affect perceptions of nature.

Do cultural differences between the East and the West affect psychological responses to restorative natural landscapes?

No cultural differences were found in terms of attention capacity when the two different restorative landscapes were viewed by participants. This may be because attention is part of a cognitive process that involves selective concentration on a stimulus. As our research focussed on restorative landscapes given equal attention by two different cultures, our findings could not be used to compare different types of natural landscapes with respect to participants' working memory, as was done in previous studies (e.g. Berman, Jonides, & Kaplan, 2008; Kuo, 2001). These studies found that exposure to natural versus urban settings yields health benefits (e.g. attention, short-term memory, emotion) (Berman et al., 2008, 2012; Chiang, Li, & Jane, 2017; Hartig, Evans, Jamner, Davis, & Gärling, 2003; Ohly et al., 2016). However, when comparing different natural landscapes, it is difficult to determine differences in psychological recovery (van den Berg, Jorgensen, & Wilson, 2014). A possible explanation for this is that ecological and maintained natural landscapes in eastern or western landscapes both possess restorative components (e.g. fascination, compatibility) and natural features (e.g. vegetation, water) that allow individuals to escape from their daily lives and experience nature.

Cultural differences do affect restorativeness and preferences as one views a restorative landscape. We found that participants from Taiwan felt more psychologically restored after viewing

photos of restorative landscapes. Our findings indicated that cultural notions about connecting with natural areas could determine how people view nature. First, the urban planning area in Taiwan is 18.67 million (73.7%), with a population density of 3888 people per square kilometre as of the end of 2019 (http://w3.cpami.gov.tw/statisty/108/1091030.pdf). Taiwan's capital, Taipei, has the highest population density in Taiwan, with an average of 52.95 hectares of public green space (i.e. parks) per 10 000 people (https://data.gov.tw/en/datasets/132589). Therefore, we can infer that the majority of the Taiwanese population lives in a more stressful urban environment when compared to the Swedish population. Second, depending on how accessible high-quality restorative landscapes are, people may be more or less attracted to these landscapes and more or less likely to view them as novel and restorative. As stated by Laumann, Gärling, and Stormark (2001), concerning restorative landscapes, the concept of novelty is related to the sense of 'being away.' The Taiwanese participants preferred both restorative landscapes much more than did the Swedish participants, indicating that, for the former, both restorative landscapes provided a sense of 'physiological and psychological escape' from everyday life. Attention restoration theory could support this finding (Kaplan & Kaplan, 1989). Third, the more accessible natural landscapes of Sweden might bolster familiarity with and affection for such landscapes and convince Swedes that nature is, in general, an essential resource in daily life. Conversely, as the Taiwanese are more disconnected from nature and natural landscapes as a means of subsistence, they may favour less familiar landscapes (Hägerhäll et al., 2018; Newell, 1997; Petrova et al., 2015).

This study indicated that connecting with restorative landscapes promoted psychological relaxation, especially among those who viewed photos of such landscapes in Sweden. Our findings did not contradict those of the empirical studies discussed above (Heerwagen & Orians, 1993; Hůla & Flegr, 2021; Orians & Heerwagen, 1992; van den Berg & van Winsum-Westra, 2010). Concerning the biophilia hypothesis, which mentions by Wilson (1984), and the evolution perspective (e.g. habitat theory, prospect-refuge theory), restorative landscapes provide more biophilic elements (e.g. flowers, plants, water), which together constitute a non-threatening landscape with a sense of wayfinding that easily clear to understand and explore in the natural restorative settings. Hence, landscape attributes correspond with landscape preferences (Kaplan, 1987) and restorativeness (Kaplan & Kaplan, 1989). These results are likely attributable to the fact that natural landscapes are more restorative than urban landscapes. Still, further studies are needed to clarify the benefits of natural landscapes when comparing cross-cultural urban environments.

Do cultural differences between the East and the West affect physiological responses to restorative natural landscapes?

EMG measures forehead muscle tension and reflects a general state of alertness or arousal. In this study, no significant differences were found in EMG with respect to cultural differences or stimulating, restorative natural landscapes. The explanation that viewing restorative natural landscapes prompts a sense of relaxation may not account for the statistical significance of EMG. According to Chang and Chen (2005), only the indoor setting with a viewing window of nature versus the city could lower EMG. It has been claimed that viewing components of restorative landscapes have psycho-physiological value as opposed to not viewing these components—nature, including the attributes of 'being away' or 'coherence,' could significantly influence EMG responses (Chang et al., 2008).

Cultural differences in HR when viewing restorative natural landscapes were found to be statistically significant. The average HR when viewing photos of restorative natural landscapes was 78.81 ± 9.81 among Taiwanese participants and 67.56 ± 7.87 among Swedish participants. These results, however, should be interpreted with caution. This is because a more likely explanation for these differences was the variation in natural features of the restorative landscapes captured in the restorative landscape photos in Taiwan, such as mountain views, forests with lower

visibility, and ponds. These landscapes can foster a sense of mystery and novelty, as well as unfamiliarity, compared to viewing restorative landscape photos taken in Sweden. However, many factors can affect environmental perceptions and evaluations of landscapes. Although viewing different restorative landscape photos significantly affected the participants' HR in the present study, we could not directly confirm the effects of cultural differences from a single study.

Limitations of the research

This study was based on restorative landscape photos shown to young and healthy Taiwanese and Swedish participants during a 14-min session. This means that the time spent viewing each of the 25 photos included in the study was relatively short compared to real-world views and experiences of these landscapes. The photos from Sweden, however, were based on a study conducted in the real-life context of a patient undergoing 12 weeks of nature-based rehabilitation. The patients used the identified places to support their physical and psychological recovery and restoration. In Taiwan, the photos represented restorative landscapes in agrotourism farms. Although these photos represented restorative gardens, the experiences of the participants when viewing the photos might have differed from those gained when actually in these gardens, especially when given more time and more immersion.

Comparing the benefits of viewing natural landscapes versus urban landscapes was beyond the scope of this study. However, since the study focussed on restorative natural landscapes as a stimulus, the results effectively demonstrated the influence of cultural differences on psychological and physiological responses. Further studies on different types of restorative natural landscapes as well as seasonal changes in these landscapes are warranted, as are comparisons of urban landscapes in the East and West. For example, enhancing urban green spaces with flowers, vegetation, water, and biophilic elements could stimulate a greater sense of aestheticism and restorativeness and thereby reduce feelings of alienation from the natural environment. In addition, different landscapes might influence one's physiological responses.

Future work will hopefully fill gaps in knowledge concerning various types of restorative natural landscapes and their relation to HR and could additionally strengthen explanations for human–nature experiences. Such expanded knowledge could also be applied to cross-cultural urban green spaces during landscape design, about which further studies are recommended. As for the participants in the present study, it was difficult to account for their state of mind before they entered the study. Some seemed relaxed, whereas others appeared to be excited to participate. How this might have affected the study and its outcomes is difficult to determine and should therefore be considered in future research.

Conclusion

This study on restorative landscapes and their psychological and physiological responses with respect to cultural differences generated findings relevant to previous research. The natural environment, with plants, flowers, and waterscapes, might be equally restorative in terms of physiological and psychological factors and generally more relaxing than urban environments, thereby promoting stress release. Our findings were significant in that they suggest that cultural differences affect restorativeness, landscape preferences, and HR—at least when viewing photos of restorative landscapes. This is especially true for those living in urban areas. Taiwanese residents who live in cities typically do not have a deep relationship with nature. When viewing natural restorative landscapes, the Taiwanese participants perceived a sense of restorativeness—yet, their HR increased when viewing unfamiliar photos. These physiological and psychological responses were different from those of the Swedish participants. Such research findings

demonstrate the value of natural and restorative landscapes to the physical and mental health of urban dwellers. It is thus essential to understand that people with different cultural backgrounds have distinct preferences and reactions to restorative landscapes, especially concerning health in urban areas. Generally speaking, restorative landscapes are vital for human health. The findings of the present research can be used to support cross-cultural landscape design and public health, emphasising 'nature as health' and the combination of restorative features with biophilic design to create healthy everyday environments in urban settings.

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