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Into the wild or into the library? Perceived restorativeness of natural and built environments☆

Marta Stragà [a], Clara Miani [a], Timo Mäntylä [b], Wändi Bruine de Bruin [c,d], Mattia Mottica [a], Fabio Del Missier [a,*]

[a] Department of Life Sciences, via Weiss 2, 34128, University of Trieste, Italy
[b] Department of Psychology, Albanovägen 12, 114 19, Stockholm University, Sweden
[c] Sol Price School of Public Policy and Dornsife Department of Psychology, VPD 512-D, 635 Downey Way, Los Angeles, CA, 90089-3333, USA
[d] University of Southern California, USA

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ABSTRACT

Exposure to natural environments can promote recovery from mental fatigue and restore cognitive resources. However, previous research has tended to compare the restorative potential of hospitable natural environments, such as lakes, with the restorative potential of harsh built environments, such as streets with traffic. Thus, it has overlooked the potential restorativeness of hospitable built environments such as libraries, or the potentially limited restorativeness of harsh natural environments, such as deserts. Moreover, studies on perceived restorativeness have traditionally focused on four basic dimensions identified by Attention Restoration Theory (ART); being away, fascination, compatibility, and extent. However, they have scarcely considered two other relevant dimensions: opportunity for reflection (also identified by ART) and feeling of safety. Additionally, there is limited empirical evidence on the relationship between basic ART dimensions, reflection, and overall perceived restorativeness. In our study, we hypothesized that (1) cluster analysis would support categorizing 12 natural and 12 built environments into four clusters (hospitable natural, harsh natural, hospitable built, harsh built), based on ratings of the six abovementioned dimensions of perceived restorativeness, (2) ratings of ART dimensions, as summarized by a Perceived Restorativeness Scale (PRS) score, reflection, and safety would predict overall perceived restorativeness, and (3) opportunity for reflection would partially mediate the relationship of the PRS score and safety with overall perceived restorativeness. We identified the four expected clusters of environments, plus a fifth cluster of functional built environments. While hospitable natural environments showed the greatest overall perceived restorativeness, hospitable built places were rated as more restorative than harsh natural ones, indicating that the distinction between natural and built environments may be too simplistic. Path analysis indicated that PRS score, reflection, and safety predict overall perceived restorativeness. Moreover, reflection partially mediated the relationship of PRS score, and safety in some environments, with overall perceived restorativeness.

1. Introduction

Exposure to natural environments or stimuli can have various positive effects, such as decreasing negative affect (e.g., Bowler, Buyung-Ali, Knight, & Pullin, 2010; Ulrich et al., 1991; for a review see McMahan & Estes, 2015), promoting recovery from stress (e.g., Berto, 2014; Hartig, Evans, Jamner, Davis, & Gärling, 2003; Hartig, Mitchell, De Vries, & Frumkin, 2014; Ulrich et al., 1991; Van Den Berg & Custers, 2011), supporting recovery from mental fatigue and restoration of mental resources (e.g., Hartig, Mang, & Evans, 1991; Kaplan & Kaplan, 1989), and improving performance on cognitive tests (e.g., Berman, Jonides, & Kaplan, 2008; Berto, 2005). In particular, two literature reviews found that exposure to natural environments improves performance on tests of short term/working memory and cognitive flexibility (Ohly et al., 2016; Stevenson, Schilhab, & Bentsen, 2018) and, less reliably, attentional control (Stevenson et al., 2018).

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* Corresponding author. Department of Life Sciences – University of Trieste, via Weiss 2, I-34128, Trieste, TS, Italy.
E-mail address: delmisfa@units.it (F. Del Missier).

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The empirical support for the restorative potential of natural environments comes from a large body of studies (see Ohly et al., 2016; Stevenson et al., 2018), which have mainly examined the restorative effects of being physically present in natural vs. built environments (e.g., Berman et al., 2008) or watching images or videos of natural vs. built environments (e.g., Berto, 2005). People seem to be aware of the restorative potential of natural environments: They evaluate natural environments as more restorative (e.g., Staats, Van Gemerden, & Hartig, 2010) and as preferable over built environments (Herzog, Maguire, & Nebel, 2003; Purcell, Peron, & Berto, 2001).

However, studies have largely overlooked potential variability within the broad categories of built and natural environments (see e.g., Joye & Dewitte, 2018; Pearson & Craig, 2014; Weber & Trojan, 2018). Indeed, most studies have treated natural vs. built environments as a dichotomy (e.g., Hartig et al., 1991, 2003; Herzog et al., 2003; Laumann, Gärling, & Stormark, 2003; Purcell et al., 2001; Staats, Kieviet, & Hartig, 2003; Ulrich et al., 1991; Van den Berg, Koole, & van der Wulp, 2003). Typically, natural environments have been represented by seemingly hospitable natural environments including lakes, rivers, woods. Thus, seemingly harsher natural environments, such as deserts or iced landscapes have tended to be excluded (for an exception, Peron, Berto, & Purcell, 2002). In a similar vein, built environments have typically been represented by seemingly harsher locations such as industrial areas or streets with traffic, instead of potentially more hospitable built environments such as libraries, museums, and oldtowns/historical city centers.[1]

A systematic review found that built environments may have restorative potential if they facilitate cultural and leisure activities or incorporate architectural and natural elements (Weber & Trojan, 2018; see also Bornioli & Subiza-Pérez, 2023). Indeed, studies have highlighted the restorative potential of museums (e.g., Kaplan, Bardwell, & Slakter, 1993), leisure destinations and activities (e.g., Scopelliti & Giuliani, 2004; Staats, Jahncke, Herzog, & Hartig, 2016), historical places (e.g., Scopelliti, Carrus, & Bonaiuto, 2019), well-designed and attractive city neighborhoods (e.g., Karmanov & Hamel, 2008), city centers and squares (e.g., Bornioli, Parkhurst, & Morgan, 2018; Subiza-Pérez, Korpela, & Pasanen, 2021), and urban green areas (e.g., Carrus et al., 2013). However, these studies tended to examine only a few built environments, leaving it unclear how restorativeness may vary between harsh built environments, hospitable built environments, harsh natural environments, and hospitable natural environments.

Additionally, most studies focused on four basic dimensions of environments' restorativeness, as identified by the Attentional Restoration Theory (henceforth ART, Kaplan & Kaplan, 1989; Kaplan, 1995): (1) the sense of *being away*, physically and psychologically, from everyday routine and hassles, (2) the *fascination* with environments that draws effortless attention, (3) the *extent* of environments, including their *coherence* and *scope* promoting interpretation and exploration, and (4) the *compatibility* of the environment with personal inclinations, interests, or goals. According to ART scholars, natural environments tend to score higher on these restorative dimensions, but this can also be the case with some built environments (Kaplan, 1995). Opportunity for *reflection* (Kaplan, 1995; Kaplan & Kaplan, 1989) and *feelings of safety* (e.g., Gatersleben & Andrews, 2013; Herzog & Rector, 2009; Staats & Hartig, 2004) have also been proposed to be relevant to restorativeness but have received less attention in the literature.

According to ART scholars, the opportunity to *reflect* on unresolved problems, important questions and issues, personal goals, and priorities in one's life contributes to restorative experiences (Kaplan & Berman, 2010). A deep feeling of restoration (i.e., full restoration) is achieved when individuals use directed attention resources, freed by a restorative environment, to reflect upon issues important to them. More specifically, Kaplan (1995) states that the "soft fascination-characteristic of certain natural settings has a special advantage in terms of providing an opportunity for reflection, which can further enhance the benefits of recovering from directed attention fatigue." (p. 172), thus hypothesizing a second-order effect of reflection in the restorative process (see also Basu, Duvall, & Kaplan, 2019). Kaplan and Kaplan (1989) state that high-quality environments in terms of ART features are needed to stimulate this enhanced level of restorativeness through reflection. Reflection would reduce internal thoughts and interference from unresolved problems that would hinder cognitive functioning in upcoming tasks. Indeed, according to Kaplan and Berman (2010), "these unresolved problems could create a kind of internal noise that would lead to excessive demands on directed attention." (p. 49). Hartig and Staats (2006) showed that opportunity for reflection is perceived as more likely when walking in a forest (vs. in a city), and this evaluation correlates with the attitude towards this behavior (see also Staats et al., 2003; Staats & Hartig, 2004). Herzog, Black, Fountaine, and Knotts (1997) showed that participants perceived ordinary natural environments as enabling the opportunity for reflection, whereas environments related to sport and entertainment such as movie theaters, bowling alleys, and tennis courts were perceived as requiring too much involvement to stimulate reflection (see also Kaplan & Berman, 2010). Evidence that people can perceive environmental opportunities for reflection allow us to hypothesize that environments more supportive of reflection should also be associated with increased perceived restorativeness, beyond the level of perceived restorativeness directly associated with ART dimensions.

The second additional dimension in need of more consideration in relation to perceived restorativeness pertains to feelings of *safety* triggered by the environment. In natural environments, people may worry about the risk of getting lost, getting injured, or encountering wild animals (Bixler, Carlisle, Hammltt, & Floyd, 1994; Coble, Selin, & Erickson, 2003; Van Den Berg & Ter Heijne, 2005). In built environments, people may worry about the risk of being hit by cars or being harmed by other people. The perceived restorativeness of natural environments may be undermined by worries about potential dangers (Herzog & Rector, 2009; Gatersleben & Andrews, 2013, see also Staats & Hartig, 2004). Moreover, directed attention is needed for monitoring potential threats in risky environments, further reducing the opportunity for restoration (see Gatersleben & Andrews, 2013). Safety has not been included within the basic ART dimensions that promote restoration, but we think that considering this additional aspect could provide a more comprehensive account of the antecedents of perceived and actual restoration, improving our predictive capacity.

Finally, it is also worth noting that perceived restorativeness has been associated with preference for environments (e.g., Herzog et al., 2003; Purcell et al., 2001). However, these two constructs are distinct (e.g., Korpela & Ratcliffe, 2021). Moreover, they may be differently related with different predictive dimensions (Kaplan & Kaplan, 1989; Hartig & Staats, 2006; Herzog et al., 2003; Laumann, Gärling, & Stormark, 2001; Van den Berg et al., 2003).

To address the aforementioned open issues in the literature on perceived environmental restorativeness, we carried out a study with two aims. The first aim was to test a four-cluster hypothesis on the classification of environments to overcome the broad distinction between natural and build categories and to distinguish, within both these categories, hospitable vs. harsh environments in relation to dimensions underlying perceived restorativeness, including the four basic ART

[1] In our study, we will refer to environments that can be perceived as less safe and less compatible with preferred human activities as 'harsh', while potentially safer places more compatible with preferred human activities will be defined as 'hospitable'. For a similar perspective see also Bornioli and Subiza-Pérez (2023) in relation to their construct of positive vs. negative environments. Concerning natural environments, this distinction implies that less safe (see also Ulrich et al., 1991) and wilder places, potentially less compatible with some preferred human activities, will be classified as harsh, while safer and milder places, usually associated with restorative effects in the literature, will be considered as hospitable.

dimensions, reflection, and safety. The second aim of our study was to test two hypotheses on the specific roles of basic ART dimensions, reflection, and safety in the prediction of overall perceived restorativeness.

1.1. Overview of the study and hypotheses

In our study, participants were asked to evaluate images of 12 natural and 12 built environments on the abovementioned ART dimensions, as well as on opportunity for reflection and perceived safety (for similar methods see e.g., Felsten, 2009; Herzog et al., 2003; Laumann et al., 2001). Our main criterion variable was a measure of overall perceived restorativeness tailored for undergraduate samples (Felsten, 2009), which we slightly adapted to be used with all our categories of stimuli (see Section 2.3 for a detailed description of all the measures). We also collected preference ratings and employed preference as our secondary criterion variable, to control for its correlation with overall perceived restorativeness in our analyses. This also allowed us to disentangle the relationships of our predictive dimensions, in particular reflection, with perceived restorativeness vs. preference. Moreover, given that in some investigations more familiar environments were perceived as more restorative (e.g., Menatti, Subiza-Pérez, Villalpando-Flores, Vozmediano, & San Juan, 2019; Purcell et al., 2001), we also asked participants to evaluate each image on familiarity, which was used as a control variable.

We examined three main hypotheses. Based on the evidence on the distinctions within natural environments and within build environments summarized in section 1 (see also Bornioli & Subiza-Pérez, 2023; Joye & Dewitte, 2018; Pearson & Craig, 2014; Weber & Trojan, 2018), our first hypothesis (H1) was that a cluster analysis would reveal four distinct clusters of environments: hospitable natural (woods, rivers, lakes, seaside, lawns, mountains), harsh natural (deserts, savannahs, caves, volcanos, lagoons, and iced landscapes), hospitable built (museums, libraries, oldtowns/historical city centers, home interiors, urban parks, residential areas with terraced houses), and harsh built (airport interiors, commercial areas, downtowns, residential areas with condos/apartment buildings, industrial areas, and roads with traffic). To test this hypothesis, we conducted a cluster analysis based on ratings of dimensions underlying perceived restorativeness for the environments examined in our study, namely the four basic ART dimensions plus reflection and safety.

In line with ART (Kaplan & Kaplan, 1989) and with our abovementioned considerations on the additional role of reflection (e.g., Kaplan, 1995; Kaplan & Berman, 2010; Staats et al., 2003; Staats & Hartig, 2004) and safety (e.g., Gatersleben & Andrews, 2013; Herzog & Rector, 2009; Staats & Hartig, 2004), our second hypothesis was that ratings of the four basic ART dimensions (summarized by a score on a short version of the Perceived Restorativeness Scale, PRS, Hartig, Kaiser, & Bowler, 1997; Hartig, Korpela, Evans, & Garling, 1997), reflection, and safety would predict overall perceived restorativeness (H2a). Additionally, relying on the idea that restorative effects triggered by ART features can be further enhanced by reflection, which is in turn stimulated by ART features (Kaplan & Berman, 2010; Kaplan & Kaplan, 1989), we hypothesized that reflection would partially mediate the relationship between ART dimensions (PRS score) and overall perceived restorativeness (H2b). The same partial mediation hypothesis would hold for safety because a place perceived as less safe could elicit more vigilance and this perception could also undermine the possibility of reflection. Hypotheses H2a and H2b were tested with a path analysis model with the overall PRS score, which allows avoiding potential problems of multicollinearity. We repeated this path analysis with models including single ART dimensions.

2. Method

2.1. Participants

An a-priori power analysis indicated that a regression analysis with eight predictors would require a minimum sample size of 158 to detect an effect size of ≥ 0.10 ($\alpha = 0.05$, $\beta = 0.80$). For prudence, we recruited 184 undergraduate participants (83.7% female, $M_{age} = 21.74$, $SD_{age} = 4.25$), who received course credits as a compensation for their time. The study was approved by the Ethical Committee of the University of Trieste. Informed consent was collected from all participants.

2.2. Materials

A pre-test was carried out to inform the selection of the stimuli. We started with eight images for each of 28 environmental categories, which were initially identified by combing the literature on environmental restoration and preference (for reviews see e.g., Ohly et al., 2016; Stevenson et al., 2018; Weber & Trojan, 2018) and by adding natural and built environments that have been less frequently studied (see Supplementary Materials, section 1). The pre-test allowed us to discard potentially problematic categories, and to select three images perceived as being very typical for each of the 24 included categories. These images were used as stimuli in our study.

Following previous studies (e.g., Berto, 2005; Staats & Hartig, 2004), images showed environments that were well-maintained, in daylight, without people or animals, and reflecting locations that participants were unable to recognize. To promote the sense of immersion, all environments were shown from ground-level perspective instead of a survey perspective (Shelton & Gabrieli, 2002), while not precluding a sufficiently ample view. All the images were 1200 px wide and 800 px high.[2]

2.3. Procedure and measures

The study was administered online through Qualtrics software. Participants were asked to evaluate three blocks of 24 images, with each block including one image for each environment, for a total of 72 stimuli. Images were randomly assigned to the blocks and were presented in random order within each block. Blocks were also presented in random order. Participants were instructed to look carefully at each picture, and to imagine being in the place it depicted. They then expressed their agreement with nine items on a 7-point scale ranging from 1 (*not at all*) to 7 (*completely*). Table 1 presents all the items used in our study, with the associated constructs and roles.

The ART dimensions were measured with four items of Hartig et al.'s version of the PRS (Hartig, Kaiser, & Bowler, 1997; Hartig, Korpela, et al., 1997), which assesses being away, fascination, compatibility, and coherence. Given the large number of images to be evaluated, employing the full version of the PRS would have been unfeasible. Therefore, we selected a representative item for each of the four dimensions (for a similar procedure see e.g., Berto, 2005; Felsten, 2009; Herzog et al., 2003). By using these items, we focused on the coherence subdimension of ART's extent dimension (i.e., the degree to which the elements of the environment are clearly organized) and not on the scope subdimension (i.e., the scale of the domain in which the perceptual activity is involved). This was motivated by the fact that we employed existing photographs as stimuli, and uncontrolled variations in photographic areas of view can affect perceived depth of environments (see e.g.,

[2] Following Hitcks et al. (2020), we tried to balance the images on contrast and luminance, but this procedure made some of the images appear very unnatural and artificially manipulated. Therefore, we decided to preserve ecological validity, avoiding any manipulation of contrast, color, and luminance.

Table 1
Constructs measured in the study with their corresponding roles and items.

Construct	Role	Example item	Reference
Being away	clustering dimension, predictor in path models	*Being here is an escape experience.*	Hartig, Kaiser, & Bowler, 1997 (item 1)
Fascination	clustering dimension, predictor in path models	*This setting is fascinating.*	Hartig, Kaiser, & Bowler, 1997 (item 12)
Coherence (Extent)	clustering dimension, predictor in path models	*Everything here seems to have a proper place.*	Adapted from Hartig, Kaiser, & Bowler, 1997; see also Purcell et al., 2001
Compatibility	clustering dimension, predictor in path models	*I can do things I like here.*	Hartig, Kaiser, & Bowler, 1997 (item 19)
Safety	clustering dimension, predictor in path models	*In this place I would feel safe.*	Adapted from Staats & Hartig, 2004
Reflection	clustering dimension, predictor in path models	*In this place I would be able to think about what is really important in my life.*	Adapted from Hartig & Staats, 2006
Familiarity	control variable in path models	*This place is familiar to me.*	Purcell et al., 2001
Preference	secondary criterion variable in cluster and path analysis	*I like this place.*	Purcell et al., 2001
Overall perceived restorativeness	main criterion variable in cluster and path analysis	*Overall, how much do you agree that this setting would be excellent for relaxing and restoring your ability to study for an exam or work effectively on a demanding project?*	Adapted from Felsten (2009)

Cooper, Piazza, & Banks, 2012; Kraft & Green, 1989), with potentially biasing effects on the perception of their scope (while coherence should be less affected, depending on the relative positions and organization of visible elements).

We also included one item to assess the perceived safety of environments (see also Staats & Hartig, 2004), and one item to measure the opportunity for reflection (see Hartig & Staats, 2006) by relying on the ART conceptualization of reflection as the opportunity to reflect on personal life issues (Herzog et al., 1997; Kaplan & Kaplan, 1989; see also Joye & Dewitte, 2018).

Our main criterion variable, overall perceived restorativeness, was measured with an item used by Felsten (2009) in a sample of undergraduates like ours, which we slightly adapted by substituting the expression "to take a break" with "to relax" to promote a more general judgment of restorativeness. This slight change should not affect the perception of the item as referring to overall restorativeness given that, in a previous study (Hartig & Staats, 2006), an item with a very similar wording ("loose all tension") loaded a "recovery" factor together with items traditionally related to restorativeness ("regain the ability to concentrate" and "renew energy").

We also included items for assessing preference and familiarity (cf. e.g., Purcell et al., 2001). Finally, participants were asked to rate how frequently they had visited each of the 24 categories of environments on a 7-point scale ranging from 1 (*never*) to 7 (*very frequently*), to provide socio-demographic information (gender, age, educational level, occupation, place where participants lived for most of their life—medium-large city, small town, rural area), and to indicate which of the 24 categories of environments were located within 500 m from their home.

3. Results

3.1. Preliminary analysis

Cronbach's alpha ranged from acceptable to good, across the three images and the 24 environments, for being away ($\alpha = 0.73$), fascination ($\alpha = 0.73$), coherence ($\alpha = 0.80$), compatibility ($\alpha = 0.79$), safety ($\alpha = 0.80$), reflection ($\alpha = 0.78$), preference ($\alpha = 0.75$), familiarity ($\alpha = 0.77$), and overall restorativeness ($\alpha = 0.80$). Therefore, we averaged the ratings of the three images in each category for each dimension. Descriptive statistics are presented in Supplementary Materials (Table SM1). Additionally, the scores of the four ART dimensions were averaged in an overall PRS score ($\alpha = 0.72$).

3.2. Does cluster analysis support categorizing natural and built environments into four categories?

To characterize the environmental categories according to the restorative dimensions and test our hypothesis of the existence of four clusters of environments, we carried out a cluster analysis in two steps (as suggested by Hair, Black, Babin, & Anderson, 2010). First, we used a hierarchical clustering technique with average linkage to select the number of clusters. Then, the k-means method was used to attain a more accurate cluster membership. Given that our goal was to group together the categories with the more similar profiles along the investigated dimensions of being away, fascination, coherence, compatibility, safety, and reflection, each category was treated as a case (averaging individuals' ratings) and the dimensions as variables. We entered in the analysis all the dimensions with the exceptions of preference and familiarity, which were included in our study as a secondary criterion variable and a control variable, respectively, and overall restorativeness, which was our main criterion variable.

The results of hierarchical clustering suggested a five-cluster solution, with each of the five clusters being introduced in detail below. This solution was superior because a four-cluster solution showed a 74% increase in the distance coefficients as compared to the five-cluster solution. We then tested a five-cluster solution using k-means clustering. The results showed that natural and built environments grouped together into different clusters: two six-category clusters were identified within natural environments (cluster 1: hospitable natural; cluster 2: harsh natural). One six-category cluster and two three-category clusters were detected within built environments (cluster 3: hospitable built; cluster 4: functional built; cluster 5: harsh built). Thus, the analysis identified the four clusters we expected to find, but some of the less hospitable built environments were assigned to an additional, unexpected cluster (functional built). Fig. 1 shows the average ratings of the five clusters on all the variables included in our study.

The first cluster referred to the *hospitable natural environments* that have traditionally been examined in previous studies, including woods, rivers, lakes, seaside, mountains, and lawns. On average, these environments received the highest ratings on three of the four basic ART dimensions: being away, fascination, and compatibility (Bonferroni's corrected pairwise comparisons: being away: $ts > 4.14$, $ps < .001$, mean $d = 2.20$; fascination: $ts > 9.75$, $ps < .001$, mean $d = 2.15$; compatibility: $ts > 7.55$, $ps < .001$, mean $d = 1.46$), but not on coherence (significantly lower than in the hospitable built cluster, $t(183) = 9.02$, $p < .001$, $d = 0.66$, and in the functional built cluster, $t(183) = 4.45$, $p < .001$, $d = 0.33$, but not different from the harsh built cluster, $t(183) = 1.29$, $p = 1.00$, $d = 0.10$). The hospitable natural environments were also rated highest on reflection ($ts > 17.56$, $ps < .001$, mean $d = 1.78$) but not on safety (significantly lower than in the hospitable built cluster, $t(183) = 5.30$, $p < .001$, $d = 0.39$; but higher than the others, $ts > 9.84$, $ps < .001$, mean $d = 1.49$).

The second cluster referred to *harsh natural environments*, including

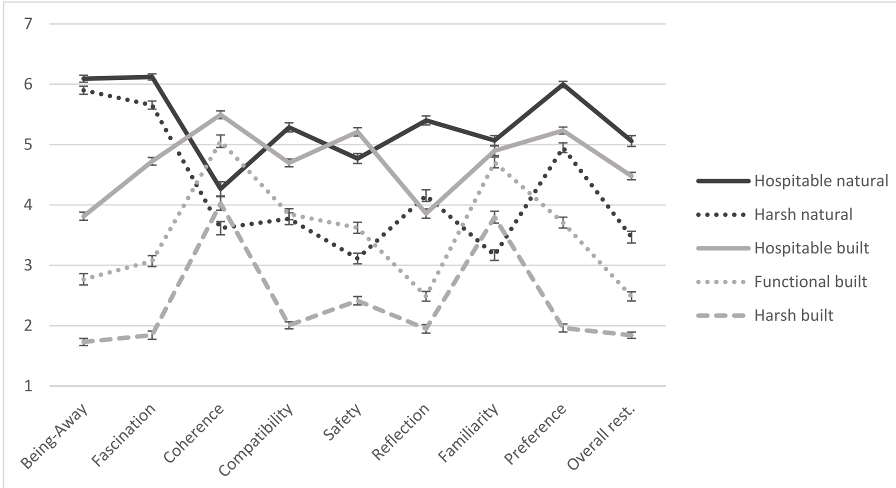

Fig. 1. Mean ratings of being away, fascination, coherence, compatibility, safety, reflection, familiarity, preference, and overall restorativeness in the five environmental clusters.
Note. Errors bars represent standard errors.

deserts, iced-landscapes, caves, lagoons, savannahs, and volcanos. These environments obtained high ratings on being away and fascination, even if these ratings were significantly lower than the ones of hospitable natural environments ($t(183) = 4.14$, $p = .001$, $d = 0.31$; $t(183) = 9.75$, $p < .001$, $d = 0.72$, respectively). The ratings were dramatically lower for compatibility ($t(183) = 23.70$, $p < .001$, $d = 1.75$) and safety ($t(183) = 27.55$, $p < .001$, $d = 2.03$). Ratings on reflection also decreased significantly ($t(183) = 18.35$, $p < .001$, $d = 1.35$). This cluster received the lowest ratings on coherence ($ts > 8.74$, $ps < .001$; mean $d = 0.88$), along with the harsh built environments cluster ($t(183) = 2.40$, $p = .18$, $d = 0.18$).

The third cluster referred to *hospitable built environments*, including libraries, museums, parks, oldtowns, home interiors, and residential areas with terraced houses. This cluster received on average lower ratings on being away, fascination, and reflection than both hospitable natural environments ($t(183) = 31.95$, $p < .001$, $d = 2.36$; $t(183) = 24.06$, $p < .001$, $d = 1.77$; $t(183) = 17.56$, $p < .001$, $d = 1.29$; respectively) and harsh natural environments ($t(183) = 26.77$, $p < .001$, $d = 1.97$; $t(183) = 14.17$, $p < .001$, $d = 1.04$; $t(183) = 3.03$, $p = .03$, $d = 0.22$). Yet, it showed ratings on compatibility higher than harsh natural environments ($t(183) = 9.75$, $p < .001$, $d = 0.72$) but lower than hospitable natural environments ($t(183) = 7.55$, $p < .001$, $d = 0.56$). Moreover, hospitable built environments received the highest ratings on coherence ($ts > 6.50$, $ps < .001$, mean $d = 0.86$) and on safety ($ts > 5.30$, $ps < .001$, mean $d = 1.63$).

The fourth cluster referred to *functional built environments*, including airport interiors, commercial areas, and downtowns. These environments received worse evaluations compared to both hospital and harsh natural environments and to hospitable built environments on being away ($ts > 12.95$, $ps < .001$; mean $d = 1.78$), fascination ($ts > 20.25$, $ps < .001$; mean $d = 1.90$), and reflection ($ts > 14.60$, $ps < .001$; mean $d = 1.55$). Nevertheless, these environments had similar evaluations on compatibility ($t(183) = 0.58$, $p = 1.00$, $d = 0.04$) and better evaluations on safety ($t(183) = 4.49$, $p < .001$, $d = 0.33$) as compared to harsh natural environments. Moreover, this cluster presented the second-best rating on coherence ($ts > 4.45$, $ps < .001$, mean $d = 0.68$).

Finally, the fifth cluster comprised *harsh built environments*: industrial areas, residential areas with condos, and roads. These environments received, on average, the worst ratings on all the dimensions ($ts > 7.03$, $ps < .001$, mean $d = 2.19$). The one exception pertained to ratings of coherence, which were similar to the hospitable natural environments ($t(183) = 1.29$, $p = 1.00$, $d = 0.10$) and the harsh natural environments ($t(183) = 2.40$, $p = .18$, $d = 0.18$).

Having established a five-cluster solution by relying on the dimensions assumed to underlie perceived restorativeness, we tested whether these clusters also differed in our measures of overall perceived restorativeness and preference. As noted above, these variables were not used in the cluster analysis. Results showed a significant difference in perceived restorativeness, $F(4, 732) = 487.74$, $p < .001$, $\eta_p^2 = .73$, with all clusters differing from each other ($ts > 6.89$, $ps < .001$, mean $d = 1.52$). In particular, the hospitable natural cluster received the highest ratings, followed by the hospitable built cluster, the harsh natural cluster, the functional built cluster, and finally the harsh built cluster (Fig. 1).[3] Clusters also differed in preference, $F(4, 732) = 706.29$, $p < .001$, $\eta_p^2 = .79$), with preference ratings following the same pattern as overall restorativeness ones ($ts > 3.57$, $ps < .01$, mean $d = 1.73$).

3.3. *Do ART dimensions, safety, and reflection (as a partial mediator of ART dimensions and safety) predict perceived restorativeness?*

In agreement with ART (Kaplan, 1995; Kaplan & Berman, 2010; Kaplan & Kaplan, 1989), our hypotheses were that the PRS score would predict overall perceived restorativeness via a direct effect (H2a) and through reflection (H2b) in all the environmental clusters. Based on previous studies connecting safety and perceived restorativeness (e.g., Gatersleben & Andrews, 2013; Herzog & Rector, 2009; Staats & Hartig, 2004), we advanced the same hypotheses also for safety as a predictor.

To test these hypotheses, we specified a path model and estimated it separately for each environmental cluster. In this model, the PRS score, safety, and reflection were direct predictors of overall perceived restorativeness, and reflection partially mediated the effects of the PRS score and safety on overall restorativeness (see Fig. 2, panel A). We also included preference as a criterion variable, correlated to overall restorativeness. Additionally, to disentangle the specific predictors of perceived restorativeness vs. preference, all predictors of overall restorativeness were also considered as predictors of preference. Familiarity was always included as a control variable, predicting overall

[3] Further analyses with linear mixed models (see Supplementary Materials, section 2.1) showed that the difference in overall perceived restorativeness between the harsh natural and hospitable built environments disappeared when controlling for safety and familiarity. This suggests that this difference may be due to higher levels of perceived safety and familiarity in the hospitable built environments. The difference between hospitable natural environments and the harsh natural environments was reduced, but remained significant, after controlling for safety and familiarity.

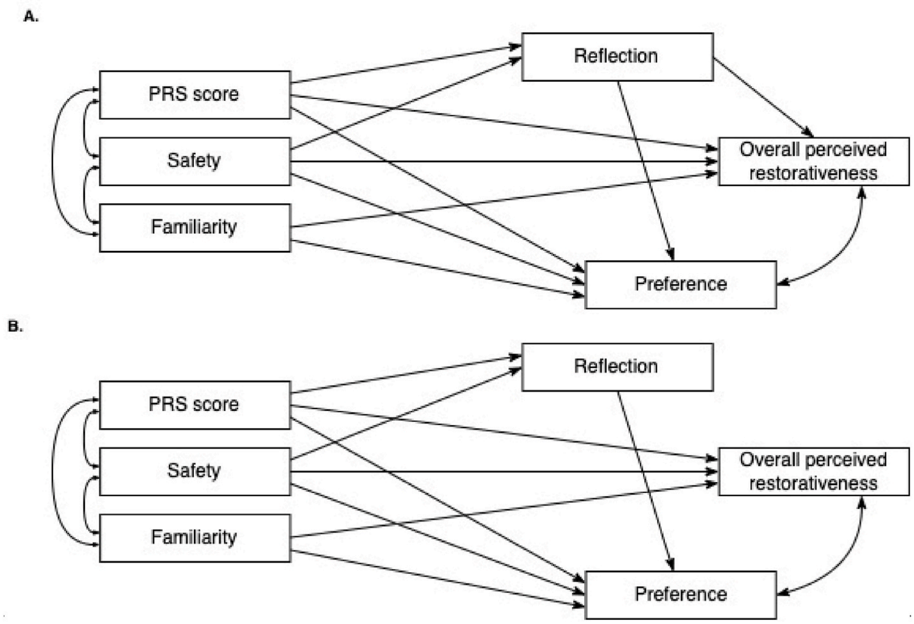

Fig. 2. Diagram of the reflection-mediator path model (A) and of the nested model (B) in which reflection was not a mediator.

perceived restorativeness and preference. This model allows us to test the hypothesis that reflection mediates the effect of PRS (and safety) on overall restorativeness via the estimation of the indirect effect of PRS (and safety) on overall restorativeness through reflection. However, to carry out a further test of the role of reflection, we also compared this reflection-mediator model with a nested model in which the directed link between reflection and overall restorativeness was removed (Fig. 2, panel B).

The models were estimated with the maximum likelihood method of the IBM SPSS AMOS 21 package (Arbuckle, 2012). For each environmental cluster, we first estimated the model as specified in Fig. 2A. Then, to appraise the indirect effects with reflection as mediator, we performed bootstrapping with 10,000 samples and computed the 95% confidence intervals with the percentile method. All the correlations between the variables included in the models for each cluster are reported in Supplementary Materials (Table SM2). Finally, as a further test of the role of reflection, we compared the fit of the reflection-mediator model (Fig. 2A) with the fit of a nested model in which the link between reflection and overall estimation was removed (Fig. 2B).

The models with reflection as a mediator of PRS on overall restorativeness (see Fig. 3) had a very good fit, as seen in Table 2. On the contrary, the fit indices were overall unsatisfactory for the nested models without reflection as a mediator. Additionally, the χ^2 difference test highlighted significant differences between the fit of the these two models in all clusters (Hospitable natural: χ^2_{diff} (1) = 23.12, $p < .001$; Harsh Natural: χ^2_{diff} (1) = 21.42, $p < .001$; Hospitable Built: χ^2_{diff} (1) = 18.43, $p < .001$; Functional Built: χ^2_{diff} (1) = 34.63, $p < .001$; Harsh Built: χ^2_{diff} (1) = 18.46, $p < .001$), showing that the nested model was significantly less able to explain the data than the model with reflection as a predictor. Furthermore, the model with reflection as a mediator explained more variance in overall restorativeness than the nested model in all the clusters (see Table 2, last column), indicating that reflection contributes significantly to the prediction of overall restorativeness.

In the model that treated reflection as a mediator (Fig. 3), restorativeness was significantly predicted by the PRS score in all the clusters (βs > 0.14, *ps* < .05), by safety in the natural clusters (hospitable: β = 0.20, *SE* = 0.08, *p* = .01; harsh: β = 0.34, *SE* = 0.08, *p* < .001) and in the harsh built cluster (β = 0.24, *SE* = 0.05, *p* < .001), and by familiarity in the hospitable built cluster only (β = 0.13, *SE* = 0.05, *p* = .03). Importantly, reflection predicted overall restorativeness in all clusters (βs > 0.30, *ps* < .001). Explained variance in overall restorativeness varied from 39% to 48%, depending on the cluster. Reflection was significantly predicted by the PRS score in all clusters (βs > 0.43, *ps* < .001) and by safety in four out of five clusters (βs > 0.15, *ps* < .04). Overall, the variance in reflection explained by the predictors ranged from 33% to 40%, depending on the cluster. We also found evidence for partial mediation of reflection, such that the PRS score had a significant indirect effect on overall restorativeness through reflection in all the clusters (see Table 3). The indirect effect of safety through reflection was observed in the two natural clusters and in the functional built one.

Preference was significantly predicted by PRS in all clusters (βs > 0.46, *ps* < .001), by safety only in the natural clusters (hospitable: β = 0.15, *SE* = 0.04, *p* = .01; harsh: β = 0.15, *SE* = 0.06, *p* = .02), and by familiarity in the hospitable natural (β = 0.15, *SE* = 0.04, *p* = .01), hospitable built (β = 0.17, *SE* = 0.03, *p* < .001) and functional built (β = 0.12, *SE* = 0.04, *p* = .01) clusters. However, preference was predicted by reflection only in the hospitable natural cluster (β = 0.14, *SE* = 0.04, *p* = .03) and in the functional built cluster (β = 0.11, *SE* = 0.06, *p* = .03). Predictors explained from 56% to 72% of variance in preference ratings (see Fig. 3). Finally, overall restorativeness was significantly related to preference in the natural clusters (hospitable: *r* = 0.20, *p* = .01; harsh: *r* = 0.17, *p* = .02) and in the harsh built cluster (*r* = 0.36, *p* < .001).

A second set of path models, with the four separate ART dimensions as predictors (presented in Supplementary Materials, section 3.1, due to space limitations), produced results generally consistent with the ones obtained with the models employing thePRS score. First, at least one of the ART dimensions was a direct and significant predictor of perceived restorativeness in all the clusters (except for the hospital natural cluster, in which the effects of the ART dimensions on overall restorativeness were fully mediated by reflection). Second, reflection mediated the effect on perceived restorativeness of at least one of the ART dimensions in all the clusters (except for the harsh built one). Third, safety always contributed directly and/or indirectly to the prediction of perceived restorativeness in all the clusters but the hospitable built one (as in the models with the PRS score). The more specific indications provided by these analyses (vs. the models with the PRS score) were that overall perceived restorativeness was mainly predicted by compatibility and by being away (directly and/or via reflection), while fascination was a stronger predictor of preference. However, being away and fascination

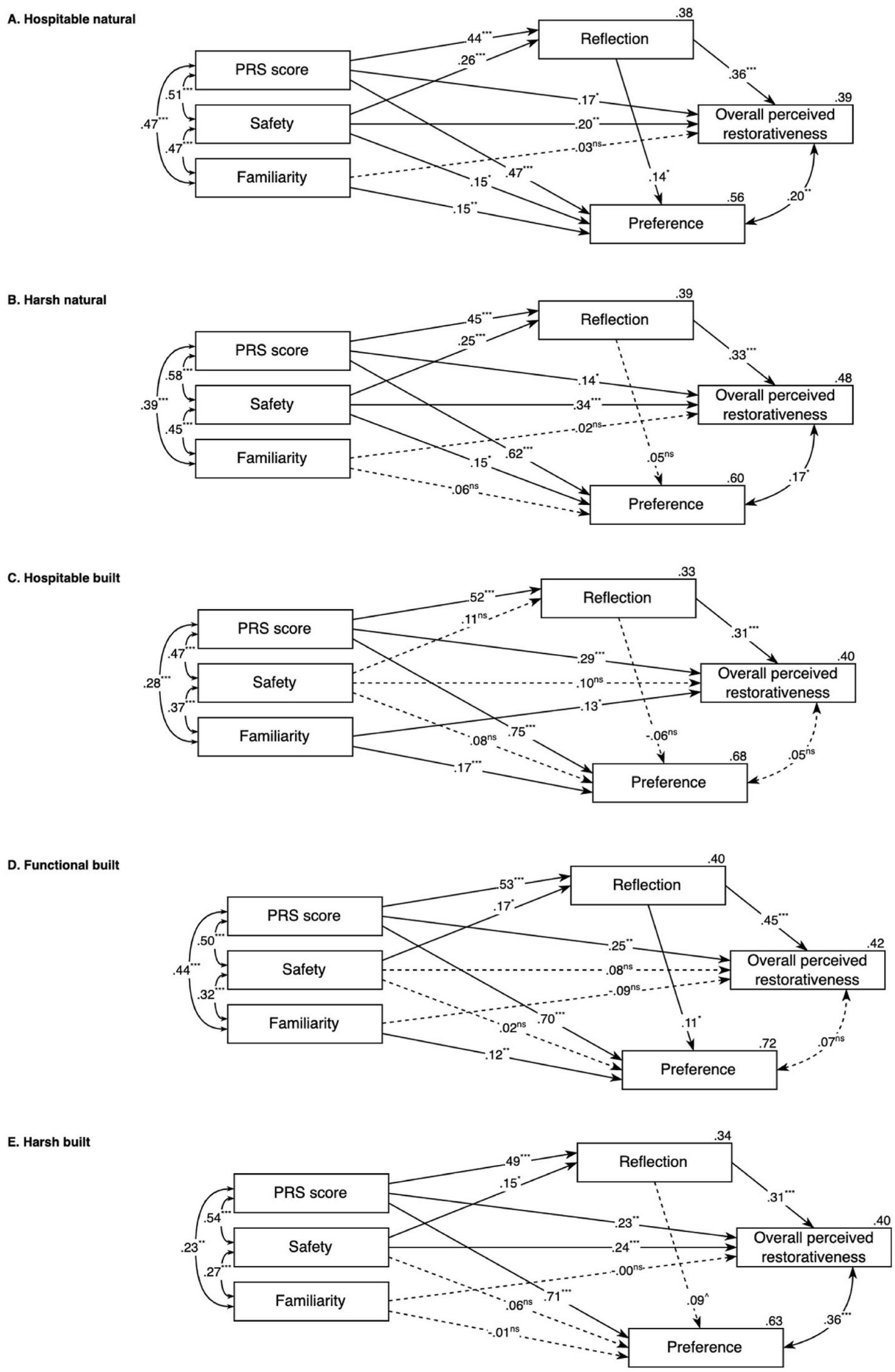

Fig. 3. Path analysis of reflection-mediator models with PRS, safety, reflection, and familiarity predicting overall restorativeness and preference for each cluster.

Note. Panels A, B, C, D, E show path analysis models for each cluster. Each model predicted overall restorativeness and preference from the PRS score, safety, and familiarity, with the mediating effects of reflection. Numbers embedded in the arrows are standardized path coefficients. Numbers above the boxes indicate explained variance (R^2). Dashed arrows represent nonsignificant effects ($p \geq .05$). Significance levels are as follows: ^{ns} nonsignificant, $^\wedge p < .10$, $*p < .05$, $**p < .01$, $***p < .001$.

were strongly correlated in all the clusters, so disentangling their respective roles may be problematic.

4. Discussion

4.1. Clusters of environments: Theoretical, methodological, and applied implications

Previous research on perceived restorativeness has often treated natural vs. built environments as a dichotomy. However, natural environments were typically selected to be relatively hospitable, and built environments to be relatively harsh (Joye & Dewitte, 2018; Scopelliti et al., 2019; Weber & Trojan, 2018). Our first hypothesis (H1) was that the natural and built environments could each be categorized into hospitable and harsh. This four-cluster hypothesis was generally in line with the five-cluster solution we identified across our 12 natural and 12 built environments. The fifth cluster we found reflected functional built environments. Within the natural environments, the difference observed between the hospitable and the harsh natural clusters agrees with studies tracing a distinction between safer natural environments and more riskier and stressful ones (Ulrich, 1983; Ulrich et al., 1991). Although both classes of natural environments were perceived as fascinating and highly capable of promoting an escape experience, the former seems to provide a more restorative experience, probably also by being perceived also as promoting a greater opportunity to reflect (Kaplan & Berman, 2010; Kaplan & Kaplan, 1989).

Table 2
Fit indices and descriptive goodness-of-fit criteria for path analysis models presented in Fig. 3.

	χ^2	χ^2 df	p	χ^2/df	CFI	SRMR	RMSEA	AIC	BIC	R^2
Hospit. natural										
Original model	0.55	1	.46	0.55	1.00	0.01	0.00	40.55	104.85	.39
Nested model	23.68	2	<.001	11.84	0.95	0.05	0.24	61.68	122.76	.31
Harsh natural										
Original model	0.01	1	.91	0.01	1.00	0.00	0.00	40.01	104.31	.48
Nested model	21.43	2	<.001	10.72	0.96	0.04	0.23	59.43	120.51	.41
Hospit. built										
Original model	0.14	1	.70	0.14	1.00	0.00	0.00	40.14	104.44	.40
Nested model	18.57	2	<.001	9.29	0.96	0.05	0.21	56.57	117.65	.34
Funct. built										
Original model	0.93	1	.33	0.93	1.00	0.01	0.00	40.93	105.23	.42
Nested model	35.56	2	<.001	17.78	0.93	0.06	0.30	73.56	134.65	.30
Harsh built										
Original model	0.23	1	.63	0.23	1.00	0.01	0.00	40.23	104.53	.40
Nested model	18.69	2	<.001	9.34	0.96	0.05	0.21	56.69	117.77	.34

Note. Cut-off values: χ^2 nonsignificant, $\chi^2/df \leq 3$, SRMR $\leq$0.09, RMSEA $\leq$0.05, CFI $\geq$0.95; see Iacobucci, 2010. R^2 refers to the amount of variance explained in overall perceived restorativeness by the model.

Table 3
Percentile-corrected bootstrap 95%CI for indirect effects on overall restorativeness and preference through reflection in each cluster for path analysis models presented in Fig. 3.

Cluster	Predictors	95% CI (Bootstrap PC)			
		Overall restorativeness		Preference	
		Lower	Upper	Lower	Upper
Hospitable natural	PRS score	0.052	0.298	0.004	0.159
	Safety	0.039	0.171	0.003	0.082
Harsh natural	PRS score	0.063	0.234	−0.043	0.100
	Safety	0.020	0.159	−0.023	0.061
Hospitable built	PRS score	0.065	0.285	−0.083	0.023
	Safety	−0.018	0.086	−0.026	0.007
Functional built	PRS score	0.141	0.357	−0.001	0.131
	Safety	0.016	0.146	−0.001	0.050
Harsh built	PRS score	0.074	0.251	−0.012	0.123
	Safety	0.000	0.114	−0.003	0.050

Concerning built environments, the hospitable built cluster was associated with very high evaluations of overall restorativeness, thus showing that some built environments (e.g., libraries, museums) can be perceived as offering highly restorative experiences, possibly also because of an history of direct or vicarious experience and learning (e.g., Egner, Sütterlin, & Calogiuri, 2020; Tuan, 1974). These results agree with the still limited number of studies that investigated the restorative potential of urban environments (cf. Weber & Trojan, 2018), consolidating their conclusions. As expected, these findings support the idea that restoration may not be confined to natural environments (Kaplan & Berman, 2010).

The functional built and harsh built cluster profiles are dominated by the hospitable built one, in that they present lower evaluations on all the dimensions, but the functional built cluster dominates the harsh built cluster. The functional built cluster, which was unexpected, includes rather standardized public places (airport interiors, shopping centers, modern downtowns), generally associated with functional uses (travel, shopping, work). These locations can be perceived as nonplaces, as suggested by Augé (1995), and thus be evaluated as less pleasant and restorative than hospitable built environments. The harsh built cluster includes industrial areas, roads with traffic, and areas with big condos, which have been usually considered as having very low restorative potential (cf. Weber & Trojan, 2018). Their low evaluations on restorativeness can be explained by referring to the stated low safety, opportunity to reflect and to perform preferred activities, perhaps together with other (inferred) negative features.

From a theoretical viewpoint, the results of our cluster analysis represent a starting point to overcome the binary natural-built distinction and move research forward (see also Joye & Dewitte, 2018), although the stability of our five-cluster solution needs to be replicated in different samples and countries. Indeed, the analysis showed that not all natural environments were perceived as offering the same level of restorativeness: harsh natural environments, despite their high ratings on being away and fascination, and medium to high preference ratings, were evaluated as being much less compatible with personal interests and less safe than hospitable natural environments. Moreover, their perceived capacity to elicit reflection and overall restorativeness was lower. Notably, hospitable built environments were perceived as highly restorative, safe, compatible with personal interests, and they received high preference ratings, despite their evaluations on the being away and fascination dimensions being lower than the ones in the natural clusters. These results also suggest that the classical measures used to assess perceived restorativeness may not be sufficient to fully characterize the restorative potential of the environments and that other dimensions, such as perceived safety and reflection, need to be considered. Thus, a theoretical and methodological implication of our findings is that perceived restorativeness may depend on a broader variety of dimensions, and weaknesses on some of them (e.g., fascination) could be potentially compensated by strengths on others (e.g., safety).

From an applied viewpoint, our findings suggest that both natural and built environments may have restorative potential. Hospitable built environments may benefit individuals who do have limited opportunity to visit hospitable natural environments. Visiting urban environments compatible with personal interests, like libraries or museums, may provide psychological benefits without the need to leave the city. Additionally, pro-environmental communication about natural environments may stress place fascination and being away experiences in the case of harsher environments but rely also on compatibility and reflection-related aspects in the case of hospitable natural environments (i.e., good things you can do during a visit). Moreover, to promote the visit of harsh natural environments, people may need to know that safety concerns have been carefully addressed.

4.2. Predictors of perceived restorativeness, and role of reflection as a mediator of ART dimensions and safety: Theoretical and applied implications

Our hypotheses on predictors of perceived restorativeness were that ART dimensions, reflection, and safety would predict overall perceived restorativeness across clusters of environments (H2a), and that reflection would partially mediate the relation between ART dimensions (and safety) and overall perceived restorativeness (H2b). The results of the path analysis models employing the PRS score showed that our predictors were significantly related with overall restorativeness as expected, explaining a remarkable amount of variance (around 40% in all the clusters). In particular, the PRS score and reflection were predictors of overall restorativeness in all the clusters, and reflection always partially mediated the effect of PRS. Safety contributed, directly or through reflection, to the prediction of overall restorativeness in four out of five clusters. Thus, our hypotheses were fully supported for PRS and reflection, and partially supported for safety.

These findings are of theoretical importance, because they confirm the predictive role of ART dimensions, as summarized by the PRS, but they also offer support for the idea that reflection and perceived safety are significant predictors of perceived restorativeness, and they start unveiling a potential network of relations connecting the dimensions underlying perceived restorativeness across different types of environments. Given the stability of the role of PRS and reflection in the five clusters, it is reasonable to conclude that some of the mechanisms underlying the perception of restorativeness are similar across different types of environments.

The results of our study support the idea that the perceived opportunity for reflection significantly contributes to the perceived restorativeness of the environment, in line with the postulated role of reflection in restoration (e.g., Kaplan & Berman, 2010; Kaplan & Kaplan, 1989), but further studies are needed to understand if actual reflection can foster actual restoration as appraised with cognitive measures (see also Joye & Dewitte, 2018).

For what concerns the perception of safety, we found that it is directly and/or indirectly related to overall perceived restorativeness in all clusters except the hospitable built one. Our results suggest that, beyond the direct effect of the feeling of safety on perceived restorativeness in natural environments and in potentially dangerous urban environments (see also Herzog & Rector, 2009), perceived restorativeness seems to depend, at least in some environments, also on the degree to which perceived safety supports the opportunity to reflect. Only in the hospitable built cluster, perceived as the safest, safety did not predict restorativeness. This can be tentatively explained by hypothesizing that, in an environment largely perceived as particularly safe, variations in respondents' judgments may no longer predict its overall restorativeness.

It is also interesting to observe that, in our models, the correlation between preference and overall restorativeness was weak and not found in every cluster. Possibly, some predictors like compatibility were related, directly and indirectly, to both these variables and explained part of their relationship (see Supplementary Materials, Figure SM6). However, it seems that the factors that make an environment perceived as restorative or pleasant do not completely overlap, as suggested also by Herzog et al. (2003). Indeed, we found that compatibility predicted both preference and perceived restorativeness, whereas fascination was a stronger predictor of preference, but not of perceived restoration, and being away was a predictor (directly or through reflection) of perceived restorativeness in all the clusters. Differently from Herzog et al. (2003), we did not find strong evidence of an effect of extent, but this difference may be due to the different item used, with our focus on coherence and Herzog et al.'s focus on scope. Moreover, our results are in line with Laumann et al. (2001) findings, which identified escape (a component of the being away dimension) and compatibility as main predictors of relaxation, while predictors of preference were fascination and compatibility. Additionally, in our study, reflection was much more strongly related to perceived restorativeness than to preference, thus indicating its greater importance for the former construct. Familiarity showed the opposite pattern.

An applied implication our findings, if they will be confirmed by studies on actual restoration, would be to promote the opportunity for reflection in natural or built places capable of triggering it, and to design places that are conducive to reflection. According to our results and the existing literature, the best-fitting places for reflection need to be perceived as safe, able to stimulate a being-away experience, and not too cognitively engaging.

4.3. Limitations and future research directions

Like any study, our investigation is not without limitations that need to be addressed in further research. First, we had to measure our perceived environmental dimensions with single items to avoid participants dropping out due to an excessive length of the procedure and to reduce participants' boredom or tiredness. Nonetheless, our items proved to be reliable across the evaluated stimuli within each category of environment. Moreover, while the single-item approach can be a limitation, this is not always the case (Allen, Iliescu, & Greiff, 2022), and it is particularly reassuring that our results generally agree with previous investigations that adopted a multi-item approach with a lower number of environments. Additionally, our main conclusions with the aggregate multi-item PRS score on the role of reflection and safety are generally consistent with the ones obtained with the single item ART dimensions.

A second limitation is represented by the fact that we measured the ART extent dimension by referring to the coherence (and not the scope) subdimension. Future studies may consider including items related to both these subdimensions to appraise the generalizability of our findings, while hopefully also controlling for the photographic area of view of the images. Additionally, due to the nature of our study, we did not delve into individual evaluations of places as related to personal meanings (e.g., Bornioli & Subiza-Pérez, 2023; Subiza-Pérez, Pasanen, et al., 2021) and orientations towards nature (e.g., Ojala, Korpela, Tyrväinen, Tiittanen, & Lanki, 2019), which are important aspects to consider in the development of this research.

A third limitation, common to many studies on restorativeness, pertains to our Italian undergraduate sample. Thus, there is a need to replicate findings in other populations and in other countries. This can be facilitated by online procedures and by the availability of a pre-tested set of stimuli that can be easily used in other contexts and by other researchers in the perspective of Open Science. However, conducting research on restorativeness on young adults is valuable, given their higher level of reported stress and worry (e.g., Stone, Schwartz, Broderick, & Deaton, 2010) and the potential benefits offered by restorative environments and interventions tailored for this segment of the population.

A fourth limitation is that we focused on perceived restorativeness, but we still need to understand whether the differences we observed in the evaluations of the environments will also translate into behavioral differences after actual restorative experiences (e.g., improvement in cognitive performance), which will require additional studies. Further research is also needed to better understand the interplay between attention recovery and reflection in promoting actual full restoration (as measured in the ability to perform complex and demanding cognitive tasks) in environments with different features. Such studies would allow testing the hypothesis that reflection strengthens actual restorative effects of environmental exposure beyond attention recovery (see also Joye & Dewitte, 2018).

A fifth limitation is that, like in many other studies on restorativeness, we employed pictures and asked participants to imagine being in the represented places instead of offering them the real experiences. Considering the number and type of environments employed in our study, this would have been clearly unfeasible, but future research could consider employing virtual environments for enhancing immersion and realism. However, it is also worth pointing out that the results of studies on restoration using AV materials and real experiences are generally consistent, although real exposure may enhance restorative effects (e.g., Stevenson et al., 2018).

5. Conclusion

We identified five meaningful clusters (hospitable natural, harsh natural, hospitable built, functional built, harsh built), grouping a wide range of natural and built environments in relation to key dimensions underlying perceived restorativeness, and we defined their specific profiles. We also contributed to unveil the pattern of relationships between these dimensions and perceived restorativeness, underlining the significant role of reflection and safety beyond ART dimensions. These results can contribute to our theoretical understanding of perceived restorativeness, and they can have significant implications for well-being, recreation, and pro-environmental communication.

Author statement file for the manuscript

Marta Stragà: Conceptualization, Methodology, Data curation, Writing - original draft, Writing - revision, Clara Miani: Conceptualization, Methodology, Timo Mäntylä: Conceptualization, Methodology, Writing - original draft, Writing – revision, Supervision, Wändi Bruine de Bruin: Methodology, Writing - original draft, Writing – revision, Supervision, Mattia Mottica: Conceptualization, Methodology, Fabio Del Missier: Funding acquisition, Conceptualization, Methodology, Writing - original draft, Writing – revision, Supervision.

Declarations of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2023.102131.

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