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Environmental Preference and Restoration:

(How) Are They Related?

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Abstract

Does the widely documented tendency to prefer natural over built environments owe to the perception of greater restorative potential in natural environments? In the present experimental study we tested the mediating role of restoration in environmental preferences. Participants viewed a frightening movie, and then were shown a video of either natural or built environments. Participants' mood ratings were assessed before and after they viewed the frightening movie, and again after viewing the environmental video. Participants also rated the beauty of the environment shown (to indicate preference) and performed a test of concentration after viewing the environmental video. The results indicate that participants perceived the natural environments as more beautiful than the built environments. In addition, viewing natural environments elicited greater improvement in mood and marginally better concentration than viewing built environments. Mediational analyses revealed that affective restoration accounted for a substantial proportion of the preference for natural over built environments. Together, these results help substantiate the adaptive function of people's environmental preferences.

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People tend to prefer natural over built environments (see reviews by Ulrich, 1983; Knopf, 1987; Kaplan & Kaplan, 1989; Hartig, 1993). For example, in samples of European and North American adults, photographs of natural scenes consistently receive higher ratings of liking, scenic beauty, or pleasantness than photographs of urban scenes (e.g. Purcell *et al.*, 1994; Stamps, 1996). Typically, levels of self-reported preference for natural scenes are so much higher than preference levels for urban scenes that the distributions of ratings for the two domains hardly overlap (e.g., Kaplan *et al*., 1972; see also Ulrich, 1983). People's preference for natural over built environments can also be inferred from behavioral indicators, such as the higher prices paid for real estate in natural surroundings (e.g. Anderson & Cordell, 1988; Luttik, 2000).

Given that the empirical evidence for the preference for natural over built environments is strong and robust, it becomes important to ask *why* people have such a ubiquitous fondness for nature. According to several authors, at least part of the answer relates to nature's ability to provide restoration from stress or attentional fatigue (Kaplan & Kaplan, 1989; Hartig & Evans, 1993; Staats et al., 2002). In particular, preference for natural over built environments may be mediated by an implicit assessment of these environments' potential for restoring or improving well-being (Appleton, 1975; Ulrich, 1983; Kaplan, 1987). Although this explanation is theoretically plausible, relatively little evidence has directly supported the mediating role of restoration in environmental preferences. The present research was designed to fill this void.

In what follows, we elaborate the theoretical rationale for assuming that certain patterns in environmental preferences, specifically the ubiquitous preference for natural environments, are linked to the given environments' potential to provide restoration from stress or fatigue. Next, we

argue that past research has not yet yielded direct evidence for this line of reasoning, given that this research has not employed the appropriate mediational analyses. Finally, the merits of mediational analyses for this field are demonstrated in the context of an experimental study in which we measured restorative effects of natural versus built environments as well as liking for those environments.

On the Relation between Preference and Restoration

Why should people's preference for a particular environment be related to the likelihood that it can bring them restoration? One possible explanation can be inferred from a functional account of environmental preference. Various environmental theories have assumed that environmental preference is reflective of perceptual mechanisms that allow the individual to assess, typically in a rather rapid and automatic manner, whether a particular environment should be approached or avoided (Appleton, 1975; Ulrich, 1983; Kaplan, 1987). Following this theorizing, environmental preference is determined by environmental properties that possess a potential functional significance for the perceiver. For instance, perceiving walkable grounds may elicit a positive evaluative response because the availability of an easy escape route may decrease the probability that predators harm the individual.

The above reasoning can explain why environmental preference and restoration may be closely related. Particularly for individuals who are feeling weak or low, environmental affordances for restoration should have great adaptive value (Ulrich, 1983). In recent years, two influential accounts have been proposed regarding the particular restorative functions that environments may fulfill. First, attention restoration theory has emphasized the importance of cognitive functioning such as restoration from attentional fatigue (Kaplan & Kaplan, 1989; Kaplan, 1995). Second, the psychoevolutionary model (Ulrich, 1983; Ulrich *et al.*, 1991) has

emphasized the importance of affective functioning such as restoration from psychophysiological stress associated with threat or challenge. Both accounts draw support from a growing body of empirical evidence indicating that environments differ in how well they support cognitive restoration, as measured by improved concentration, and affective restoration, as measured by improvements in self-reported positive and negative mood states and physiological indicators such as reduced blood pressure and lower levels of stress hormones (Ulrich, 1993; Kaplan 1995).

In sum, based on a functional account of environmental preference, one may expect to obtain a positive relation between the preference for a particular environment and that environment's potential to provide restoration from stress or mental fatigue. Theoretically speaking, this relation might be especially pronounced among stressed or fatigued individuals, because these are most likely to benefit from the environment's restorative potential (Ulrich, 1983; see also Herzog *et al.*, 1997; Staats *et.al.,* 2002).

Is Preference for Natural over Built Environments Mediated by Restorative potential?

The presumed link between environmental preference and restoration suggests that people's widespread tendency to prefer natural over built environments may be at least partly explained in terms of variations in restorative potential between these respective types of environment. In statistical terms, this would mean that people's preference for natural over built environments is *mediated* by the perception of greater restorative potential in natural environments. In order for restorative potential to qualify as a mediator, three basic conditions must be met (Baron & Kenny, 1986; Kenny *et al*., 1998). First, there must be a significant relation between type of environment (e.g. whether it is natural versus built) and preference. Second, there must be a significant relation between type of environment and restorative potential. Third, there must be a significant relation between restorative potential and preference

when the influence of type of environment on preference is statistically held constant. If all of these conditions are met, then it follows that there necessarily is a reduction in the effect of type of environment on preference (cf. Kenny *et al.*, 1998). To establish that restorative potential completely or partially mediates the relationship between type of environment and preference, the effect of type of environment on preference controlling for restorative potential should be zero or significantly reduced.

As we have noted already, there is strong evidence for the first condition, namely, that type of environment is related to preference. Evidence for the second condition -that type of environment is related to restorative potential-, derives from two types of research. First, a number of studies have employed self-reports of *perceived* restorative potential to test for differences between natural and built environments. For example, Herzog *et al.* (1997) asked participants to rate the effectiveness of various settings to restore abilities to concentrate or reflect. Their results showed that natural settings were rated as more effective than urban settings. Hartig and colleagues (Hartig *et al*., 1997) have reported similar effects using a more elaborate measure of perceived restorative potential based on attention restoration theory (Kaplan & Kaplan, 1989; Kaplan, 1995). This measure captures four aspects of restorative experiences, namely, psychological distance from one's usual routines (being away), effortless attention drawn by objects in the environment (fascination), immersion in a coherent environment (extent), and a good match between personal inclinations and environmental supports and demands (compatibility). Studies among different populations and presentation modes have found that, as a set, the natural environments studied consistently elicited higher ratings of perceived restorativeness than the set of built environments (Hartig *et al.*, 1997).

A potential limitation of the aforementioned line of research is that it has relied on participants' own estimates of restorative potential. Although such estimates may be easy to apply and are seemingly straightforward, the question remains to what extent people's estimations of an environment's restorative potential correspond to the automatic, unconscious perceptions of restorative potential that are thought to guide preference. Conceivably, people's estimates of an environment's restorative potential may be distorted by memory biases or lay theories about restoration (Nisbett & Wilson, 1977; Wilson & Brekke, 1994).

Alternatively, a second line of research has measured *actual* restorative effects, such as increases in positive mood, performance on concentration tests, and changes in physiological measures (Ulrich, 1979; Hartig *et al*., 1991; Ulrich *et al.*, 1991; Hartig *et al*., 1996). Although measures of restorative effects are less prone to response biases, it should be pointed out that these are not one-to-one measures of restorative potential either. Most importantly, actual restorative effects depend not only on an environment's potential for restoration, but also on the perceiver's need and capacity to bring that potential into effect. Despite this limitation, studies employing measures of actual restoration have consistently shown that natural environments elicit more restorative effects than urban environments. For example, Hartig *et al*. (1991) have shown that cognitively fatigued individuals who walked through natural environments showed more positive change in mood state and performed better on a proofreading task than cognitively fatigued individuals who walked through an urban environment or sat in a room leafing through magazines. Likewise, Ulrich *et al.* (1991) have demonstrated that stressed individuals who viewed scenes dominated by natural content showed more pronounced changes characteristic of physiological stress recovery, including lower levels of skin conductance fluctuations, lower blood pressure, and greater reduction in muscle tension than stressed individuals who viewed

scenes dominated by built content. Furthermore, a recent study by R. Kaplan (2001) suggests that having natural elements or settings in the view from the window contributes substantially to diverse aspects of residents' self-reported well-being, including "being at peace", "feeling effective" and "not being distracted".

The third condition for mediation stipulates that restorative potential must be related to preference for natural over built environments, even when the influence of type of environment on preference is statistically held constant (Baron & Kenny, 1986). As yet, explicit tests of this third condition have not been reported in the literature. Several studies have found evidence that restoration is positively related to environmental preference (Korpela & Hartig, 1996; Hartig *et al*., 1998; Purcell *et al*., 2001; Staats *et al*., 2002). For instance, Hartig *et al*. (1998) reported a correlation of .49 between pretest-posttest changes in positive affect and environmental preference across groups of participants who walked through natural or urban field sites. However, demonstrating a significant relation between restoration and preference is not sufficient for establishing the mediational role of restorative effects in accounting for people's preference for natural over built environments. Indeed, when the influence of type of environment is not taken into account, it remains possible that the relation between type of environment and preference is responsible for the relation between restorative potential and preference (i.e., the relation between restorative potential and preference is spurious).Thus, in order to explicitly test for mediation, it is necessary to demonstrate that restorative potential (or actual restoration) is related to preference, even when influences of type of environment on preferences are statistically controlled for. The mediating role of restoration in people's greater preferences for natural over urban environments is established when the influence of type of environment on preference shrinks significantly when the relation between restoration and preference is taken into account.

In sum, a substantial amount of evidence indicates that natural environments are evaluated more favorably than built environments, and that natural environments have more restorative potential than built environments. Thus, the available evidence suggests that two important conditions are met for concluding that people's preference for natural over built environments is mediated by restorative potential (Baron & Kenny, 1986). At the same time, there exists no solid evidence that the third condition for mediation is met, which states that environmental preferences should be related to restorative potential when type of environment is statistically held constant. Thus, there remains an important gap in the literature regarding the issue of whether or not preference for natural over built environments is mediated by restorative potential.

The Present Research and Hypotheses

In the present research, we examined the interrelationships between environmental preference and restorative effects. In an experimental study, we first exposed all our participants to a stressful situation, and then introduced them to a video recording of either natural or built environments. In addition, we obtained measures of participants' environmental preference and restorative processes. Based on the preceding analysis, we made the following set of interrelated predictions. First, we expected natural environments to be evaluated more positively than built environments. Second, we anticipated that exposure to natural environments would be associated with greater restoration from stress than exposure to built environments. Third, we expected preferences for natural over built environments to be mediated by differences in measured restoration between these environments. Finally, in a more exploratory vein, we tested for the presence of systematic individual differences in people's preferences for each type of environment (see Van den Berg *et al.,* 1998). Because we expected that highly stressed individuals would be more sensitive to opportunities for restoration than less-stressed individuals,

we hypothesized that the intensity of negative changes in affect following from the stress manipulation would be positively related to preferences for natural environments, and negatively related to preferences for built environments.

In designing the study, we wanted to include a selection of natural and built environments that differed in restorative potential. We chose presence of water as an indicator of high restorative potential because previous studies indicated that the presence of water is experienced as particularly relaxing and peaceful (Ulrich, 1993). To test for relations between restorative effects and presence of water, we created four environmental videos that varied systematically with regard to type of environment (natural versus built) and presence of water.

To measure environmental preference, we obtained participants' beauty ratings of the environmental videos. We chose to use beauty ratings instead of preference ratings mainly for practical reasons, because the Dutch language does not contain a commonly used equivalent for the question "how much do you prefer (or like) this environment?" The use of beauty ratings in measuring environmental preferences is justified by empirical studies (e.g., Zube *et al.*, 1975) which have generally reported a strong convergence between beauty judgments and preference ratings.

In selecting our stress manipulation and measures of restoration, we were guided by the literature on the relative importance of cognitive and affective processes in the unfolding of restorative effects. As discussed previously, some authors have emphasized the importance of cognitive processes such as attentional restoration (e.g., Kaplan, 1995). Methodologically, this emphasis has resulted in a focus on cognitive stressors (e.g., attentional depletion) and cognitive measures in the assessment of restorative effects (e.g., concentration tasks). In contrast, other authors have argued for the importance of affective processes (e.g., Ulrich, 1983), and have

correspondingly studied the influence of more affectively charged stressors (e.g., watching a scary movie) and affective and/or psychophysiological measurements (e.g., self-reported affect or heart rate). Based on these lines of research, it seems important to discriminate between cognitive and affective processes in studying restorative effects. Accordingly, we decided to use a stress manipulation that was predominantly affectively driven, i.e., exposure to a frightening movie. Frightening movies have been used in several other studies of restorative environments (Ulrich *et al.*, 1991; Parsons *et al*., 1998; cf. Fredrickson & Levenson, 1998). We deliberately exposed participants only briefly to the frightening movie, to make sure that this stress manipulation was primarily affective and not confounded with attentional fatigue (cf. Kaplan, 1995).

At the same time, we acknowledged the possibility that both cognitive and affective processes may be important as restoration unfolds. For instance, when a person experiences negative feelings, that person is likely to instigate active attempts to regulate his or her emotions (Kaplan, 1995). Because such active attempts at affect regulation presumably draw upon the person's cognitive resources, they could lead to attentional depletion. As such, even people's coping responses to primarily affective stimuli might consist of a mixture of cognitive and affective processes. In recognition of the complex nature of restorative processes, we measured restoration using a multi-method strategy that included affective measures (i.e., self-reported mood changes), and a cognitive measure (i.e., performance on a concentration task). Given the predominantly affective nature of our stress induction, restoration might be more easily apparent in our affective measures. On the other hand, to the extent that affect regulation represents an integral aspect of coping with an affective stressor, the cognitive measure might also speak to differences in restoration in the environments shown.

Method

Participants and design

We recruited 114 participants at Wageningen University, The Netherlands. Of these participants, two chose to terminate the experimental session prematurely (see Procedure). An additional six participants were removed from the sample because their responses indicated that they had either not understood the experimental instructions or did not wish to disclose their actual mood states (i.e., they had marked all positive and negative mood states ”not at all applicable” at each of the three measurement points). The remaining 106 participants (67.9% female, mean age = 21.9 years) were randomly assigned to the four conditions (i.e., natural environment with and without water; urban environment with and without water). Percentages of female participants did not differ significantly between natural (62.3%) and built (73.6%) conditions. Participation was voluntary, and participants received a voucher of Dfl. 12.50 (approximately $ 6 U.S.).

Environments

Four color videotapes with sounds were made by the experimenters to simulate slowly paced walks through two urban and two natural environments. The two urban videos were made in the city of Utrecht, a large city in the center of The Netherlands. One of the urban videos showed a walk through a street along a canal, with houses and shops on the other side of the street, the other showed a walk through a nearby street with houses and shops on both side of the street, without views of the canal. People and traffic were visible and audible in each of the urban videotapes. The two natural videos were made in a park-like forest area (Estate Quadenoord in Renkum, The Netherlands). One of the natural videos showed a walk on a path along a creek, the other showed a walk on a path in the same forest area without views of the creek. All environments were filmed in winter at about the same time of day and under similar weather

conditions. Sounds of birds and other animals were clearly audible in each of the natural tapes. Each tape lasted exactly seven minutes.

Procedure and Questionnaire

The experiment was run in sessions with 8 to 10 participants. At the start of each session, an experimenter provided participants with a general overview of the experimental procedures. The experimenter also told participants that they were free to leave the experimental session at any time. Participants then reported their age, gender and disciplinary background. Next, they provided baseline ratings on a set of 21 adjectives measuring the subscales Depression, Anger, and Tension of a Dutch translation of the abbreviated Profiles Of Mood States scale (POMS; Wald, 1984). Responses were made using 10-point scales (1 = *Do not feel at all*; 10 = *Feel very strongly*). In addition to the POMS-subscales, participants also expressed their total happiness and overall level of stress in scores of 1-100 (1 = *Not at all happy/stressed*; 100 = *Cannot be happier/more stressed*). After providing the initial measures, participants viewed fragments of the movie ”Faces of Death # 1”, which has served as an effective stressor in other studies (e.g., Brand *et al*., 1997). The particular fragments shown included a farmer’s wife decapitating a rooster (one minute) and images from a slaughterhouse where sheep and bulls are killed in a bloody fashion (three minutes). During the presentation of the stressful movie, two participants (both vegetarians) chose to leave the experimental session because they found the images too disturbing. These two participants were told that they could not continue with the experiment, and were then paid and dismissed. The remaining participants went on to complete the POMS subscales and the overall happiness and stress measures for the second time.

Next, participants viewed one of the four videos representing walks through built or natural environments. Participants were instructed to watch the videos carefully and imagine

themselves actually walking through the environment shown. After viewing the video, they first rated the environments on several characteristics, including beauty and naturalness (1 = *Not at all beautiful/natural*; 9 = *Very beautiful/natural*). They then completed, for the third time, the POMS-subscales and the overall happiness and stress measures. Internal consistencies of the POMS-subscales Depression, Anger, and Tension were high at each of the three times of measurement, with Cronbach's alpha ranging from 0.81 to 0.92.

Participants then moved on to complete the d2 Mental Concentration Test (Brickenkamp & Zillmer, 1998). The d2 test is a letter cancellation task that consists of fourteen rows, each row containing a random sequence of the letters *p* and *d*. Placed above and below each letter, there are one, two, or no apostrophes. Participants were given 14 seconds to check in each row as many *d*s having two apostrophes as possible. All participants were told to work through each row as quickly and precisely as possible. Following Brickenkamp and Zillmers' (1998) recommendation, an index of concentration performance was calculated by subtracting both errors of commission (non-d2s erroneously marked) and errors of omission (d2s not marked) from the total number of symbols checked. This measure (number of correctly identified symbols) reflects both speed and accuracy of performance. In addition to this concentration index, we also calculated separate indices of speed (total number of symbols checked) and accuracy (percentage of errors). The completion of the d2 test lasted about six minutes.

Upon completion of the d2 test, participants completed two personality scales that are not relevant for the present investigation. Finally, participants were debriefed, paid and dismissed.

Results[1]

Manipulation Checks

Effectiveness of the stress induction. A series of 2 (environment: natural, built) x 2 (time: t1, t2) ANOVAs with repeated measures on the second factor revealed that the average rating on each of the five mood scales was significantly more negatively toned after viewing the frightening movie (t2) than during baseline measurement (t1), all *p*s < .001 (see Table 1). These results indicate that the stress-induction manipulation was successful. One-way MANOVAs of ratings on the five mood scales showed that the built and natural groups did not differ with respect to t1-measures of mood states, $F(5, 95) = 0.90$, $p = .48$, nor with respect to t2-measures of mood states, $F(5, 94) = 0.59$, $p = .71$, indicating that these groups were comparable with respect to their mood state prior to viewing the environmental videos.

Naturalness. A one-way ANOVA of the naturalness ratings revealed a significant main effect of environment, $F(1, 104) = 169.43$, $p < .001$. The natural environments were generally rated as ”natural” ($M = 6.08$), while the built environments were generally rated as ”not natural” ($M = 1.98$). These results are consistent with our classification of the four environmental videos into two natural environments and two built (i.e., not natural) environments.

Tests for environmental effects on restoration

The videotapes were originally constructed to systematically investigate restorative effects of two environmental factors: natural vs. built environment and presence of water vs. absence of water. Because the presence of water did not exert any systematic influence on affective restoration, concentration, beauty or naturalness, either alone or in combination with other variables, presence of water was dropped from the analyses reported below.

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[1] Degrees of freedom may vary, because not all participants had complete scores on all dependent variables.

Affective restoration. A series of 2 (environment) x 2 (time: t2, t3) ANOVAs with repeated measures on the second factor yielded significant Environment x Time interaction effects on each of the affective dimensions [depression: $F(1, 99) = 9.93$, $p < .01$; anger: $F(1, 104) = 9.68$, $p < .01$; tension: $F(1, 104) = 8.98$, $p < .01$; overall happiness: $F(1, 100) = 7.53$, $p < .01$; overall stress: $F(1, 100) = 6.64$, $p < .05$]. As can be seen in Table 1, participants who viewed natural environments, as compared to participants who viewed built environments, showed greater restoration on all five affective measures. Tests of the simple main effect of time within each environment condition revealed that participants who viewed natural environments experienced restoration on all affective dimensions, all *ps* < 0.001. Notably, participants who viewed built environments also experienced some affective restoration, as indicated by significant main effects of time on these participants' scores on depression, anger, and tension, all *ps* < 0.05. Participants who viewed built environments did not show affective restoration with respect to overall happiness and overall stress, both *ps* > .10.

Attentional restoration. One-way ANOVAs of participants' performance on the d2 test yielded marginally significant effects of environment on the concentration index , $F(1, 102) = 2.79$, $p = .098$ and the speed index, $F(1, 102) = 2.74$, $p = .10$. Participants who had viewed natural environments correctly identified somewhat more symbols ($M = 399.84$) than participants who had viewed built environments ($M = 379.30$). They also checked a somewhat larger number of correct and incorrect symbols ($M = 421.18$) than participants who had viewed built environments ($M = 399.92$). Additional analyses of the separate speed and accuracy indices revealed no significant effects of environment on the separate accuracy index, $p = .86$.

Mediational Analysis

Following Kenny *et al.* (1998), the mediational analysis was carried out in three steps. In Step 1, beauty ratings were used as the criterion variable in a regression equation with environment (dummy coded so that built environment = 0 and natural environment = 1) as a predictor to estimate the effect of type of environment on preference. In Step 2, affective restoration was used as the criterion variable in a regression equation with environment as a predictor to estimate the effect of type of environment on affective restoration. Finally, in Step 3, beauty ratings were used as the criterion variable in a regression equation with affective restoration and environment as predictors to estimate (a) the effect of affective restoration on preference with environment held constant, and (b) the effect of environment on preference with affective restoration held constant.

The upper part of Figure 1 displays the estimated standardized regression coefficient for the unmediated model relating environment to preference, as described in Step 1. The effect of environment on beauty ratings was beta = 0.76, $t(96) = 11.58$, $p < .001$. On average, the natural environments were rated as more beautiful (M= 6.75) than the built environments (M =3.26).

The lower part of Figure 1 displays the estimated standardized regression coefficients for the mediated model as described in Step 2 and Step 3. We constructed a single measure of affective restoration by submitting participants' t2-t3 change scores for each of the mood scales to a principal components factor analysis with varimax rotation. Results of this analysis confirmed that the change scores on the five mood scales reflected one underlying factor, which explained 58% of the variance in the change scores (with absolute values of factor loadings greater than .70). As can be seen in the figure, the effect of environment on affective restoration was beta =

0.32, $t(96) = 3.27$, $p < .01$, meaning that participants who viewed natural environments scored higher on the affective restoration factor than participants who viewed built environments.

Figure 1 also shows that the estimated effect from the mediator to the outcome was beta = 0.20, $t(95) = 3.05$, $p < .01$. This effect corresponds to a partial correlation coefficient of . 30. Thus, there was a significant positive relationship between affective restoration and beauty ratings, even when the influence of environment was held constant. Additional analyses revealed that there were positive correlations between affective restoration and beauty ratings within each environmental domain. The correlation between affective restoration and beauty ratings was somewhat less strong in the urban condition, $r = .26$, $p = .08$, than in the natural condition, $r = .35$, $p < .05$; however, this difference was not statistically significant, $p = 71$.

Finally, Figure 1 presents the beta weight for the effect of environment on beauty ratings, controlling for the influence of affective restoration. That effect decreased from .76 to .70, $t(95) = 10.49$, $p < .001$. While this may seem a small reduction in effect size, the Sobel test, as modified by Baron and Kenny (1986), indicated that the reduction was significant, $z = 2.27$, $p < .05$. The mediational power of affective restoration is also indicated by the finding that the portion of variance explained in beauty ratings by type of environment decreased markedly, from 58.3% to 44.0%, after affective restoration was partialed out. These results indicate that preferences for natural over built environments were partially mediated by differences in affective restoration across the two environments.

Effects of Stress on Beauty Ratings

According to our theoretical analysis, highly stressed individuals might be more sensitive to opportunities for restoration than less-stressed individuals. Therefore, we conducted a final series of analyses to investigate the influence of t1-t2 changes in affect on beauty. We first

constructed a single measure of changes in affect following from the frightening movie by submitting t1-t2 change scores for each mood state to a principal components factor analysis with varimax rotation. Results of this analysis confirmed that the t1-t2 change scores on the five mood scales reflected one underlying factor, which explained 54.8% of the variance in the change scores (with absolute values of factor loadings all greater than .69).

As expected, greater t1-t2 changes in affect were associated negatively with perceived beauty of the built environments (r = -.09), and positively with perceived beauty of the natural environments (r = .14). However, neither of these correlations, nor the contrast between these correlations, reached significance, all ps > .20. To obtain some clue as to the validity of our expectations, we compared the beauty ratings of the 30% participants with greatest t1-t2 changes in mood (n = 30) to the beauty ratings of the other participants (n =69). Results of this analysis revealed a significant interaction between environment and stress level (high, low) on beauty, $F(1, 95) = 7.5$, $p < .01$. In the urban conditions, the participants with relatively high levels of experienced stress rated the environment shown as less beautiful than the other participants (M = 2.46 versus M = 3.58), while in the natural conditions the participants with high levels of experienced stress rated the environment shown as more beautiful than the other participants (M = 7.17 versus M = 6.54). These results provide some tentative support for our hypothesis that environmental preferences reflect differential restoration needs.

Discussion

In the present research, we sought to identify some of the links between environmental preference and psychological restoration. Previous work has shown that natural environments are generally preferred over built environments (Ulrich, 1983; Knopf, 1987; Kaplan & Kaplan, 1989; Hartig, 1993). In line with this, the results of the present study showed that simulated natural

environments were rated as more beautiful than simulated built environments. Natural environments have further been found to elicit stronger restorative effects than built environments (Ulrich, 1979; Hartig *et al*., 1991; Ulrich *et al.*, 1991; Hartig *et al.*, 1996). Supporting this, the present study found that exposure to a natural environment was associated with more positively toned changes in mood states and marginally better performance on a concentration test than exposure to a built environment.

Previous work has also theorized that greater preferences for natural over built environments are mediated by perceptions of greater restorative potential in natural environments (Kaplan & Kaplan, 1989; Hartig & Evans, 1993; Staats *et al*., 2002). In the present experiment this mediation hypothesis was directly tested and confirmed for the first time using measured restoration as the mediator. More specifically, higher preferences were found to be associated with greater affective restoration, even when type of environment was statistically held constant. Furthermore, after restorative effects were statistically removed, differences in aesthetic preference between natural and built environments were significantly reduced. These findings are consistent with the notion that environmental preferences are mediated by perceptions of the environment's potential to provide restoration from stress.

Theoretically, the link between environmental preference and restoration also implies that preferences for natural over built environment should be more pronounced among stressed individuals because they are more in need of restoration (Ulrich, 1983; Herzog *et al.*, 1997; Staats *et al.,* 2002). Indeed it was observed that high levels of stress were associated with higher preferences for natural environments, while these were associated with lower preferences for built environments. The finding that degree of stress influenced environmental preferences is paralleled by recent findings by Staats *et al*. (2002), who found that participants who were

instructed to imagine themselves as mentally fatigued showed less favorable attitudes toward walking in a simulated urban environment than participants who were instructed to imagine themselves as refreshed and energetic. The present research adds to these previous findings by providing some tentative evidence that enhanced preferences for natural over built environments can also be found among people who are stressed but not fatigued.

The present study was specifically designed to gain more insight into the relative contributions of affective and cognitive processes in the unfolding of restorative effects. We applied an affectively charged stressor, namely, a frightening movie that was deliberately kept short to prevent the occurrence of mental fatigue, but at the same time we used a combination of affective and cognitive measures to assess restoration. Given the predominantly affective nature of our stress manipulation, we expected that differences in restorative potential between natural and built environments would be more readily apparent in the affective measures. Consistent with this expectation, we found highly significant effects of type of environment on all affective mood states, while there were only marginally significant differences in concentration between the natural and built conditions. Yet, the finding that natural scenes did engender marginally better concentration at the posttest than urban encourages us to consider how attentional resources may play an integral role in restorative experiences.

Taken together, the present findings add to the growing support for the adaptive functions of environmental preferences (Appleton, 1975; Ulrich, 1983; Kaplan, 1987). Importantly, the effects found in the present study speak to a broad functional significance of environmental preference that includes not only restoration from mental fatigue but also restoration from anxiety-based stress.

Limitations and Future Perspectives

In the present research, we have introduced mediational analysis as a powerful methodological tool for enhancing our understanding of the links between psychological restoration and environmental preferences. Although we believe that mediational analysis can be extremely useful to the development of our field, it is also important to acknowledge the limitations of this method. In particular, we want to emphasize that mediational analysis is essentially a correlational technique. Accordingly, conclusions regarding causal relations between variables can never be substantiated by mediational analysis and must hence be evaluated on the basis of external sources of evidence. In the present study, we have argued for restoration as a potential mediator of people's preference for natural over built environments, because we believe that restoration represents a more basic adaptive phenomenon than environmental preference. Consistent with this, various authors have argued that the human species may have an evolved preference for certain configurations in natural environments because these environments allow people to recover from stress and to replenish their energies (Kaplan & Kaplan, 1989; Ulrich, 1993. Although such evolutionary accounts of environmental preference have considerable credibility, the current findings by themselves do not preclude the possibility that the causal arrow may also flow in the reverse direction, from landscape preference to restoration. For instance, our participants may have acquired positive attitudes towards nature through the media, which in turn may have fostered restorative effects from exposure to nature. In light of the feasibility of such alternative accounts, more research is needed to uncover the precise causal mechanisms that mediate environmental preference and restoration.

A second concern of the present study involves the measurement of environmental preferences. According to the current theoretical analysis, environmental preferences are predominantly driven by rapid and automatic affective responses. In the present study, however,

aesthetic preferences were measured only after prolonged exposure to environmental videos. In this case, environmental preferences are probably more similar to what Ulrich (1983) has labeled 'post-cognitive' affective responses, that is, affective responses that reflect more detailed perception and cognitive processing. As Ulrich has pointed out, the passive intellectual contemplation of a natural setting can be quite beneficial in itself, and therefore post-cognitive affective responses may themselves be considered measures of restorative experience. In future research, this problem may be overcome by measuring preferences directly after the first exposure to an environment, while measuring mood states only after a longer period of exposure to that same environment. When employing such a design, special care should be taken that participants will not get bored from having to watch the same environment for a long time. This might be accomplished by using a moving camera that surveys a certain spot from a fixed position, or by taking participants to actual settings and let them view the setting from a bench or another designated spot.

The representation of water in the environmental videos constitutes another methodological point of concern. In the present study, presence of water was not found to have a reliable influence on environmental preference or restoration. However, a visual inspection of the experimental stimuli reveals that the presence or absence of water was rather difficult to discern in the video recordings. Accordingly, our manipulation of the presence of water may have been too weak to have any impact on participants' preferences or restoration from stress. Because positive effects of water on preference have consistently been found in other studies (e.g., Ulrich, 1986), it seems worthwhile to further investigate the independent contribution of water to the occurrence of restorative effects in future studies (cf. Fredrickson & Levenson, 1998).

In the present research we tried to capture restorative experiences in an experimental setting using simulated environments. One may question the validity of such an approach, because an experimental setting imposes restrictions on people and environments that, in many ways, seem antithetical to restorative experiences. For example, as S. Kaplan (2001) has pointed out, intrinsic motivation is an important factor in many real-life restorative experiences because it reduces the ”costs” of dealing with demanding situations. Because participating in an experiment is likely to be motivated by extrinsic reasons such as earning money, this aspect of restorative experience may be difficult to capture in an experimental setting. Furthermore, it is obvious that visual simulations of environments lack certain characteristics (e.g., smell and other sensory aspects) that many people consider a vital component of real-life restorative experiences. Still, though, the lack of intrinsic motivation and the use of simulations would have only made it more difficult to detect the effects that we have described here. So, despite these concerns, we believe that experimental studies are useful to this area of research because they provide a unique and indispensable means for unraveling the various components of restorative experiences and their links to environmental preferences.

Finally, we wish to draw attention to the possible practical implications of this study for land management and spatial planning. By providing firm evidence for the adaptive function of environmental preferences, the results of this study strengthen the rationale for considering public preferences in guidelines for management and planning. In particular, the results of the present study suggest that ignoring public preferences for natural over built environments may have serious public health consequences. Eventually, the ongoing expansion of cities at the cost of natural areas may not only upset the environment’s delicate ecological balance, but also take away vital restorative opportunities for the human species itself.

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Table 1

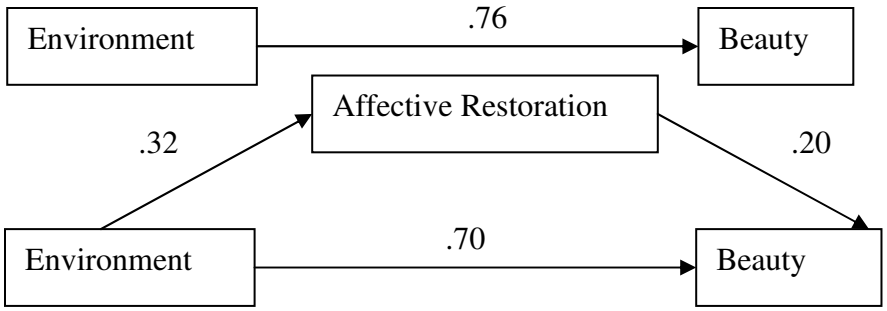
Mood States as a Function of Environment Type and Time of Measurement.

		Urban			Natural		
		t1	t2	t3	t1	t2	t3
Depression (1-10)	*M*	2.7	4.0	3.4	2.3	3.7	2.3
	SD	1.5	2.0	1.8	1.3	1.5	1.3
Anger (1-10)	*M*	2.5	3.9	3.2	2.2	3.7	2.0
	SD	1.3	1.9	1.8	1.3	2.0	1.0
Tension (1-10)	*M*	3.0	3.6	3.2	2.9	3.7	2.5
	SD	1.5	1.9	1.7	1.5	1.9	1.4
Overall Happiness (1-100)	*M*	74.5	66.3	66.5	77.1	71.4	76.5
	SD	13.3	17.0	16.6	14.5	16.3	14.9
Overall Stress (1-100)	*M*	34.5	40.0	36.4	27.5	37.2	25.3
	SD	22.3	23.8	22.8	23.1	24.2	21.5

Note. t1 = baseline measure; t2 = pretest measure (after viewing stressful movie, before viewing environmental movie); t3 = posttest measure.

Figure 1.

Unmediated Model (Upper Part) and Mediated Model (Lower Part) of the Effect of Environment (Natural, Built) on Beauty.



Note . $N = 97$. Coefficients are Standardized Betas. All Betas are Significant at the .01 Level.