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Mental imagery of nature induces positive psychological effects

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Abstract
Exposure to natural environments promotes positive psychological effects. Experimental studies on this issue typically have not been able to distinguish the contributions of top-down processes from stimulus-driven bottom-up processing. We tested in an online study whether mental imagery (top-down processing) of restorative natural environments would produce positive psychological effects, as compared with restorative built and non-restorative urban environments. The participants (n = 70) from two countries (Finland and Norway) imagined being present in different environments for 30 s, after which they rated their subjective experiences relating to vividness of imagery, relaxation, emotional arousal, valence (positivity vs. negativity) of emotions, and mental effort. In addition, a psychometric scale measuring vividness of imagination, a scale measuring nature connectedness, and a questionnaire measuring preference of the imagined environments were filled-in. Imagery of natural environments elicited stronger positive emotional valence and more relaxation than imagery of built and urban environments. Nature connectedness and preference moderated these effects, but they did not fully explain the affective benefits of nature. Scores in a psychometric imagery scale were associated in consistent way to the subjective ratings in the imagery task, suggesting that the participants performed attentively and honestly in reporting their subjective experiences. We conclude that top-down factors play a key role in the psychological effects of nature. A practical implication of the findings is that inclusion of natural elements in imagery-based interventions may help to increasing positive affective states.

Keywords Affect · Nature exposure · Mental imagery · Emotion · Relaxation

Introduction

Exposure to natural environments and green spaces has been shown to be related to many positive psychological and physiological effects. Nature exposure is associated with both perceived and physiological reduction of stress, relaxation, restoration of attention, and improvement of mood (Berto, 2005; Corazon et al., 2019; Shuda et al., 2020). The prominent theories explaining the positive effects of nature are *Attention Restoration Theory* (ART) (Kaplan, 1995; Kaplan & Kaplan, 1989) and *Stress Reduction Theory* (SRT) (Ulrich, 1983; Ulrich et al., 1991). According to ART, the stress and mental fatigue produced by urban lifestyle is associated with reduced capacity to direct attention. Spending time in "fascinating" natural environments, away from the stress produced by urban lifestyle, enables people to restore the capacity to direct attention, because attention to natural environments is dominated by effortless bottom-up attention. Natural environments place few demands on top-down directed attention and thereby provide an opportunity to restore the cognitive system. SRT focuses more on emotional effects. It assumes that exposure to nature automatically elicit pre-cognitive positive affective reactions which counteract the negative ones and therefore reduce stress. This occurs because nature has provided favourable conditions for biological survival, causing humans to develop an inherent positive perception of non-threatening nature. Joye and Van den Berg (2011) criticized the assumptions stated in SRT and ART because also exposure to natural environments which do not support survival have been shown to be restorative. They suggest a *Perceptual Fluency Account* (PFA) (Joye & Van den Berg, 2011) which explains the benefits of nature exposure by arguing that natural stimuli consist of features (e.g., some types of

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fractal patterns, Hagerhall et al., 2015) that are processed fluently and effortlessly. Such ease processing of features on nature is assumed to be accompanied with positive affective responses (Winkielman & Cacioppo, 2001).

The previous experimental research showing the psychological effects of nature exposure has concentrated on the effects of actual out-door visits in nature or on the effects of viewing nature pictures, videos, or hearing sounds from nature in more controlled laboratory settings (Berto, 2005; Frost et al., 2022; Ohly et al., 2016; Stevenson et al., 2018; Velarde et al., 2007). The research methods in the experimental studies have been such that they have not been able to support any clear statements about the roles of bottom-up and top-down processes in the restorative outcomes. As reviewed by Ohly et al., (2016), they have typically compared the effects of exemplars of natural and urban environments without directly assessing the cognitive processes occurring between environment and measured outcomes. However, some of the studies on perceived restorative potential of favourite places (vs. unpleasant places), focusing on ART's and STR's assumptions (concerning e.g., "being away", "fascination", "positive affects"), have made use of top-down processes by asking participants to image themselves being in the favourite (or unpleasant) place and to imagine how they feel there (Korpela & Hartig, 1996; Korpela et al., 2001, p. 579).

Human-environment interaction may be influenced not only by bottom-up processing of the physical features of the environment, manipulated in typical experiments, but also by the features of the person, such as the person's connection toward different environments, environmental preferences, and beliefs and meanings attributed to environments, that is, by top-down factors. The role of top-down factors in the psychological benefits of nature has only recently become the subject of experimental research. Haga et al., (2016) showed that top-down processing influenced the perception of an ambiguous sound. The sound was evaluated as more psychologically restorative when it was attributed to nature, as compared with attribution to urban setting. Koivisto et al., (2022) showed that such top-down interpretations were reflected not only in subjectively evaluated relaxation but also in increase of brain's alpha band activity, which is assumed to reflect relaxed state of mind (Aftanas & Golocheikine, 2001; Lagopoulos et al., 2009; Lomas et al., 2015) and has been observed also during viewing natural images (Grassini et al., 2019) and videos (Grassini et al., 2022). Van Hedger et al., (2019) found that scrambled sounds for which their origin was concealed were aesthetically preferred over urban sounds only when they could be recognized and associated with nature—not because of their acoustic features *per se*. These findings highlight the importance of top-down factors, such as the meanings and associations individuals attribute to environments, in theorizing about the psychological effects of nature exposure. Here we focus on the effects of the top-down interpretations persons give to nature in its purest form, in mental imagery.

Mental imagery is a model example of top-down processing. Mental imagery is like 'seeing with the mind's eye' or 'hearing with the mind's ear' (Kosslyn et al., 2001, p. 635). In other words, imagery resembles perception but a central difference between them is that imagery lacks the external sensory stimuli. The similarity between perception and mental imagery has been shown in many ways. Mental imagery and perception compete when they share the same modality, suggesting that they use common cognitive resources; for example, holding a visual image (or auditory sound) interfere with visual (or auditory) perception, and *vice versa* (Baddeley & Andrade, 2000; Segal & Fusella, 1969). At neural level, imagery activates same sensory areas as well as higher areas as perception does, although the response in sensory areas is less strong than during perception (Ganis et al., 2004). The parahippocampal place area, which is activated during perception and memory of visual scenes, is activated also during imagining familiar places (Ishai et al., 2000). Thus, neural processing during perception and imagery partially overlaps, although imagery lacks bottom-up processing of the stimuli (Dijkstra et al., 2019). Imagery is not, however, completely independent of sensory bottom-up processes; instead of external stimuli, the mental images are constructed using memory for past experiences (Kosslyn et al., 1995).

Humans use mental imagery almost all the time during normal waking state, for example in thinking (Kosslyn et al., 1995), decision making (Taylor et al., 1998), and in using memory (Keogh & Pearson, 2011). In addition, because imagery and emotions are tightly coupled, problems in mental imagery play a significant role in many emotional disorders, and image-based therapeutic techniques have been developed for treatment of such disorders (Holmes & Mathews, 2010). Imagery may produce emotional responses in relation to the imagined contents in different complementary ways. Holding perception-like images in mind may induce affects relating to the imagined object or event, or the affects may be directly stored in the memory representations activated and used in the construction of imagery (Holmes & Mathews, 2010). Therefore, mental imagery may induce as strong affective reactions as pictures (Görgen et al., 2015). However, the previous research on mental imagery relating to restorative potential of natural vs. urban environments has been scarce. A recent study (Menzel & Reese, 2022) found that viewing nature-related words for 10 minutes led to higher perceived restoration than viewing urban-related words. Although this study did not explicitly focus on imagery, it is likely that the described effects were generated by mental imagery of the word meanings and not by the bottom-up processing of the physical features of the words. Furthermore, Ratcliffe and Korpela (2016) showed that top-down processes and the contents of autobiographical memories, especially their affective value, predict imagined restorative perceptions of favourite places. The present study examined how mental imagery of being present in natural, built, or urban environments influences participants' subjective affective states and relaxation level.

Humans experience, relate, and are connected to nature in different ways, which may influence their responses to nature. Therefore, it is important to consider individuals' orientation toward nature as a source of top-down influences. *Nature connectedness* ("connection with nature," "nature in self") (Tam, 2013) is a relatively stable, trail-like feature (Mayer & Frantz, 2004). It is positively associated with the time spent in nature and outdoors (Nisbet et al., 2009). It may mediate the effects of nature exposure on psychological well-being (Mayer et al., 2009; Pensini et al., 2016) and emotions (McMahan et al., 2018). A recent study showed that people with different nature connection levels had variable attention allocations on trees or buildings, as measured with eye movement recordings (Chen et al., 2022), suggesting that the observer's top-down processes influence whether they prefer to look at natural or non-natural objects. In addition, the effects of source attribution of an ambiguous sound to nature or industry on brain activity and skin conductance were shown to be moderated by nature connectedness (Koivisto et al., 2022). When the participants were told that the sound originated from nature, the brain's alpha activity and the skin conductance responses were different as compared with the condition in which the sound was told to originate from industry – the strength of these effects depended on nature connectedness, suggesting that the top-down effects of environmental exposure depend on individual factors. In the present study, we hypothesize that nature connectedness predicts the subjective states during imagery: the higher are the persons connected to nature, the more positive affective states and relaxed they feel when imagining natural setting as compared to imagining urban settings.

Environmental preference, typically assessed as aesthetic preference or "liking", may be a strong predictor of the perceived restoration potential of an environment (Wilkie & Clouston, 2015; Wilkie & Stavridou, 2013). In other words, persons who "like" nature may rate the restorative potential of nature as higher than persons who like urban settings, and *vice versa*. It is also likely that nature connectedness and preference correlate in such way that highly nature connected persons also like nature more than persons on average. Therefore, in the present study we considered the relationship of both nature connectedness and preference on the effects of imagination so that they could be considered in the analyses. The interesting question here is whether imagery of being immersed in nature produces affective effects that are "over-and-above" of preference of nature or nature connectedness. Meidenbauer et al., (2020) found that exposure to natural images improved affective state. However, when the influence of preference was controlled for, the environmental category did not have any effect on affective state, suggesting the influence of natural images did not result because they were natural stimuli *per se*, but because they displayed highly preferred environments.

In the current experiment we examined the effects of imagery of being immersed in different environments on subjective evaluations of relaxation and the emotional valence and arousal, with special focus on the effects of imagining natural environments. In addition, the subjective vividness of imagery and the mental effort needed in imagery of environments were measured. Emotional valence correlates with the vividness of images (highly pleasant or unpleasant images being more vivid than neutral images) (Bywaters et al., 2004) and vividness reflects the ease of retrieving relevant sensory experiences (Baddeley & Andrade, 2000). The to-be-imagined natural environments were "restorative" natural environments such as "forest path", "seaside", "natural park", "mountain lake", and "flower field. The urban environments in the present study involved non-restorative urban ("grey") settings such as city street, commercial, and industrial areas. However, some urban settings, such as museums (Kaplan et al., 1993), cafés (Staats et al., 2016), and historical settings (Bornioli et al., 2018a, b) have been found to be associated with perceived restoration and positive affects (Weber & Trojan, 2018). Therefore, for comparison, also imagery of "restorative" built settings commonly related to urban environments were included.

During the experiment, the participants imagined eyes-closed being immersed in each environment for 30 seconds. After the experimental phase, the participants filled in also scales such as the nature connectedness scale (Extended Nature in Self, EINS) (Martin & Czellar, 2016), a questionnaire measuring preference for the imagined environments, and a multisensory imagery scale (Plymouth Sensory Imagery Questionnaire (Psi-Q) (Andrade et al., 2014) measuring the ability to form vivid mental images in different sensory modalities. The Psi-Q was used as an attention check to verify that the participants followed the instructions: we correlated the Psi-Q scores with the subjective ratings given in the imagination tasks. Because imagining the environments can be expected to be dominated by visual imagery, which most often is the dominant modality in imagining (Leibovitz et al., 1972), the score in the vision subscale of Psi-Q was expected to correlate positively with the vividness of imagery and negatively with mental effort experienced during the experimental imagination tasks.

Given the shared cognitive and neural mechanisms in imagery and perception, and the ability of imagery to activate emotions, we hypothesized that mere mental imagery of being in natural environments, as compared with restorative built ones, would induce positive psychological effects such as feeling of relaxation and positive emotions. Demonstration of the possible effects of mere top-down processing is important, because the empirical work on the benefits of nature has focused mainly on the effects of exposure to physical stimuli such as real environments, images, or videos. Results suggesting that mental imagery alone may produce similar psychological outcomes as physical exposure would highlight the importance integrating top-down processes into the existing theories as a more essential part than previously has been thought.

Method

Participants

Seventy students (55 females, 12 males, and 3 other) volunteered (mean age = 27.2 years, SD = 7.9, range: 19-51). Forty-seven of them were from the University of Turku or from the Open University of Turku, Turku, Finland, and 23 were from the Norwegian University of Science and Technology, Trondheim, Norway. The students in the University of Turku had a possibility to get course credits from the participation.

We did not determine the sample size *a priori* based on power analysis because we planned to use linear mixed effect models on single trials in the analyses. Therefore, it would have been challenging to select the numerous effect sizes for the numerous fixed and random effects needed to perform an *a priori* power analyses (the most complex analyses involved 3-way interactions between one categorical variable and two continuous variables + the random effects). However, we assumed that the statistical power with 70 participants in the linear mixed effect models would be substantially higher than in standard analyses of variance or linear regressions, because in our analyses the dependent variables were based on 350 scores per environmental category (see the section Statistical Analyses), whereas in standard analyses they would have been based on 70 scores representing the average scores for each environmental category. Post-hoc power analyses based on 1000 simulations on the obtained data with simr package (Green & MacLeod, 2016) confirmed, for example, that we had 96.70% power, 95% CI [95.40, 97.72], with alpha level of .05 and the observed *B*-values, to detect the effect of environmental category on valence in the model with the environmental category (nature, built, urban) as the only fixed effect (i.e., independent variable); the power was 95.00%, 95% CI [93.46, 96.27], for detecting the effect of environmental category on valence in the most complex model involving three variables and their interactions (i.e., environmental category, nature connectedness, preference, and their interactions as fixed effects), and 100.0% power, 95% CI [99.63, 100.0], for detecting the effect of the interaction between nature connectedness and preference on valence.

The study was conducted online via PsyToolkit (Stoet, 2010, 2017) which did not collect any direct individuating information and did not store IP addresses of the participants. The study was conducted in accordance with the Declaration of Helsinki and with the explicit understanding and consent of each participant. Participation was voluntary and the participants were free to withdraw from the study at any time without consequences. There were separate Finnish and Norwegian language versions of the study.

Materials

The to-be-imagined environments in the experiment were chosen from three categories: natural restorative, built restorative, and urban ("gray") non-restorative. Each category included five environments. All 15 environments were presented as words in random order to every participant without any other description of them. The restorative natural environments were "forest path", "seaside", "natural park", "mountain lake", and "flower field". The restorative built environments were "museum", "monastery", "library", "spa", and "art gallery". The non-restorative urban ones were "city street", "commercial center", "block building suburb", "factory area", and "parking lot". The outcome variables (i.e., dependent variables) of the experiment were "vividness", "relaxation", "arousal", "valence", and "effort"; they are explained in detail in the Procedure section.

Other materials were Extended Inclusion of Nature in Self (EINS) scale (Martin & Czellar, 2016), the short version of Plymouth Sensory Imagery Questionnaire (Psi-Q) (Andrade et al., 2014), and a questionnaire measuring preference for the 15 environments included in the imagination experiment.

The EINS questionnaire measures self-nature connectedness. EINS consists of four pictorial items (overlap, size, distance, centrality), each having seven alternatives (*min*=1, *max*=7). The 4 items of the scale were presented on the screen one at the time and the participants selected the alternative which best described their relationship with the natural environment. The total EINS score could vary between 4 and 28. Cronbach's alpha for EINS in the present study was .81.

The short version of Psi-Q measured the vividness of imagination with 3 items in 7 different sensory domains (vision, sound, smell, taste, touch, body, feels). The participants were asked to try to form mental images of each item word and to rate each image on the scale from 0 ("*no image at all*") to 10 ("*image as clear and vivid as real life*"). Cronbach's α was .96 for the total score of Psi-Q (see Table 1 for α in the subscales).

Table 1 The scores in Plymouth Sensory Imagery Questionnaire (Psi-Q, Short Version)

	M	*SD*	*Min*	*Max*	*α*
Psi-Q (total)	7.20	0.83	0.67	9.90	0.96
vision	7.61	1.05	0	10	0.86
sound	7.25	1.04	0	10	0.81
smell	6.61	1.37	0	10	0.82
taste	6.71	1.52	0	10	0.87
touch	7.63	1.06	0.67	10	0.83
body	7.36	1.16	0	10	0.86
Feels	7.20	0.96	2	10	0.82

α = Cronbach's alpha

The preference questionnaire listed names of the 15 environments which were used in the imagination experiment. Each environment was rated on scale 1 ("*not at all*") to 9 ("*very much*") according to the instruction "*how much in general do you like the following environments*".

Procedure

After informed consent and collection of background information, the participants performed the experimental phase of the study, followed by the questionnaire phase. The outline of the study is illustrated in Fig. 1.

After checking that the sound of the computer was working, the instructions for the experimental phase of the study were presented in the screen. The participants were told that "*In each imagination trial, you are first presented with a word. Read the word and close your eyes. Imagine with all your senses that you are in the place or environment that the word refers to. Immerse yourself and experience your imagination as well as you can. After 30 seconds, you will hear a tone indicating that you are allowed to open your eyes. Then your task is to answer a few questions related to your imagination on a scale from 1 to 9*".

After the instructions, the experiment began. The text "*Imagine...*" was presented on the center of the screen for 2 sec, after which the name of the to-be-imagined environment was presented for 2 sec. This was followed by the 30 second period during which the participants were asked to imagine eyes closed being in the environment. In the end of the period, a tone was presented, indicating that they should stop imagining and open their eyes. This was followed by five questions one at a time. These questions were responded on scale from 1 to 9 by selecting the value with a mouse click. The response had to be given within 30 seconds. The

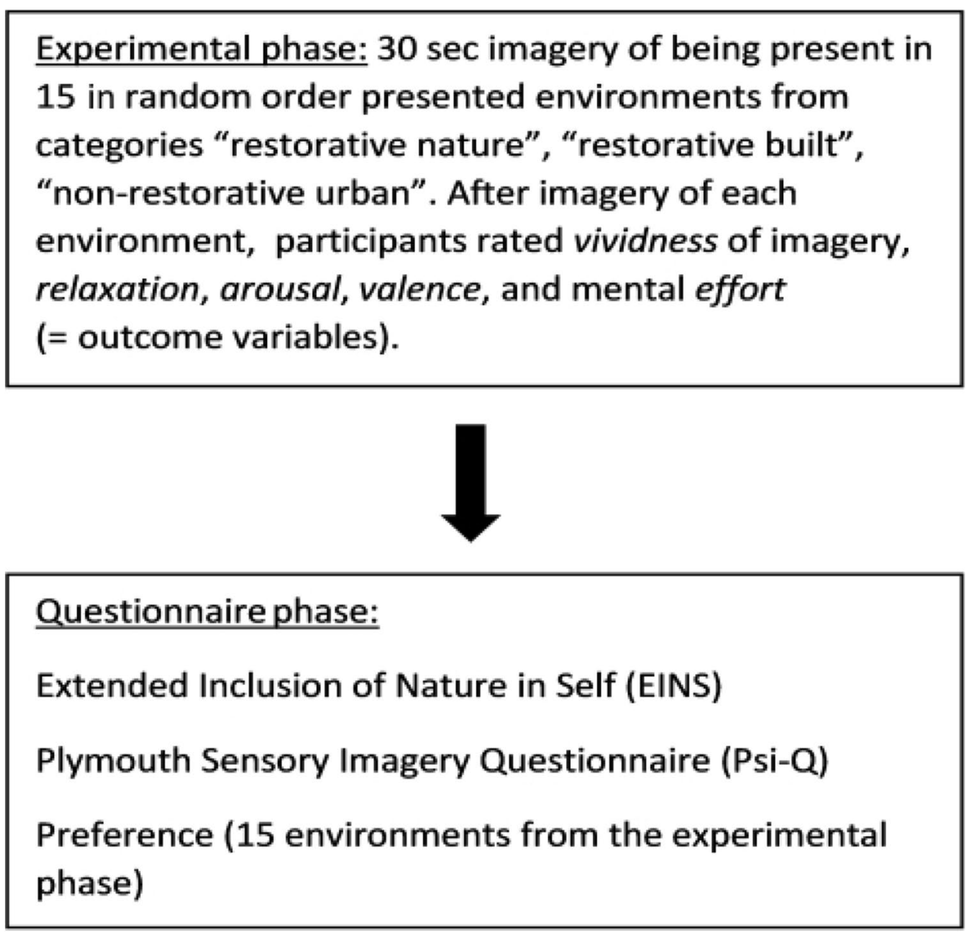

Fig. 1 Outline of the study

questions for the dependent variables “vividness”, “relaxation”, “arousal”, “valence”, and “effort”, respectively, were: "*How vivid (clear and detailed) was your imagination?*", "*How relaxed did you feel?*", "*How strong emotions did you experience?*", "*Were your emotions negative or positive?*", and "*How much effort did imagination require?*". The end points of the scale (1 and 9 points), which were visible on the screen, were marked as “*not at all*” and “*extremely*” for all the questions except for the question about the emotional valence, in which they were “*extremely negative*” and “*extremely positive*”. The order of the 15 to-be-imagined environments was randomized.

After imagining oneself in all the 15 environments and responding to the questions, the questionnaire phase of the study was performed. It included filling in the Extended Inclusion of Nature in Self (EINS) scale (Martin & Czellar, 2016), the short version of Plymouth Sensory Imagery Questionnaire (Psi-Q) (Andrade et al., 2014), and the preference questionnaire.

Statistical analyses

The analysis scripts and data are available at OSF.io (https://osf.io/y4ugz/). The analyses for each dependent variable (vividness, relaxation, arousal, valence, effort) were conducted with linear mixed-effect models in R (vers. 4.1.2) (R Core Team, 2018). Packages lme4 (Bates et al., 2015) and lmerTest (Kuznetsova et al., 2017) were used in the analyses and packages sjPlot (Lüdecke, 2017) and ggplot2 (Wickham, 2016) were used in producing the figures.

After computing descriptive statistics for the psychometric EINS and Psi-Q scales, we studied the effect of environmental category on each experimental outcome variable (vividness, relaxation, arousal, valence, effort). All the single trials were entered into the analyses, so that the dependent variables were based on 15 trials per participant (5 environments/environmental category), and the total number of trials per dependent variable in the whole group of 70 participants was 1050 (350 observations per category). However, in the whole group there were from 4 to 12 trials/variable in which the response was not given within 30 sec; these trials were not included in the analyses and thus the final number of observations was from 1038 to 1046/variable (i.e., less than 1% of the data was lost). The data from all participants were included in the analyses as no one had an excessive number of invalid trials.

In the first set of models, Category (built, nature, urban) was the fixed-effect and random slope for Category and random intercept for environment (i.e., specific environment such as “forest path”, “museum”, etc.) were the random effects (dv ~ Category + (Category|id) + (1|environment)). Category was defined as a factor. The restorative built category was the reference category because we were specifically interested whether the effects nature (usually considered as restorative category) differ from those of another non-natural restorative category. Next, we studied the contribution of connectedness to nature by adding the centered EINS score with its interactions as fixed effects into the models where Category had a significant effect. In the final models, the centered preference scores with their interactions were added as fixed effects, so that both EINS and preference were controlled for in the effects of Category.

We analysed the main effects and interactions in the models with performing the R’s anova function (Satterthwaite’s method) on each model. For the statistically significant main effects or interactions involving Category as a fixed effect, the model’s contrasts (restorative nature vs. restorative built, non-restorative urban vs. nonrestorative built) were computed with the R’s summary function.

The relationship between the Psi-Q subscales and the ratings in each question in the imagination experiment was studied with linear mixed-effect models by including the centred scores in the subscales as fixed effects and the random slope for category and the random intercept for environments as random effects (dv ~ vision + sound + smell + taste + touch + body + feels + (Category|id) + (1|environment).

Results

Questionnaires

The mean EINS score was 20.0 (SD = 3.8, range = 12-28). Shapiro-Wilk test (p = .172) suggested that the scores were normally distributed. Cronbach’s alpha for EINS in the present study was .81. The descriptive statistics for Psi-Q are presented in Table 1. As can be seen, Cronbach’s α is very high for the total score of Psi-Q, but good also for the subscales, ranging from .81 to .87.

The preference ratings for each specific environment in the three environmental categories are presented in Table 2. One-way ANOVA on ratings with the environment type as a factor (restorative built, restorative nature, non-restorative urban) showed a highly significant effect, $F(2,138) = 408.28$, $p < 0.001$, $\eta_p^2 = 0.855$. All the categories differed from each other (Bonferroni-corrected p-values < 0.001), showing that restorative nature was the most preferred category and non-restorative urban was the least preferred category, whereas the ratings for restorative urban environments fell between them.

Table 2 Preference ratings for each environment in the three environmental categories (Built, Nature, Urban)

Restorative Built			Restorative nature			Non-restorative urban		
Environment	*M*	*SD*	Environment	*M*	*SD*	Environment	*M*	*SD*
Art gallery	6.03	2.04	Seaside	8.20	1.19	Parking lot	2.81	1.50
Monastery	4.17	1.95	Forest path	7.84	1.30	Suburban	3.64	1.45
Museum	6.23	1.74	Flower field	7.51	1.45	City street	5.64	1.75
Spa	6.33	2.10	Natural park	7.56	1.44	Factory area	2.40	1.54
Library	6.74	1.74	Mountain lake	7.41	1.59	Commercial center	3.99	1.86
M	5.90	1.05	M	7.71	0.92	M	3.70	1.08

EINS scores correlated statistically significantly with the mean preference scores for restorative natural environments (r_s = .556, p < .001) and restorative built environments (r_s = .253, p = .034), but not with the preference for non-restorative urban environments (r_s = -.164, p = .174).

Subjective ratings after imagination

Figure 2 displays the observed subjective ratings in the imagination task as a function of environmental category and, for comparison, the preference ratings.

First, we performed the linear mixed-effect models on the ratings with only the category as a fixed effect. The random slope for category and random intercept for items were the random effects in these models. For *vividness* (Fig. 2a), the effect of Category was not significant, $F(2, 12.608) = 0.620$, $p = 0.554$, $\eta_p^2 = 0.09$. For *relaxation* (Fig. 2b), the effect of Category was highly significant, $F(2, 15.168) = 36.904$, $p < 0.001$, $\eta_p^2 = 0.83$ The ratings for restorative nature were higher than those for restorative built category ($B = 1.0697$, $SE = 0.2937$, 95% *CI* [0.51, 1.63], $t(13) = 3.64$, $p < 0.001$), and for the restorative built category higher than for the

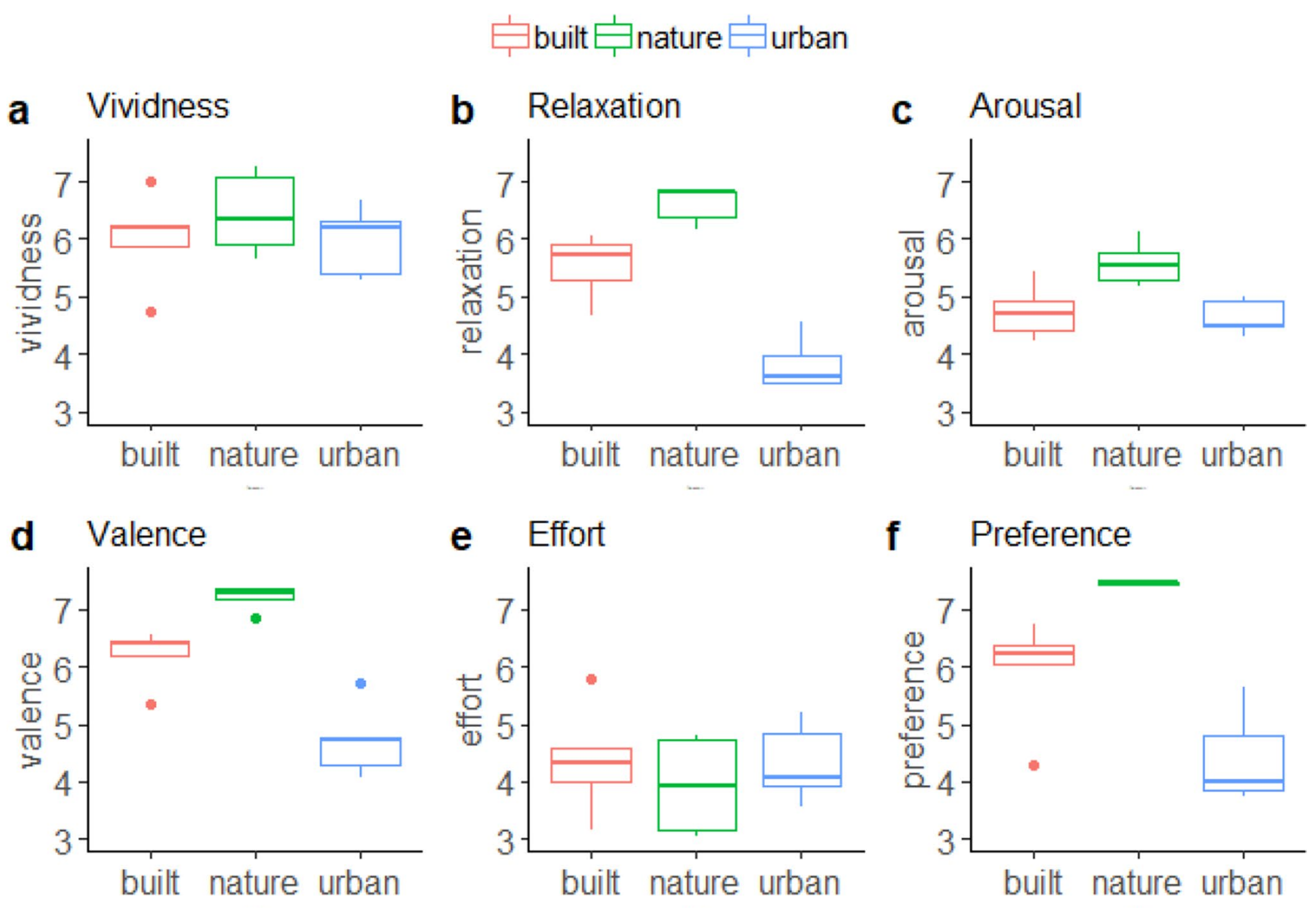

Fig. 2 The Boxplots (**a**-**e**) show observed subjective ratings in the imagination experiment in the three environmental categories (Restorative Built, Restorative Nature, Non-restorative Urban) on Scale from 1 to 9, and the Corresponding Preference Ratings (**f**)

non-restorative urban one (B = -1.71, SE = 0.31, 95% CI [-2.30, -1.12], $t(15)$ = -5.57, p < 0.001).

Category influenced ratings of *arousal* (Fig. 2c), $F(2,13.66)$ = 7.931, p = 0.005, η_p^2 = 0.54. Restorative nature was associated with significantly higher subjective arousal ratings than the restorative built category (B = 0.84, SE = 0.25, 95% CI [0.36, 1.32], $t(14)$ = 3.35, p = 0.005), whereas the ratings for the restorative built category did not differ from those for the non-restorative urban one (B = -0.094, SE = 0.25, 95% CI [-0.57, 0.38], $t(13)$ = -0.38, p = 0.708). Category had an effect also on ratings of *valence* (Fig. 2d), $F(2, 13.777)$ = 30.16, p < 0.001, η_p^2 = 0.81. Restorative nature was associated with significantly more positive emotions than restorative built environments (B = 1.01, SE = 0.31, 95% CI [0.43, 1.59], $t(13)$ = 3.29, p = 0.006), and non-restorative urban environments with less positive emotions than restorative built ones (B = -1.48, SE = 0.31, 95% CI [-2.07, -0.89], $t(14)$ = -4.72, p < 0.001). The environmental categories did not differ statistically significantly in the mental *effort* (Fig. 2e) that was needed in imagination, $F(2, 12.34)$ = 0.4125, p = 0.671, η_p^2 = 0.06.

In summary, imaging restorative natural environments were experienced as the most relaxing, arousing, and associated with more positive emotions than the other environments. The imagery of non-restorative urban environments was experienced as less relaxing and less associated with positive emotions than the other environments. The environmental categories did not differ in subjective vividness of imagination or in the mental effort needed in imagining oneself as being present in the environments.

Subjective ratings: relationship with nature connectedness

Next, we studied whether individual differences in connectedness to nature are related to the variables which showed statistically significant relationships with environmental categories[1]: subjective ratings of relaxation, arousal, and valence. The linear mixed-effect models were otherwise the same as above, but the centred EINS score with its interactions were added as fixed effects.

For *relaxation* (Fig. 3a, d), the main effects for Category, $F(2, 14.540)$ = 38.5863, p < 0.001, η_p^2 = 0.84, and EINS, $F(1, 68.060)$ = 4.4698, p = 0.038, η_p^2 = 0.06, were statistically significant. Relaxation was rated to be higher after imagining natural environments than built ones, B = 1.07, SE = 0.29, 95% CI [0.51, 1.63], $t(13)$ = 3.65, p = 0.003, and lower after imagining urban environments than built ones, B = -1.71, SE = 0.30, 95% CI [-2.29, -1.13], $t(14)$ = -5.66, p < 0.001. The interaction between Category and EINS was significant, $F(2\ 67.877)$ = 6.3125, p = 0.003, η_p^2 = 0.16. The higher the EINS score, the higher was the rated relaxation for built and natural environments, but not for the urban ones, B = -0.128, SE = 0.038, 95% CI [-0.20, -0.053], $t(68)$ = -3.377, p = 0.001.

For *arousal* (Fig. 4b, e), the main effects for Category, $F(2, 13.518)$ = 8.012, p = 0.005, η_p^2, and EINS, $F(1,67.939)$ = 7.3926, p = 0.008, η_p^2 = 0.54, were significant. The natural environments were rated to elicit stronger arousal than built ones, B = 0.84, SE = 0.25, 95% CI [0.36, 1.32], $t(13)$ = 3.36, p = 0.005, and the ratings for built and urban categories did not differ from each other, B = -0.093932, p = 0.709. EINS was positively associated with arousal ratings, as indicated by the main effect of EINS, but the effect of EINS did not interact with environment type, $F(2, 67.47)$ = 1.936, p = 0.152, η_p^2 = 0.05.

For *valence* (Fig. 3c, f), the main effects for Category, $F(2, 13.229)$ = 31.5477, p < 0.001, η_p^2 = 0.83, and EINS, $F(1, 68.133)$ = 6.6537, p = 0.012, η_p^2 = 0.09, as well as their interaction, $F(2, 67.992)$ = 9.294, p < 0.001, η_p^2 = 0.21, were statistically significant. Valence ratings for natural environments were more positive than for built ones (B = 1.01, SE = 0.31, 95% CI [0.43, 1.59], $t(13)$ = 3.30, p < 0.01); for urban environments they were more negative than for built ones (B = -1.48, SE = 0.31, 95% CI [-2.06, -0.89], $t(13)$ = -4.77, p < 0.001). The higher the EINS score, the more positively the built environments were rated, as compared with the urban ones (B = -0.10, SE = 0.032, 95% CI [-0.16, -0.037], $t(68)$ = -3.11, p < 0.001); the interaction between EINS and the nature-built difference was not statistically significant, B = 0.051, SE = 0.029, 95% CI [-0.0063, 0.11], $t(68)$ = 1.76, p = 0.084.

Subjective ratings: relationship with EINS and preference

Finally, we analysed the results for relaxation, arousal, and valence by controlling for the effects of Preference (Fig. 4). As was noted earlier, preference ratings favoured the nature category most and the urban category least. The models were similar to those above, but the preference rating with its interactions were added as fixed effects in addition to those of Category and EINS.[2]

For *relaxation* (Fig. 4a,d), Preference predicted relaxation ratings, $F(1, 584.95)$ = 263.08, p < 0.001, η_p^2 = 0.31: the higher the preference for an environment, the more relaxed did the observers rate themselves. The interaction

[1] The fixed effects of Category for variables vividness (p = .550) and effort (p = .671) remained non-significant also after adding EINS and its interactions into the models.

[2] The fixed effects of Category for variables vividness (p = .134) and effort (p = .163) remained non-significant also after adding Preference, EINS, and their interactions into the models.

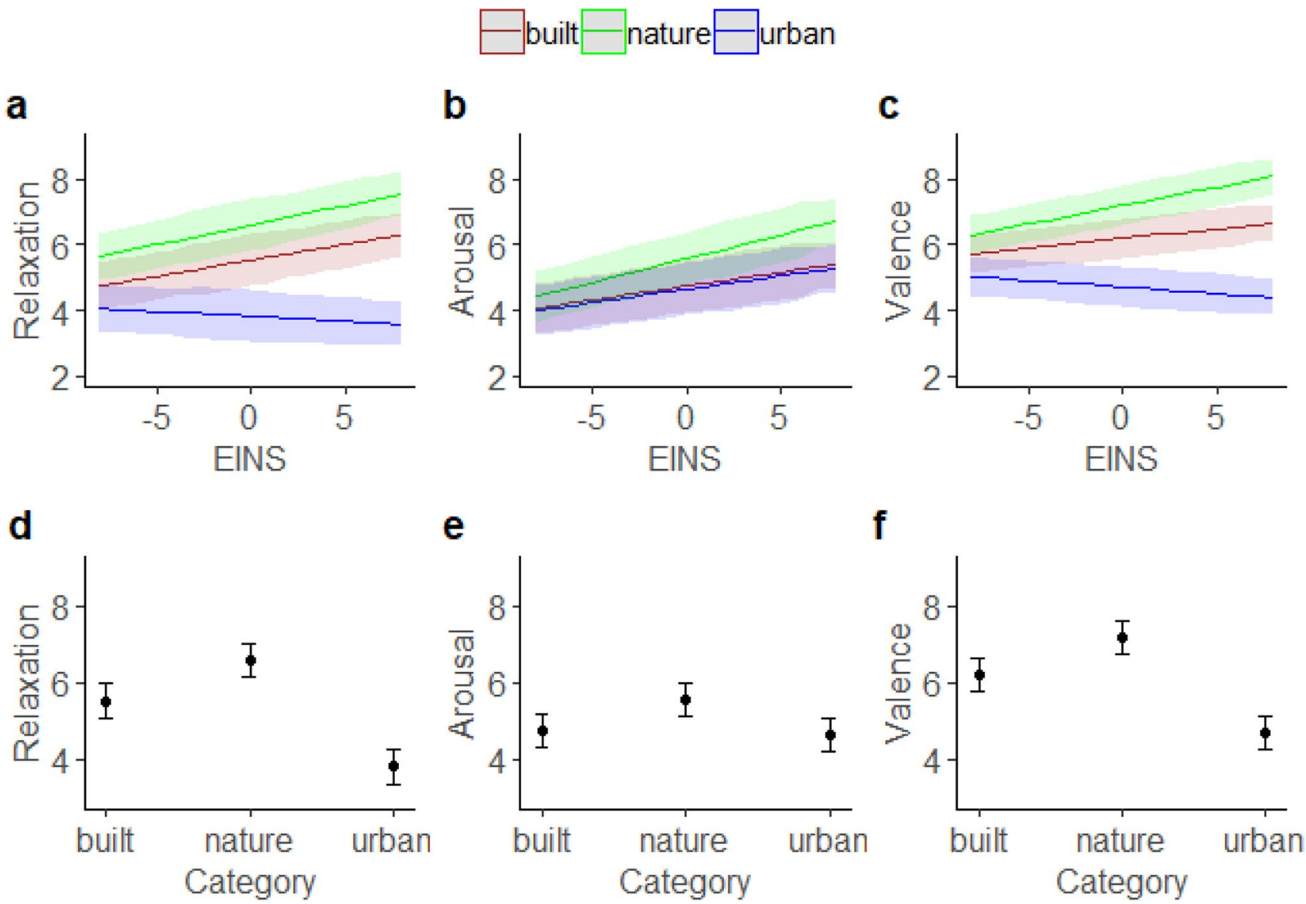

Fig. 3 Results of the models for relaxation, arousal, and valence with environmental category (Restorative Built, Restorative Nature, Non-restorative Urban) and Centred EINS as Predictors. The Upper Figures (**a**, **b**, **c**) Show how EINS Score Interacts With the Environmental Category. The Lower Figures (**d**, **e**, **f**) Show the fixed effects of environmental category when the influence of EINS has been controlled for

between Preference and Category was only marginally significant, $F(2, 487.86) = 2.588$, $p = 0.076$, $\eta_p^2 = 0.01$, with this interaction effect resulting from the lower effect of preference in non-restorative urban category than in the restorative built one, $B = -0.12$, $SE = 0.054$, 95% *CI* [-0.23, -0.014], $t(304) = -2.18$, $p = 0.030$. The only statistically significant effect associated with EINS was its interaction with Preference, $F(1, 964.24) = 5.5461$, $p = 0.019$, $\eta_p^2 = 0.01$, indicating that the higher the EINS score, the stronger was the effect of preference on relaxation. The effect of Category was statistically significant, $F(2, 31.56) = 14.240$, $p < 0.001$, $\eta_p^2 = 0.47$. Imagining oneself in restorative natural environments was associated with higher relaxation than imagining oneself in restorative built environments, $B = 0.38$, $SE = 0.19$, 95% *CI* [0.027, 0.74], $t(33) = 2.05$, $p = 0.048$, and imagining oneself being in restorative built environments was associated with higher relaxation than imagining oneself in non-restorative urban environments, $B = -0.83$, $SE = 0.19$, 95% *CI* [-1.19, -0.47], $t(29) = -4.38$, $p < 0.001$.

Analysis of *arousal* (Fig. 4b,e) showed that the higher the preference score, the higher was the rated arousal level, $F(1, 739.04) = 63.874$, $p < 0.001$, $\eta_p^2 = 0.08$. Preference interacted with Category, $F(2, 623.82) = 5.690$, $p = 0.004$, $\eta_p^2 = 0.02$. The effect of Preference on the difference between restorative natural and restorative built environments in arousal did not reach statistical significance ($B = 0.13$, $SE = 0.070$, 95% *CI* [-0.0082, 0.27], $t(766) = 1.84$, $p = 0.067$), but Preference predicted the difference in arousal between restorative built and non-restorative urban environments significantly, $B = -0.12$, $SE = 0.060$, 95% CI [-0.24, -0.0066], $t(431) = -2.04$, $p = 0.042$). After controlling for Preference and EINS, the environmental category was not a significant predictor of arousal, $F(2, 23.68) = 0.400$, $p = 0.675$, $\eta_p^2 = 0.03$.

Analysis of *valence* (Fig. 4c,f) showed that the higher the preference score, $F(1, 373.69) = 377.35$, $p < 0.001$, $\eta_p^2 = 0.50$, or EINS score, $F(1, 123.81) = 5.102$, $p = 0.026$, $\eta_p^2 = 0.04$, the more positively the emotions were rated. In addition, Preference and EINS interacted, $F(1, 971.58) = 7.028$,

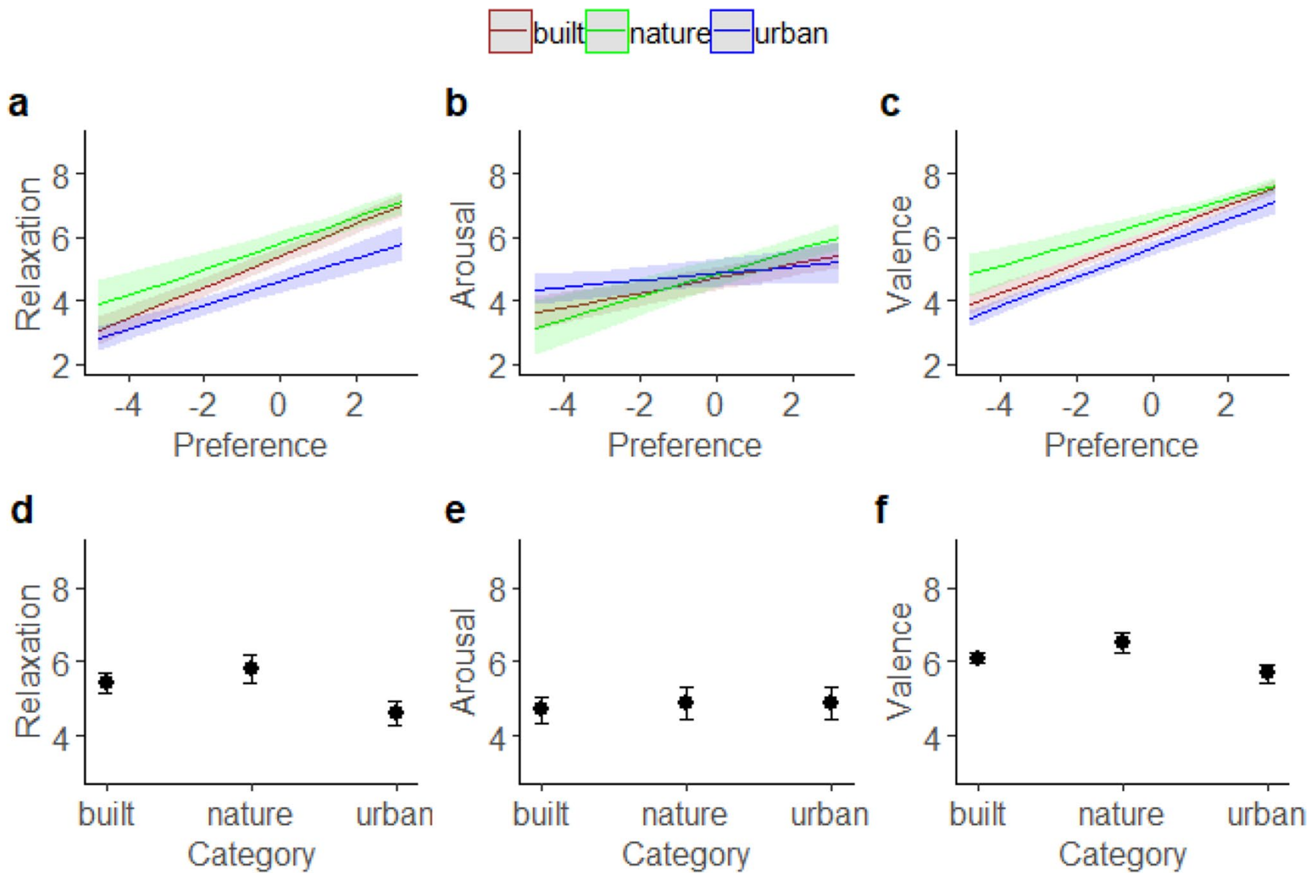

Fig. 4 Results of the models for relaxation, arousal, and valence with environmental category (Restorative Built, Restorative Nature, Non-restorative Urban), Centered EINS, and Preference as Predictors. The Upper Figures (**a**, **b**, **c**) Show how Preference Interacts with the Environmental Category. The Lower Figures (**d**, **e**, **f**) Show the Effects of Environmental Category When EINS and Preference has Been Controlled for

$p = 0.008$, $\eta_p^2 = 0.01$, indicating that the higher the EINS score, the more strongly preference was positively associated with positive emotions. Most importantly, after accounting for the effects of Preference and EINS, the effect of Category was statistically significant, $F(2, 36.91) = 11.7085$, $p < 0.001$, $\eta_p^2 = 0.39$. Restorative nature was associated with more positive emotions than restorative built environments, $B = 0.42$, $SE = 0.14$, 95% *CI* [0.16, 0.69], $t(48) = 3.01$, $p = 0.004$, and restorative built environments were associated with more positive emotions than non-restorative urban ones, $B = -0.43$, $SE = 0.13$, 95% *CI* [-0.67, -0.19], $t(26) = -3.36$, $p = 0.002$.

Relationship between Psi-Q scores and subjective ratings during experimental phase

If the participants followed the instructions and made the ratings in the imagination experiment reliably, one would expect that their ability to form mental images, as measured with Psi-Q, would be related to their ratings in the imagination experiment in a reasonable way. We examined how the self-report measures of imagery in the subscales of Psi-Q predicted the outcome variables in the experimental phase, that is, subjective ratings of vividness, relaxation, emotional arousal, emotional valence, and effort. Separate linear mixed-effect models were performed on each subjective variable. In each model, the fixed effects were the centered scores of the seven subscales, and random slope for category and random intercept for item were the random effects.

The results are presented in Table 3. It shows that the score in the *vision* subscale in Psi-Q was positively related to *vividness* and negatively related to *effort*. In other words, the better the individuals were in visual imagery, the livelier and more detailed their self-rated vividness of imaging was and the less mental effort imagining required in the imagination task. The score in the *body* subscale was positively related to ratings of *relaxation*, *arousal,* and *effort*: the more vividly and clearly the participants were able to form mental images of bodily sensation, the more relaxed and aroused they rated themselves in the imagination task, and the less imagination required mental effort.

Table 3 Subscales of plymouth sensory imagery questionnaire (Psi-Q) as predictors of the experimental outcome variables

	Vividness			Relaxation			Arousal			Valence			Effort		
Subscale	*B*	*95% CI*	*p*	*B*	*95% CI*	*p*	*B*	*95% CI*	*p*	*B*	*95% CI*	*p*	*B*	*95% CI*	*p*
Vision	0.34	0.16 – 0.51	<0.001***	−0.02	−0.17 – 0.12	0.747	−0.08	−0.28 – 0.13	0.479	0.05	−0.04 – 0.14	0.306	−0.47	−0.67 – −0.27	<0.001***
Sound	0.06	−0.11 – 0.23	0.505	0.07	−0.07 – 0.20	0.361	−0.05	−0.25 – 0.14	0.598	0.01	−0.08 – 0.09	0.898	−0.07	−0.26 – 0.13	0.521
Taste	−0.04	−0.20 – 0.12	0.616	−0.06	−0.19 – 0.07	0.369	−0.05	−0.23 – 0.13	0.606	−0.02	−0.10 – 0.06	0.616	−0.07	−0.25 – 0.11	0.491
Smell	0.08	−0.08 – 0.23	0.332	0.06	−0.06 – 0.18	0.360	0.14	−0.04 – 0.32	0.152	0.07	−0.01 – 0.15	0.087	0.07	−0.11 – 0.24	0.488
Touch	0.08	−0.12 – 0.29	0.441	0.11	−0.06 – 0.27	0.225	0.01	−0.23 – 0.25	0.922	−0.04	−0.15 – 0.06	0.425	0.22	−0.02 – 0.45	0.087
Body	0.12	−0.08 – 0.31	0.261	0.26	0.10 – 0.41	0.002**	0.41	0.19 – 0.64	<0.001***	0.03	−0.07 – 0.13	0.555	−0.24	−0.47 – −0.02	0.040*
Feels	−0.14	−.27 – −0.00	0.060	−0.11	−0.22 – −0.00	0.052	−0.05	−0.21 – 0.11	0.565	0.06	−0.01 – 0.12	0.125	0.02	−0.13 – 0.18	0.776

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$

Discussion

Previous research on the psychological benefits and health effects of nature has focused mostly on exposure to real environments or laboratory simulation of environments (e.g., pictures, videos) and mostly on the bottom-up processing of information. Recently, the contribution of top-down processes has gained increased attention (Haga et al., 2016; Koivisto et al., 2022; Menzel & Reese, 2022; Ratcliffe & Korpela, 2016; Van Hedger et al., 2019). The present study examined whether mental imagery (top-down processing) of restorative natural environments could foster positive psychological effects as compared to imagery of non-restorative urban and restorative built environments. As expected on basis of the overlap between mental processes in imagery and real experiences (Dijkstra et al., 2019; Holmes & Mathews, 2010), the results support the hypothesis that mere imagery of being in natural environments can produce positive psychological effects. The results showed that imagery of being present in restorative natural settings increased positive psychological outcomes, such as positive emotions and relaxation, compared to imagery of being in non-restorative urban or restorative built settings (such as spa, art gallery, museum). In addition, imagery of being present in restorative built settings were experienced to evoke more positive emotions and relaxation as compared to non-restorative urban settings. In general, the results are similar to those obtained using images or videos of environments (Berto, 2005; Frost et al., 2022; Grassini et al., 2019, 2022; Ulrich et al., 1991; Velarde et al., 2007). Importantly, the environmental categories did not differ in subjective vividness of imagination or in the mental effort needed in imagining oneself as being present in the environments. Thus, the differences in the emotional responses to the environmental categories cannot be explained by differences in vividness or effort.

Nature connectedness was a strong predictor of the effects of imagery when the contribution of preference was not accounted for. The higher the connection to nature, the more positive emotions and relaxation the participants felt during imagery of restorative natural and built settings. For valence of emotions and level of relaxation during imagery of non-restorative urban settings, nature connectedness was negatively associated. These results are in line with previous demonstrations showing that nature connectedness predicts the benefits of exposure to nature in relation to urban settings (Mayer et al., 2009; McMahan et al., 2018; Pensini et al., 2016). The finding that nature connectedness was associated with positive emotional valence and relaxation also during imagery of restorative built settings was not expected, and we cannot provide any evidence-based explanation for this result. However, the environmental category remained as a significant predictor after accounting for the effect of nature connectedness: positive valence and relaxation were evaluated to be higher during imagery of restorative natural environments than restorative built ones, and lower in imagining non-restorative urban environments than built ones. Thus, the connection with nature did not explain the differences in affective states between the imagined environments. This pattern of results also speaks against the interpretation that the subjective evaluations were influenced by "nature-positive" bias (Corazon et al., 2019), as one might have expected that people who report high connection with nature would most probably show such a bias.

Previous research has shown the robust impact of nature on emotions, but the influence of preference typically has not been controlled for. Important exception is the study of Meidenbauer et al., (2020). They found that affective state was improved more after nature than urban images, but this effect disappeared when the preference for the stimuli was controlled for, suggesting that affective benefits are only due to preference and not due to anything unique to nature scenes. In the present study, the effect of environmental category for arousal disappeared when preference (and nature connectedness) was included in the statistical model, replicating the pattern observed by Meidenbauer et al., (2020). However, in the present study, even after accounting for individual preferences, positive emotional valence and relaxation were higher during imagining restorative natural environments as compared to restorative built environments, which in turn were associated with higher positive emotional valence and relaxation than non-restorative urban environments. While preference explained the affective arousal, it did not fully explain the positive vs. negative valence of the affects. These results resemble those of Korpela and Ratcliffe (2021) who found that restorative outcomes after viewing nature images directly predicted the preference for nature, whereas preference did not directly predict outcomes. Thus, our results are consistent with the idea that nature is preferred because it elicits positive affects (Korpela & Ratcliffe, 2021), whereas the arousal associated with nature may be due to nature being such highly preferred environment.

In general, the empirical work on the benefits of nature in the context of the dominant theories has focused on the effects of exposure to physical stimuli (real environments, images, or videos). Our results suggest that mental imagery alone may produce similar outcomes as real exposure to environmental stimuli. At general level, this highlights the importance of taking top-down processes into account in empirical research and integrating top-down processes into the existing theories as an essential part. A recent study (Menzel & Reese, 2022) showed that viewing nature images was rated as more restorative than urban images. This was true for both the original images and line drawings but not for phase-scrambled versions of the images (depleted of their semantic content). In addition, restoration was higher for original images than line drawings. This pattern suggests that the spatial information available in the original images and line drawings, enabling higher-level processes such as recognition, is essential for perceived restoration. However, also the low-level visual features contributed to the phenomenon because the original images produced a stronger effect than line drawings, which lack many low-level properties. Processing the low-level properties was shown to be insufficient for promoting restoration, because the phase-scrambled version did not produce restoration. Thus, restoration arises from interaction between bottom-up processes and top-down processes (Menzel & Reese, 2022), such as activating the concept of nature (Van Hedger et al., 2019) or retrieving learned positive associations (Egner et al., 2020).

The finding that mere imagery of natural settings is affectively beneficial, without the need for any bottom-up processing of stimuli, may be interpreted as contrasting the assumptions of PFA (Joye & Van den Berg, 2011), which argues that such benefits are due to fluent processing of some of the stimulus features in nature. Menzel and Reese (2022) argued that PFA cannot explain their finding that viewing nature-related words, which do not contain any diagnostic visual features of nature, led to higher perceived restoration than viewing urban-related words. We do not completely agree with this line of reasoning. In areas of research outside psychology, as for example in marketing research, the concept of *imagery fluency* is commonly used to refer to the ease or difficulty of mental imagery (Chang, 2013). It is assumed that perceptual fluency (among other fluent processes) leads to imagery fluency, which is accompanied by positive emotions. Similarly, assuming in line with PFA that some features (e.g., some types of fractals) in nature are perceptually processed fluently, and additionally if perceptual representations and imagery share neurocognitive resources (Dijkstra et al, 2019), one can hypothesize that imagery of natural environments on basis of memory for past perceptual experiences is more fluent than imagery of urban environments. Such interpretation, while being theoretically interesting in the context of PFA, may be challenging to be supported empirically. Furthermore, it is worth noting that in the current study the environmental categories did not differ statistically significantly in subjective vividness of imagery or in the mental effort that was needed in imagination, suggesting that ease of imagery may not explain the affective differences resulting from imagery of the environments. However, the subjective evaluations of vividness and effort do not directly measure fluency of imagery, although they are related to the ease or difficulty of imagery.

SRT (Ulrich, 1983; Ulrich et al., 1991) assumes that nature automatically elicits positive affects in humans. These affects are the primary course for stress reduction and relaxation. Our results suggest that mere imagination of nature can produce positive affect and relaxation. ART (Kaplan, 1995; Kaplan

& Kaplan, 1989) assumes that attention will restore in nature because natural environments are associated with "being away" from everyday life and they provide "fascinating" settings where attention is captured in bottom-up manner. Our results are not directly relevant for ART, because we did not measure attention. However, it is conceivable that that one can experience a feeling of being away and fascination simply by imagining oneself as being in an environment that is associated with such feelings. It remains as an empirical question whether imagery of nature will restore attention or stress.

There is some evidence that meditation training in natural environment may improve its efficiency in restoration of attention, compared with standard indoor meditation (Lymeus et al., 2018). In addition, inclusion of natural elements in Guided Imagery (GI) may increase its positive psychological effects (Nguyen & Brymer, 2018). GI is a mind-body therapy which uses external instructions to guide generation of mental images in different sensory modalities (Hart, 2008). It has been used in clinical settings to reduce symptoms of stress, anxiety, and other disorders which include intruding thoughts. Nguyen and Brymer (2018) studied whether nature-based GI would help to reduce state anxiety. They presented scripts occurring either in natural or urban environment through audio recordings. Both the nature and urban GI conditions significantly reduced state anxiety, but the pre-post change in anxiety levels was greater in the nature condition than in the urban condition. Another study (Coughlan et al., 2022) using nature-based GI showed that a nature script involving taking a walk in a natural setting increased participants connectedness to nature. These studies suggest that adding mental imagery of nature into existing meditation or relaxation techniques may add additional benefits to them. The present study shows directly that imagery of simply being present in natural environments may have positive affective effects.

Limitations

A limitation in our study is that the data was collected only in two countries (Finland and Norway), where cities and villages are typically surrounded by nature, and in particular forests (Gundersen et al., 2005), providing availability and easy access to nature, which make the generalisability of the results to other countries and cultures challenging. Another limitation is that the outcome variables (e.g., relaxation and valence) were based only on subjective ratings, not on more "objective" physiological measures, and to keep the online study sufficiently short and the participants attentive and motivated, each of outcome variable (relaxation, valence, etc.) was measured with one question only.

Subjective ratings may be influenced by nature-positive bias. However, also preference ratings can be subject to the nature-positive bias, and one can expect that especially highly nature connected persons are most likely to show the highest biases. By accounting for both preference and nature connectedness in the analyses we think that we have effectively controlled for the nature-positive bias as the source for the valence and relaxation effects. A further problem may be related to the general performance and motivation of the participants during the online study. Did they really concentrate on the tasks and perform them as instructed? To explore this, we included the Psi-Q in the study and examined how the Psi-Q scores were related to the imagery scores given in the imagery task. Based on the dominance of vision in mental imagery (Leibovitz et al., 1972), we expected, assuming the participants' ratings are reliable, that specifically the vision score in Psi-Q should be related to the vividness of imagery and to the effort needed in imagery. The results confirmed these expectations: the vision score was positively associated with the vividness of imagery and negatively associated with the effort needed in imagery during the imagery experiment. In addition, we found that the body score in Psi-Q was positively associated with the arousal and relaxation ratings in the imagery experiment. The body subscale asks about the vividness of bodily sensations during imagery of relaxing in a warm bath, walking briskly in the cold, and jumping into a swimming pool. Thus, participants scoring high in bodily imagery rated their arousal and relaxation as higher than average during the experiment, which is logical as arousal and relaxation are essentially physiological and bodily sensations. These findings suggest that the participants, at least at group level, carefully and honestly followed the instructions. In addition, we set 30 sec time limits for responding to each question about the outcome variables. Less than 1% of the total number of the responses had to be rejected due to this limitation, suggesting that the participants were motivated and attentive during the tasks.

The wash out period between the trials was the time that it took to respond to the five questions about the outcome variables before the next trial started. This raises the question whether the period was too short for the emotions of the previous trial to wash out before the next one started, that is, the emotional responses in trial N might be confounded by a crossover effect from the emotional responses elicited in trial N-1. We do not consider this as an important limitation. Despite possible crossover effects,[3] we observed clear differences between the environmental categories; the focus here is in the subjective differences between the categories, not in the absolute or "pure" values of subjective ratings. In real life situations, many different factors influence our subjective states all the time.

[3] If crossover effects existed, they most likely overestimated the positive valence of emotions and relaxation in the non-restorative urban category, because it was more likely that they were preceded by restorative environments (either natural or built) than by another non-restorative urban environment. Despite that, highly significant differences in valence and relaxation were observed between non-restorative urban and restorative built environments.

Conclusion and practical implications

This study demonstrated that mental imagery of being present in restorative natural environments, as compared to restorative built or non-restorative urban environments, has similar affective benefits that has been previously shown with exposure to real environments or pictures or videos depicting them. The influence of nature imagery was moderated by nature connectedness and preference, but they did not fully explain the phenomenon. Whereas previous nature exposure studies usually have not been able to distinguish the top-down effects from stimulus-driven bottom-up effects, the present findings emphasize the importance of top-down processes in the beneficial psychological and mental health effects of nature exposure. The meanings and associations individuals attribute to environments should be taken into account in theorizing about the psychological effects of nature exposure. Besides the theoretical implications concerning the mechanisms of the effects of nature exposure, the results give empirical support to the benefits of including natural environments in imagery-based interventions developed for increasing positive affective states and thereby reducing negative affective states. Improving mood with imagery of nature may be cost-effective and useful way to promote mental health, especially for public health interventions targeting people who have limited access to the great outdoors.

In further studies, the research could be expanded to different countries and cultures, as well as to different groups of people and professionals that have varying contacts with nature in their daily lives. Since subjective measures are prone to distortions and demand characteristics, it would also be important to verify the results with physiological measures.

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Authors' contributions Mika Koivisto: Conceptualization, Methodology, Software, Data curation, Formal analysis, Investigation, Writing- Original draft preparation, Writing- Reviewing and Editing. Simone Grassini: Conceptualization, Methodology, Writing- Reviewing and Editing.

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Data availability The analysis scripts and data are available at OSF.io (https://osf.io/y4ugz/).

Declarations

Conflict of interest We have no conflict of interest to disclose. The study was accepted by the Ethics Committee for Human Sciences at the University of Turku.

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