Does a brief virtual dose of an environment affect subjective wellbeing and judgements of perceived restorativeness? Considering the role of place preference

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ABSTRACT

Two studies investigated whether a brief dose of an environment influenced subjective wellbeing and the perceived restorativeness of the setting; and if either varied by place preference. Participants (N_{S1} = 211; N_{S2} = 338) were randomly allocated to view one environment online for 30-seconds, rated perceived restorativeness and indicated state mood and emotion. In study 1, mood did not differ by environment. In study 2, the emotions happy, relaxation and desire were lowest and anger and fear/anxiety highest in the urban street condition. In both studies, perceived restorativeness was lower in the urban street condition and the interaction between preference/environment type significant. Nature settings were rated more restorative than urban streets; the effect was greatest with a nature preference. A similar interaction effect existed for positive emotion in study 2. Virtual brief doses of environments can elicit differences in emotion but not mood (which should be differentiated) and place preference should be considered in future studies.

1. Introduction

A compelling case for nature's potential to enhance wellbeing has been made in recent reviews. Benefits include better self-reported general health (Wilkie and Davinson, 2021b; Houlden et al., 2018), increased quality of life/life satisfaction (Houlden et al., 2018; Pritchard et al., 2020), and reduced stress and anxiety (Wilkie and Davinson, 2021a, b; Browning et al., 2020a; Kondo et al., 2018; Kruize et al., 2019; Meredith et al., 2020). One of the most studied subjective wellbeing outcomes is mood (Bowler et al., 2010; Corazon et al., 2019). Overall, the evidence weighs in favour of improved positive and lowered negative mood from nature experiences (Wilkie and Davinson, 2021a, b; Browning et al., 2020b; Houlden et al., 2018; McMahon and Estes, 2015; Meredith et al., 2020; Pritchard et al., 2020); yet others report mixed findings, suggesting a more nuanced investigation of nature's effect on mood is needed (Mygind et al., 2019). The aim of the two studies presented here was to further explore the subjective wellbeing effects in person-environment research.

1.1. Subjective wellbeing: Mood and emotion

Mood is an important subjective wellbeing outcome in person-environment studies for several reasons. From a theoretical perspective, mood has been linked to two frameworks commonly used in environment social science research: stress reduction theory (SRT, Ulrich, 1983; Ulrich et al., 1991) and attention restoration theory (ART, Kaplan, 1995; Kaplan and Kaplan, 1989). Both theories start from the position of individual's experience in a negative state, either in terms of stress and/or negative affective arousal (SRT) or depleted cognitive resources (ART); and both operate primarily through the *restoring capacities* pathway domain[1] of nature experience (Wilkie and Davinson, 2021b; Marselle et al., 2021). In SRT, physical and psychological capacities are restored by viewing non-threatening visual nature stimuli (Ulrich et al., 1983, 1991). These stimuli evoke an immediate, unconscious emotional re-

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[1] *Restoring capacities* is as a pathway domain primarily operating via the nature experience pathway. It is also referred to by other terms but is recognised as a key component in other pathway-wellbeing frameworks. A comparison of frameworks is beyond the scope of this paper (see Wilkie and Davison, 2021b; Marselle et al., 2021, Hartig et al., 2014, Shanahan et al., 2015, and Bratman et al., 2019).

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sponse, which shapes cognitive evaluations of an environment as having the potential to enhance wellbeing, and, subsequently, to produce changes in mood, attentional capacity, and environmental approach behaviours (Ulrich, 1983, 1991). In SRT, emotion is the mechanism driving the cognitive processing of environments containing non-threatening natural features and improved mood is one resulting outcome (Wilkie and Davinson, 2021b).

In ART, nature stimuli have visual characteristics that draw attention effortlessly. This use of effortless involuntary attention, referred to as soft fascination, allows for depleted directed attention resources to replenish or restore (Kaplan, 1995). Here, the mechanism by which nature operates is cognitive. It produces restoration of directed attention resources, which then results in improved positive and/or reduced negative mood (Wilkie and Clouston, 2015; Bratman et al., 2015; Brooks et al., 2017; Han, 2017; Kinnafick and Thørgersen, 2014); negative mood reduction has been the most robust outcome (Bowler et al., 2010). Although the evidence of improved mood is considered relatively robust, there have also been mixed reports of mood-related effects from viewing different environments (Frost et al., 2022; Mygind et al., 2019).

These mixed findings may possibly be better understood by considering an explanation rarely addressed in environment-wellbeing research: the distinction between emotion and mood. Person-environment researchers regularly use emotion and mood interchangeably (e.g., Brooks et al., 2017; Frost et al., 2022; Han, 2017; McMahan and Estes, 2015; Nisbet and Zelenski, 2011); even Ulrich did while also acknowledging their conceptual distinction (1983). Yet mood and emotion differ in several key respects (Ekman, 1992; Beedie et al., 2005; Gomez et al., 2009; Scherer, 2005). Emotions are directed towards an object (*e.g.*, a nature setting) while mood results from responses to multiple objects or experiences. Emotion and mood also differ in duration (Ekkekakis and Petruzzello, 2000; Fiebig et al., 2020). Moods are more enduring and emotions short, immediate, and often transient responses (Beedie et al., 2005; Ekman, 1992). According to Beedie et al. (2005), emotions cause the development of mood. They proposed "emotion is defined as a feeling caused by a specific object and focused on that object.....mood is a set of feelings that are neither caused by nor focused on a specific object" (p. 229, 2011). Others further distinguished mood from emotion, with mood described as "unfocused" (Gomez et al., 2009) and a "diffuse affect state characterized by a relatively enduring predominance…that affects behaviour and experience" (Scherer 2005, p. 705).

Three prior person-environment studies focused on emotion instead of mood (Faullant et al., 2011; Korpela and Ratcliffe, 2021; Lopéz-Mosquera and Sánchez, 2014). Emotion was linked to mountaineering experience satisfaction; and positive emotions were higher for nature, associated with nature use, willingness to pay for nature visits, and visit loyalty to urban greenspaces. We felt it was important to disentangle mood from emotion because, depending on the duration, a "dose" of nature may not be long enough to consistently change mood but instead could elicit emotions that later contribute to changes in mood after a longer timeframe.

1.2. Perceived restorativeness

An important influence on an individual's decision to approach (or avoid) different environments when seeking to restore capacities is the setting's perceived restorativeness. Restoration has been defined as "the renewal or recovery of resources or capacities that have become depleted in meeting the demands of everyday life" (p. 41, Hartig, 2011). According to ART, people differ in their *perception* of whether a specific setting might provide the opportunity for restoration to occur; this is referred to as its *perceived restorativeness* (Pasini et al., 2014). A meta-analysis indicated perceived restorativeness differed between nature and urban environments (Menardo et al., 2021); and it influenced the relationship between virtual nature exposure and changes in positive and negative mood (McAllister et al., 2017). Perceived instorative-

ness (i.e., restorativeness without a preceding depleted cognitive state) has been linked to emotional reactions to nature, with the authors suggesting this perception is important in the appraisal of an environment (Korpela and Ratcliffe, 2021). If the appraisal were positive, this could lead to approach behaviour; conversely, negative appraisals could lead to avoidance behaviour.

1.3. Mode and duration of experience

Generally, real-world nature experiences are considered the most effective to achieve wellbeing benefits. Yet virtual experiences can elicit improvements to mood (McMahon and Estes 2015; Ulrich et al., 1991; White et al., 2018; Yu et al., 2018), so may be suitable for nature-health research (Menardo et al., 2021; White et al., 2018). Several recent studies found 2D-stimuli have similar mood effects to more immersive virtual methods (Yeo et al., 2020). However, another study using videos showed mixed mood-effects (Brancato et al., 2022). These contradictory findings suggest the potential for virtual nature experiences to influence mood should be further investigated.

An important question relates to how long a virtual nature experience should be to elicit desired effects, with some authors calling for 'dose' studies to be a research priority (Frumpkin et al., 2017; Shanahan et al., 2015). Evidence indicated mood can be improved after viewing natural environments virtually between 2 - 5 min duration (McAllister et al., 2017; Yeo et al., 2020), particularly for positive mood. Brief virtual exposure to natural environments also elicits different perceptions in perceived restorativeness (Browning et al., 2020b; Kang and Kim, 2019).

Some authors argued even short experiences, or 'micro-doses', could also be an important public health resource (Browning et al., 2020a; 2020b). The concept of a 'micro-break' could be useful to this aim. A micro-break broadly refers to very brief breaks, usually in a work context, that allow an individual to disengage from tasks and recover important resources (Kim et al., 2022; Kim et al., 2017; Lee et al., 2018). Several studies investigated the effectiveness of 40–90 s. micro-break involving viewing either a roof with greenery on it or concrete roof (Lee et al., 2015, 2017, 2018). Improved mood, measured as tension, was indirectly observed via perceived restorativeness (Lee et al., 2017, 2018). They also reported improved directed attention task performance after viewing a green, flower-covered roof (Lee et al., 2015), which was perceived as more restorative. Collectively, these studies support the potential for micro-breaks (*i.e.*, dose) of less than 1 min to elicit judgements of perceived restorativeness for environmental stimuli and influence mood. However, we are unaware of any studies that apply this concept using a virtual nature experience outside of a workplace setting. The studies presented here investigated whether a virtual micro-dose was effective in eliciting perceptions of the restorative potential of different environments and if this experience influenced two aspects of subjective wellbeing: mood and emotion.

Specifically, we focused on mood in the first study but explored mood and emotion separately in the second study. Afterall, if mood is a more enduring state resulting from multiple experiences (Beedie et al., 2005) potentially lasting for days (Ekman, 1992; Scherer, 2005) and not necessarily associated with an object (Beedie et al., 2005; Scherer, 2005), then a brief dose of nature may not evoke the expected change in mood. Instead, it may elicit emotions that *potentially* drive later mood effects, as speculated by others (Faullant et al., 2011).

1.4. Factors associated with 'dose" effectiveness

It was important to consider several additional influences on nature's potential to impact mood and/or emotion: the environment type and an individual's place preference. In environment-wellbeing studies grounded in ART and SRT, nature settings are often compared to highly built-up, busy urban streets (e.g., Yu et al., 2018); this comparison was raised as a methodological limitation based on a concern that observed

differences in perceived restorativeness and mood may simply be due to the starkness of this contrast (Wilkie and Clouston 2015). It is important to recognise settings, such as urban greenspace, can improve mood (Wilkie and Clouston 2015; Barton and Pretty, 2010; Van den Berg et al., 2014). In the current studies, nature, urban greenspace, and an urban street were included to address this limitation.

It was also important to consider the individual's place preference, defined here as representing place identity or that part of the self-concept linked to place (Wilkie and Stavridou, 2013; Wilkie and Clouston 2015). Aspects of place identity have been linked to the perceived restorativeness of favourite places (Ratcliffe and Korpela, 2016), was a mediating factor in the link between urban greenspace and well-being (Knez et al., 2018), and improved positive mood (Wilkie and Clouston, 2015). Differences in judgements of an environment's perceived restorativeness have been observed based on the congruence (i.e., "match") between the person's place preference and the environment type (Wilkie and Stavridou, 2013; Wilkie and Clouston 2015; Wilkie and Clements 2018); but not with mood (Wilkie and Clements, 2018). The current studies included place preference to further investigate how it interacts with environment type to influence mood, emotion, and perceived restorativeness.

Another potentially relevant influence on an individual's responses to different environments was also considered for the first time. Ruch and Ruch (1997a) proposed trait-level individual differences exist regarding readiness to respond to cheerfulness-enhancing stimuli and the propensity to experience state cheerfulness. Trait cheerfulness and trait bad mood are affective dispositions. One is dominated by positive and the other with negative hedonic tone (Ruch et al., 1996). Individuals higher in trait cheerfulness showed better mood outcomes compared with those low in trait cheerfulness after viewing humorous stimuli (Ruch et al., 1997b). Lõpez-Benítez et al. (2018) found trait cheerfulness modulated the experimental effect of visual stimuli designed to induce positive and negative affect. Trait cheerfulness has also been associated with pro-environmental behaviours (Soutter and Mõttus, 2021). Therefore, it is possible trait cheerfulness and trait bad mood, as dispositional influences, impact positive or negative response elicited by environmental stimuli. In the current study, these trait-level factors were included as covariates to investigate this.

1.5. The present research

Two studies presented were conceptual replications (Wilkie and Clouston 2015; Wilkie and Clements 2018) with several methodological changes. The first unique contribution was to replace virtual 7-minute slideshows or videos of either nature, urban greenspace or an urban street with a 30-second micro-dose to investigate if it had effects like those reported after longer virtual exposure. Two other unique contributions of the studies presented was to distinguish between mood and emotion and control for trait characteristics that may impact reaction to different environments. Specifically, in the first study we explored whether environments depicted in a micro-dose were perceived as *potentially* restorative, whether this brief exposure impacted on mood, and if an individual's place preference interacted with environment to produce differential effects. Study 2 replicated study 1 but disentangled mood and emotion, as well as controlling for trait cheerfulness/bad mood.

1.6. Hypotheses

In both studies, 30 sec "doses" of nature or urban greenspace were predicted to produce higher positive mood and perceived potential restorativeness compared to an urban street, with negative mood higher in the latter. The best mood outcomes (higher positive, lower negative) were also expected to result after viewing images congruent (i.e., matching) with an individual's place preference and images incongruent with that preference, would produce the worst outcomes. In study 2, we also predicted that nature and urban greenspaces will elicit higher levels of

the emotions happiness, relaxation and desire but lower levels of anger and fear/anxiety, after controlling for trait cheerfulness/bad mood respectively.

2. Study methodologies

2.1. Design

A between-subjects 3 x 2 factorial design was utilised. The independent variable was environment type (nature, urban greenspace, urban); place preference (nature, urban) was a quasi-independent variable. Positive/negative mood and perceived restorativeness were dependent variables in both studies. In study 2, basic emotions (anger, fear/anxiety, desire, relaxation, happiness) were dependent variables (see Analytic strategy for details). Trait cheerfulness and bad mood were covariates.

2.2. Participants

2.2.1. Study 1

Of those commencing the study ($N = 310$), 63 exited the survey without completing any questions and 36 had missing data involving either more than 2% of their responses or entire measures, which was considered too extensive for missing data replacement (Widaman, 2006). This yielded 211 participants with data suitable for further analysis. The majority were female (73%) and approximately 27 years old ($M = 26.61$, $SD = 11.17$; range $= 16 - 68$). Most participants were from the UK (60%), USA (25%) or Australasia (11%).

2.2.2. Study 2

There were 338 participants with useable data. Participants were removed for excessive missing data ($n = 58$), declined consent ($n = 11$), or due to a survey software error ($n = 3$). Most participants were female (75%) with an average age of 27.94 years old ($SD = 12.79$; range $= 18 - 78$). Participants were from the UK (54%), North America (31%), Europe (11%), or other/not specified (4%).

2.3. Procedure

Study 1 data was collected as part of an online 30-minute study with two phases requiring the same visual stimuli but focused on distinct research outcomes (pro-environmental behaviour; wellbeing). Data for both strands was collected simultaneously to reduce participant burden. Study 2 replicated the wellbeing phase and took 15 min to complete. Both studies were approved by the University of Sunderland ethics committee (002582; 008495).

Convenience sampling was used to recruit participants. Study 1 was advertised on online psychology research sites such as socialpsychology.org and hanover.edu, researcher and School of Psychology social media (e.g., Facebook, Twitter), and the University of Sunderland research participation scheme. A similar convenience sampling strategy was employed for study 2 with the addition of dissemination through professional networks on Linked In. No specific demographic groups were targeted in the sampling process. Participants provided informed consent, indicated their place preference, provided demographic information (including trait cheerfulness in study 2), and viewed one environment that was randomly allocated by the Qualtrics survey software. When viewing the image, participants were told to "*study the image carefully so they could answer questions about it later in the survey*". This instruction was given to encourage adherence with the experimental stimuli. Average image viewing was 28.59–29.85 s (study 1) and 28.31 - 30.52 s (study 2). Across environments, viewing time did not differ in study 1 (all $p > .12$). Study 2 participants in the urban street condition on average spent approximately 2 s more viewing that image compared to those who viewed nature or urban greenspaces, which did not differ ($F (2, 335) = 4.29$, $p = .02$).

Fig. 1. Environment Types Displayed as Visual Stimuli.

1A: Nature
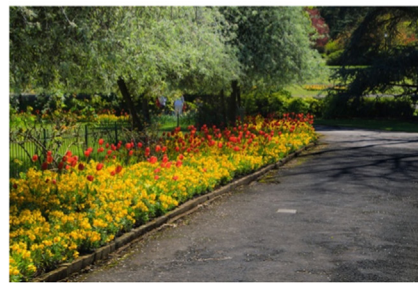
1B: Urban Greenspace

1C: Urban Street

2.4. Materials and stimuli

Cronbach's alpha statistics were compared with a minimum value of 0.70 considered suitable for group comparisons (Bland and Altman, 1997).

2.4.1. Place preference

Participants read the following: "People who most enjoy spending time in a natural environment may consider themselves 'country people' whereas individuals who most enjoy spending time in an urban environment may consider themselves 'city people'." They self-categorised as either a city or country person based on this description. 'City persons' were considered to have an urban place preference and 'country persons' a nature preference. This method has been used by others (Knez, 2005; Morton et al., 2017; Wilkie and Clouston, 2015; Wilkie and Clements, 2018). Study 1 participants were evenly self-categorised as having place preferences for either a city ($n = 106$) or country ($n = 105$). More participants reported an urban preference ($n = 196$, 58%) than a nature one ($n = 140$; 41.42%) in study 2. Place preference did not differ by country of residence in either study ($p > .18$ for respective x^2 analyses).

2.4.2. Environment type (visual stimuli)

Environment type (nature, urban greenspace = UGS, urban street = US) of the image was an experimental independent variable randomly allocated by Qualtrics survey software. See Fig. 1 for the images which have been used in prior studies (Wilkie and Clouston 2015). The images were 1) a managed but relatively wild nature setting with a trail, 2) a well-maintained urban greenspace with a clearly demarcated path, and 3) a shopping street in central London. People were only present in the urban street condition. Images were typical of those widely used to depict environmental characteristics associated with bottom-up processing in restorative environment research; the urban street image could be classified as a 'grey' rather than a 'positive' urban setting (Bornioli and Subiza-Perez, 2023); however, 'grey' settings can be restorative (Subiza-Perez et al., 2021a).

2.4.3. Dependent variables and covariates

Where appropriate, Cronbach's alpha statistics were compared with a minimum value of 0.70 considered suitable for group comparisons (Bland and Altman, 1997).

2.4.3.1. Mood. Mood was measured in Study 1 using the 20-item Positive and Negative Affect Scale (Watson et al.,1988). This scale (1 = *very slightly/not at all*; 5 = *extremely*) generates positive and negative mood scores with either a positive or negative valence (max = 50). In study 2, mood was measured using the 10-item international PANAS short form (Thompson, 2007; max score = 5). The shorter scale was used to reduce participant burden and mean scale score used for consistency with the other study 2 measures. In both studies, participants were instructed to complete the measure based on the way they *feel right now, in the current moment* (state). Sample items included: upset, afraid, attentive, and active. Cronbach's alpha was 0.92 and 0.72 for positive mood in study 1 and 2 respectively, and 0.89 and 0.83 for negative mood. These values were consistent with the two original measures (Watson et al., 1988; Crawford and Henry, 2004; Thompson, 2007).

2.4.3.2. Emotion. In Study 2, emotion was conceptualised using psychological theories of basic emotions organized around emotion families (Ekman, 1992), under which varied emotion words are structured (Power, 2006; Shaver et al., 1987).[2] Self-reported state emotions were measured with the discrete emotion questionnaire (DEQ, Harmon-Jones et al., 2016) consisting of words expressing "basic" emotions: anger, disgust, fear/anxiety, sadness, desire, relaxation, happiness. A DEQ short form (DEQ-SF) consisting of 14 (of 32) emotions words from

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[2] Emotion frameworks are typically differentiated as discrete (Ekman, 1992) or dimensional (Russell, 1980; Russell and Caroll, 1999). The former is based on emotion families to provide specificity and the latter provides dimensions of pleasantness/arousal. Detailed discussions of them and their conceptualizations of emotion/mood/affect/valence are beyond this paper's scope (Further reading: Ekkekakis and Petruzello, 2000; Ekman, 2016; Mauss and Robinson, 2009; Power, 2006; Yik et al, 2023).

the original DEQ was created to reduce participant burden after the brief environment dose (see Supplementary Materials). To create the short form, we selected two items from each original DEQ subscale based on 1) the highest factors loadings for each emotion in previous DEQ studies (see study 3, Harmon-Jones et al., 2016) and 2) consistency with nature-based theories (e.g., ART, SRT). Sample emotion words included mad, sad, revulsion, and calm.

Participants were instructed to respond based on the extent to which they experienced each emotion while *viewing the photograph of the setting* from 1 (*very slightly*) to 5 (*a lot/often*). Cronbach's alpha of the DEQ-SF subscales for *Disgust* and *Sad* were below 0.70 and not included in comparative analyses (see Supplementary Materials). The internal consistency of the remaining five subscales ranged from 0.78 (*fear/anxiety, desire*) to 0.93 (*relaxation*).

2.4.3.3. Perceived restorativeness. The 11-item Perceived Restorativeness Scale (PRS-11, Pasini et al., 2014) captured the perceived restorative potential of the environment; perceived restorativeness is a widely used measure in environmental social science research (Han, 2018). Ratings were on a 10-point Likert scale (1= *not all*; 10 = *very much*) in Study 1 and an overall perceived restorativeness was calculated as the mean of the items. Cronbach's alpha was 0.85 in study 1 and 0.84 in study 2. In study 2, the scale was modified to 1 = *not at all* to 5 = *a lot* to ease participant burden (max = 5); thus, values should not be directly compared between study 1 and 2. However, modification of rating scales to reduce the number of response options is acceptable based on evidence this procedure it does not substantially affect the mean or standard deviation (Dawes, 2008).

2.4.3.4. Trait cheerfulness and bad mood. Trait cheerfulness and trait bad mood were measured with the State-Trait Cheerfulness Inventory short from (STCI-T, Ruch et al., 1996, 1997b). This measure consists of 10 items that refer to general mood or mentality (1 = *strongly disagree*; 4 = *strongly agree*) for each subscale, which are summed to provide a trait score (max = 40). Sample items include "*I am a cheerful person*" or "*There are many days on which I think I got up on the wrong side of the bed.*" Cronbach's alpha was 0.86 and 0.88 for trait bad mood and cheerfulness respectively.

2.5. Analytic strategy

Based on the study designs, 3 (environment type) x 2 (place preference) multi-variate analyses of variance (MANOVA) were planned. However, a review of the dependent variables for both studies indicated they did not meet the requirements (see Supplementary materials). In the first study, three 3 x 2 analyses of variance (ANOVA) were conducted (*a priori* reduced alpha level = 0.017). For study 2, positive/negative mood, positive/negative emotion, and perceived restorativeness were analysed using five 3 x 2 ANCOVA's (*a priori* reduced alpha level = 0.01). G Power (Faul et al., 2009) indicated a sample size of 205 was sufficient for study 1 and 256 for study 2 (*ES* = 0.25, power = 0.80, *df* = 2, groups = 6). All post-hoc analyses used Bonferroni adjustment. In each study, one missing value was replaced with the median (S1: negative mood; S2: STCI-T) based on guidelines for Likert-type item missing data (Widaman, 2006).

3. Study 1 results

3.1. Environment type and place preference effects

Table 1 presents descriptive and inferential statistics overall, by place preference and by environment type. Environment type did not affect positive or negative mood (both *p* = .30). Participants reported positive mood near the scale mid-point and a lower negative mood, consistent with normative data (Crawford and Henry, 2004). Perceived restorativeness differed by environment type (*p* < .001, η_p^2 = 0.28). Nature and UGS

Table 1
Study 1: Descriptive Statistics for Mood and Perceived Restorativeness Overall and by Environment Type and Place Preference.

Outcome	Overall (N = 211) M	Overall SD	Nature (N = 69) M	Nature SE	Urban Street (N = 70) M	Urban Street SE	Urban Green Space (N = 69) M	Urban Green Space SE	F	η_p^2	Nature (N = 106) M	Nature (N = 106) Post-hoc	Urban (N = 105) M	Urban SD	F	η_p^2
Positive mood[a]	26.56	9.13	27.49	1.10	25.19	1.09	26.96	1.10	1.20	0.01	27.31	–	25.78	0.90	1.45	0.01
Negative mood[a]	15.01	6.43	14.27	0.77	15.90	0.77	14.73	0.78	1.20	0.01	14.82	–	15.12	0.63	0.11	0.00
Perceived restorative-ness[b]	6.02	1.69	6.67	0.16	4.82	0.16	6.47	0.16	39.11 ***	0.28	6.03	N = UGS>US***	5.95	0.13	0.20	0.00

The environment type x place preference interaction was non-significant for positive and negative mood. It was significant for perceived restorativeness. See additional analyses and Fig. 2 for post-hoc comparisons of this interaction.
** *p* < .01;.
* *p* < .05.
*** *p* < .001;.
[a] Positive and Negative Affect Scale (Watson et al., 1983) Max = 50;.
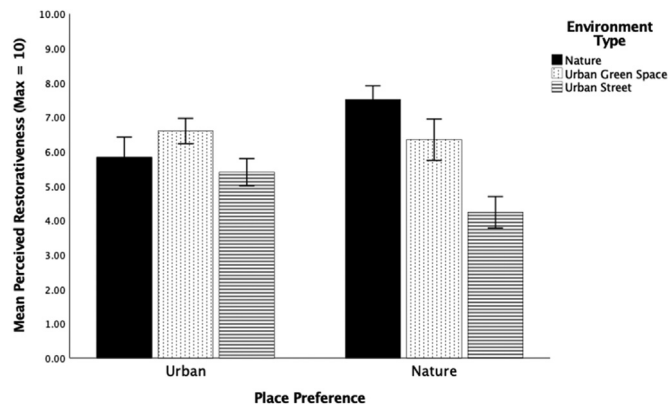[b] Perceived Restorativeness Scale (Pasini et al., 2014) Max = 10.

Fig. 2. Study 1 Environment Type x Place Preference interaction on perceived restorativeness.

Note: Error bars represent 95% confidence intervals. Max = 10. Urban place preference: UGS > N = US; Nature place preference: N > UGS > US.

images were rated equally ($p = .75$). Both were significantly higher than US (both $p < .001$). Neither mood nor perceived restorativeness differed by place preference (all $p > .23$).

3.2. Environment type/place preference interaction

The expected interaction between place preference and environment type did not exist for positive or negative mood (both $p > .25$). This interaction was significant for perceived restorativeness ($F (2, 204) = 19.81$, $p < .001$, $\eta_p^2 = 0.16$). A series of planned post-hoc comparisons was implemented (see Fig. 2). The first contrast compared perceived restorativeness by environment type for *only* the urban preference group ($F (2, 102) = 7.95$, $p < .001$). Those in the urban greenspace condition rated the stimuli higher than participants in the urban street ($p < .001$); the nature and urban street conditions did not differ ($p = .52$). The second contrast replicated the first, but for *only* the nature preference group ($F (2, 201) = 50.16$, $p < .001$). Persons with a nature preference rated the nature stimuli higher in perceived restorativeness than those in urban greenspace ($p = .002$); both were rated higher than the urban street conditions (both $p < .001$). The third comparison was between preference groups in the urban street condition. The nature preference group rated this image significantly lower ($t (67) = 3.90$, $p < .001$). The final planned comparison was the same but for ratings of the nature image ($t (67) = −4.93$, $p < .001$). For this image, the nature preference group's rating was significantly higher.

3.3. Study 1 summary

The anticipated effect of environment type on mood was not observed. After the 30-second dose, depicted nature and urban greenspaces were perceived as higher in potential restorativeness compared to urban streets. The 'congruence' effect (i.e., interaction) was not present for mood; but was evident for perceived restorativeness. Overall, the results suggested both place preference groups considered urban greenspace equal in perceived restorativeness, but differed in their perceptions of urban streets and nature. Generally, participants with a nature preference illustrated a trend consistent with the hypothesis, with their most congruent environment eliciting the highest ratings and the incongruent setting the least.

4. Study 2 results

4.1. Environment type and place preference effects

A summary of descriptive and inferential statistics can be found in Table 2. The multi-variate main effect of environment type was signif-

icant for the emotions *happy* and *relaxation*, controlling for trait cheerfulness ($V = 0.48$). Post-hoc analyses indicated that nature and urban greenspace were equal and higher in eliciting both emotions compared with the urban street (both $p < .001$). The effect size was stronger for relaxation ($\eta_p^2 = 0.47$) than happy ($\eta_p^2 = 0.31$). Environment type also significantly impacted desire controlling for the covariate ($\eta_p^2 = 0.14$); nature elicited higher reports of desire compared to urban greenspace ($p = .002$) and both were higher than urban streets (all $p < .001$).

A similar environment type main effect was found for anger ($\eta_p^2 = 0.09$) and fear/anxiety ($\eta_p^2 = 0.24$) controlling for trait bad mood, although these effects were smaller in magnitude than happiness and relaxation. Post-hoc analyses indicated both anger and fear/anxiety were highest when presented with an urban street image compared to either nature or urban greenspace images (both $p < .001$). Positive and negative mood ratings did not differ by environment type[3]; only the effects of the relevant covariates were significant. Like study 1, participants reported being in a 'moderately' positive mood and low negative mood irrespective of environment type.

Perceived restorativeness differed based by environment type ($p < .001$, $\eta_p^2 = 0.26$). Nature and urban greenspace elicited the highest restoration ratings compared with the urban street image. There were no differences in mood, emotion, or perceived restorativeness based on place preference (all $p > .008$).

4.2. Environment type/place preference interaction

The environment type/place preference interaction was not significant for either positive or negative mood, nor anger. The interaction was significant for both happy and relaxation ($V = 0.07$, $p < .001$, $\eta_p^2 = 0.03$); effect sizes were small (both $\eta_p^2 = 0.05$). Planned comparisons for post-hoc analyses used one-way ANCOVAs (see Fig. 3). Separate analyses were conducted by place preference to determine the within-group effect of environment type, controlling for trait covariate. For the urban preference group, happiness and relaxation were equal in the nature and urban greenspace conditions; both were significantly higher the urban street image (η_p^2 Happy $= 0.16$; η_p^2 Relax $= 0.30$). Fear/anxiety was highest in the urban street condition, and lower in the nature and urban greenspace conditions which did not differ ($\eta_p^2 = 0.11$). Desire did not differ across conditions ($p = .12$) for those with an urban preference. The same patterns were evidenced in the nature preference group for the following emotions but with larger effect sizes: happiness ($\eta_p^2 = 0.49$), relaxation ($\eta_p^2 = 0.66$), fear/anxiety ($\eta_p^2 = 0.42$). However, desire was significantly higher for those in the nature condition, followed by the urban greenspace condition, with the lowest level reported in the urban street condition ($\eta_p^2 = 0.34$).

The interaction effect was significant for perceived restorativeness ($p < .001$, $\eta_p^2 = 0.09$). The post-hoc strategy was the same as above. For the urban preference group, ratings of the perceived restorativeness of the environments differed significantly[2] ($F (1, 194) = 7.41$, $p = .001$, $\eta_p^2 = 0.07$). It was significantly lower for urban streets than the other two environments (both $p < .04$), despite this being the congruent environment for this preference group. This pattern was also present in the nature group, but again with a much larger effect ($F (2, 138) = 70.82$, $p < .001$, $\eta_p^2 = 0.51$).

4.3. Study 2 summary findings

The environment type did not impact either positive or negative mood. It did affect all emotions except anger, after controlling for the

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[3] Levene's test of equality of error variances was significant for negative mood, relaxation, desire, anger, and fear/anxiety. Pituch and Stevens (2016) suggest analyses are robust to this violation when the ratio of largest/smallest group sizes are approximately 1.5.

Table 2

Descriptive and Inferential Statistics for Emotions, Mood, and Perceived Restorativeness by Environment Type and Place Preference.

	Environment Type											Place Preference						
	Overall (N = 338)		Nature (N = 114)		Urban Green Space (N = 112)		Urban Street (N = 112)						Nature (N = 140)		Urban (N = 196)				Post-hoc
Outcome	M	SD	M	SE	M	SE	M	SE	F		η_p^2	Post-hoc	M	SD	M	SD	F	η_p^2	
Emotion[a]																			
Happy	3.20	1.20	3.76	0.09	3.61	0.09	2.32	0.09	75.18	***	0.31	*N*=UGS>US	3.32	0.08	3.13	0.07	3.03	.01	
Relaxation	3.13	1.38	3.90	0.1	3.73	0.10	1.82	0.09	148.33	***	0.47	*N*=UGS>US	3.21	0.08	3.09	0.07	1.29	.00	
Desire	2.44	1.17	3.00	0.10	2.47	0.10	1.94	0.10	24.56	***	0.14	*N*>UGS>US	2.57	0.09	2.35	0.08	3.60	.01	
Anger	1.24	0.63	1.11	0.06	1.10	0.06	1.51	0.06	17.02	***	0.09	US>*N*=UGS	1.25	0.05	1.24	0.04	0.02	.00	
Fear/anxiety	1.7	0.94	1.47	0.08	1.3	0.08	2.32	0.08	52.04	***	0.24	US>*N*=UGS	1.73	0.06	1.66	0.06	.71	.00	
Mood																			
Positive[b]	2.62	0.83	2.64	0.08	2.60	0.08	2.62	0.08	0.08		0.00		2.66	0.07	2.58	0.06	0.84	0.00	
Negative[b]	1.56	0.77	1.50	0.07	1.50	0.07	1.69	0.07	3.04		0.02		1.53	0.06	1.58	0.05	0.39	0.00	
Perceived restorativeness[c]	3.21	0.80	3.59	0.06	3.44	0.07	2.67	0.06	58.42	***	0.26	*N* = UGS>US	3.32	0.06	3.14	0.05	5.49	0.02	

*** $p < .001$, else exact *p* value reported.

[a] Discrete emotion questionnaire (Harmon-Jones et al., 2016);.

[b] Positive and Negative Affect Scale (Watson et al., 1983) Max = 5; cPerceived Restorativeness Scale (Pasini et al., 2014) Max = 5. Values reported are adjusted for trait cheerfulness or trait bad mood were appropriate. The covariate effect was significant for both mood outcomes and all emotions except desire. The environment type x place preference interaction was non-significant for positive and negative mood and anger. This interaction was significant for happy, relaxation, fear/anxiety, and perceived restorativeness.
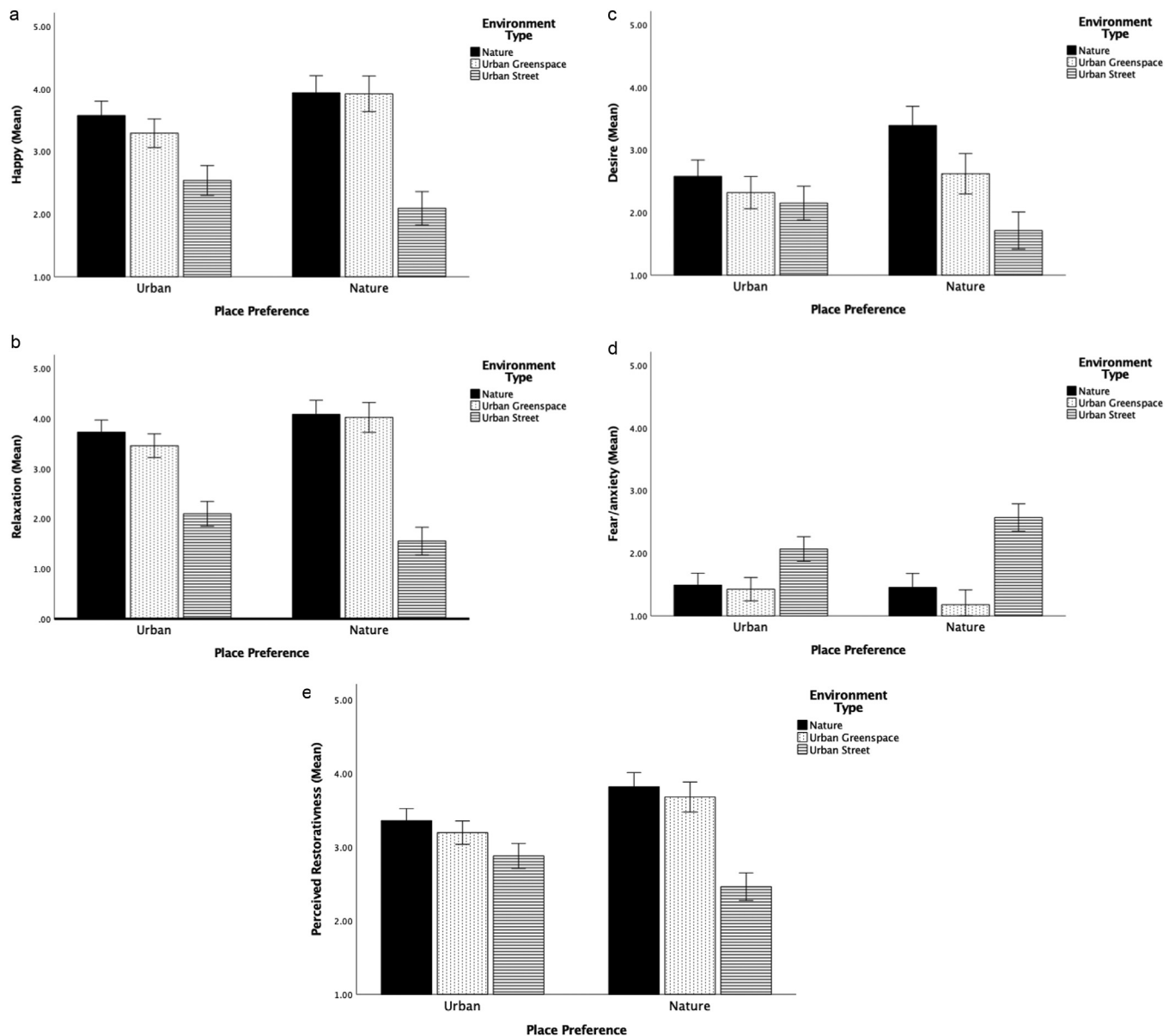
Fig. 3. Post-hoc comparisons for significant environment type x place preference interactions
Note. N = UGS > US. Effect sizes were larger for the nature preference group. Error bars = 95% CI.

appropriate trait characteristic. Specifically, the emotions happy, relaxation and desire were higher and fear/anxiety lowest in the nature or urban greenspace conditions. Both nature and urban greenspaces were rated higher in perceived restorativeness compared to urban streets as hypothesized; yet neither was rated highly on this measure by participants. The 'congruence' effect (i.e., interaction) was not present for mood or anger; it existed for the other emotions and perceived restorativeness, with the findings replicating the general patterns from study 1.

5. Integrated discussion

The overall aim was to investigate if a micro-dose of an environment, operationalised as a 30-second virtual exposure to an image effected outcomes previously influenced using longer stimuli-exposure methods. Specifically, we explored whether environments were perceived as potentially restorative and if a brief exposure to them impacted mood and 5 discrete emotions after controlling for trait characteristics. An addi-

tional aim was to determine if an individual's place preference had an influence; and, if so, should be considered when designing virtual microbreaks.

5.1. Environment type

The anticipated main effect of environment type on mood was not present in either study, consistent with other reports of no mood effect (e.g., Wilkie and Clements, 2018). However, improved positive mood was observed after a longer virtual dose (Wilkie and Clouston, 2015; Browning et al., 2020a) but not for negative mood (Browning et al., 2020a), or that negative mood was improved (Wilkie and Clouston, 2015; Kinnafick and Thorgersen-Ntoumani, 2014; Yu et al., 2018). Collectively, the current findings and prior research reinforce the need for the environment-mood link to be further explored due to inconsistent findings (Frost et al., 2022).

One-way researchers can better understand any environment-mood link is to also focus on emotion, which should be clearly distinguished

from mood. In study 2, five emotions were elicited. A recent study by Korpela and Ratcliffe (2021) found positive emotion was higher for 'ordinary nature' images compared to other urban settings (both commercial/residential and industrial). This raises the possibility there may be a more consistent emotion effect, rather than a mood effect. According to SRT (Ulrich 1983, 1991), emotional responses to the environment are due to preferenda (general structural characteristics) that are processed quickly. These emotional responses drive the evaluation of the setting, which in turn impacts outcomes such as mood. This sequential causal explanation aligns with theories of basic emotions and the distinction between emotions and mood (Beedie et al., 2005, 2011). Future studies should continue with this line of enquiry because it clarifies the differential impact of environments on a range of subjective wellbeing outcomes, potentially providing better insight into the drivers of the environment-wellbeing relationship.

Both nature and urban greenspaces were perceived higher in restorative potential compared to urban streets; this was consistent with prior findings using visual stimuli (Wilkie and Clouston, 2015) or green micro-breaks (Lee et al., 2015). In this regard, the 30-second micro-dose was suitable for eliciting perceptions of perceived restorativeness. The next logical progression would be to determine whether actual restoration takes place, for example such as improved cognitive task performance. A further interesting point is that urban streets, although rated lower, were rated approximately mid-way on this scale in both studies. Others have reported similar findings (e.g., Wilkie and Clouston, 2015; Bornioli et al., 2018; Korpela and Ratcliffe, 2021; Stigsdotter et al., 2017), suggesting "grey" urban settings are not always lacking in perceived restorativeness (Subiza-Pérez et al., 2021b).

5.2. Place preference and congruence

No mood or emotion differed by place preference; but there was no expectation this would be the case. Instead, it was anticipated that any effect would be due to *whether* the environment was congruent with that preference that may have an effect. This interaction was not present for positive/negative mood, despite an earlier study indicating positive mood differed based on it (Wilkie and Clouston, 2015). It also did not affect anger; but there was a significant interaction effect on the emotions of happy, relaxation, desire and fear/anxiety (study 2) and perceived restorativeness (both studies). Happy and relaxation emotions were highest for nature and urban greenspaces compared with urban streets; however, the size of the difference between the emotions elicited by them was more pronounced for the nature preference group. In other words, there was a much starker contrast between natural spaces and urban streets for the nature preference group compared to those with an urban preference, even though the general pattern of results was the same. Desire was also differentially affected based on place preference, with only a significant difference in reported desire for the nature preference group. In a recent study, areas of the brain associated with emotion were activated by personally meaningful places (Gatersleben et al., 2020). This may partially explain these findings because positive emotions were elicited most by places that were congruent with their self-concept linked to nature, as reported by others (Subiza-Perez et al., 2021a).

The same pattern of results also occurred for perceived restorativeness in both studies. Together, the evidence for the congruence effect was mixed because the level of emotion and perceived restorativeness elicited was not consistently highest in congruent environments or lowest in incongruent ones. However, there did appear to be more of a congruence effect for those with a nature preference. Future studies need to investigate the influence of place preference, representing the individual's place identity, on a range of restorative outcomes across virtual and real-world environmental contexts. Our current level of understanding of the environment-wellbeing relationship has primarily been driven by bottom-up processing models focused on environmental characteristics; there is less exploration of top-down influences (Subiza-Pérez et al., 2021b), an example of which could be place preference as defined here.

5.3. Study strengths

The studies presented here had three unique strengths. The first was its focus on a virtual micro-dose of an environment outside of a workplace context. The findings supported the potential benefit of brief exposure methods in other settings. For example, brief virtual exposure methods could ascertain places that could potentially enhance (or detract) from health/wellbeing to identify appropriate real-world activities or nature-based interventions best suited to the individual. Brief "doses" could also be used in varied indoor or virtual settings as well, where users need quick restorative interventions such as when studying or recovering from illness.

The second strength was the inclusion of emotion as a possible response to different environments, with particular emphasis on the important distinction to be made between mood and emotion. Despite measures sharing some similar underlying terminology (e.g., happy or fear/afraid in both PANAS and DEQ), the more diffuse state of mood was not affected by brief doses, yet several specific emotions were. These findings are consistent with the definition of emotions being object-specific and short duration and mood was a more diffuse state that takes longer to form/change (Beedie et al., 2005). This reinforces the need for researchers to be clear on which frameworks are guiding their conceptualization of these key, *distinct* subjective wellbeing outcomes, as well as not using the terms interchangeably. The distinction is important to a broader discussion around the mechanisms by which environments impact wellbeing and which to target depending on the research context.

The third unique strength (study 2) was the investigation of trait cheerfulness and bad mood as possible covariates. Each trait characteristic directly influenced the respective relationships between the environment and positive or negative emotions elicited, mood generally irrespective of environment, and the environment type/place preference interaction effects on all emotions except desire. These findings support earlier links between trait cheerfulness and bad mood, environmental stimuli, and emotion (Lõpez-Benítez et al., 2018). It may be some of the differences between natural and built environments previously observed are dispositional, with some people simply less likely to experience the same level of positive (or negative) benefits at baseline. Trait cheerfulness is also relevant for future research based on its link with emotion regulation and management (Lõpez-Benítez et al., 2018); thus, it may also be affecting emotional responses to environments indirectly via its influence on emotion regulation. Additionally, prior studies have established links between nature relatedness, a trait-like characteristic (Nisbet et al., 2009), with personality traits (Nisbet et al., 2009; Tam, 2013), character strengths (Merino et al., 2020), positive affect (Nisbet and Zelenski, 2013), and affect balance (Tam, 2013). Collectively, these findings and those of study 2 reinforce a need to use an individual differences approach in environment-wellbeing research.

5.4. Methodological limitations

Despite the unique strengths of the studies presented, it is also important to recognise several limitations to the studies presented that may limit the generalizability of the findings. In a workplace context, micro-breaks (i.e., micro-doses) are voluntary activities (Kim et al., 2015, 2017, 2022; Hunter and Wu, 2016). Participants were *required* to engage with the stimuli rather than choosing to do so. As such, they may have felt required to expend effort based on instructions to 'study' the image, effectively making this a directed attention task rather than a task that allows directed attention to disengage (Kaplan, 1995). Conversely, participants may have not actually adhered to those instructions. Both factors may have had an impact (Hunter and Wu, 2016) and potentially explain a lack of effect on mood. Yet there were observed differences in emotional response. This pattern of results might support SRT

(Ulrich, 1983; 1991) and its focus on emotion as the mechanism for environmental influences on wellbeing over ART's (Kaplan, 1995) attention-driven mechanism (Wilkie and Davinson, 2021b). In future studies, participants should be asked to rate the level of effort they put into 'studying' the image as a possible control variable with adherence checks to ensure they did engage with the image. Depending on the wider research context, it might also be possible to 'randomly' display the image while doing other tasks, effectively as a break from what they were doing. However, this would not rectify a concern that micro-breaks should be voluntary. Another recommended aspect of micro-breaks is they involve doing something the individual prefers (Hunter and Wu, 2016), so it is also important to continue to include place preference to determine if it has any effect.

Use of natural and urban environments may also be driven by the need to regulate emotion. For example, individuals may *seek out places* as a type of *situational selection* or *situation modification* for this aim, irrespective of whether any positive benefit is perceived in advance (Korpela et al., 2018; Bratman et al., 2020) or feel a *drive* to engage with an environment to regulate their emotions thus achieving emotional balance (Richardson et al., 2019). Emotion regulation processes, particularly cognitive reappraisal, has resulted in improved subjective vitality after virtual blue space exposure (Theodorou et al., 2023). Future studies could integrate predictive aspects grounded in ART and SRT, as well as emotion regulation, to better ascertain mechanisms underlying the link between specific environmental experiences and health and wellbeing. Aspects of emotion regulation may be relevant mechanisms to both the restoring and building capacities, as outlined by Wilkie and Davinson (2021b).

Several limitations related to study design. The current study focused on a brief dose of a visual stimulus because ART and SRT emphasize the visual characteristics of environments (Kaplan, 1995; Ulrich, 1983). Yet, evidence also suggests that our environmental experiences are multisensory and senses including sound and touch should be included to fully understand restorative experiences (e.g., Fiebig et al., 2020; Payne, 2013; Ratcliffe et al., 2013; Rickard and White, 2021). Future work could manipulate other sensory modes (Bratman et al., 2020), along with visual stimuli characteristics (Delicato, L. Wilkie, in preparation). In both studies, participants were also presented with a single image of a specific environment type, which replicated the bias in comparisons of positive nature with non-positive urban settings (Bornioli and Subiza-Perez, 2023). These images were used successfully in prior research (Wilkie and Clouston, 2015) and images can induce emotional responses (Harmon-Jones et al., 2016; Siedlecka and Denson, 2019). Yet, future studies should include a range of environment types and images should also be further examined to ensure consistency of visual characteristics such as colour and luminance (Kardan et al., 2015; Delicato, L. Wilkie, in preparation). Additionally, if multiple images are used as an image set for each category of environment, researchers may want to consider treating the images as a random factor in any statistical model (Judd et al., 2012).

Participants did not complete baseline subjective wellbeing measures (i.e., mood or emotion). Although we controlled for trait cheerfulness/bad mood, a repeated measured design would reflect change in emotion or mood and may be a useful approach in future studies. Additionally, we did not expose participants to a stressor or require them to complete a task to deplete their directed attention. In essence, participants may not have been in stressed or cognitively depleted, important precedent states in SRT and ART. This may explain the lack of mood effects; although if that were the case, there should not have been differences in emotion in the present studies. Yet, our findings could support those in studies of instoration, when participants are not stressed/depleted (e.g., Korpela and Ratcliffe, 2021). Future studies should determine whether individuals are stressed or cognitively fatigued prior to taking part and possibly also induce stress/cognitive fatigue as part of the study.

Place preference was a dichotomous categorial variable. Although this method has been used previously (e.g., Wilkie and Clements, 2018; Morton et al., 2017), participant choice of a nature or urban preference could have also been influenced geographic trends which show country-wide differences in favourite place types (Subiza-Pere.ez et al., 2021a). Asking participants to make this choice was intended to prime positive identity salience, which has influenced cognitive restoration (Morton et al., 2017). It is important to recognise place identity – like other social identities and self-categorizations - are not exclusively positive (Biddau et al., 2023); thus, perceived negative social associations with the place may have impacted which option a participant chose. However, the self-categorization of place preference (i.e., place identity) in the current studies was contextualised with instructions associating the type of person they considered themselves to be with *the place they most enjoy spending time*. In that respect, self-categorization and the influence of different place types on emotion should have been driven to be congruent with positive identity processes (Devine-Wright and Clayton, 2010). Although there was no difference in place preference by country of residence in either study, the demographic profile of residence countries in study 2 had a higher proportion of European residents, which may have resulted from convenience sampling via researcher professional networks on Linked In. Although mean age and gender composition was similar between studies, the difference in residence may have influenced the findings.

In study 2, Likert scales for all measures utilised the same 5-point scale. This meant we were unable to directly compare the findings between the two studies here or with prior studies using the same measures due to differing scales of measurement. It is common practice to reduce participant burden by making scales the same across all measures and easily to allow comparison between measures within a study. However, in future, researchers might consider retaining the original Likert scales to facilitate comparison between their results and published studies. For comparisons within a study, different scale scores could be converted to a percent-scale-maximum (International Wellbeing Group, 2013). This would facilitate interpretation within a study but also has practical implications for recommendations to policy and individual stakeholders who may better understand a percentage value than a Likert rating scale. Perhaps more importantly, we operationally defined emotion as an 'in the moment' manifestation using discrete framework linked to unique emotions (Mauss and Robinson 2009) and differentiated it from state mood capturing dimensions of positive or negative affect. However, readers may query whether the words used in the DEQ-SF and the PANAS were substantively different enough to capture the distinction between emotion and mood. We did review the list of words between the measures in Study 2 and believe they do manifest different, but related constructs. Future research – both within person-environment research and the broad psychological study of emotions and mood - should further explore the complexities of this interplay, which was beyond the scope of the current research (interested readers see Beedie et al., 2005; Ekkekakis and Petruzello, 2000; Scherer et al., 2005). One way to achieve this could be to look at the difference in physiological response time between emotion and mood words endorsed in response to environmental stimuli.

5.5. Implications and conclusion

The findings presented indicated a virtual micro-dose of nature, urban greenspace, or an urban street can have similar effects to longer doses when assessing the perceived restorativeness of these settings. There may be circumstances where researchers want to obtain rapid judgements of different environments from a large sample, so this method can be effectively implemented using online survey platforms. The evidence supported the use of a brief virtual dose to elicit positive emotions. Another methodological implication is a brief dose could also be used to induce the desired emotion in a short period of time. However, the widely accepted mood effect of natural spaces compared with

urban streets was not elicited from a micro-dose. One of the most important recommendations from this research is that future studies should further explore emotion and clearly differentiate it from mood. Doing so will both expand our understanding of the ways in which environments impact us, as well as allow researchers to testing important theoretical predictions of the difference causal pathways linking our environments and our wellbeing.

Ethics & informed consent statement

The research adhered to the ethics guidelines of the British Psychological Society. The authors confirm that all procedures were performed in compliance with relevant laws, institutional guidelines and that the appropriate institutional committee(s) approved them. Informed consent was obtained from participants and the privacy rights of participants were observed.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.cresp.2023.100127.

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