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Nature Adds Color to Life: Less Boredom in Natural Versus Artificial Environments

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Boredom is a common and unpleasant experience associated with a range of problematic correlates and consequences. We examine a catalyst and its putative remedy all but neglected in the psychological science of emotion, and boredom in particular: the living environment. Specifically, we proposed and tested that "artificial" (e.g., urban) environments elicit boredom and that natural environments may counter it. Study 1, a field experiment, showed that people placed in natural versus artificial surroundings experienced less boredom. In Study 2, we found that the more prominently regions were characterized by natural (vs. artificial) geography, the less boredom was expressed on social media in the region. Study 3 showed experimentally that images of natural environments elicited less boredom than artificial ones, and Study 4 found that this effect is partly due to the vividness of colors in nature. Study 5 established that higher boredom in artificial versus natural environments can be attributed especially to the increase in boredom that artificial environments bring about. These findings provide the first systematic evidence of the importance of the environment on boredom and illustrate the cumulative effects that changes in one's environment can have on emotion experiences.

Public Significance Statement

Boredom is a experience that is increasingly common in society. Despite appearances, this seemingly mundane feeling is associated with a range of problematic outcomes (e.g., aggression, substance use, attentional difficulties), especially when left to fester unresolved. We examined and found that boredom thrives when people look at or are surrounded by artificial environments, such as urban or industrial landscapes; natural environments are comparatively less conductive to boredom. We also found that these differences in boredom that natural versus artificial environments breed are at least partially due to the difference in perceptual vividness of these environments, with nature offering higher color brightness, contrast, and saturation. Our findings can help develop ways to reduce and prevent boredom, for example, by introducing more nature in artificial environments and increasing access to natural spaces for those who may otherwise be at risk of excessive boredom (e.g., in care settings).

Keywords: boredom, nature, environment, emotion, geography

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Muireann K. O'Dea and Ioana E. Militaru are shared first authors. Open Science Framework contains data (Studies 1, 3–5), analysis scripts in *R* (Studies 1–5), instructions and measures (Studies 1, 3–5), and stimuli (Study 4) at https://osf.io/8tbkj/?view_only=e4d6be7149444847b97811 09cb486c91. The associated identifications of tweets in Study 2 will only be made available for the purpose of academic research upon request to preserve users' anonymity and in accordance with Twitter's terms of service at the time of data collection. County-level sociodemographic data were collected from the U.S. Census Bureau and are publicly available. County-level mobility estimates were retrieved upon request from Cuebiq's Data for Good program (https://www.cuebiq.com). Land cover data are publicly available at https://www.openicpsr.org. Stimuli of Study 3 cannot be shared due to copyright protection. Stimuli of Study 5 are available through the Southampton-York Natural Scenes database at https://syns.soton.ac.uk. Study 5 was preregistered at https://aspredicted.org/h5hz-f7p7.pdf. Studies 1–4 were presented at the 2024 Annual Convention of the

continued

Now I'm in the subway and I'm looking for the flat

This one leads to this block, this one leads to that

The wind howls through the empty blocks looking for a home

I run through the empty stone because I'm all alone

London's burning with boredom now

—London's Burning, *The Clash*

Where in the environment does boredom stir? According to the Clash, we may find it among the cold blocks of monotonous residences in London. Blaming such artificial environments for boredom may stand to reason; natural environments, after all, tend to have a comparatively positive impact on physical and psychological well-being (Bowler et al., 2010; Hartig et al., 2014). We set out to test if artificial environments, as opposed to natural ones, indeed breed boredom. We did so as chronic boredom levels have been consistently identified as problematic for healthy psychological and societal functioning (Goldberg et al., 2011; Pfattheicher et al., 2021; van Tilburg, Igou, Maher, & Lennon, 2019). While some internal psychological resources have been provided to mitigate boredom (Coughlan et al., 2019; O'Dea et al., 2022; O'Dea, Igou, & Van Tilburg, 2024; van Tilburg, Igou, Maher, Moynihan, & Martin, 2019), no empirical research has focused on large-scale solutions, taking environmental factors into account. We aim to redress this imbalance by looking at how the environment in which people live affects boredom.

Boredom

Boredom involves "the aversive experience of wanting, but being unable, to engage in satisfying activity" (Eastwood et al., 2012, p. 482). It is an unpleasant and common emotion (Chin et al., 2017; Larson & Richards, 1991), and one that is distinct from other forms of negative affect, such as sadness, frustration, or anger (van Tilburg & Igou, 2017a). Boredom's hallmark characteristics involve a lack of perceived purpose (van Tilburg & Igou, 2012) combined with attention failures (Hunter & Eastwood, 2018). Bored people report low arousal (van Tilburg & Igou, 2017a; Smith & Ellsworth, 1985), though physiological measures suggest that a mix of low and high arousal can occur (Danckert, Hammerschmidt, et al., 2018; Merrifield & Danckert, 2014).

Boredom accompanies repetitive, meaningless, and unchallenging (in)activity (Barbalet, 1999; Chan et al., 2018; van Tilburg & Igou, 2011; van Tilburg & Igou, 2012). Boredom, in turn, facilitates self-regulatory behavior (Bench & Lench, 2013; Danckert, Mugon, et al., 2018; van Tilburg & Igou, 2012) directed at coping with this undesirable state. Thus, boredom is not merely a passive state of disinterest, disengagement, or inactivity, but, instead, it effectively regulates behavior by signaling that a current course of action is not serving the pursuit of a valued goal, subsequently directing attention elsewhere in pursuit of more satisfactory courses of action (Elpidorou, 2018; Gerritsen et al., 2014; Tam et al., 2021). Accordingly, boredom triggers attempts at escaping from these adverse conditions, for example, by turning to perceived sources of meaning (e.g., nostalgic reverie; van Tilburg et al., 2013), seeking novelty (Bench & Lench, 2019), propelling exploration (Geana et al., 2016; see also Danckert, 2019), or through behaviors that may be attempts at momentarily numbing the feeling of boredom, such as snacking (Moynihan et al., 2015), impulsive decision-making (Moynihan et al., 2017; Kılıç et al., 2020), and self-inflicted pain (Nederkoorn et al., 2016; T. D. Wilson et al., 2014).

While recent work portrays boredom as an emotion that serves potentially adaptive psychological functions, its correlates and outcomes are predominantly negative. For example, people who are prone to boredom display higher levels of aggression, a lack of perceived meaning in life, and depression (Goldberg et al., 2011; Pfattheicher et al., 2021; van Tilburg, Igou, Maher, & Lennon, 2019). They are at greater risk of issues such as pathological gambling, dropping out of education, and substance abuse (Blaszczynski et al., 1990; Iso-Ahola & Crowley, 1991; Tvedt et al., 2021). While state boredom—its transient and common form (Chin et al., 2017; Chan et al., 2018)—is capable of prompting a number of arguably desirable outcomes in specific situations (e.g., nostalgic reverie and willingness to help; van Tilburg et al., 2013; van Tilburg & Igou, 2017b), it also causes attention failures, reduced performance, impulsiveness, financial risk-taking, and even intergroup bias (Eastwood et al., 2012; Kılıç et al., 2020; Moynihan et al., 2017; Pekrun et al., 2014, 2023; van Tilburg & Igou, 2016). Clearly, boredom—while playing a potentially beneficial self-regulatory

Society for Personality and Social Psychology by Muireann K. O'Dea. Study 2 served as basis of a chapter in the 2024 PhD thesis of Ioana E. Militaru.

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role—can be deeply problematic and negatively impact personal and societal welfare.

While remedies for boredom are relatively understudied, they are an important area for examination. Evidently, there is great diversity in boredom's consequences. This diversity in outcomes suggests that the way people respond to boredom is likely shaped by context (Tam, Chan, et al., 2023; Tam, Van Tilburg, & Chan, 2023). In other words, the psychology of boredom is situated in the environment that people inhabit, and putative remedies to boredom may be equally situated in the broader environment.

Boredom and the Environment

Research on boredom, especially in recent years, has uncovered its significance for the individual and society in light of its detrimental correlates and outcomes. In the search for its causes, psychologists have predominantly focused on individual-level predictors of momentary boredom and boredom proneness, such as introversion, disagreeableness, a lack of openness to experience (Ashton & Lee, 2009), low prevention focus, low self-control, a lack of internal stimulation (Struk et al., 2016), attention failures, and lack of meaning in life (Fahlman et al., 2009; Moynihan et al., 2021; Tam et al., 2021; Westgate & Wilson, 2018). The same focus on individual-level variables has characterized research on putative remedies to boredom, such as personally significant nostalgic reverie (van Tilburg et al., 2013), the affirmation of individual heroes (Coughlan et al., 2019), practicing self-compassion (O'Dea et al., 2022), identifying sources of gratitude (O'Dea, Igou, & Van Tilburg, 2024), or religiosity (van Tilburg, Igou, Maher, Moynihan, & Martin, 2019). While it is certainly valuable to understand such personal causes and cures of boredom, their utility for combatting boredom at a large scale may be limited. Furthermore, they do not inform the field about the broader environment and situations where boredom flourishes—a feature that arguably ought to be present in contemporary boredom models (e.g., Danckert & Elpidorou, 2023; Eastwood & Gorelik, 2019; Tam et al., 2021; van Tilburg & Igou, 2019; Westgate & Wilson, 2018) but has been understudied.

The predominant focus on individual-level causes and remedies of boredom does not take away that there has indeed been some, albeit limited, empirical work into situational or broader environmental factors. The most extensive investigation of situational factors in boredom has been in educational settings. For example, extensive work by Pekrun (2006, 2014, 2023) showed that a lack of value associated with educational goals and being either too much or too little challenged breeds student boredom. Furthermore, being made to expect that classes are boring or being taught by a bored teacher cultivates subsequent boredom in class (Tam et al., 2020; Tam, Van Tilburg, & Chan, 2023). Yet, while such findings are clearly valuable for educational settings in particular, these insights into situational causes (and their putative remedies) may not readily generalize beyond.

To our knowledge, no research has empirically and systematically examined environmental causes and remedies of boredom at a large scale—that is to say, research that examined characteristics of the environment that affect many, or perhaps even all, people or entire societies. This is an important issue: While dwelling on nostalgic memories, turning to one's heroes, being self-compassionate, increasing attentional resources, seeking novelty, or practicing self-control may help *oneself* to prevent or mitigate boredom, they rely on the individual's motivation to draw on these psychological resources and are arguably not solutions that can be realistically implemented at a larger scale. Yet, finding such a collective solution to boredom is a pressing issue: Recent work shows that boredom is a major problem for groups at risk (e.g., unemployed young White men in the United States; adolescents; Chin et al., 2017) and is on the rise (Weybright et al., 2020).

As a case in point, Elpidorou (2022) argued that boredom disproportionally affects those of low-socioeconomic backgrounds and called for a focus on large-scale factors, such as poverty and a lack of resources and opportunities in the environment. While Elpidorou's work focuses on the psychological impact of low-socioeconomic status on meaning and attention en route to boredom, his novel call for research more broadly highlights the need to understand boredom in the context of the social and physical environment, an issue that is of both practical relevance and would add a hitherto neglected component to the contemporary scientific understanding of boredom. We sought to address this issue by examining one particular large-scale variable: artificial and natural environments.

"Artificial environments" are used here to refer to environments that are largely made-up of elements of human origin, such as buildings and streets, but also agricultural lands where humans' intervention is visibly dominant. In turn, we used "natural environments" to refer to environments of mostly nonhuman origin, where humans' presence or intervention is generally not apparent (e.g., forests, beaches). We propose that artificial environments elevate boredom relative to natural ones, or vice versa, that natural environments alleviate the boredom that artificial environments breed. Within *natural* environments, we refer to those environments that are typically classified as "blue" (spaces that "feature visible outdoor surface waters"; Britton et al., 2020) or "green" (spaces that feature "any vegetated land or water"; Wicks et al., 2023).

Boredom and the Living Environment

An emerging stream of research investigates the associations between elements of the physical environment and a plethora of psychological characteristics, including personality traits (Militaru et al., 2024), cognitive styles (Uskul et al., 2008), aggression (Van Lange et al., 2017), creativity (Van de Vliert & Van Lange, 2019), or well-being (Fischer & Van de Vliert, 2011). Behind many strands of research within the corresponding field of geographical psychology lies the assumption that environments come with their own set of pressures and affordances that largely shape individuals' thoughts, feelings, behaviors, and personality traits (Rentfrow et al., 2008; Rentfrow, 2020). Following this idea, it is plausible that certain types of environments are more conducive to boredom than others. Specifically, natural environments that are more conducive to active endeavors (sports, walking) may be perceived and experienced as less boring compared to artificial environments. This assumption is aligned with recent findings showing that those who engage in sporting activities, gardening, writing, or reading are seen as less boring, whereas those who sleep, watch TV, study, or collect items are perceived to be stereotypically boring (van Tilburg et al., 2023).

While the proposition that natural environments may alleviate boredom has, to our knowledge, not been examined before, the more general notion that natural environments can exert a positive influence on human functioning is well-established. Research suggests that being near nature benefits memory and attention (R. Kaplan & Kaplan, 1989) and builds physical and psychological resilience (Berto, 2014; Capaldi et al., 2014). In a daily diary study, participants reported greater satisfaction with life on the days they experienced nature (Anderson et al., 2018). Furthermore, "blue" and "green" natural environments can help to alleviate negative affect (Thompson Coon et al., 2011) and reduce stress (Bowler et al., 2010; Hartig et al., 2014). Similarly, exposure to computer generated blue environments was found to decrease boredom (N. L. Yeo et al., 2020). The pathways through which nature promotes physical health and well-being include better air quality, increased physical activity, social cohesion, and stress reduction (see Hartig et al., 2014 for a review). These findings resonate with lay beliefs in society about the beneficial impact of nature, for example, within pantheistic cultural beliefs and the biophilia hypothesis (E. O. Wilson, 1984; see Fromm, 1973).

Spending time in nature boosts positive affect and alleviates negative affect (Bowler et al., 2010; Beckmann et al., 2019; Donnelly & MacIntyre, 2019; Hartig et al., 2014). However, limited research has examined the role of discrete emotions during nature experiences, with some notable exceptions (e.g., MacKerron & Mourato, 2013; Militaru et al., 2025; Monroy & Keltner, 2023; Sturm et al., 2022). This is a significant limitation as specific emotions, like fear and gratitude, elicit unique effects on physical health and well-being (e.g., Gordon et al., 2017; Wood et al., 2010; Stellar et al., 2015). As discussed above, boredom is no exception and is predictive of many negative well-being outcomes. As argued by Anderson et al. (2018), illuminating the impact of nature on specific emotions will enhance our understanding of the mechanisms through which nature leads to enhanced psychological functioning.

Color Vividness in Natural Vistas

Why might natural environments help to alleviate boredom (relative to artificial environments)? One reason is that, relative to artificial environments, the vivid colors present in natural environments engage attention. A review and meta-analysis by Ohly et al. (2016) of research into attention restoration theory—which posited that natural environments have the capacity to restore attention (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995)—found that, despite variation in the magnitude of effects across methodologies, natural environments overall positively impact features of attention such as digit spans and task switching. Attention restoration theory proposes that nature allows people to "be away" from their usual (presumably nonnatural) environment, providing a "soft fascination" that cognitively restores. To this day, the attention restoration theory has received abundant support. For example, Berto (2005) found that participants exposed to images of nature compared to urban environments performed better in a sustained attention test, providing evidence for the attention restoration theory.

The proposition that attentional engagement through natural environments might, in turn, produce less boredom also rhymes with boredom research. Attention failures are a hallmark feature of boredom (Eastwood et al., 2012), which tends to arise in tasks that do not engage attention satisfactorily (Hunter & Eastwood, 2018). Furthermore, related factors such as monotony and lack of stimulation are known triggers of boredom (Eastwood et al., 2012; Tam et al., 2021). Indeed, nature likely contains sensorial patterns that lead to increased cognitive activation and may, in turn, decrease boredom. Color and pattern preferences that are more complex, diverse, or intense, as typically found in nature, are preferred. For instance, landscapes' level of complexity, measured as the landscape's outline fractal dimension, plays a role in our preference for nature (Hagerhall et al., 2004) and increases cortical activation (Taylor et al., 2011). Similarly, colors were found to partly account for humans' biophilic tendencies. Natural scenes containing more green and blue hues are rated more scenic than artificial scenes containing human-made structures. In turn, those living in more scenic areas report better health (Seresinhe et al., 2015). Green, compared to subjectively darker green-red foliage was also found to be more appealing, increase attention, and enhance cerebral blood flow (Elsadek & Fujii, 2014; Elsadek et al., 2017), outcomes that plausibly counter boredom.

Indeed, factors such as brightness, saturation, and contrast—which we collectively group under "vividness" features—capture attention. An experiment by Camgöz et al. (2004), for example, showed that colors high in saturation and brightness increased attention across a range of backgrounds, and Stuart et al. (2014) found that saturation and brightness impacted attentional engaging independently and in a complementary fashion. Parkhurst and Niebur (2004) furthermore reported that contrast and luminance (a strong correlate of subjective brightness) attract visual attention. In fact, some work suggests that focusing attention also increases perceptions of visual contrast and saturation (Carrasco et al., 2004; Fuller & Carrasco, 2006), suggesting the existence of a positive feedback loop between vividness indicators and attention.

The Current Research

In five studies, we examined the impact of natural (vs. artificial) environments on boredom. We tested four hypotheses, one principal, and three complementary. The principal hypothesis was that natural (vs. artificial) environments produce less boredom (H1). The complementary hypotheses focused on the variable we anticipated to be (partially) responsible for this link process: color vividness. Our second hypothesis was that natural (vs. artificial) environments feature more vivid colors (H2), our third hypothesis was that higher color vividness is associated with lower boredom (H3), and our fourth hypothesis was that vividness acts as a mediator between nature and boredom (H4).

We tested (H1) across all studies, tested (H2) and (H3) in Studies 1, 3, 4, and 5 and tested (H4) in Study 4. Study 1 was a field experiment where participants were randomly positioned in a natural versus artificial environment, followed by measures of boredom and perceived vividness. In Study 2, we took a broader perspective in which we examined how expressions of boredom on social media varied as a function of the local environment in which participants were located, quantified in terms of its naturalness using satellite land cover data. In Study 3, we examined boredom and perceived vividness in response to displays of natural versus artificial environments presented to participants as part of a between-subjects lab experiment. Study 4 extended Study 3 by using a more powerful within-subjects design, where we manipulated vividness orthogonally to the environment. Doing so allowed us to experimentally test the proposed mediating role of vividness (Spencer et al., 2005). Study 5 went beyond Studies 1–4, by specifically testing whether natural environments reduce boredom or whether artificial environments induce it. Study 5 was preregistered, while Studies 1–4 were not.

Study 1: A (Green) Field Experiment

We began by testing the hypothesized difference in boredom between natural and artificial environments in an ecologically valid setting. Specifically, people were randomly taken to either a natural versus artificial environment and, once there, answered a series of questions, including how bored they felt. We tested if boredom would be lower in the natural or artificial environment (H1). In addition to probing boredom, participants evaluated the vividness of their environment, which we again anticipated to be comparatively higher when surrounded by nature (H2) and was expected to correlate negatively with boredom (H3).

The current field study furthermore served as a test to identify if the expected comparatively palliative impact of nature was specific to boredom and not to general positive and negative affect. To that end, we complemented our boredom measure with matched ones of sadness and happiness and checked if the hypothesized effect of nature was specific to boredom versus these other forms of affect. Furthermore, natural environments are a known precursor to the emotion of awe (Anderson et al., 2018; Piff et al., 2015), and awe, in turn, prevents boredom (O'Dea, Igou, Van Tilburg, & Kinsella, 2024). Accordingly, we measured awe and explored if nature caused this experience to rise in parallel to boredom's presumed decline.

Method

Participants and Design

We aimed to recruit as many people on the University of Essex campus grounds as feasible, up to a maximum of 200, over a set period of 3 weeks, with recruitment scheduled for midday depending on researcher availability. We avoided mornings due to low student foot traffic and avoided late afternoons due to early sunsets. The period was also restricted by occasional poor U.K. weather conditions (rain, strong wind, a few surprisingly cold days) that caused us to pause data collection on those days for experimenter and participant well-being. We managed to recruit 155 people over the period (81 women, 72 men, 2 nonbinary; $M_{age} = 24.45$, $SD = 5.59$). They self-reported a range of national (39 British, 29 Indian, 12 Pakistani, 10 Chinese, 65 nationalities with fewer than 10) and ethnic backgrounds (41 White British, 38 Asian/South Asian, 79 ethnicities with fewer than 10). Participants were randomly assigned to the two conditions of a between-subjects design (environment: natural [$n = 73$] vs. artificial [$n = 81$]). Sensitivity analysis indicated that this sample size afforded 90% power to detect differences between the conditions of $d = 0.53$, with a two-sided Type I error rate of $\alpha = .05$. The study received ethical approval from the University of Essex (ETH2223-0659).

Materials and Procedure

The study took place on the Colchester campus of the University of Essex. This campus architecture is an iconic example of Brutalist architecture, featuring heavy use of minimalist grey concrete structures (Murphy, 2022). Strikingly, the campus is situated in the middle of the award-winning *Wivenhoe Park*, containing woodland, fields, and ponds. This setup, placing unforgiving concrete masses in the center of blue and green vistas, served as the backdrop to our study.

People were approached in the "Square 5" area of the University of Essex Colchester campus—approximately equidistant to the park and to an inner campus plaza lined with concrete structures. After giving informed consent, experimenters walked participants from the recruitment location either into the park or further onto the campus. The walk to each location took approximately 2 min from the recruitment location; Figure 1 displays panoramic photos of these locations. Once arrived, participants verbally answered the experimenter questions. We first asked them, "To what extent do

Figure 1

Panorama Photos of the Natural and Artificial Environments From Study 1

Note. See the online article for the color version of this figure.

you experience happiness?" (1 = *not at all*, 7 = *extremely*), followed by the same question for boredom, sadness, awe, and meaning (Note that results for meaning are reported in the Supplemental Material). We then asked participants to rate perceptual vividness on similar scales, using the items "How saturated would you say that the environment around is us?," "How high in visual contrast would you say that the environment around us is?" and "How high in brightness would you say that the environment around us is?" Concerned that some participants may not be familiar with this terminology, these questions were accompanied by short verbal descriptions of these features ("Saturation is the degree to which colors are deep or intense," "Visual contrast refers to differences in the colors of things around us," "Brightness refers to seeming to give out or reflect light."). We averaged these items into an overall vividness index ($\alpha = .82$). Erring on the side of caution, we also assessed vividness with a separate single item: "How vivid would you say that the environment around us is?".

Participants then reported age, gender, nationality, and ethnicity and gave three key words that described their day. They were then thanked and received sweets as a token of appreciation. After they left, the experimenter recorded temperature and time, as well as the presence of rain, clouds, wind, and sunshine.

Results and Discussion

H1: Natural Environments Elicits Lower Levels of Boredom

An independent samples *t* test confirmed that participants who visited the natural environment felt significantly less bored (M = 3.08, SD = 1.63) than those who visited the artificial environment (M = 3.93, SD = 1.90), $M_{\text{nature}} - M_{\text{artificial}} = -0.844$, SE = .287, $t(152) = 2.945$, p = .004, 95% CI [−1.410, −0.278], $d = -0.475$. This confirmed our principal hypothesis.

H2: Natural Environments Are More Vivid

Independent samples *t* test indicated, as predicted, that the natural environment was more vivid than the artificial environment. This was the case both for the three-feature (saturation, contrast, vividness) index of vividness (M = 4.68, SD = 1.26 vs. M = 3.85, SD = 1.30), $M_{\text{nature}} - M_{\text{artificial}} = 0.829$, SE = .207, $t(152) = 4.002$, $p < .001$, 95% CI [0.420, 1.238], $d = 0.646$, as well as for the single-item measure (M = 5.11, SD = 1.45 vs. M = 3.90, SD = 1.60), $M_{\text{nature}} - M_{\text{artificial}} = 1.210$, SE = .248, $t(151) = 4.879$, $p < .001$, 95% CI [0.720, 1.699], $d = 0.790$.

H3: Vivid Environments Feature Less Boredom

In keeping with the prediction that boredom is lower in vivid environments, we found significant negative correlations between boredom and the three-feature index of vividness, $r(153) = -.199$, p = .013, and between boredom and the single-item vividness measure, $r(152) = -.200$, p = .013. Vivid environments are less boring.

Auxiliary Analyses: Sadness, Happiness, and Awe

To get a sense of how specific the impact of nature on boredom was, we tested if the natural (vs. artificial) environment resulted in changes in other forms of affect that may relate to boredom (sadness, happiness, awe). Indeed, boredom had medium-sized and significant negative correlations with happiness and awe and a positive one with sadness (see Supplemental Material for details). Independent samples *t* tests showed no significant differences in average happiness between the natural (M = 5.22, SD = 1.30) and artificial (M = 4.94, SD = 1.32) environments, $M_{\text{nature}} - M_{\text{artificial}} = 0.281$, SE = .212, $t(152) = 1.328$, p = .186, 95% CI [−0.137, 0.699], $d = 0.214$. Likewise, sadness did not differ significantly between the natural (M = 2.51, SD = 1.32) and artificial (M = 2.95, SD = 1.82) environments, $M_{\text{nature}} - M_{\text{artificial}} = -0.444$, SE = .283, $t(152) = 1.567$, p = .119, 95% CI [−1.003, 0.116], $d = -0.253$, and neither did awe (M = 3.56, SD = 1.82 vs. M = 3.15, SD = 1.77), $M_{\text{nature}} - M_{\text{artificial}} = 0.413$, SE = .273, $t(152) = 1.516$, p = .132, 95% CI [−0.125, 0.952], $d = 0.245$. These results offer no evidence that the remedial impact of nature on boredom is paralleled by changes in happiness, sadness, or awe.

Note on Statistical Mediation

Our sample size offered insufficient power to detect statistical mediation of the effect of environment on boredom through vividness, assuming small-to-medium effect sizes for the associations between these variables ($1 - \beta = 61\%$; r = .25, α = .05). For full transparency, no significant statistical mediation was found for either the three-item index of vividness, $B = -.077$, SE = .054, 95% CI [−0.194, 0.022], or the single-item version, $B = -.082$, SE = .066, 95% CI [−0.216, 0.046]; see Supplemental Material for full details. We further address to the matter of mediation in Study 4 and the General Discussion section.

Study 2: Boredom in the Wild

Study 1 provided evidence from a real-life context that artificial environments elicit more boredom than natural ones. Study 2 sought to further expand on the real-life context that Study 1 introduced in two ways. First, we adopted a different operationalization of boredom. Rather than having people self-report how they felt, we examined expressions of boredom in posts ("tweets") on the social media platform formally known as *Twitter*. Second, we used satellite data to quantify how natural or artificial the local area was where these tweets were written. We tested if tweets written in areas that featured proportionally natural spaces contained fewer expressions of boredom. In addition, we measured expressions of sadness to check if the proposed association between natural environments and boredom generalized to this prototypical form of negative affect or if it was at least somewhat unique to boredom, similar to Study 1. Sadness is a suitable comparison, because it shares several similarities with boredom. For instance, both states are characterized by low self-reported arousal and negative affect (van Tilburg & Igou, 2017a), both are associated with feeling unable to control one's situation and feeling that the current situation is incongruent with one's goals (G. C. Yeo & Ong, 2024). Furthermore, while boredom can occur and can be induced independently of sadness (van Tilburg & Igou, 2012), they might to co-occur in naturalistic situations (Chan et al., 2018; Chin et al., 2017).

Method

Twitter Data

We collected U.S.-located tweets through the Twitter Application Programming Interface using the *R* package *rtweet* (Kearney et al., 2016) over the course of 14 days, starting on April 4, 2020. We searched for tweets that included at least one of three key words that signal self-reported boredom: (a) bored, (b) boredom, and (c) boring. We collected tweets that were in English and were not from verified accounts, as these tend to be associated with businesses or people of notable public interest. We excluded retweets as we sought to capture unaltered emotional experiences.

To assign a boredom score to each tweet, we used a frequency-based dictionary approach. The boredom dictionary contained the words "bored," "boring," "boredom," "dull," "uninterested," and "uninteresting" (Table 1). We used an extant sadness dictionary (Mohammad & Turney, 2013) to assign a sadness score to each tweet, containing words such as "agony," "withdraw," "secluded," and "suffer." To estimate the location of each tweet, we used the free-text location variable that users provided on their profiles (Schwartz et al., 2013). 126,119 tweets were successfully associated with a state, out of which 76,256 were associated with a state, county, and city, which we retained. We additionally excluded states that were represented by less than 100 tweets, a method used in geopsychological sciences to deal with the scarcity of geographical data. This approach allows the analysis of data at the preferred level of aggregation while still ensuring reliable aggregate-level estimates (Ebert et al., 2023). 75,882 tweets were retained for analyses. The study received ethical approval from the University of Cambridge (2021/57).

Land Cover

We collected the land cover composition data set from the U.S. National Neighborhood Data Archive 2016 release (Yang et al., 2018). Land cover composition was derived from satellite images and digital cartography (https://www.openicpsr.org/openicpsr/project/110663/; Clarke & Melendez, 2019). The data set records the proportions of the following land cover types: developed land, cultivated land, barren land, forest, shrub, herbaceous land, wetland, snow, and water (Yang et al., 2018). We aggregated the categories into two parent categories: (1) artificial spaces (developed, cultivated lands) and (2) natural spaces (barren land, forest, shrub, herbaceous land, wetland, snow, water).

Control Variables

We controlled for county-level gender composition and age, two typical controls in geographical psychology research (Ebert et al., 2020; Rentfrow, 2010). Notably, gender (Isacescu et al., 2017) and age (Chin et al., 2017) were previously found to be associated with boredom levels. We retrieved the county-level percentage of males and median age from the United States Census Bureau's 5-year estimates (United States Census Bureau, 2024). We additionally controlled for levels of mobility since physical movement may alleviate boredom (Bösselmann et al., 2021). We retrieved a county-level mobility index from Cuebiq's Data for Good program (https://www.cuebiq.com). The mobility index recorded the county-level distance travelled by anonymized users during our data collection period (Pepe et al., 2020).

Results and Discussion

Table 2 contains the zero-order correlations between variables. To test if people in areas that are comparatively natural express less boredom, we ran a series of random intercept multilevel analyses to account for the regional clustering of individuals (Level 1) within states (Level 2). All predictor variables were z-standardized to allow for cross-model comparison. Four models were built in a stepwise manner. An empty model (Model 0) was followed by the inclusion of the nature variable (Model 1), the regional mobility variable (Model 2), and regional demographics (Model 3). The same approach was used to assess the association between sadness and nature. We used three indicators to assess the relative model performance: R^2-marginal, R^2-conditional, and *Akaike information criterion*. R^2-marginal captures the variance explained by fixed factors, while R^2-conditional captures the variance explained by both the fixed and random factors. Last, we used *Akaike information criterion* as an information criterion indicator (Nakagawa et al., 2017).

The proportion of natural environments was negatively associated with boredom (Table 3, Model 1). When controlling for regional mobility and demographic variables, boredom continued to be

Table 1
Example Tweets With Boredom and Sadness Scores in Study 2

No.	Text	Boredom	Sadness
1	"With all the chaos and sadness we are seeing everywhere, this is a good time to emphasize how important it is to take the time to show gratitude. I know everyone is bored and going crazy, but right now being bored at home with loved ones sounds ideal."	0.04	0.06
2	"I need music. Without music, my ears are just boring instruments used to listen to stupid people chatting about meaningless things."	0.05	0.14
3	"Sick of being bored, sick of being lonely, sick of staying home, sick of a lot of things."	0.06	0.22
4	"Anyone else throw on a boring documentary to try and sleep but then realize it's not boring to you at all. I'm about to make that mistake now."	0.07	0.04
5	"Unbelievably bored and lonely:/. Fantastic."	0.2	0.2
6	"I get bored easily."	0.25	0
7	"I hate being bored."	0.25	0.25
8	"Feeling excruciatingly bored."	0.33	0.33
9	"Bored!!!"	1	0

Note. To protect users from potential reverse text searches, some words from the original posts have been modified while maintaining the core features of the message.

Table 2
Zero-Order Pearson's Correlations in Study 2

Variable	1	2	3	4	5	6
1. Boredom	—					
2. Sadness	−.053	—				
3. Nature	−.013	.004 *(.310)*	—			
4. Mobility	.062	−.014	.038	—		
5. Percent male	−.026	−.004 *(.224)*	−.030	.531	—	
6. Median age	−.022	.009 *(.011)*	.057	−.216	−.195	—

Note. Computed correlations used Pearson's method with listwise deletion. All correlations were significant at $p < .001$ unless otherwise stated italicized in parentheses.

negatively associated with nature (Table 3, Models 2 and 3). The association between boredom and nature was robust when controlling for sadness (Table 3, Model 4), suggesting that boredom may be distinctly associated with nature. We note that sadness was computed from tweets that were specifically collected to include boredom-related words, which was reflected in the lower mean score in sadness (M = 0.029, SD = 0.07) compared to boredom (M = 0.191, SD = 0.19). Boredom varied across counties and across states (Figure 2).[1]

Although consistent with the hypothesis that natural (vs. artificial) environments produce lower levels of boredom (H1), the effect was notably small. While these effect sizes are not uncommon in the field of geographical and socioecological psychology (Wei et al., 2017), they warrant clarification.

First, the results are (a) consistent with the effect uncovered in Study 1 and (b) aligned with what may be expected between emotions and a distal ecological factor such as landscape (e.g., Götz et al., 2020). We additionally note that regional boredom scores were derived from tweets rather than traditional self-reports. Tweets represent a naturalistic measure of state boredom, yet they are biased in at least two ways: (1) They may capture social-desirability biases that impact the users' content; (2) Twitter users are not a representative sample of the general U.S. population, in terms of age (Eichstaedt et al., 2015), education, or demographic characteristics (Mislove et al., 2011). Despite these limitations, Twitter data constitutes a cost-efficient alternative to expensive cross-national surveys while providing comparable or even better results. Twitter-based models outperform, at times, models using typical regional variables, such as income, education, or smoking rates, when predicting county-level heart disease mortality (Eichstaedt et al., 2015). Taken together, these results methodologically complement the findings in Study 1 and confirm nature's palliative role in countering boredom.[2]

Study 3: Boredom in Response to Natural and Artificial Imagery

Studies 1 and 2, using a field experiment and Twitter and satellite data, found that nature predicts less boredom in real-life contexts. Our third study sought to systematically test our hypotheses in a controlled experimental environment. We tested our principal hypothesis that boredom is lower in response to natural than artificial environments (H1). We also tested if natural (vs. artificial) environments are more perceptually vivid (H2) and if more vivid environments are less boring (H3).[3] In Study 3, we showed participants images of either natural or artificial environments and then asked them to rate their experienced boredom, as well as the perceived brightness, saturation, and contrast in these displays.

Method

Participants and Design

We recruited 108 people residing in the United States using the online MTurk (https://www.mturk.com) crowdsourcing platform, which was the maximum number of participants we could recruit with the remaining funds of one of the authors' yearly research budget, with sufficient remaining for Study 4. Sixteen observations from duplicate participants were dropped, resulting in a final sample of 92 participants. We randomly assigned participants to one of two conditions (environment: nature [n = 49] vs. artificial [n = 43]) of a between-subjects design. Sensitivity analysis indicated that this sample size allowed us to detect effects of d = 0.69 (r = .33) with a power of $(1 - \beta) = 0.90$ and two-sided Type I error of $\alpha = .05$. The study received ethical approval from King's College London (MR/16/17-151).

Materials and Procedure

Participants were randomly assigned to the nature or artificial environment condition. Those in the nature condition were shown, in random order, 10 pictures of nature (e.g., poppy field, forest, beach). Each picture was displayed for 5 s. Participants in the artificial environment condition instead saw 10 artificial environments (e.g., townhouses, interchange, port). Images were selected by the authors through an Internet search for high-quality photographs. We avoided detailed depictions of humans and other animals in the imagery and attempted to source a reasonable range of different environments. Participants then indicated how bright, saturated, and contrasting the colors in these displays were ("These pictures were bright," "These pictures featured contrasting colors," "These pictures featured saturated ['deep' or 'pure'] colors," respectively; 1 = *not at all*, 7 = *very much*). These three features of vividness displayed high internal consistency (α = .81), and we accordingly averaged them into a three-feature index of vividness. Participants next reported how bored they felt ("I feel bored," 1 = *not at all*, 7 = *very much*) and completed the five-item presence of meaning in life questionnaire (Steger et al., 2006; e.g., "I understand my life's meaning"; 1 = *absolutely untrue*, 7 = *absolutely true*; α = .92). Results for meaning in life are reported in the Supplemental Material. Participants were then debriefed, thanked, and rewarded.

[1] Note that Alaska and Hawaii are not represented on the map as they did not reach the 100 cases threshold for inclusion.

[2] The Supplemental Material contain analyses where we also examined the link between nature and "landscape entropy"—an indicator of variability in the geographical characteristics of the surrounding environment. Results of these analyses suggests that people located in areas characterized by highly (vs. little) variable landscape express less boredom.

[3] Originally, and before power estimation for mediation analyses were common, we also planned to test the hypothesis that vividness mediated the impact of nature on boredom. Given that we lacked power to do so—only $(1 - \beta) = 0.60$ for the indirect effect, assuming moderate effect sizes of (r = .30 [d = .629]) and two-sided Type I error of $\alpha = .05$ (Schoemann et al., 2017)—we refrained from this analysis.

Table 3
Results From Multilevel Models for Boredom in Study 2

Model	Model 0 Estimate	Model 0 95% CI	Model 1 Estimate	Model 1 95% CI	Model 2 Estimate	Model 2 95% CI	Model 3 Estimate	Model 3 95% CI	Model 4 Estimate	Model 4 95% CI
Dependent variable:										
Boredom										
Intercept	0.1885***	[0.1783, 0.1987]	0.1535***	[0.1401, 0.1670]	0.1526***	[0.1390, 0.1662]	0.1433***	[0.1300, 0.1566]	0.1480***	[0.1347, 0.1612]
Nature			−0.0278***	[−0.0340, −0.0216]	−0.0362***	[−0.0426, −0.0298]	−0.0299***	[−0.0365, −0.0234]	−0.0298***	[−0.0363, −0.0232]
Mobility					0.0088***	[0.0071, 0.0104]	0.0080***	[0.0063, 0.0096]	0.0079***	[0.0063, 0.0096]
Percent male							−0.0003	[−0.0050, 0.0043]	−0.0003	[−0.0049, 0.0044]
Median age							−0.0279***	[−0.0353, −0.0205]	−0.0279***	[−0.0353, −0.0206]
Sadness									−0.1410***	[−0.1606, −0.1213]
Model fit										
Marginal R^2/ Conditional R^2	0.000/0.025		0.002/0.031		0.014/0.043		0.008/0.029			
Adjusted *ICC*	0.02		0.03		0.03		0.02			
AIC	−30,732.777		−30,798.197		−30,892.643		−30,921.289			

Note. N = 75,882, N_{state} = 39. The adjusted ICC captures Level-2 random effects. CI = confidence interval; ICC = intraclass correlation; AIC = Akaike information criterion.
*** $p < .001$.

Results and Discussion

H1: Natural Environments Elicits Lower Levels of Boredom

An independent samples t test confirmed that participants who viewed images of natural environments felt significantly less bored (M = 2.33, SD = 1.57) than those who viewed artificial environments instead (M = 3.26, SD = 1.88), $M_{\text{nature}} - M_{\text{artificial}} = -0.929$, SE = .360, $t(90)$ = 2.582, p = .011, 95% CI [−1.644, −0.214], d = −0.54. This confirmed our primary hypothesis.

H2: Natural Environments Are More Vivid

An independent samples t test indicated, as predicted, that natural environments were more vivid than artificial environments (M = 5.65, SD = 1.06 vs. M = 4.36, SD = 1.19), $M_{\text{nature}} - M_{\text{artificial}}$ = 1.289, SE = .235, $t(90)$ = 5.486, $p < .001$, 95% CI [0.822, 1.755], d = 1.146. The images of nature proved more vivid than those of artificial environments.

H3: Vivid Environments Feature Less Boredom

Correlational analysis showed that participants who rated the images they viewed as more vivid felt less bored, $r(90) = -.476$, $p <$ .001. As predicted, the perceived vividness of an environment is accompanied by less boredom.

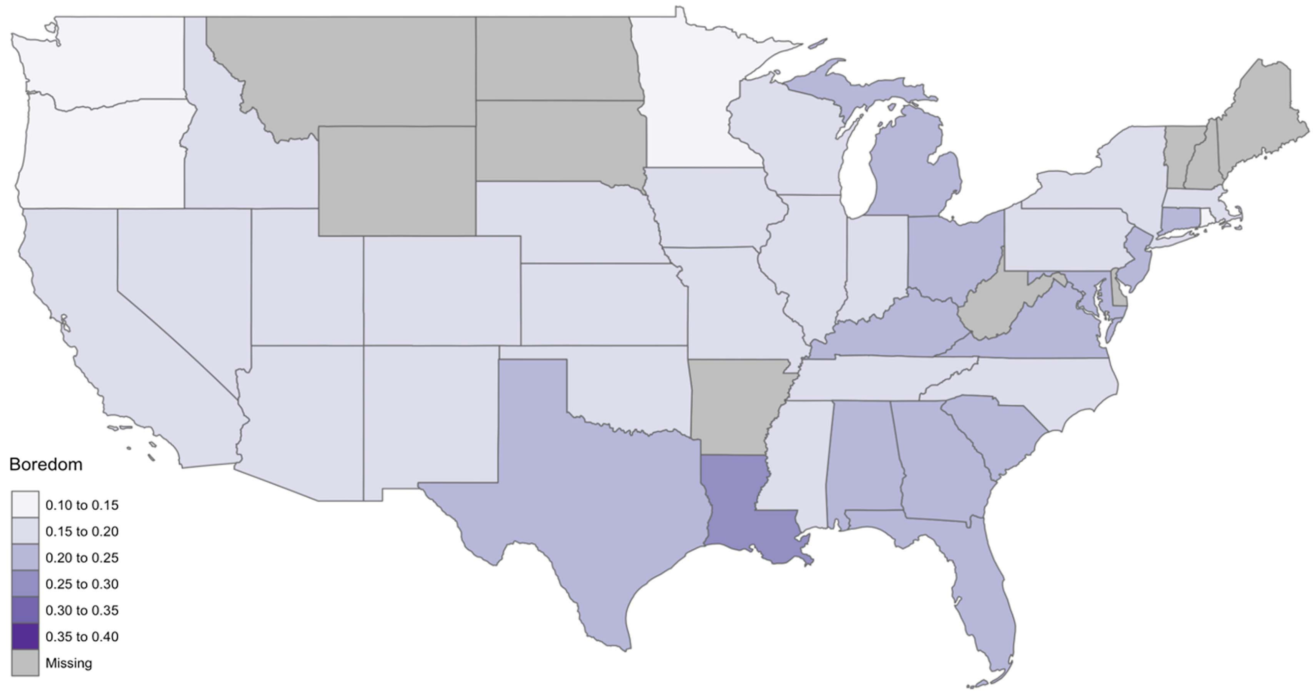
Note on Statistical Mediation

We initially planned to test if vividness mediated the effect of environment on boredom, but after power estimation tool became more widely available, we realized that power would be insufficiently low ($1 - \beta$ = 32%; assuming r = .25, α = .05). Hence, we placed details of this analysis in the Supplemental Material for transparency, where we did detect significant statistical mediation, $B = -.407$, SE = .120, 95% CI [−0.652, −0.187]. We return to mediation considerations in Study 4 and the General Discussion section.

Study 4: Boredom and the Vividness of Nature and Artificial Imagery

Study 3 confirmed, using a range of displays, alongside Studies 1 and 2, that natural environments appear less boring than artificial ones. The findings of Studies 1 and 3 tentatively point to vividness as the underlying process. Studies 1 and 3 provided support for the hypotheses that natural (vs. artificial) environments produce lower levels of boredom and that nature is seen as more vivid in color. While we found that increases in vividness also corresponded to lower boredom—consistent with our reasoning that this variable mediated nature's effect of boredom (H4), but not evidentiary—we tested this presumed mediating factor in Study 4 by manipulating it orthogonally to the environment. If vividness is one of the reasons why natural displays elicit less boredom than their artificial counterparts, then elevating the vividness in these artificial environments should likewise reduce boredom. The corresponding methodological approach to test this is called the *moderation-of-process* design (Spencer et al., 2005), where the proposed mediating variable (vividness) is manipulated, offering a superior test of mediation by

Figure 2
Variation in State-Level Boredom Across the United States in Study 3



Note. See the online article for the color version of this figure.

employing an experimental, rather than solely a measurement, design (Kim et al., 2018; Vancouver & Carlson, 2015). In Study 4, we therefore manipulated both environment (nature vs. artificial) and their vividness (low vs. high). In line with Spencer et al. (2005), we accordingly predicted an interaction between these two manipulated variables, where elevating vividness would produce less boredom, especially in the artificial environment—where boredom otherwise thrives—as compared to the already vivid and little boring natural environment.

Method

Participants and Design

Participants were 131 people residing in the United States using the online MTurk (https://www.mturk.com) platform. This was the maximum number of participants we could recruit with the remaining funds of one of the authors' yearly research budget. Of these, 11 observations from duplicate participants were dropped, as was a participant with an impossibly low participation duration (1 min, 44 s, vs. median duration 6 min) and another one with an extremely long participation duration (48 min, 39 s). The final sample contained 118 participants ($M_{\text{age}} = 36.28$, $SD = 12.98$; 53 men, 63 women, 2 unspecified). The study consisted of 20 trials in which 10 nature and 10 artificial pictures were displayed. The characteristics of the displayed image within each trial followed a 3 (Feature Type: brightness, saturation, contrast) × 2 (Feature Level: high, low) between-image design. Thus, all participants saw each of the 10 nature and 10 artificial displays, but the exact configuration of brightness, saturation, and contrast was randomly determined for each image. Specifically, for each image trial, one of the six Feature Type × Feature Level combinations was randomly and independently selected, resulting in different combination frequencies for each participant. This design and sample size afforded over 80% power to detect small effects ($r = .11$) for our image-level predictors (Arend & Schäfer, 2019). The order of the pictures was fully randomized for each participant. The study received ethical approval from King's College London (MR/16/17-151).

Materials and Procedure

Participants reported demographics and then viewed 20 images. Ten of these images were nature displays (e.g., poppy field, mountain range, desert); 10 images were of artificial environments (e.g., airport, shopping street, residential flats). These images were selected by the authors through an internet search for high-quality photographs that were cleared for public use. We avoided detailed depictions of humans and other animals in the imagery and attempted to source a reasonable range of different environments. We created six versions for every image: one with 20% enhanced brightness levels, one with 20% reduced brightness levels, one with twice its base saturation level, one with two-third its base saturation level, one with 40% higher contrast, and one with 40% lower contrast. The displayed image in each trial was randomly drawn from these six variations, following a 3 (Feature Type: brightness, saturation, contrast) × 2 (Feature Level: high, low) between-image design. Figures 3 and 4 contain example images with their vividness variations, and the full set of images is available through the Open Science Framework page (https://osf.io/8tbkj/?view_only=e4d6be

Figure 3

Example Nature Stimuli (Study 4)

Level

Feature Low High

Brightness

Saturation

Contrast

Note. Image was adapted from https://www.pexels.com/photo/red-petaled-flowers-with-blue-petaled-flowers-on-a-field-during-daytime-86588/. See the online article for the color version of this figure.

7149444847b9781109cb486c91). The order of all 20 trials was randomized for each participant. Each image was followed by a measure of boredom ("This environment makes me feel bored"; 1 = *not at all*, 7 = *very much*). After the main part of the study, participants also completed the five-item presence of meaning in life questionnaire (e.g., "I understand my life's meaning"; 1 = *absolutely untrue*, 7 = *absolutely true*; α = .94; Steger et al., 2006) were debriefed, thanked, and rewarded (Results for the meaning in life measure are again located in the Supplemental Material.)

Results and Discussion

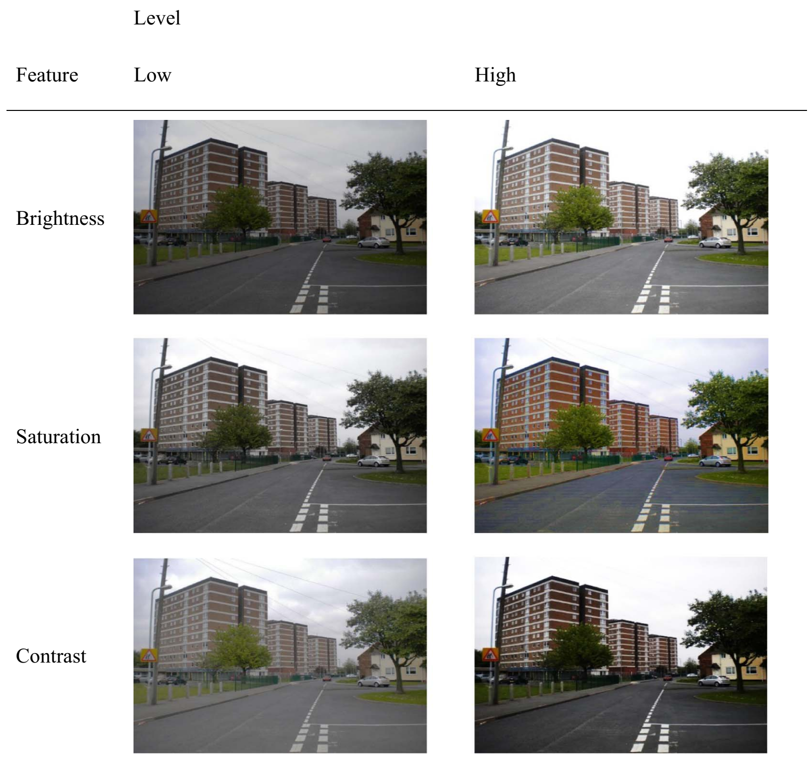
Evaluations of the 20 images were nested within participants. Therefore, we conducted a 2 (Environment: nature, artificial) × 3 (Feature: brightness, saturation, contrast) × 2 (Level: high, low) multilevel analysis on boredom. In this analysis, environment, feature, and feature level served as image-level fixed factors, with a random intercept assigned to participants (Figure 5).

The analysis indicated that the type of vividness feature that was manipulated (brightness, contrast, saturation) did not exert a significant main effect on boredom, $F(2, 2{,}260.20) = 2.430$, $p = .088$, $\eta_p^2 < .001$, and neither interacted with level (high, low) of the manipulated feature, $F(2, 2{,}259.60) = 0.470$, $p = .625$, $\eta_p^2 = .001$, nor with environment type (nature, artificial), $F(2, 2{,}258.20) = 0.119$, $p = .888$, $\eta_p^2 < .001$. Also the triple interaction (Vividness Feature × Feature Level × Environment Type) was not significant, $F(2, 2{,}255.40) = 0.915$, $p = .401$, $\eta_p^2 = .001$. Thus, the type of vividness feature that was manipulated did not appear consequential.

The same was not the case for the level of vividness and environment type, which exerted significant main and interaction effects. The significant main effect of environment type, $F(1, 2{,}225.10) = 800.622$, $p <$ 001, $\eta_p^2 = .056$, indicated that boredom was overall higher in response to the artificial environments ($M = 4.031$, $SE = 0.093$) than to the nature images ($M = 2.106$, $SE = 0.093$). The significant main effect of vividness level, $F(1, 2{,}342) = 13.237$, $p <$ 001, $\eta_p^2 = .005$, showed that displays with low vividness were more boring ($M = 3.184$, $SE = 0.095$) than high-vividness displays ($M = 2.949$, $SE = 0.096$). Most importantly, these main effects were qualified by a significant Environment Type × Vividness Level Interaction, $F(1, 2{,}342) = 10.071$, $p = .002$, $\eta_p^2 = .003$ (Figure 6).

Nature displays consistently elicited less boredom than artificial environments. This occurred both when corresponding displays were low in vividness, $M_{\text{nature}} - M_{\text{artificial}} = -2.147$, $SE = .097$, $t(2{,}249.79) = 22.159$, $p < .001$, 95% CI [−2.337, −1.957], and when they were high in vividness $M_{\text{nature}} - M_{\text{artificial}} = -1.703$, $SE = .098$, $t(2{,}249.82) = 17.436$, $p < .001$, 95% CI [−1.895, −1.512]. Critically, while boredom levels did not significantly differ between nature displays of low and high vividness,

Figure 4
Example Artificial Stimuli (Study 4)



Note. Images are modified versions we made of an original photograph. Copyright 2023 by Richard Vince (https://www.geograph.org.uk/photo/3524139). CC BY-SA 2.0. See the online article for the color version of this figure.

M_{low}–M_{high} = 0.032, *SE* = .098, $t(2{,}262.13) = 0.325$, $p = .745$, 95% CI [−0.160, 0.224], higher levels of vividness significantly predicted less boredom in response to the artificial environments, M_{low}–M_{high} = 0.475, *SE* = .098, $t(2{,}267.47) = 4.824$, $p < .001$, 95% CI [0.282, .668]. Thus, adding vividness to artificial environments appears to predict less corresponding boredom. These findings are consistent with the mediational role we ascribed to vividness (H4).

Study 5: Unnaturally Bored

The studies so far indicate that natural environments elicit lower levels of boredom than artificial ones, and that this effect goes hand in hand with the comparatively high vividness of natural (vs. artificial) environments. The previous studies did not indicate, however, whether natural environments tend to *reduce* boredom or whether artificial environments instead *induce* it, or possibly both. The main aim of Study 5 was to test this. We did so by measuring boredom before and after exposing participants to natural or artificial imagery, and then analyzing its change. While we again hypothesized that natural environments would be associated with less boredom than artificial ones (H1), we did not have a specific prediction about whether nature reduced it, or artificial environments increased it relatively to pre-measured levels and treated this instead as an open question.

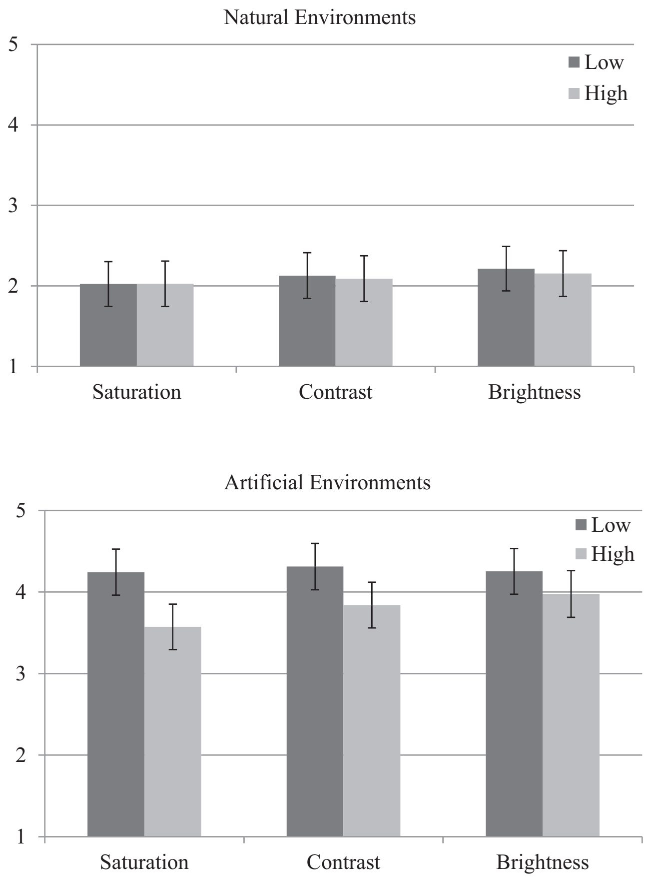
As in Studies 1, 3, and 4, we again tested if natural (vs. artificial) environments were more vivid (H2) and if this vividness was associated with lower boredom (H3). We additionally tested the role of relevant other emotions, as in Study 1 but with a more powerful sample size. Specifically, we explored if changes in boredom may correspond to changes in awe, sadness, and happiness. As discussed earlier, natural environments can increase awe (Anderson et al., 2018; Piff et al., 2015), and awe can prevent boredom (O'Dea, Igou, Van Tilburg, & Kinsella, 2024). Researchers have also linked natural environments to lower sadness (Bowler et al., 2010) and higher happiness (MacKerron & Mourato, 2013), which are positive and negative correlates of boredom, respectively (Chin et al., 2017; van Tilburg & Igou, 2017a). Study 5 thus explored if the impact of the environment on boredom related to changes in awe, happiness, or sadness. The hypotheses, exploratory questions, design, sample size, exclusion criteria, and analyses of Study 5 were preregistered at https://aspredicted.org/h5hz-f7p7.pdf.

Method

Participants and Design

Participants were 300 people residing in the United Kingdom, recruited for this online study through Prolific (https://www.prolific.com). We determined sample size a priori and estimated power analyses using a dedicated Shiny app (https://shiny.ieis.tue.nl/anova_power/). Power analysis indicated that this sample size afforded

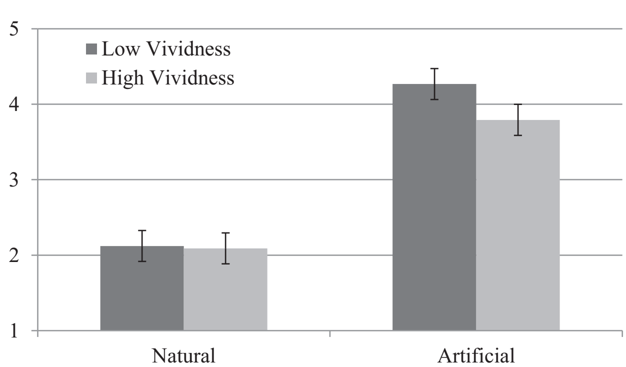
Figure 5
Boredom Across Vividness and Environment Conditions (Study 4)



Note. Higher scores indicate more boredom. Error bars reflect 95% confidence intervals.

statistical power of over 90% for the omnibus interaction test in a 2 (Time: before, after [within-participants]) × 2 (Environment: nature, artificial [between-participants]) mixed-design. We assumed for this estimation Type I error of $\alpha = .05$ (two-sided) and an interaction where the mean difference in environment was $d = 0.00$ for the *before* time point, and increased to a medium effect size of $d = 0.50$ in the *after* time point (in line with Study 3), with this latter difference being split equally between the nature and artificial environments (i.e., before vs. after differenced at, $d = -0.25$, and, $d = +0.25$, for the natural and artificial environments, respectively). We assumed a strong correlation between measures taken before and after of $r = 0.50$ and no sphericity.

Figure 6
Boredom by Environment and Vividness Level (Study 4)



Note. Higher scores indicate more boredom. Error bars reflect 95% confidence intervals.

Five participants were excluded for exceeding thrice the median study completion time (297.50 s), suggesting they were otherwise occupied. The final sample contained 295 participants ($M_{age} = 39.44$, $SD = 12.65$; 118 men, 173 women, 2 nonbinary, 1 unspecified). The majority of participants (265) had a British nationality.

After giving informed consent, participants rated their boredom, happiness, sadness, and awe ("To what extent do you experience [boredom/happiness/sadness/awe] right now?"; 1 = *not at all*, 7 = *very much*). They were then randomly assigned to one of the two between-participant conditions (environment: nature, artificial). Participants viewed 16 photographs of either natural environments or artificial environments, with each photograph being displayed for 10 s. The images were retrieved from the Southampton-York Natural Scenes (SYNS) data set (Adams et al., 2016). The SYNS data set includes stereo scans of outdoor landscapes, corresponding to 19 landscape categories. In the present study, we use stereo pairs to create panoramic images to mimic the impression of a larger landscape. We use Adobe Lightroom to create cylindrical panoramic images from the first three, left-oriented, stereo images of outdoor scans in the SYNS data set.

We used all SYNS landscape categories except for "agriculture: mixed use," "agriculture: farm," and "agriculture: glasshouses," to (a) ensure an equal number of landscape categories per experimental condition (eight natural landscapes, eight artificial landscapes), and (b) exclude categories that are ambiguous regarding the parent categories (natural vs. artificial environments). The SYNS data set indexes both winter and summer scenes. We used the two summer scenes for each of the 16 landscape categories. Figure 7 displays example images for each condition.

After viewing the photographs, participants again rated their boredom, happiness, sadness, and awe ("To what extend do you experience [boredom/happiness/sadness/awe] right now?"; 1 = not at all, 7 = very much), as well as the perceived saturation of the images ("Saturation is the degree to which colors are deep or intense. How saturated would you say that the images were?"), visual contract ("Visual contrast refers to differences in the colors of things around us. How high in visual contrast would you say that that the images were?"), and brightness ("Brightness refers to seeming to give out or reflect light. How high in brightness would you say that that the images were?"; 1 = *not at all*, 7 = *very much*). Responses to these latter three items were averaged into a vividness score ($\alpha = .79$). The study received ethical approval from the University of Essex (ETH2425-0052).

Results and Discussion

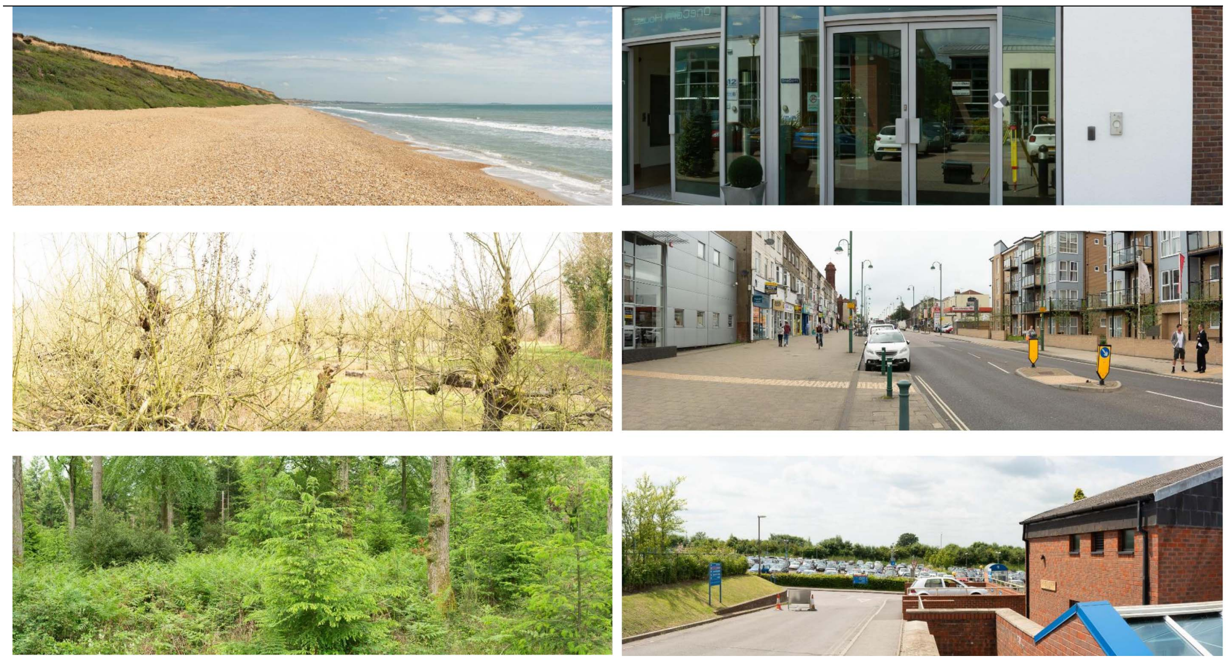
H1: Does Nature Reduce, or Do Artificial Environments Inflate, Boredom?

We examined the change in boredom across the two environments with a 2 (Time: before, after [within-participants]) × 2 (Environment: nature, artificial [between-participants]) mixed-analysis

Figure 7

Example Natural and Artificial Environment Photographs (Study 5)

Natural Environment Artificial Environment

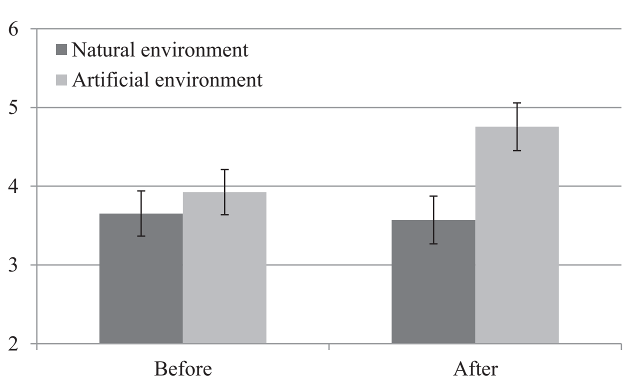


Note. Copyright 2026 by Southampton-York Natural Scenes Data set (Adams et al., 2016, https://syns.soton.ac.uk). See the online article for the color version of this figure.

of variance. A Significant Time × Environment Interaction indicated that the rate of change in boredom before versus after viewing the photographs differed between the two environments, $F(1, 292) = 25.485$, $p < .001$, $\eta_p^2 = .080$ (Figure 8). Conform (H1), boredom was lower in the postphotograph measurement for those who viewed natural vistas ($M = 3.57$, $SD = 1.92$), compared to artificial imagery ($M = 4.76$, $SD = 1.81$), $M_{\text{nature}} - M_{\text{artificial}} = 1.184$, $SE = .218$, $t(292) = 5.437$, $p < .001$, 95% CI [0.755, 1.612], $d = 0.634$. No such significant difference existed prior to viewing the photographs ($M_{\text{nature}} = 3.66$, $SD = 1.83$ vs. $M_{\text{artificial}} = 3.93$, $SD = 1.71$), $M_{\text{nature}} - M_{\text{artificial}} = -0.263$, $SE = .206$, $t(293) = 1.279$, $p = .202$, 95% CI [−0.668, 0.142], $d = 0.149$. The difference in boredom that emerged after the photographs appeared primarily attributable to the artificial environment condition, which featured significant higher boredom after the images, than before, $M_{\text{after}} - M_{\text{before}} = 0.830$, $SE = .134$, $t(146) = 6.215$, $p < .001$, 95% CI [0.566, 1.094], $d = .513$. Whereas boredom after the nature imagery did not differ significantly from its levels before, $M_{\text{after}} - M_{\text{before}} = -0.082$, $SE = .122$, $t(146) = 0.672$, $p = .503$, 95% CI [−0.322, 0.159], $d = -.055$. These results suggest that natural environments cause less boredom than artificial ones (H1), and, importantly, that this can plausibly be attributed to the boredom that artificial environments breed.

Figure 8

Boredom Before and After Environment Exposure (Study 5)



Note. Higher scores indicate more boredom. Error bars reflect 95% confidence intervals.

Note that the same analyses for happiness, awe, and sadness showed that nature yielded Significant Time × Environment Interactions for each (see Supplemental Material for details). Compared to the before measures, natural environments significantly increased happiness and awe, and reduced sadness; the artificial environments significantly reduced happiness and awe but did not significantly alter sadness. On the postphotograph measures, happiness and awe were significantly higher for the natural than artificial environments, but no significant difference in sadness emerged. We return to these variables, and their relevance, in analyses later on.

H2: Natural Environments Are More Vivid

An independent samples t test with environment (natural vs. artificial) as independent variable and the vividness scores as dependent variables showed that the natural environments were perceived as more vivid ($M = 4.31$, $SD = 1.00$) than the artificial ones ($M = 3.63$, $SD = 1.05$), $M_{\text{nature}} - M_{\text{artificial}} = 0.683$, $SE = .120$, $t(292) = 5.696$, $p < .001$, 95% CI [0.447, 0.919], $d = 0.664$. As predicted (H2), vistas of nature appear more vivid than their artificial counterparts.

H3: Vivid Environments Feature Less Boredom

Vividness ratings were correlated significantly and negatively with boredom reported after seeing the photographs, $r(291) = -.193$, $p < .001$. This is consistent with (H3). Note that we failed to preregister this analysis due to an oversight.

What Role Might Happiness, Awe, and Sadness Play in the Impact of Environments on Boredom?

As in previous studies, we found that natural environments elicit less boredom than artificial environments, and we additionally found that this difference is due to the boring nature of artificial environments in particular. At the same time, we found that artificial environments also reduced happiness and awe (and that natural environments increased happiness and awe, and reduced sadness; see Supplemental Material). Each of these emotions has been linked to boredom, with awe being known to prevent boredom (O'Dea, Igou, Van Tilburg, & Kinsella, 2024), happiness to be a negative boredom correlate, and sadness being a positive one instead (Chin et al., 2017; van Tilburg & Igou, 2017a). Indeed, boredom measured before the landscape viewing task had a significant negative correlation with happiness and a positive one with sadness, but was not significantly related to awe. Boredom after the task correlated significantly negatively with both happiness and awe and positively with sadness (see Supplemental Material for details). Therefore, we next tested to what extent the effect of the environment on boredom is unique and to what degree it is interlinked with these other emotions.

We tested this with a (preregistered) 2 (Time: before, after [within-participants]) × 2 (Environment: nature, artificial [between-participants]) mixed-analysis of covariance. Boredom served as (repeated) dependent variable and measures of happiness, awe, and sadness were included as covariates. Table 4 contains the full list of effects. The Time × Environment interaction was no longer significant after controlling for happiness, awe, and sadness. These results suggest that the effect of natural versus artificial environments on boredom covary with changes in happiness, awe, and sadness.

Table 4
Analayis of Covariance Effects in Study 4

Variable	F	df	p	η_p^2
Environment	0.757	1, 41	.389	.018
Time	1.196	1, 41	.280	.028
Sadness	0.768	1, 41	.386	.018
Awe	0.074	1, 41	.787	.020
Happiness	5.010	1, 41	.031	.011
Time × Happiness	0.054	1, 41	.817	.001
Time × Sadness	0.110	1, 41	.742	.003
Time × Awe	0.168	1, 41	.684	.004
Time × Environment	0.001	1, 41	.975	.000

Note on Statistical Mediation

We did not preregister mediation analysis for this study. For exploratory and transparency purposes, we report it in the Supplemental Material, where we found support for vividness as mediator of the effect of environment on changes in boredom, $B = -.082$, $SE = .039$, 95% CI [−0.160, −0.006]. We come back to the topic of mediation in the General Discussion section.

Transparency and Openness

For this and the following studies, Open Science Framework contains data (Studies 1, 3–5), analysis scripts in *R* (Studies 1–5), instructions and measures (Studies 1, 3–5), and stimuli (Study 4) at https://osf.io/8tbkj/?view_only=e4d6be7149444847b9781109cb486c91. The associated identifications of tweets in Study 2 will only be made available for the purpose of academic research upon request to preserve users' anonymity and in accordance with Twitter's terms of service at the time of data collection. County-level sociodemographic data were collected from the U.S. Census Bureau and are publicly available. County-level mobility estimates were retrieved upon request from Cuebiq's Data for Good program (https://www.cuebiq.com). Land cover data are publicly available at https://www.openicpsr.org. Stimuli of Study 3 cannot be shared due to copyright protection. Stimuli of Study 5 are available through the Southampton-York Natural Scenes database at https://syns.soton.ac.uk. Study 5 was preregistered at https://aspredicted.org/h5hz-f7p7.pdf.

General Discussion

In the current investigation, we examined whether natural environments produce lower levels of boredom than artificial environments (principal hypothesis). We also tested whether color vividness would partially explain this difference. The results of all five studies support our principal hypothesis. In Study 1, a naturalistic induction of a natural environment (vs. an artificial environment) provided initial support for the hypothesis that natural environments produce less boredom than artificial ones. Study 2, using Twitter and satellite data, found that people who live in areas with more natural geography expressed less boredom on social media. This negative association between natural environments and boredom did not co-occur with changes in happiness (Study 1), awe (Study 1), or sadness (Studies 1 and 2). Study 3 replicated the effect of natural (vs. artificial) environments on boredom in a controlled experiment, and Study 4 found that this remedial effect of natural environments on boredom can be partially attributed to the higher vividness of natural environments. The main purpose of preregistered Study 5 was to test whether natural environments *reduce* boredom, artificial environments *increase* boredom, or possibly both. Comparing boredom before (control) and after viewing either natural or artificial landscapes, the findings showed that artificial environments elevated boredom relative to the control, with natural environments not leading to a significant change in boredom. Complementing the prior studies, Study 5 also showed that—compared to the before measures—natural environments significantly increased happiness and awe and reduced sadness; artificial environments significantly reduced happiness and awe but did not significantly alter sadness. Furthermore, accounting for changes in these emotions removed the environment effect on boredom, suggesting that the higher degree of boredom in artificial environments co-occurs with changes in a blend of different emotions.

All in all, the findings align with prior research highlighting the benefits of immersion in natural environments for well-being (Bowler et al., 2010; Hartig et al., 2014; White et al., 2020, 2021). Natural (vs. artificial) environments were found to be conducive of distinct behaviors and positive well-being outcomes compared to artificial environments, such as reduced negative affect (Thompson Coon et al., 2011), less stress (Bowler et al., 2010; Hartig et al., 2014), and enhanced memory and attention (R. Kaplan & Kaplan, 1989). To date, research on nature has mostly looked at its effect on general positive or negative affect while neglecting discrete emotions. The present investigation extended this field of research by demonstrating that nature (vs. artificial environments) produces less boredom, a discrete emotion with important implications for well-being.

Indeed, boredom is predominantly related to negative individual and societal outcomes such as greater depression symptoms (Goldberg et al., 2011), aggression (Pfattheicher et al., 2021; van Tilburg, Igou, Maher, & Lennon, 2019), and impulsiveness (Moynihan et al., 2017). The present investigation addresses a major deficiency in the literature, which is the identification of evidence-based remedies for boredom. Furthermore, it goes beyond recent attempts to address boredom at the psychological level (e.g., O'Dea et al., 2022) by incorporating the environment as a key elicitor/alleviator of boredom. This is the first program of research, in our knowledge, to provide a large-scale solution to general feelings of boredom (rather than academic boredom; e.g., Pekrun, 2006). Time spent in nature rather than in artificial environments may be an effective, low-cost remedy for alleviating boredom and its negative consequences. Evidence suggests that an intervention involving daily outdoor "awe walks" boosted positive emotions and diminished negative emotions for older adults (Sturm et al., 2022). Building on the studies presented, a similar intervention focusing on daily walks in natural environments appears to be a promising avenue for alleviating boredom. Existing literature on enriched environments further supports the idea that even the addition of plants in indoor spaces improves mood (ten Brinke et al., 2015; Shibata & Suzuki, 2002). Taken together, these results suggest that the inclusion of green spaces in architecture and urban planning may be a valuable means of fighting boredom, which likely affects some vulnerable groups more than others (e.g., Chin et al., 2017; Elpidorou, 2022).

It is noteworthy that we did not find a difference in happiness, sadness, or awe scores between natural and artificial environments in Study 1; however, we did witness such differences in Study 5. Reasons for this inconsistency across studies may be that the field experiment setting for Study 1—while being more naturalistic—may have offered less control over extraneous variables, increasing noise in these data. Study 5 was furthermore comparatively high in statistical power, making the detection of differences in happiness, sadness, and awe more likely. Methodological specifics aside, differences in happiness, sadness, and awe between natural and artificial environments are to be expected, with past literature documenting these effects (Anderson et al., 2018; Bowler et al., 2010; MacKerron & Mourato, 2013; Piff et al., 2015). The finding that natural (vs. artificial) pictures of landscapes, as one particular trigger of affect, elicit a blend of emotions, rather than any single emotion, is largely consistent with work on visual triggers of affect, such as the blended "emotion palettes" evoked by visual artwork (Stamkou et al., 2024). Interestingly, boredom was the only emotion in Study 5 that increased in the artificial environment while showing no clear decrease for natural environments relative to control. This differential effect may indicate that boredom's causes can be attributed particularly to features of the artificial environment rather than "uplifting" features of natural environments responsible for increasing happiness and awe, and for decreasing sadness. Study 4 results seem consistent with this interpretation, as the (lack of) vividness in the artificial environments caused changes in boredom in particular. Nonetheless, we take these results to suggest that nature is the viable counterpart to artificial environments and the boredom these can breed.

We proposed and found that vividness—which we operationalized as brightness, saturation, and contrast—is a low-level, visual feature that contributes to nature's palliative properties in countering boredom. While we found that natural scenes are rated as more vivid, higher levels of vividness also predicted less boredom in response to artificial environments. This finding sits closely with past research investigating the contribution of visual features in explaining natural scenes preference. For example, low-level visual features such as hue, saturation, brightness, and edge density were previously found to contribute to perceptions of naturalness (Berman et al., 2014; Kardan et al., 2015; Meidenbauer et al., 2020). Our findings further this line of research by proposing that vividness contributes to nature's affective profile by reducing levels of boredom. While more nature may be more difficult to be introduced into existing human-made, urban environments, vividness can be readily manipulated and incorporated into existing and new urban and interior designs.

It is important to clarify that we do not propose that the vividness of colors in the environment is the only plausible mechanism through which the natural environment alleviates boredom (relative to artificial environments). There are other aspects that are part of the difference between artificial and natural environments—cultural activities, opportunities to socialize, the daily squeezing into an overcrowded subway, and so on. Instead, we deliberately narrow our focus on the visual aspects of these environments. Apart from recognizing the general theme of the environments (artificial, nature), we thus ignored specific environmental content (e.g., particularly exciting trees, dull cars, scary alleys, deceptively cute squirrels). We focus on the basic cues of brightness, color saturation, and visual contrast, *because* they are basic; vividness offers a wealth of tangible opportunities for designing interventions aimed at countering boredom.

Some readers may be surprised that we did not preregister statistical mediation analysis for Study 5, and that we relegated results from exploratory mediation analyses to the Supplemental Material for Studies 1, 3, and 5. Aside from the low statistical power for testing mediation in Studies 1 and 3, the common "measurement-of-mediation" approach to statistical mediation testing has received criticism for assuming causality (both in the specific ordering of variables, as well as assuming any causality at all; see Spencer et al., 2005), and measurement biases that tend to occur when mediating variables "sit close" to other variables (e.g., Agler & De Boeck, 2017; Fiedler et al., 2011). Despite the popularity of the "measurement-of-mediation" approach, there are alternatives available, including the "experimental causal chain" and "moderation-of-process" approaches (Spencer et al., 2005). The former consists of experimentally manipulating the independent variable and mediator in sequential studies, building experiment-by-experiment evidence for a causal mediation chain. The second involves manipulating the independent variable and mediator simultaneously in one study, as we did in Study 4. An attenuating effect of the manipulated mediator on the impact of the independent variable (i.e., interaction in Study 4) then provides causal and experimental evidence for mediation, strengthened by the findings from Studies 1, 3, and 5 that the independent variable causally affects the mediator. Both "experimental-causal-chain" and "moderation-of-process" approaches are considered methodologically more convincing tests for causal mediation than measurement-of-mediation' (MacKinnon & Fairchild, 2009; Spencer et al., 2005).

Limitations

While this study makes some noteworthy contributions toward a geographical understanding of boredom, it also has some limitations. First, while we controlled for mobility in Study 2, it is plausible that the different opportunities offered by natural environments reduce levels of boredom, notably physical exercise and social connectedness. Indeed, individuals may associate nature with certain activities (running), stress relief (time spent away from work), or time spent with loved ones that may indirectly affect boredom. Future research may wish to compare nature experiences to active controls (e.g., physical exercise) to isolate the unique effect of nature on boredom. In addition, there are some psychological variables that may moderate the effect of nature on boredom. For instance, nature connectedness—a sense of oneness with the natural world (Mayer & Frantz, 2004)—is positively related to well-being (Howell et al., 2013). Some individuals may not feel the same connection to nature as others, and this is likely to impact boredom levels.

Notably, Studies 1, 3, 4, and 5 relied on a self-reported, single-item measurement of boredom. Using multi-item alternatives may reduce measurement error and offer more precise estimates in future research. Furthermore, our results focused on boredom in the moment. While Study 2 arguably offers a glimpse into the momentary expression of boredom across a longer period of time (2 weeks), we cannot effectively conclude how long the effects of exposure to different types of environments last. It would be important to investigate the effect of nature on boredom over time in a longitudinal study. Frequent exposure to nature may be particularly helpful for overcoming chronic boredom.

Constraints on Generality

Our studies relied on the general population and on-campus samples from the United Kingdom and United States. Although especially the sample in Study 1 was somewhat diverse, and the Twitter uses in Study 2 likely represent a range of different groups in the United States, we have not tested how well our findings generalize to other groups and countries. It is important to extend this research further in subsequent projects to identify the findings in other groups. We see our studies as a foundation on which such extensions can be built.

Conclusion

Boredom can lead to many negative well-being outcomes, while natural environments are associated with ample psychological and physical health benefits. We present five empirical studies that provide evidence to suggest that artificial environments lead to higher levels of boredom than natural ones. This effect appears to be at least partially explained by perceptions of vividness. Spending time in nature and introducing more natural features in artificial environments may effectively remedy boredom in society.

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