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ORIGINAL PAPER

Effects of green and urban environment exposure during classroom breaks in a video-based setting

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Abstract

Natural environments are beneficial for cognitive functioning and affect. Appraisals of such benefits can lead to the development of pro-environmental attitudes and behaviors in the long run. This study aimed to investigate the effects of an indirect exposure to a natural and urban environment during a short break in a school day, using a 'green' video depicting a walk through a lush forest and comparing it to an urban video portraying a walk through a busy city. We involved 91 fourth and fifth graders in a within-participants design. Results show that students decreased their performance in an arithmetic calculation task after watching the urban video, while no significant differences were observed before and after the exposure to the green environment. Students also reported experiencing more negative affect in relation to the exposure to the urban than the natural environment. Moreover, the students perceived the natural environment as more restorative than the urban environment. Taken together, our findings suggest that exposure to urban environments, in contrast to natural environments, may have negative effects on cognitive and affective functioning during school breaks. Educational implications suggest that when it is not possible to stay in a natural environment around the school, or there is no access to nature due to distance, videos of natural environments can be used during short breaks. They have potential to cognitively and affectively benefit students' who may often be exposed to environmental stressors.

Keywords Nature · Video-break · Stress · School performance · Affect · Restorative

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Introduction

For various reasons children today spend more school time in artificially designed environments and less and less time outdoor, especially in nature. Urban schools, for example, may not have green areas or access to outdoor natural areas (parks, forests) due to distance (Walker et al., 2021). Some exceptions are forest schools where children develop a sense of belonging to a natural community by learning and experiencing nature connection (Cudworth & Lumber, 2021; Sella et al., 2023), or outdoor education programs included in the school curriculum where children learn not only knowledge for their ecological literacy, but also pro-environment attitudes and behaviors (Braun & Dierkes, 2017; Gray & Martin, 2012). Educators, parents, and child development researchers have raised concerns about the impact that the loss of outdoor experiences in natural environments −which include green (park, forest) and blue (sea, lake) areas− have on multiple psychological domains, including the cognitive and affective (Gray & Martin, 2012; Howell et al., 2011). In the same vein, psychological research has revealed the negative effects of city living and urban upbringing on psychological well-being (e.g., Lederbogen et al., 2011), mainly due to the larger incidence of exposure to chronic environmental stressors (e.g., noise, traffic, crowding, and pollution). It is widely acknowledged that environmental stress has detrimental effects on physiological states, cognitive performance, affective states, and motivation (Bilotta et al., 2019), both in children and adults. Specifically, increased blood pressure, lower ability to allocate attention, decreased memory, more tension and anxiety, and lesser persistence in a task are commonly effects of environmental stressors (Berto, 2014; Dettweiler et al., 2017, 2023; Mygind et al., 2018). Related to the school experience that is important in the current study, there is evidence that noise in classrooms impacts negatively on cognitive functioning (Vettori et al., 2022) and motivation (Gilavand & Jamshidnezhad, 2016).

One of the ways to compensate and mitigate the detrimental effects of environmental stressors is the exposure to restorative environments, defined as environments whose characteristics are likely to trigger physiological and psychological restoration (Berto, 2014). Typically, natural environments tend to be more restorative than built environments (Menardo et al., 2019). As the next section will indicate, their restorativeness may occur through regeneration of our limited attention resources after effortful cognitive activities, or through stress reduction in favor of a calm and serene affective state.

Different areas of scientific research have documented the multiple benefits of exposure to the natural environment for individuals at different age levels, including preschool children (García-González & Schenetti, 2022; Sella et al., 2023), and typical (Norwood et al., 2019) and atypical (Galbraith & Lancaster, 2020; Taylor & Kuo, 2009) development populations. However, several aspects of that environment like tree density, and vegetation diversity and composition (Sivarajah et al., 2018), or proximity to the built environment can moderate the positive effects of nature (Leung et al., 2019).

The benefits of green environments during breaks in a school day are particularly relevant to the current study (Mason et al., 2022b). Interestingly, short

exposures to the natural environment are beneficial even when students do not directly interact with such environment as they do, for example, during an outdoor lesson to observe micro-invertebrates of the soil. Benefits regard cognitive functioning, namely attention and working memory (Amicone et al., 2018; Berto et al., 2015), and emotional well-being in terms of positive affective states like calm and joy (Berman et al., 2008).

Even more interesting and relevant is that indirect or vicarious short exposures to nature also have positive effects. The available evidence in the literature has indicated the positive impact of indirect exposure on students' attention and recovery from stress. In this case, students view static or dynamic pictures of green environments. To the best of our knowledge, studies on indirect exposure to nature through photographs or videos have only involved college students and used typical laboratory tasks to measure attention or working memory, and physiological parameters to measure arousal and stress (e.g., Crossan & Salmoni, 2019).

For our study we moved from the broader context of environmental education that aims not only to promote knowledge and understanding of the environment but also sensitivity to, and awareness of, environmental challenges, attitudes of concern and care, and motivation to act for the environment. We therefore considered the importance of supporting students, from primary school, in feeling connected to nature to develop their pro-environmental attitudes and behaviors. Connection to nature can be a consequence of experiencing its benefits, for example, for cognitive performance and emotional well-being (Berto et al., 2015). Nowadays a growing concern regards children's lack of exposure to outdoor experiences in our urbanized and technology-driven world, which may have worrisome consequences for their health and well-being (Cudworth & Lumber, 2021). The increase of screen-based activities and the decrease of outdoor-based activities, and parental concerns for children's safety outside the home, are contributing to the nature-deficit disorder (Cudworth & Lumber, 2021). The increasingly reduced contact with nature may also lead in the long run to a loss of support for environmental issues and nature conservation (Soga et al., 2018). When children have no or minimal exposure to natural spaces, they cannot develop a sense of attachment to nature and, as a consequence, comprehending its value and developing pro-environmental attitudes and practices become more difficult (Schwass et al., 2021). Even if not every type of contact with natural areas is conducive to connection to nature (Baird et al., 2020; Ives et al., 2018), experiences in natural areas during school time are important for developing students' engagement with environmental initiatives (Braun & Dierkes, 2017; Cudworth & Lumber, 2021; Schwass et al., 2021).

Thus, in this study we focused on promoting a positive impact of exposure to nature in children as a proximal aim for students' and teachers' awareness of the relevance of natural environments also for improving cognitive functioning in a typical school task and reducing at least negative affective state (anxiety, sadness). The long-term, distal aim is to contribute to students' connection with nature (Braun & Dierkes, 2017; Gal, 2023) and environmental self-identity, intention, and behavior as future active citizens (Neville & Petrass, 2023; van der Werff et al., 2013).

Moreover, we considered that contact with nature during school time is limited in many countries by weather conditions or difficult access to greenspaces. Similarly,

students with mobility difficulties, in hospital, or recovering from injuries and illness may not have direct access to a natural environment. An indirect encounter with nature through videos of natural environments can be a very feasible alternative, when a direct 'green' experience is not possible, to foster students' subsequent learning and emotional well-being. Systematic reviews indicate that nature simulations via photographs or videos (Browning et al., 2021), or even virtual reality (Frost et al., 2022) reduce negative affect (Frost et al., 2022) and restored attention, at least to some extent, in adults (Browning et al., 2021).

For a novel contribution to this research area, the current study focused on students of primary schools in Northern Italy. We compared two short video-breaks during a school day, one representing a green environment, the other an urban environment, to examine their effects on fourth and fifth graders' performance in an arithmetic calculation task, affective state, and perception of the restorative quality of the environments.

Theories about the positive impact of nature

Studies on the benefits of contact with nature are grounded on two major theories: the *Attention Restoration Theory* (ART) and the *Stress Reduction Theory* (STR), which are briefly introduced for the rationale of our study. To understand the ART (Kaplan, 1995), the distinction between involuntary and voluntary or directed attention is essential. The former is automatic, bottom-up attention that is captured by stimuli of the environment without requiring the use of mental resources. For example, students can pay involuntary attention when something interesting or unusual happens, like when an unexpected person appears in the classroom (Kaplan & Berman, 2010). In contrast, top-down, capacity-limited voluntary or directed attention requires students' effort to focus, for example, on what the teacher is explaining even if it may be perceived uninteresting, too difficult or easy, and goal-directed action to learn from what is paid attention to. It is students' voluntary attention that keeps under control various distractions that may happen in the classroom by exerting inhibitory mechanism, and is susceptible to fatigue. Natural environments are characterized by stimuli (e.g., water sound, bird songs) that can attract our involuntary attention and simultaneously minimize the use of voluntary attention required to keep distractions under inhibitory control. Therefore, in a natural environment, like a park, directed attention can be restored after intense cognition (Kaplan, 1995; Kaplan & Berman, 2010), for example, demanding school activities, so that performance in cognitive tasks increases after a green break during a school day (Mason et al., 2022c). In contrast, research has indicated that urban environments deplete mental and attentional resources (Schertz & Berman, 2019; Stevenson et al., 2019). Yet, attention is a fundamental function required in learning activities. Students must be focused and maintain attention to understand teachers' explanations, to solve a math problem, or to read a text to answer comprehension questions, just to mention only few very common school activities (Mason et al., 2022a).

Stress Reduction Theory explains the benefits of nature on emotional functioning (Ulrich, 1981; Ulrich et al., 1991). When an environmental stimulus threatens our

well-being, we can generate a stress reaction on physiological, psychological, and behavioral levels. Physiologically, for example, both the cardiovascular and neuroendocrine systems activate to cope with the environmental demands and the increased arousal wastes many of our resources if it is prolonged. Psychologically, based on the cognitive appraisal of the condition we try to cope with, we likely feel emotions like anxiety, anger, or sadness. Behaviorally, our stress manifestations can lead to a decrease in cognitive functioning and performance avoidance (Ulrich et al., 1991). Of note, in contemporary urbanized contexts, acute and chronic stress, as well as inadequate recovery from stress, are increasingly problematic and in the long-term threaten our health. Stress is indeed related not only to mental but also various physical diseases (Tyrväinen et al., 2014). SRT posits that experience with nature, unlike that with urban environments, supports recovery from very high psychophysiological arousal because, during human evolution, nature provided protection for safety, and elicits a state of calm (Ulrich et al., 1991). Thus, the natural environments have restorative power refueling the energy depleted in responding to stress, and enhance emotional well-being. Alongside these advantages, interactions between humans and nature can also result in various degrees of effects, including some negative impacts on people's health and well-being, especially when individuals have had previous negative experiences in certain natural settings (see Soga & Gaston, 2022). Therefore, it is worth noting that the benefits of exposure to nature may vary and depend on a person's environmental preferences (McMahan & Josh, 2017), which are shaped by their past experiences and familiarity with natural environments.

ART and SRT are not incompatible as both assume that nature offers recovery from mental fatigue or stress, respectively. A large number of studies documenting the positive effects of experience with nature are based on ART, SRT or both. For example, in the study by Chen et al. (2020), college students' degree of recovery from mental fatigue increased attention-related performance in a lab task that measures failures to maintain concentration. Even if other investigations did not reveal a link between attention restoration and stress reduction (Crossan & Salmoni, 2019; Li & Sullivan, 2016), it is conceptually legitimate to consider the link between increase in attention and decrease in stress as effects of experiences with nature. For the current study focused on indirect exposure to nature, we considered both its benefits in terms of better performance in a school task requiring attention and less stress as reflected in less negative affective state.

Exposures to natural environments during school time

Taking into account the school context, we can make a distinction between passive long- and short-term exposure to nature and between direct and indirect exposure. Long-term exposure may refer to an accumulated effect of the nature that surrounds schools. To exemplify, Kuo et al. (2018) examined the relation between nature and academic achievement for a large number of public elementary schools in Chicago. They documented that school green area, especially with trees, was positively associated with students' school achievement, as reflected in their scores on standardized tests of math, after accounting for indices of disadvantage, poverty, and minority

status combined. Similar results in the United States for achievement in standardized tests of English language arts, mathematics, and science were indicated by Lin and Van Stan II (2020) when considering elementary schools in the metropolitan area of Atlanta, and by Li et al. (2019) when considering ACT scores and college readiness of public high school students in Illinois. Very recently, the association between green and school achievement in standardized tests was indicated for third and sixth graders in elementary schools at Ontario in Canada (Rakowska et al., 2023).

Long-term exposure to nature also refers to a series of traditional lectures that take place outdoors. A systematic review of studies on regular classes taught outdoors has revealed their benefits not only for academic achievements but also for social and health psychological domains (Becker et al., 2017). An investigation based on teaching regular lessons over a school term in nature, not in the classroom, has highlighted that eighth graders spent more time on task and this positive outcome maintained for weeks (Norwood et al., 2021).

Short-term exposure to nature mainly refers to a short break in a school day to recover from mental fatigue and regenerate attention as a recent meta-analysis indicates (Mason et al., 2022c). Green breaks had positive effects on cognitive functioning, specifically on students' attention restoration across grade levels, from primary school to college. The reviewed studies compared a short recess in a green environment to a recess in a built or urban environment measuring attention performance before and after the recess, usually using lab tasks. For instance, in two studies Amicone et al. (2018) found that after a break in the green school garden, fourth and fifth graders had higher scores for both selective and sustained attention in a lab task than after a break in the built environment of the courtyard in front of the school entrance. Moreover, children perceived the school garden as more restorative than the courtyard. Recently, short-term exposure to nature also includes the effects of a single regular lesson on a school subject taught in the classroom and a similar lesson taught outdoor in a green area. For instance, Mason et al. (2022b) documented the positive, cognitive and affective effects of a single lesson in the school garden compared to a similar lesson in the usual classroom. Second and third graders had higher scores not only in a typical lab task of attention but also in two typical school tasks of arithmetic calculation after the teacher's lesson in the green environment. Children with higher self-reported emotional difficulties also reported more positive affective states and less negative affective states after the lesson in the green space than in the classroom. Thus, a single lesson in a natural environment which requires students to pay attention to the teacher, seems to deplete their attentional resources less (Kaplan & Berman, 2010).

It is also relevant qualitative research that explores children and youth perspectives on the impacts of exposure to nature during outdoor experiential programs. For instance, Baird et al. (2020) identified three main themes in the responses to open-ended questions asked to participants after completing one of those programs: Appreciation of nature, awareness of the conditions of nature, and concern for nature. Specifically, participants appreciated nature because they perceived it not only in terms of danger but also of beauty and safety. They were aware of the role of nature in the broader systems, and felt concerned for it to some extent. Interestingly, the majority of the participants reported that they developed a connection to nature through its appreciation, awareness, and concern. Some of them

also expressed a clear intention for pro-environmental behavior (Baird et al., 2020). In this regard, forest schools indicate how learning and achievement cannot be only confined to perform well in tests. By experiential learning (Gray & Martin, 2012), students in forest schools develop place attachment, caring attitude, and nature connection in the natural learning environment that also supports their health and well-being (Cudworth & Lumber, 2021).

The aforementioned long and short-term exposures to nature are based on direct contact with nature. However, geographical location, unfavorable weather conditions, or no access to nearby natural environments may allow only very limited direct experience with nature during school time. A very feasible alternative could be indirect or vicarious exposure through photographs or videos of natural environments.

In the literature, there are some studies with adults on indirect exposure to nature using photographs, virtual reality (Marois et al., 2021; Mostajeran et al., 2021), or simulated nature walk (Crossan & Salmoni, 2019). For example, Mostajeran et al. (2021) compared exposure to a virtual forest and to a virtual urban environment which were introduced as photograph slideshows or immersive 360° videos. Results revealed that the natural environment had positive influence on cognition, specifically a mental arithmetic task. Photographs, regardless of the kind of environment, were more effective than immersive videos in reducing physiological arousal.

Of note, however, there are currently no studies that have specifically examined the effects of video exposure to natural and urban environments during classroom breaks. As regular schools cannot use sophisticated technological equipment for indirect exposure to nature, we considered the opportunity of using simple videos of natural and urban environments to be used for short breaks after intense cognitive activity in a school day. It is worth noting that that vicarious experiences of nature, based on photographs or videos, have been suggested as effective in cultivating pro-environmental behavior (Sun et al., 2023).

The current study: research questions and hypotheses

The current study sought to contribute in five different ways to the advancement of knowledge on the benefits of contact with green environments by: (1) examining the potential positive (and negative) impacts of indirect or vicarious exposure to natural (and urban) settings by involving children of primary school in their regular classrooms (not in a lab), who were not considered in previous research, (2) comparing a video of a green walk in a forest to a video of an urban walk during a break in a school day, (3) focusing on a short break that is more feasible when considering the succession of activities that require cognitive effort during school time, (4) using a typical school task to measure the effect of a short break on cognitive performance (arithmetical calculus) as well as self-reported positive and negative affective states to measure the impact on affect in the school context, and (5) assessing the perceived restorativeness of green and urban environments.

Specifically, the study was guided by three research questions:

RQ1. After cognitive activity, do short breaks in the classroom watching a video of a natural environment and a video of an urban environment differentiate children's cognitive performance in an arithmetic calculation task carried out after watching the videos?

We hypothesized that after cognitive activity, a short break with the video of the green environment would have some restorative effect on children's attention, or at least would preserve cognitive resources available before the break. In contrast, a short break with the urban video would lead to a decrease of cognitive functioning because of the experience of stress. As a consequence, children would have lower scores in the arithmetic calculation task, which requires sustained attention, after the urban video-break. We based our hypothesis on the aforementioned research on direct exposure to a natural environment during breaks in primary school (Amicone et al., 2018) and indirect exposure to nature in college students (Brancato et al., 2022; Mostajeran et al., 2021). According to ART, nature attracts involuntary attention and at the same time allows directed or voluntary attention to rest. In contrast, an urban busy environment is stressful and taxes voluntary attention as multiple stimuli should be paid attention to (Schertz & Berman, 2019).

RQ2. Do these short video-breaks also differentiate children's positive and negative affect?

We also hypothesized a negative impact of the urban video on children's affective states, at least some increase of negative affect compared to prior the break. In contrast, the green video-break would reduce negative affect and increase, or at least preserve, positive affective states. According to SRT, nature reduces physiological arousal and leads to a state of calm and relaxation. We based our hypothesis on the aforementioned literature on stress relief at different ages by direct experience with nature in children (Berto et al., 2015; Dettweiler et al., 2023; Mygind et al., 2018) and adults (Tyrväinen et al., 2014), and on indirect experience with nature by college students (Brancato et al., 2022; Crossan & Salmoni, 2019; Mostajeran et al., 2021).

RQ3. Do these short video-breaks finally differentiate the perception of the restorative quality of the environments?

We hypothesized that the environment of the green video would be perceived as more restorative than the environment of the urban video. This hypothesis is based on research with students of various ages, including children of elementary school who are able to appreciate the restorative quality of greenspaces (Amicone et al., 2018; Berto et al., 2015; Stevenson et al., 2019).

Method

Participants and design

We involved 91 fourth and fifth graders (42 females and 49 males, age range = 9–11 years old) from a primary school located in Northern Italy. After the approval by the university ethics committee, we had permission from the school principal and teachers. Children participated voluntarily upon written consent signed by their parents. Most children's first language was Italian. The twelve students whose mother tongue was not Italian, had sufficient language knowledge to participate in the study. Students were involved in a within-subjects pre-test/post-test research design.

Materials and instruments

Green and urban videos

The green video represented a walk through a lush forest with a very rich vegetation, high trees, and torrents. No people appeared along the walk that was only accompanied by natural sounds like the rustle of the leaves, the chirping of the birds, and the sound of water flowing in the stream. Figure 1 shows a frame of the video with the natural environment.

The urban video represented a walk through a busy city with buildings on both sides of the roads, cars, buses, motorcycles, and pedestrians. Along the walk there was traffic noise and the voices of the people walking. Figure 2 shows a frame of the urban video.

Both videos were 5 min long. This short length was deemed the most appropriate given the results of a pilot study in which we tested videos of different lengths (5 and 10 min) with 62 children of the same age in a school that did not participate

Fig. 1 A frame of the green video

Fig. 2 A frame of the urban video

in the study. Children of the pilot study were observed by the researchers while they watched the videos. According to their observations, the shorter videos kept children involved in the virtual environments for the entire duration, whereas the longer videos made them less engaged after 5–6 min.

The videos were shown on the whiteboard in their usual classroom. Before watching each video, the following instructions were given: "Now you can take a rest from today's school activities by watching a video. Please remain seated at your place and watch the video".

Measures

Arithmetic calculation tasks

Before and after watching each video, students were asked to perform as many of 64 row additions and subtractions as possible in a short time frame (three minutes); half were additions and half subtractions (maximum score = 64). Of note is that we used an arithmetic task that all students were supposed to be able to perform as new learning was not of interest in the current study. Four tasks with 64 operations on each sheet were prepared, to be completed prior and after watching the green and urban videos. In the four tasks the operations were not the same to avoid any possible repetition effect, but they were similar for the level of difficulty.

Positive and affective states

By using a short version of the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) we measured students' current mood before and after watching the videos. They rated on a five-point scale (0 = not at all; 4 = extremely) a list of six adjectives describing how they feel at the time. Three items referred to positive affect (PANAS-P; e.g., calm; maximum score = 12) and three to negative affect

(PANAS-N; e.g., nervous; maximum score = 12). The scale showed adequate reliability for both green (PANAS-P, α = 0.79; PANAS-N, α = 0.69) and urban videos (PANAS-P, α = 0.80; PANAS-N, α = 0.69).

Perceived restorativeness

We used the Perceived Restorativeness Scale - Children (PRS-ch) that was designed for school children by Berto (2007; Berto et al., 2015), based on the original adult version (Hartig et al., 1997). This self-report instrument includes 17 items measuring perceived restorativeness and 1 item on environmental preference, all to be rated on a five-point scale (0 = completely disagree; 5 = completely agree; maximum score = 90). Based on ART (Kaplan, 1995), the PRS-ch measures different restorative factors, including being away (PRS-BA: perception of an environment different from the usual), fascination (PRS-FAS: the effortless attraction to certain stimuli), coherence (PRS-COH: the perception that the environment is compatible with one's purposes), preference (PRS-PREF: the preference for an urban or natural environment), and scope (PRS-SCOPE: the perceived environmental characteristics that extend in time and space). In our study the items were worded with reference to the videos. The PRS-ch subscales and a total score exhibited good reliability for both green videos (PRS-BA, α = 0.805; PRS-FAS, α = 0.844; PRS-COH, α = 0.712; PRS-Total score, α = 0.886) and urban videos (PRS-BA, α = 0.823; PRS-FAS, α = 0.922; PRS-COH, α = 0.724; PRS-Total score, α = 0.937). The two subscales measuring PRS-SCOPE and PRS-PREF were assessed using only one item each, as indicated in Berto et al. (2015).

Procedure

Data collection took place over three different sessions for each class. In the first session, students familiarized with the researcher, generated their own code for anonymity of the tasks, indicated their gender, and performed a series of tasks not considered for the goals of the study. The session lasted about 40 min. The second session took place three days later. First, the classroom teacher gave lessons for around three hours. Then, students completed the same cognitive task provided by the researchers (i.e., an attention lab task or a text comprehension task). Afterwards, when the participants were supposed to be mentally fatigued, they carried out the pre-test arithmetic calculation task and completed the short questionnaire to indicate their affective state. Then, they viewed the video of the green environment or the video of the urban environment to rest from the school activities. After viewing the video, the participants carried out another similar arithmetic calculation task, completed again the questionnaire about affect, and the scale for perceived restorativeness of the environment watched on the video. The part of the session that succeeded the three hours of school activities, lasted for about 30 min. The third session took place a week later and was similar to the previous, except that the students watched the video of the other environment. If they had the previous video-break in the natural environment, they were

shown the video with the urban walk and vice versa, as we counterbalanced the video presentations to avoid an order effect. This session also lasted about 30 min.

Statistical analyses

We used linear mixed-effects models (LMMs) to answer our research questions asking whether the indirect exposure to green and urban environments during a short break in a school day would differentiate fourth and fifth graders' arithmetic calculation performance, affective state (positive and negative), and perceived restorative quality. Participants were considered as a random factor in all models. The models included: y ~ intercept + time (pre vs. post) * condition (green vs. urban) (random1|participantNumber) to examine the influence of exposure on arithmetic calculation performance and affect. We also conducted LMMs to investigate the effects of exposure on perceived restorativeness (total score and subscales). The model for perceived restorativeness included: y ~ intercept + condition (green vs. urban) (random1|participantNumber). All LMMs models were run in R software (R Core Team, 2016) using the lme4 package (version 1.1–31; Bates et al., 2015). .

Results

We report the results organized by the three research questions. Table 1 shows the descriptive statistics for the examined variables.

Research question1: video-breaks and performance in arithmetical calculation task

From the linear mixed model analysis, the main effect of condition emerged for arithmetic calculation, B = -2.58, 95% CI [-3.90 – -1.27], $p < 0.001$, indicating that, overall, children who viewed the video of the urban environment reported lower arithmetic performance compared to those who viewed the video of the green environment. Additionally, the interesting significant time x condition interaction also emerged, B = -2.13, 95% CI [-3.99 – -0.27], $p = 0.025$, indicating that children who watched the urban video had lower arithmetic performance at post-test than at pre-test, that is after a vicarious break in a busy city area, compared to their performance after watching the green video (see Table 1S in the Supplementary material). Figure 3 visualizes students' arithmetical performance prior and after each video-break.

Research question 2: video-breaks and affective states

The analysis regarding the current affective states before and after watching the videos revealed the main effect of environment for negative mood as children reported, overall, higher scores when considering the session in which they watched the urban video ($B = 0.64$, 95% CI [0.08 1.20], $p = 0.026$) compared to the session in which they were indirectly exposed to the green environment

Table 1 Descriptive statistics (mean and standard deviations) for arithmetic calculus, affective states (positive and negative), and perceived restorativeness

	Green		Urban	
	M	*SD*	*M*	*SD*
Arithmetic calculus				
Pre	26.033	10.460	23.451	7.725
Post	26.121	8.779	21.407	8.299
Affect (PANAS)				
PANAS, Positive affect				
Pre	8.275	2.741	7.714	3.246
Post	8.330	3.211	7.209	3.427
PANAS, Negative affect				
Pre	1.714	2.072	2.352	2.505
Post	1.835	2.377	2.824	2.972
Perceived restorativeness scale (PRS)				
PRS-BA	15.867	5.661	13.593	6.125
PRS-FAS	16.989	6.311	15.110	8.012
PRS-COH	7.857	3.072	7.769	3.113
PRS-PREF	2.967	1.329	2.495	1.537
PRS-SCOPE	1.813	1.490	2.099	1.944
PRS-Total Score	45.560	13.993	40.923	17.208

Pre = before the video-break; Post = after the video-break; PRS-BA = being away; PRS-FAS = fascination; PRS-COH = coherence; PRS-PREF = preference; PRS-SCOPE = scope

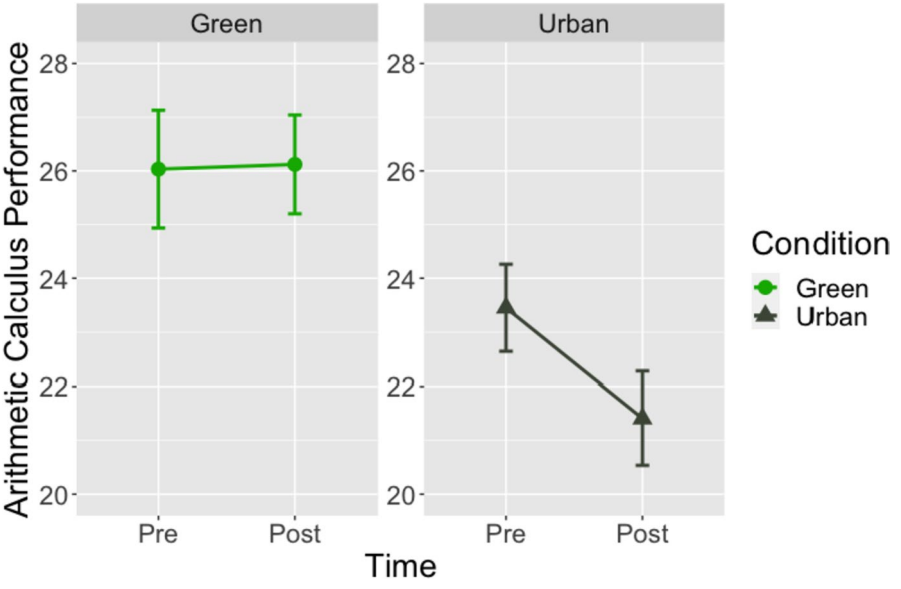

Fig. 3 Interaction between environment (green vs. urban) and time (pre vs. post) for arithmetic calculus performance

during the break. However, no significant main effect of time, nor time x condition interaction emerged for negative affective states. Moreover, neither time, nor the time x environment interaction significantly emerged for positive affective states (see Table 2S in the Supplementary material). Figure 4 shows negative affect at pre and post-tests, that is before and after watching the videos.

Figure 5 shows positive affect at pre and post-tests.

Research question 3: video-breaks and perception of environmental restorativeness

The main effect of environment emerged for the total score on PRS, B = -4.58, 95% CI [-6.98 – -2.19], $p < 0.001$, indicating that after watching the urban video, students reported lower overall perceived restorativeness than when they watched the green video. More specifically, the main effect of environment emerged for the subscales of Being Away (B = -2.17, 95% CI [-3.06 – -1.27], $p < 0.001$), Fascination (B = -1.84, 95% CI [-2.96 – -0.72], $p < 0.001$), and Preference (B = -0.47, 95% CI [-0.70 – -0.25], $p < 0.001$) (see Table 3S in the Supplementary material). When children were exposed to the video with the urban environment, they reported lower feeling of psychological distance from the usual thoughts and concerns, lower feelings of reduced fatigue, and lower preference for that place. No significant effects of environment were observed for the subscales of Coherence and Scope (B ranging from -0.11 to 0.29, all $p > 0.05$). Figure 6 shows the significant differences between the green and urban environments watched in the videos,

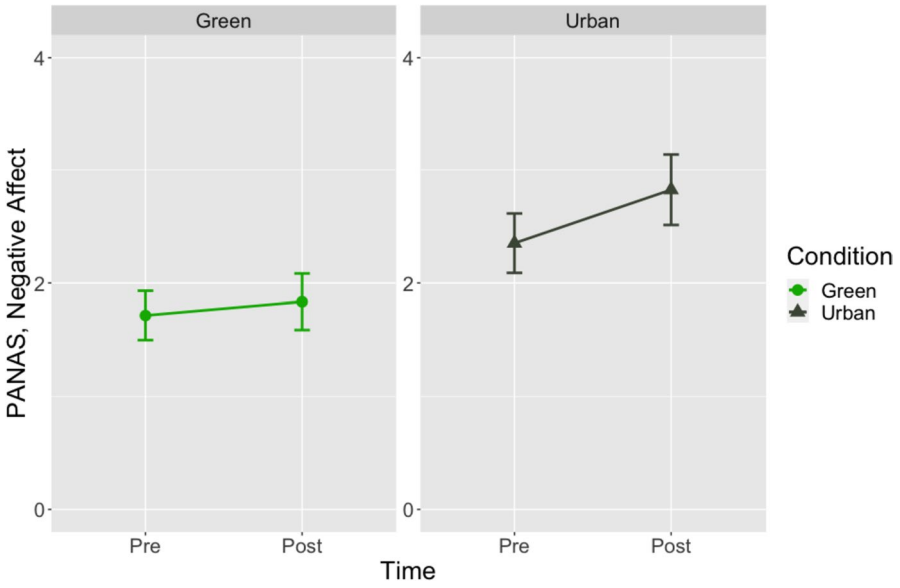

Fig. 4 Interaction between environment (green vs. urban) and time (pre vs. post) for PANAS - Negative affective states

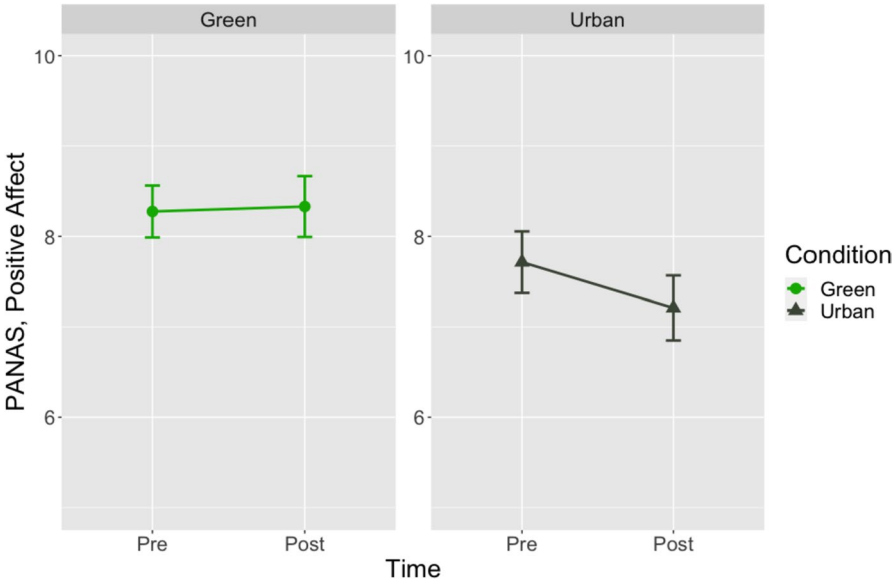

Fig. 5 Interaction between environment (green vs. urban) and time (pre vs. post-test) for PANAS - Positive affective states

globally (upper left) and specifically regarding the perception of being away (upper right), fascination (median left), and preference (bottom left), as well as the non-significant differences for coherence (median right) and scope (bottom right).

Discussion

Our study sought to contribute to current research by examining the effects of a vicarious or indirect experience of exposure to nature in the regular classroom during a short break of a day in elementary school. Our first research question asked whether scores in the calculation task after the video break would differ in relation to the environment represented. We hypothesized that after the green video-break students would perform better or at the same level as before the short break in the natural environment while they would have lower scores after watching the urban video. Our hypothesis was confirmed as children's performance was poorer after being exposed to the video with the busy urban area, while their scores in the task were similarly the same as before the green video-break. These findings are only partially aligned with previous research on the effects of direct exposure to natural and built environments in children (Amicone et al., 2018; Berto et al., 2015; Schutte et al., 2017) and virtual exposure to urban, stressful environments in adults (Mostajeran et al., 2021), which found a stronger benefit of virtual nature for cognitive performance in lab tasks.

Our second research question asked whether the affective states reported by the students would also differentiate in relation to the environment experienced during

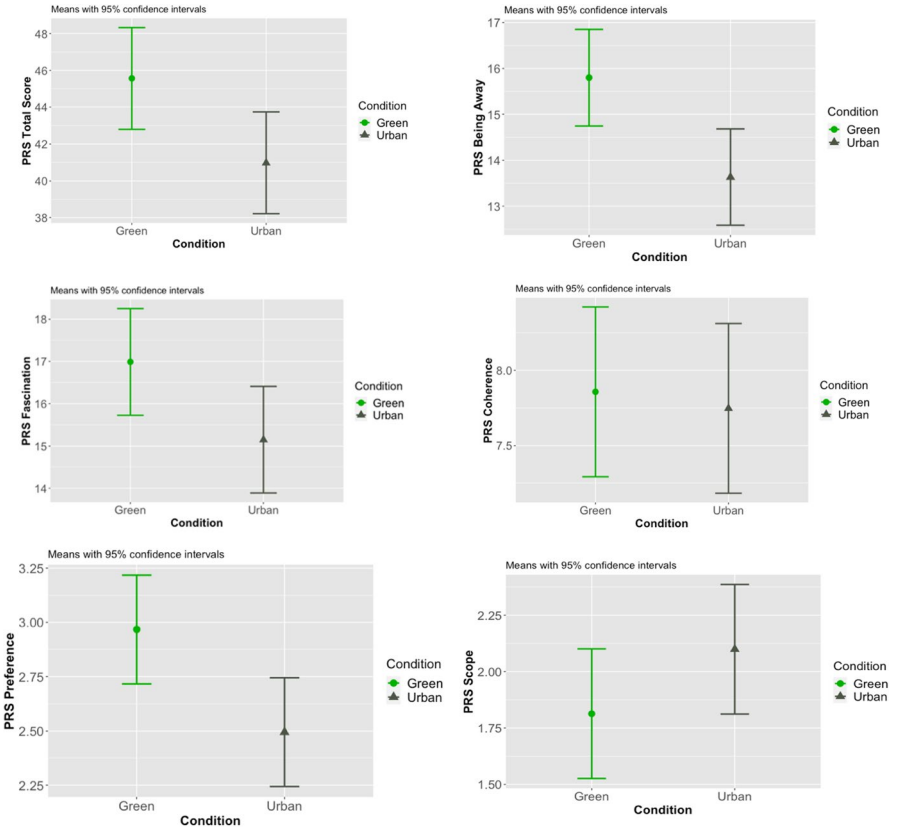

Fig. 6 Perceived restorative quality of the green and urban environments (PRS total and subscales scores)

the video-break. Results show that after the indirect exposure to the urban environment, the students reported more negative affect than before. Even if the green video-break did not alter positively children's mood, the urban video-break was not beneficial, overall. Extant literature in other research areas more clearly indicates that spending resting time in urban environments, compared to green ones, does not permit students to recover from stress (e.g., Bailey et al., 2018; Mygind et al., 2018).

Our third research question asked whether children's perception of the restorative quality of the environment they were exposed to would differentiate between the two videos. Our hypothesis was confirmed as the young students perceived the green environment as more restorative; an outcome that provides further evidence to the findings of previous studies that involved children of elementary school (Amicone et al., 2018; Berto et al., 2015; Mygind et al., 2018; Stevenson et al., 2019). Looking at the specific dimensions of perceived restorativeness according to the attention restoration theory (Kaplan, 1995), it emerges that children preferred the environment of the green video as they perceived it as an opportunity to be away from the previous source of fatigue and recover from depleted directed attention.

Practical implications

Taken together, our results suggest that a stressful environment, even only virtual, may have some negative effects on cognition and affect, as documented in other research areas. The debate on increased stress has very recently reached the school context, at least in our country. As biological systems are developing in childhood and adolescence, if young students undergo to stressful experiences also when they are at school because, for instance, they feel much pressure for school success, they need to recover from stress once in a while during a day (Dettweiler et al., 2017). We know that exposure to nature has positive effects on mental health of adults (Twohig-Bennett & Jones, 2018) and children (Norwood et al., 2019). To take breaks in a school day is a basic student need at all grade levels. Funding available to schools might also be used to improve the grounds they have. In this regard, experts in the link between green areas and academic achievement wondered whether school performance might grow on trees, given their documented positive effects (Kuo et al., 2018). Direct experience with nature is essential to take advantage of its cognitive and affective benefits. In our urbanized and technology-driven world, children spend less and less time outdoor. Yet, they need contact with nature for health and well-being (Flom et al., 2011). In this regard, school can play an essential role by providing them with experiential opportunities with nature (lawn, park) as a learning environment or, at least, as an environment for short breaks in a school day. If resources are available, they can be used to build a green area nearby school. The need for child-nature connection is clearly stronger for children who live in urban contexts where they miss experiences with natural spaces and could even perceive nature as dangerous. However, videogames are also replacing outdoor games generally in children's leisure activities (e.g., Chawla, 2020), thus it becomes crucial to incorporate the 'outdoors' as a school space (Cudworth & Lumber, 2021).

Interestingly, when it is not possible to stay in a natural environment around the school or there is no access to nature nearby school, virtual videos of natural environments have some potential to support students' cognitive functioning and mood. Interventions of outdoor education are, of course, of vital importance for pro-environmental attitudes and behaviors (Braun & Dierkes, 2017; Chawla, 2020; Chawla & Cushing, 2007; De Dominicis et al., 2017). Even when such interventions are not implemented, teachers can promote students' connection to nature starting from making them reflect on the personal benefits of being exposed to a natural environment compared to an urban one, even through short and indirect exposures (Sun et al., 2023).

Limitations

As any study, the current has some limitations. First, we used the green and urban videos in the regular classrooms for a rest. On the one hand, this characterizes the ecological validity of our study; on the other hand, we used only the resources available in the classrooms, that is, the videos were shown on the whiteboard. It

has a limited size, thus the vision was very far from being immersive, and this might have interfered with the results. In other words, the context for the indirect exposure to nature was not optimal as it could be with more powerful technological resources. Second, based on the pilot study, the video was short, so the effects cannot be expected to be particularly strong. Five minutes is the typical duration of videos or photograph shows that are used in studies with university students (e.g., van Oordt et al., 2023). However, future research can further investigate the most appropriate length of videos for younger students of elementary school by varying the duration of videos systematically. Even a slight difference in length could make a difference. Third, a possible negative interference was that children remained in the classroom to watch the videos for the breaks, as classrooms were the only spaces equipped with whiteboards. Future research on virtual contacts with nature should provide some more effective experiences with natural environments to make children appreciate all aspects that make a green environment as restorative. Fourth, we did not consider students' individual differences that can moderate the effects of environment on cognition and affect. To shed more light in this research areas, future investigations need to test possible moderating effects of cognitive, motivational, or emotional characteristics of the participants.

Conclusions

Despite these limitations, the study has theoretical and practical significance. It provides for the first time evidence that an indirect and short exposure to nature on a video during a break in a school day has some potential to support elementary school students' attention and affective state, and their perception of the restorative quality of a green environment compared to an urban environment. Such students' appraisal can in the long run lead to feeling of connection with nature and pro-environmental attitude and behavior. The study therefore also has practical relevance as it is very feasible in the school context to have virtual experiences with natural environments through short breaks. Importantly, virtual experiences with nature are no-cost opportunities to sustain students' cognition and affect in a day of school activities that demand mental resources.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s42322-023-00158-w.

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Data availability Data underlying the study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee for psychological research of the University of Padova (original protocol code 4493).

Conflict of interest The authors declare no conflict of interest.

References

Amicone, G., Petruccelli, I., De Dominicis, S., Gherardini, A., Costantino, V., Perrucchini, P., & Bonaiuto, M. (2018). Green breaks: the restorative effect of the school environment's green areas on children's cognitive performance. *Frontiers in Psychology, 9*, 1−15. Article 1579. https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01579/full

Bailey, A. W., Allen, G., Herndon, J., & Demastus, C. (2018). Cognitive benefits of walking in natural versus built environments. *World Leisure Journal, 60*(4), 293–305. https://doi.org/10.1080/16078055.2018.1445025

Baird, J., Hutson, G., & Plummer, R. (2020). Examining links between connections to nature and intentions for pro-environmental behavior as outcomes of NOLS. *Journal of Outdoor Recreation Education and Leadership, 12*(4), 367–379. https://doi.org/10.18666/JOREL-2020-V12-I4-9992

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*, 1–48. https://doi.org/10.18637/jss.v067.i01

Becker, C., Lauterbach, G., Spengler, S., Dettweiler, U., & Mess, F. (2017). Effects of regular classes in outdoor education settings. a systematic review on students' learning. social and health dimensions. *International Journal of Environmental Research and Public Health, 14*(5), 485. https://doi.org/10.3390/ijerph14050485

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science, 19*(12), 1207–1212. https://doi.org/10.1111/j.1467-9280.2008.02225.x

Berto, R. (2007). Assessing the restorative value of the environment: A study on the elderly in comparison with young adults and adolescents. *International Journal of Psychology, 45*, 331–341. https://doi.org/10.1080/00207590601000590

Berto, R. (2014). The role of nature in coping with psycho-physiological stress: A literature review on restorativeness. *Behavioral Sciences, 4*(4), 394–409. https://doi.org/10.3390/bs4040394

Berto, R., Pasini, M., & Barbiero, G. (2015). How does psychological restoration work in children? An exploratory study. *Journal of Child & Adolescent Behavior, 3*(3), 1–9. https://doi.org/10.4172/2375-4494.1000200

Bilotta, E., Vaid, U., & Evans, G. W. (2019). Environmental stress. In L. Steg, & de J. I. M. Groot (Eds.), *Environmental psychology: An introduction* (2nd ed., pp. 37–44). Wiley. https://doi.org/10.1002/9781119241072.ch4

Brancato, G., Van Hedger, K., Berman, M. G., & Van Hedger, S. C. (2022). Simulated nature walks improve psychological well-being along a natural to urban continuum. *Journal of Environmental Psychology, 81*, 101779. https://doi.org/10.1016/j.jenvp.2022.101779

Braun, T., & Dierkes, P. (2017). Connecting students to nature – how intensity of nature experience and student age influence the success of outdoor education programs. *Environmental Education Research, 23*(7), 937–949. https://doi.org/10.1080/13504622.2016.1214866

Browning, M. H. E. M., Saeidi-Rizi, F., McAnirlin, O., Yoon, H., & Pei, Y. (2021). The role of methodological choices in the effects of experimental exposure to simulated natural landscapes on human health and cognitive performance: A systematic review. *Environment and Behavior, 53*(7), 687–731. https://doi.org/10.1177/0013916520906481

Chawla, L. (2020). Childhood nature connection and constructive hope: A review of research on connecting with nature and coping with environmental loss. *People and Nature, 2*(3), 619–642. https://doi.org/10.1002/pan3.10128

Chawla, L., & Cushing, D. F. (2007). Education for strategic environmental behavior. *Environmental Education Research, 13*(4), 437–452. https://doi.org/10.1080/13504620701581539

Chen, Z., He, Y., & Yu, Y. (2020). Attention restoration during an environmental exposure via alpha-theta oscillation and synchronization. *Journal of Environmental Psychology, 68*, 101406. https://doi.org/10.1016/j.jenvp.2020.101406

Crossan, C., & Salmoni, A. (2019). A simulated walk in nature: Testing predictions from the attention restoration theory. *Environment and Behavior, 53*(3), 277–295.

Cudworth, D., & Lumber, R. (2021). The importance of Forest School and the pathways to nature connection. *Journal of Outdoor and Environmental Education, 24*, 71–85. https://doi.org/10.1007/s42322-021-00074-x

De Dominicis, S., Bonaiuto, M., Carrus, G., Passafaro, P., Perucchini, P., & Bonnes, M. (2017). Evaluating the role of protected natural areas for environmental education in Italy. *Applied Environmental Education & Communication, 16*(3), 171–185. https://doi.org/10.1080/1533015X.2017.1322014

Dettweiler, U., Becker, C., Auestad, B. H., Simon, P., & Kirsch, P. (2017). Stress in school. Some empirical hints on the circadian cortisol rhythm of children in outdoor and indoor classes. *International Journal of Environmental Research and Public Health, 14*. Article 475. https://doi.org/10.3390/ijerph14050475

Dettweiler, U., Gerchen, M., Mall, C., Simon, P., & Kirsch, P. (2023). Choice matters: Pupils' stress regulation, brain development and brain function in an outdoor education project. *British Journal of Educational Psychology, 93*(S1), 152–173. https://doi.org/10.1111/bjep.12528

Flom, B., Johnson, C., Hubbard, J., & Reidt, D. (2011). The natural school counselor: using nature. to promote mental health in schools. *Journal of Creativity in Mental Health, 6*, 118–131. https://doi.org/10.1080/15401383.2011.579869

Frost, S., Kannis-Dymand, L., Schaffer, V., Millear, P., Allen, A., Stallman, H., Mason, J., Wood, A., & Atkinson-Nolte, J. (2022). Virtual immersion in nature and psychological well-being: A systematic literature review. *Journal of Environmental Psychology, 80*, 101765. https://doi.org/10.1016/j.jenvp.2022.101765

Gal, A. (2023). Strengths, weaknesses, opportunities and threats: A SWOT analysis of a long-term outdoor environmental education program in Israel. *Journal of Outdoor and Environmental Education*. https://doi.org/10.1007/s42322-023-00125-5

Galbraith, C., & Lancaster, J. (2020). Children with autism in wild nature: Exploring Australian parent perceptions using photovoice. *Journal of Outdoor and Environmental Education, 23*, 293–307. https://doi.org/10.1007/s42322-020-00064-5

García-González, E., & Schenetti, M. (2022). Education in nature and learning science in early childhood: A fertile and sustainable symbiosis. *Journal of Outdoor and Environmental Education, 25*, 363–377. https://doi.org/10.1007/s42322-022-00110-4

Gilavand, A., & Jamshidnezhad, A. (2016). The effect of noise in educational institutions on. learning and academic achievement of elementary students in Ahvaz, South-West of Iran. *International Journal of Pediatrics, 4*(3), 1453–1463.

Gray, T., & Martin, P. (2012). The role and place of outdoor education in the Australian National Curriculum. *Journal of Outdoor and Environmental Education, 16*, 39–50. https://doi.org/10.1007/BF03400937

Hartig, T., Korpela, K., Evans, G. W., & Gärling, T. (1997). A measure of restorative quality of environments. *Scandinavian Housing and Planning Research, 14*, 175–194. https://doi.org/10.1080/02815739708730435

Howell, A. J., Dopko, R. L., Passmore, H. A., & Buro, K. (2011). Nature connectedness: Associations with well-being and mindfulness. *Personality and Individual Differences, 51*(2), 166–171. https://doi.org/10.1016/j.paid.2011.03.037

Ives, C. D., Abson, D. J., von Wehrden, H., Dorninger, C., Klaniecki, K., & Fischer, J. (2018). Reconnecting with nature for sustainability. *Sustainability Science, 13*(5), 1389–1397. https://doi.org/10.1007/s11625-018-0542-9

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology, 15*, 169–182. https://doi.org/10.1016/0272-4944(95)90001-2

Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and self-regulation. *Perspectives on Psychological Science, 5*(1), 43–57.

Kuo, M., Browning, M. H. E. M., Sachdeva, S., Lee, K., & Westphal, L. (2018). Might school performance grow on trees? Examining the link between greenness and academic achievement in urban, high-poverty schools. *Frontiers in Psychology, 9*, 1669. https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01669/full

Lederbogen, F., Kirsch, P., Haddad, L., Streit, F., Tost, H., Schuch, F., Wüst, S., Pruessner, J. C., Rietschel, M., Deuschle, M., & Meyer-Lindenberg. (2011). City living and urban upbringing affect neural social stress processing in humans. *Nature, 474*, 498–501. https://doi.org/10.1038/nature10190

Leung, W. T. V., Tam, T. Y. Y., Pan, Y. C., Wu, C. D., Lung, S. C. C., & Spangler, J. D. (2019). How is environmental greenness related to students' academic performance in English and Mathematics? *Landscape and Urban Planning, 181*, 118–124. https://doi.org/10.1016/j.landurbplan.2018.09.021

Li, D., Chiang, Y. C., Sang, H., & Sullivan, W. C. (2019). Beyond the school grounds: Links between density of tree cover in school surroundings and high school academic performance. *Urban Forestry & Urban Greening, 38*, 42–53. https://doi.org/10.1016/j.ufug.2018.11.001

Li, D., & Sullivan, W. C. (2016). Impact of views to school landscapes on recovery from stress and mental fatigue. *Landscape and Urban Planning, 148*, 149–158. https://doi.org/10.1016/j.landurbplan.2015.12.015

Lin, M., & Van Stan II, J. T. (2020). Impacts of urban landscapes on students' academic performance. *Landscape and Urban Planning, 201*, e03840. https://doi.org/10.1016/j.landurbplan.2020.103840

Marois, A., Charbonneau, B., Szolosi, A. M., & Watson, J. M. (2021). The differential impact of mystery in nature on attention: An occulometric study. *Frontiers in Psychology, 12*, 759616. https://doi.org/10.3390/j5040033

Mason, L., Zagni, B., Bacchin, F., Frison, C., & Scrimin, S. (2022a). Children's attentional processes in outdoor and indoor environments: the role of physiological self-regulation. *International Journal of Environmental Research and Public Health, 19*(20), 13141. https://www.mdpi.com/1660-4601/19/20/13141

Mason, L., Manzione, L., Ronconi, A., & Pazzaglia, F. (2022b). Lessons in a green school environment and in the classroom: Effects on students' cognitive functioning and affect. *International Journal of Environmental Research and Public Health, 19*(24), 16823. https://doi.org/10.3390/ijerph192416823

Mason, L., Ronconi, A., Scrimin, S., & Pazzaglia, F. (2022c). Short-term exposure to nature and benefits for students' cognitive performance: A review. *Educational Psychology Review, 34*, 609–647. https://doi.org/10.1007/s10648-021-09631-8

McMahan, E. A., & Josh, P. (2017). Measuring preference for natural versus built environments: Initial validation of the preference for nature questionnaire. *Ecopsychology, 9*(3), 161–171. https://doi.org/10.1089/eco.2017.0009

Menardo, E., Brondino, M., Hall, R., & Pasini, M. (2019). Restorativeness in natural and urban environments: A meta-analysis. *Psychological Reports, 124*(2), 417–437. https://doi.org/10.1177/0033294119884063

Mostajeran, F., Krzikawski, J., Steinicke, F., & Kühn, S. (2021). Effects of exposure to immersive video and photo slideshows of forest and urban environments. *Scientific Reports, 11*, 1–12. https://doi.org/10.1038/s41598-021-83277-y

Mygind, L., Stevenson, M. P., Liebst, L. S., Konvalinka, I., & Bentsen, P. (2018). Stress response and cognitive performance modulation in classroom versus natural environments: A quasi-experimental pilot study with children. *International Journal of Environmental Research and Public Health, 15*(6), 1–15. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6025376/

Neville, J. A., & Petrass, N. A. (2023). Review of children's environmental identity development: Negotiating inner and outer tensions in natural world Socialization, authored by Carie Green. *Journal of Outdoor and Environmental Education, 26*, 147–151. https://doi.org/10.1007/s42322-023-00120-w

Norwood, M. F., Lakhani, A., Fullagar, S., Maujean, A., Downes, M., Byrne, J., Stewart, A., Barber, B., & Kendall, E. (2019). A narrative and systematic review of the behavioural, cognitive and emotional

effects of passive nature exposure on young people: Evidence for prescribing change. *Landscape and Urban Planning, 189*, 71–79. https://doi.org/10.1016/j.landurbplan.2019.04.007

Norwood, M. F., Lakhania, A., & Kendall, E. (2021). Teaching traditional indoor school lessons in nature: The effects on student learning and behaviour. *Landscape and Urban Planning, 206*, 103963. https://doi.org/10.1016/j.landurbplan.2020.103963

R Core Team (2016). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. http://www.R-project.org/

Rakowska, S. B., Lutz, K., Réquia, W. J., & Adam, M. D. (2023). Examining the effects of green space accessibility on school performance for 3421 elementary schools. *Landscape and Urban Planning, 234*, 104731.

Schertz, K. E., & Berman, M. G. (2019). Understanding nature and its cognitive benefits. *Current Directions in Psychological Science, 28*(5), 496–502. https://doi.org/10.1177/0963721419854100

Schutte, A. R., Torquati, J. C., & Beattie, H. L. (2017). Impact of urban nature on executive functioning in early and middle childhood. *Environment and Behavior, 49*(1), 3–30. https://doi.org/10.1177/0013916515603095

Schwass, N. R., Potter, S. E., O'Connell, T. S., & Potter, T. G. (2021). Outdoor journeys as a catalyst for enhanced place connectedness and environmental stewardship. *Journal of Outdoor and Environmental Education, 24*, 215–231. https://doi.org/10.1007/s42322-021-00079-6

Sella, E., Bolognesi, M., Bergamini, E., Mason, L., & Pazzaglia, F. (2023). Psychological benefits of attending forest school for preschool children: A systematic review. *Educational Psychology Review, 35*, 29. https://doi.org/10.1007/s10648-023-09750-4

Sivarajah, S., Smith, S. M., & Thomas, S. C. (2018). Tree cover and species composition effects on. academic performance of primary school students. *Plos One, 13*(2), 0193254. https://doi.org/10.1371/journal.pone.0193254

Soga, M., & Gaston, K. J. (2022). The dark side of nature experience: Typology, dynamics and implications of negative sensory interactions with nature. *People and Nature, 4*(5), 1126–1140. https://doi.org/10.1002/pan3.10383

Soga, M., Yamanoi, T., Tsuchiya, K., Koyanagi, T. F., & Kanai, T. (2018). What are the drivers of and barriers to children's direct experiences of nature? *Landscape and Urban Planning, 180*, 114–120. https://doi.org/10.1016/j.landurbplan.2018.08.015

Stevenson, M. P., Dewhurst, R., Schilhab, T., & Bentsen, P. (2019). Cognitive restoration in children following exposure to nature: Evidence from the attention network task and mobile eye tracking. *Frontiers in Psychology, 10*, 42. https://doi.org/10.3389/fpsyg.2019.00042

Sun, Y., Lu, X., Cui, J., Du, K., & Xie, S. (2023). Effects of vicarious experiences of nature, environmental beliefs, and attitudes on adolescents' environmental behavior. *Environmental Education Research*. https://doi.org/10.1080/13504622.2023.2202368

Taylor, A. F., & Kuo, F. E. (2009). Children with attention deficits concentrate better after. walk in the park. *Journal of Attention Disorders, 12*(5), 402–409. https://doi.org/10.1177/1087054708323000

Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and metaanalysis of greenspace exposure and health outcomes. *Environmental Research, 166*, 628–637. https://doi.org/10.1016/j.envres.2018.06.030

Tyrväinen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y., & Kagawa, T. (2014). The influence of urban green environments on stress relief measures: A field experiment. *Journal of Environmental Psychology, 38*, 1–9. https://doi.org/10.1016/j.jenvp.2013.12.005

Ulrich, R. S. (1981). Natural versus urban scenes: some psychophysiological effects. *Environment and Behavior, 13*, 523–556. https://doi.org/10.1177/0013916581135001

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

Van der Werff, E., Stegg, L., & Keizer, K. (2013). The value of environmental self-identity: The relationship between biospheric values, environmental self-identity and environmental preferences, intentions and behaviour. *Journal of Environmental Psychology, 34*, 55–63. https://doi.org/10.1016/j.jenvp.2012.12.006

Van Oordt, M., Ouwehand, K., & Paas, F. (2023). Restorative effects of observing natural and urban scenery afterworking memory depletion. *International Journal of Environmental Research and Public Health*, *20*. https://doi.org/10.3390/ijerph20010188

Vettori, G., Di Leonardo, L., Secchi, S., Astolfi, A., & Bigozzi, L. (2022). Primary school children's verbal working memory performances in classrooms with different acoustic conditions. *Cognitive Development, 64*, 101256. https://doi.org/10.1016/j.cogdev.2022.101256

Walker, E., Bormpoudakis, D., & Tzanopoulos, J. (2021). Assessing challenges and opportunities for schools' access to nature in England. *Urban Forestry and Urban Greening, 61*, 127097. https://doi.org/10.1016/j.ufug.2021.127097

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect - the PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063–1070. https://doi.org/10.1037//0022-3514.54.6.1063

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