Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Int. J. Human–Computer Studies 171 (2023) 102982

Contents lists available at ScienceDirect

International Journal of Human - Computer Studies

journal homepage: www.elsevier.com/locate/ijhcs

Virtual nature experiences and mindfulness practices while working from home during COVID-19: Effects on stress, focus, and creativity

Nabil Al Nahin Ch [a,*], Alberta A. Ansah [a], Atefeh Katrahmani [b], Julia Burmeister [c], Andrew L. Kun [a], Caitlin Mills [d], Orit Shaer [c], John D. Lee [b]

[a] University of New Hampshire, Electrical and Computer Engineering, 105 Main Street, Durham, 03824, NH, USA
[b] University of Wisconsin-Madison, Industrial and Systems Engineering, 702 West Johnson Street, Madison, 53715, WI, USA
[c] Wellesley College, Computer Science, 106 Central St, Wellesley, 02481, MA, USA
[d] University of New Hampshire, College of Liberal Arts, 105 Main Street, Durham, 03824, NH, USA

ARTICLE INFO

Keywords:
Working from home
COVID-19
Stress
Creativity
VR
Mindfulness

ABSTRACT

In this study, we focus on the impact of daily virtual nature experiences combined with mindfulness practices on remote workers' creativity, stress, and focus over an extended period (9 weeks) during the COVID-19 pandemic. Our results show a positive effect of virtual reality (VR) nature experience on increasing focus and reducing stress. When VR nature and mindfulness practices were combined, we also found an increase in convergent thinking task performance. Our findings demonstrate that 10-minute daily exposure to VR nature and mindfulness practices could compensate for some of the adverse effects of working remotely by improving some aspects of workers' well-being and creativity.

1. Introduction

The COVID-19 pandemic has drastically changed the way we live and work (Rudnicka et al., 2020). Many people were suddenly forced to work from home, a change that neither workers nor organizations have planned or prepared for. Although previous studies show that working from home may have some benefits like increasing productivity (Hunter, 2019; Bloom et al., 2015) and worker satisfaction (Bloom et al., 2015), the situation for workers during the pandemic was often challenging. The change was abrupt and many people were not prepared to work from home. Without a proper work setup at home, many workers had to improvise with limited resources (Newbold et al., 2021). Sometimes that meant working from the couch or kitchen table or sharing a small workspace with others in the home. A major challenge for some was juggling work with personal life while surrounded by ambient distractions. In particular, parents with younger children faced additional obstacles since the closure of schools meant they had to take care of the children during working hours (Gorlick, 2020). Restrictions on traveling and social gatherings made it harder to get a break from this difficult situation.

Studies examining work-from-home arrangements during the pandemic indicate some negative consequences of such arrangements. Some workers find themselves spending more hours working than before the pandemic (DeFilippis et al., 2020; Teodorovicz et al., 2021). Even if the workers do not spend more total time working, they sometimes extend the workday by taking breaks during the day and working later at night (Teodorovicz et al., 2021). To make things worse, at the end of the long working day many workers struggle to unplug from work (Routley, 2020). This might indicate an erosion of boundaries between work and personal life, a situation that increases work-related physical and emotional exhaustion among workers (Palumbo, 2020). Workers also report challenges to concentrate while working from home because of the surrounding distractions. Household chores, noisy neighbors, and interruptions by children or pets make it difficult for remote workers to focus on work and might lead to lower productivity (Mark et al., 2017). Lack of social interactions and of new and exciting experiences might make the life of remote workers more monotonous, which in turn may impact the creativity of workers (Peppercorn, 2020).

Despite facing many challenges, a recent survey found that the vast majority of workers want to have the option to continue working from home for the rest of their careers (Routley, 2020). They stated that a flexible schedule, the ability to work from anywhere, and no need to commute are the main reasons behind this choice (Routley, 2020). Many organizations are adopting a hybrid workplace model where employees can perform at least part of the work remotely. This helps the companies to attract top talent and reduce operational costs at the same time (Barbuto et al., 2020). Because more than one-third of the

* Corresponding author.
E-mail address: nabilalnahin.ch@unh.edu (N.A.N. Ch).

https://doi.org/10.1016/j.ijhcs.2022.102982
Received 14 March 2022; Received in revised form 11 December 2022; Accepted 13 December 2022
Available online 15 December 2022

jobs in the United States can be performed entirely from home (Dingel and Neiman, 2020) and both employers and employees could benefit from work-from-home arrangements, it is clear that remote work arrangements will continue (Barrero et al., 2021). So it is crucial to explore ways to help remote workers deal with challenges presented by the COVID-19 pandemic in particular, and by working-from-home arrangements more generally.

For this reason, we conducted a longitudinal field study focusing on the impact of daily virtual nature experiences combined with mindfulness practices on remote workers' creativity, perceived stress, and focus over an extended period of time (9 weeks) during the Covid-19 pandemic. Over the years researchers have investigated the effect of nature exposure (real and virtual) and mindfulness practices on stress, focus, and creativity (Atchley et al., 2012; Palanica et al., 2019). However, most studies were *cross-sectional* and were conducted in *controlled* laboratory environments. In contrast, this article expands on the existing literature by reporting findings from a *field* study focusing on the *long-term* effects of daily at-home virtual nature experience combined with mindfulness practice on remote workers. Even though in such a study we lose some experimental control compared to cross-sectional laboratory experiments, our experimental design increases ecological validity by observing remote workers in real-life environments without risking their well-being. The general hypothesis guiding this study is that an at-home intervention, which combines exposure to nature through a VR headset with mindfulness practice (using a mobile app) enhances the creativity and focus of remote workers and reduces stress. In the following, we present results from the study we conducted, which show a positive effect of VR nature experiences on increasing focus and reducing stress. When VR and mindfulness practice were combined, we also found an increase in convergent thinking task performance. Our findings demonstrate that 10–20 min of daily exposure to VR nature and mindfulness practice could compensate for some of the negative effects of working remotely by reducing stress, enhancing focus, and convergent thinking.

2. Related work

Well-being and productivity are two major considerations for effective remote work arrangements during the COVID-19 pandemic. Prior research suggests that stress, focus, and creativity are linked with the well-being and productivity of workers. Stress is an indicator of well-being (Lazarus and Folkman, 1984) and also a major concern for workers and organizations worldwide (World Health Organization et al., 2011). Difficulties in focusing on work can negatively affect productivity (Mark et al., 2017). The creativity of the workers is vital for solving personal and work-related problems. Working from home, especially during the COVID-19 pandemic, has been shown to increase workers' stress levels (Galanti et al., 2021; Gómez et al., 2020). Frequent switching between work and personal life might make it harder for remote workers to focus on a task. Moreover, the uniformity of everyday life of remote workers can negatively impact their creativity (Peppercorn, 2020; Amabile, 1998).

2.1. Stress, focus, and creativity

According to the World Health Organization (WHO), health is not just the absence of disease, but rather "a state of complete physical, mental and social well-being" (World Health Organization et al., 1995). This definition explicitly links well-being with health and underlines its importance. Over the years, researchers introduced various definitions and descriptions for well-being. Dodge et al. defined well-being as a balance between someone's resource pool and the challenges they face (Dodge et al., 2012). When someone experiences an environment where their resources are not enough to meet the challenges they face, it endangers their well-being and the relationship between the person and the environment can be defined as stress (Lazarus and Folkman, 1984). Experiencing stress can cause both physical and psychological health problems (Byrne et al., 2007; Fink, 2016; Stansfeld et al., 1997). Stress is associated with sleep difficulties (Kim and Dimsdale, 2007; Waters et al., 1993; Lundh and Broman, 2000; Van Reeth et al., 2000), increased blood pressure (Gasperin et al., 2009; Kulkarni et al., 1998), and depression in some people (Van Praag, 2004; Hammen, 2005; Caspi et al., 2003). Previous studies also found evidence of deleterious effects of stress on the heart which may lead to cardiovascular diseases (Dimsdale, 2008; Roux, 2003; Steptoe and Brydon, 2009; Schnall et al., 1994). Stress can also be related to work. A poll conducted by European Agency for Safety and Health at Work (EU-OSHA) found that as much as 50% of workers in Europe find their workplace stressful (European Agency for Safety and Health at Work, 2011). Work-related stress is considered a major challenge for organizations around the world as it can negatively affect workers' health and productivity (World Health Organization et al., 2011). Research suggests that high job-strain is associated with elevated blood pressure (Landsbergis et al., 1994), cardiovascular diseases (Johnson and Hall, 1988), musculoskeletal problems (Houtman et al., 1994), and psychiatric disorders (Stansfeld et al., 1997). Stress-related issues are among the leading causes of missing working days and retiring early from work (European Agency for Safety and Health at Work, 2011; World Health Organization et al., 2011).

While well-being is an important consideration for remote workers, so is productivity. The ability to maintain focus while working from home impacts the productivity of the workers. Focus has been shown to depend on criteria such as activity involvement, time of day, and type of work (Mark et al., 2014). Research shows that workers are often interrupted during work and that switching focus between tasks may be difficult (Czerwinski et al., 2004; González and Mark, 2004). Increasing focus in the workplace increases productivity (Mark et al., 2017).

Creativity is the capacity to produce original and useful ideas or work (Sternberg and Lubart, 1999). According to Runco & Jaeger, for an idea to be considered creative, it needs to be original, and it also needs to effectively solve the problem (Runco and Jaeger, 2012). Workers rely heavily on their creativity to deal with work-related challenges. Creativity is often assessed in terms of divergent and convergent thinking (Runco and Acar, 2012; Cropley, 2006). *Divergent thinking* is the capacity for exploring multiple potential answers or solutions to a given problem. People can come up with different valid answers which are novel and unusual for the same question (Cropley, 2006). On the other hand, *convergent thinking* is the capability to narrow in on a single answer to a given situation. Convergent thinking helps people find the correct or best solution for a clearly defined problem (Cropley, 2006). The emphasis here is on accuracy and how quickly one can find the solution. It is most effective in real-life situations where a correct solution already exists and needs to be worked out by applying logical reasoning (e.g. multiple choice tests).

Measuring creativity is a challenging task (Baer and McKool, 2009; Batey et al., 2010; Kaufman et al., 2008). Over the years, researchers have adopted different approaches to measuring creativity (Said-Metwaly et al., 2017). This resulted in the development of various tools and assessment techniques (Torrance, 1966; Amabile, 1982; Guilford, 1968, 1950; Mednick, 1968; Guilford, 1978; Urban, 2005). However, a review of different creativity tests shows that each test has some advantages and disadvantages and using multiple tests may provide a more accurate assessment of creativity (Cropley, 2000; Said-Metwaly et al., 2017).

Studies show that experiencing unusual and unexpected events or situations can enhance creativity (Ritter et al., 2012; Martindale, 1972; Goertzel et al., 1978), while lack of interactions with coworkers and limited exposure to new situations can negatively affect the creativity of the workers (Peppercorn, 2020; Amabile, 1998). Thus, working from home, which can limit experiencing new situations as well as interactions with others, can undermine creativity.

2.2. Positive effects of nature

One way to counteract the negative effects of working from home might be by spending time in nature. Spending time in nature can improve health, wellness, and creativity (Palanica et al., 2019). People who spend 120 min per week in nature reported a higher level of health and well-being (White et al., 2019). Nature helps reestablish our mental equilibrium, which in turn helps us recover from stress (Ulrich et al., 1991; Grahn and Stigsdotter, 2003). This process was named "environmental self-regulation" by Korpela (1989). Nature experience also helps people think less about the negative aspects of life (Bratman et al., 2015). Even watching three-dimensional videos of tree-covered streets (Jiang et al., 2016), driving along such roads (Parsons et al., 1998), or sitting in a room with tree views (Hartig et al., 2003) can help recover from stress faster. Spending time in nature has been shown to decrease symptoms of attention-deficit/hyperactivity disorder in children (Taylor et al., 2001), and lowers aggressive behaviors (Guite et al., 2006). People who spend more time in green spaces are less depressed and are less likely to have high blood pressure (Shanahan et al., 2016; Hartig et al., 2003). Exposure to nature can also increase concentration (Taylor et al., 2001) and enhance the ability to maintain focus (Berto, 2005). Studies show nature experience improves working memory (Berman et al., 2008) and helps people perform better on attention tests (Berman et al., 2008; Berto, 2005; Li and Sullivan, 2016). Attention Restoration Theory (ART) (Kaplan, 1995) emphasizes natural environments central to restoring attentional resources depleted by work. Even exposure to natural lights can improve the creativity and productivity of office workers (Peters, 2015). The benefits of experiencing nature can be gained through both short- and long-term exposure to nature. As short as a 40-second micro-break in nature can help people perform better in cognitive tests (Lee et al., 2015). On the other hand, 4 day long nature exposure can improve creativity and problem-solving task performance by as much as 50% (Atchley et al., 2012).

Many of the therapeutic effects of being in nature do not require people to be in direct contact with nature. Observing nature through a window (Kaplan, 2001; Li and Sullivan, 2016) or looking at an artificial window (Radikovic et al., 2005), viewing pictures or videos of nature (Wooller et al., 2016; Jiang et al., 2016), experiencing nature through virtual reality (VR) (Yu et al., 2018; Li et al., 2021; Anderson et al., 2017; Liszio et al., 2018), and even listening to nature-based soundscapes (Newbold et al., 2017) can provide similar benefits. Researchers found that watching nature videos can increase connectedness to nature, positive emotions, and attentional ability (Mayer et al., 2009), and exposure to VR nature video can increase physiological arousal and improves positive mood levels (Browning et al., 2020). Even though in both studies the effects were more dramatic for actual nature experience, the benefits of virtual nature experience were also significant. Immersive experiences, such as virtual reality environments that include sounds and images, promote stress recovery more than only images of nature (Annerstedt et al., 2013) and also enhance creativity (Fleury et al., 2021).

These studies demonstrate how exposure to nature can improve physical and mental health, productivity, and creativity. However, these studies did not focus on remote workers, and the effects of nature exposure were not evaluated over an extended period of time. Based on these studies we hypothesize that using VR headsets to experience nature scenes may negate some of the undesirable effects of working from home, especially for workers who have limited opportunities to go out in nature.

2.3. Positive effects of mindfulness

In addition to nature experiences, one effective method to enhance well-being and creativity is mindfulness practice. Mindfulness can improve the well-being and productivity of remote workers by helping them establish a strict boundary between work and personal life (Toniolo-Barrios and Pitt, 2021). Over the years researchers defined mindfulness in various ways. Most of the definitions describe mindfulness as a state of mind in which a person is aware or paying attention to the present, both internally and to the external environment (Brown et al., 2007; Herndon, 2008; Kabat-Zinn, 2005; Dane, 2011). Bishop et al. defined mindfulness as "non-elaborate, nonjudgmental, present-centered awareness in which each thought, feeling, or sensation that arises are acknowledged and accepted as it is" (Bishop et al., 2004). Despite the inherent challenges of promoting and measuring mindfulness (Davidson and Kaszniak, 2015), there is substantial evidence of its positive effect on health, productivity, and creativity (Brown et al., 2007; Klainin-Yobas et al., 2016; Baer, 2003; Dane, 2011; Lebuda et al., 2016). Mindfulness practice can enhance psychological well-being (Klainin-Yobas et al., 2016), help processing one's negative emotions (Shepherd and Cardon, 2009) and improve mood (Broderick, 2005). A clinical intervention study conducted by Brown and Ryan shows that increases in mindfulness can result in lower stress levels over time (Brown and Ryan, 2003). Since mindfulness can lead to a better attentional focus on the task, it is also associated with improved task performance (Kersemaekers et al., 2018; Good et al., 2016) in different types of jobs. Mindfulness has been linked with job performance among restaurant workers (Dane and Brummel, 2014), health care professionals (Beach et al., 2013), and managers working in leadership roles (Reb et al., 2014). A wide body of research also links mindfulness to creative thinking (Greenberg et al., 2012; Ostafin and Kassman, 2012). Mindfulness can improve the ability to solve insight problems (Ostafin and Kassman, 2012; Ren et al., 2011) and to find novel solutions to given problems (Greenberg et al., 2012). This indicates that mindfulness can affect creativity in terms of both convergent and divergent thinking. We are also seeing uses of different technologies to support mindfulness practice (Terzimehić et al., 2019) and the popularity of applications developed for this purpose (Daudén Roquet and Sas, 2018; Salehzadeh Niksirat et al., 2017) suggests that more and more people are realizing its benefits.

These studies demonstrate that mindfulness has many benefits in terms of enhancing well-being, productivity, and creativity. Given the challenges remote workers are facing during the COVID-19 pandemic, it is important to examine if mindfulness can help them in similar ways. Our contributions focus on examining mindfulness practice as complementary to virtual nature experiences.

3. Method

We conducted a longitudinal field study to explore how VR nature experiences combined with mindfulness practices affect the stress, focus, and creativity of remote workers during the COVID-19 pandemic. The dependent variables in this study are focus, stress, and creativity as measured by daily questionnaire data collected using text messages. The independent variables are engagement in nature experiences through VR (yes/no), and engagement in mindfulness practice (yes/no). In our nine-week study, the participants were asked to participate in each of the following three phases:

- Weeks 1—3: No Intervention: Text check-in
- Weeks 4—6: VR + No Mindfulness: 10 min of VR practice daily and text check-in
- Weeks 7—9: VR + Mindfulness: 10 min VR + 10 min mindfulness practice daily and text check-in

The first three weeks are for collecting baseline data, weeks four to six are for evaluating the effects of the VR nature experience, and the last three weeks are for evaluating the effects of the VR nature experience combined with mindfulness practice. We decided not to include a phase for only mindfulness practice in the study for two reasons: (1) the benefits of mindfulness are well documented. The expected results would not contribute new knowledge; (2) in order to measure the impact of mindfulness only (without VR), some participants would have had to

give up either using VR for nature exposure or mindfulness practice in the later phases of the study. Since we conducted the study during the challenging time of COVID-19, we did not want the participants to give up a potentially helpful intervention. Instead, we decided to investigate whether *combining* mindfulness practice with VR nature exposure yields additional benefits compared to just experiencing nature through VR. The study was conducted between October 2020 and January 2021. Data from the study was used in another paper where researchers investigated the stability of an individual's creativity over time (Katrahmani et al., 2022), but did not report on the effect of different interventions on stress, focus, and creativity. The study was approved by the University of New Hampshire Institutional Review Board (IRB).

3.1. Task

The participants were asked to check in using text messages and answer questions (see Section 3.4) every weekday during the 9-week study. They also completed a survey before starting each 3-week phase. Fig. 1 shows the steps of the study. During the first three weeks of the study, participants were only required to check in via text messages. For the next three weeks, participants experienced nature through a VR headset. They were instructed to use an application (Guided Relaxation VR on Oculus Go Cubicle Ninjas, 2018) to experience nature scenes for 10 min every weekday and check in via texts after that. Each nature scene presented participants with the sights and sounds of a dynamically changing place in nature, such as a waterfall or a beach with waves (Fig. 2). During the weekdays of the final three weeks, participants experienced both natures through VR for about 10 min and practiced mindfulness for about 10 min. They then checked in via text messages. For practicing mindfulness, participants selected a mindfulness session using the HealthyMinds application (Healthy Minds Innovations, Inc, 2019). We provided the following options for mindfulness sessions in the HealthyMinds application for the participants to choose from:

1. Calm in the midst of chaos: This practice aims to help people to calm their minds by connecting to their inner resilience.
2. Clarity in uncertain times: This practice aims to help people to re-frame things with insight and appreciation.
3. A true break: This practice aims to help people to take a break by focusing on doing nothing at all.

We did not track which session participants were choosing. The mindfulness practice sessions we selected in that application were similar in nature, where a speaker guided the participant through meditative practices focusing on breathing, awareness, etc. These mindfulness sessions were guided through audio only, no visuals were used. The sessions we selected were also similar in duration (about 10 min). Since the participants were practicing mindfulness daily for three weeks, giving them a list of options allowed them to try various mindfulness sessions instead of practicing the same session every day. The aim was to ensure that each mindfulness practice session for all the participants was similar in nature and duration. The HealthyMinds application can be installed on both Android and iOS systems. This application has been shown to enhance well-being in a clinical trial (Goldberg et al., 2020).

After completing the 9-week study, participants were invited to participate in a semi-structured exit interview (via Zoom) regarding their experience in the study including the use of VR headset and mindfulness practice throughout the study.

3.2. Procedure

We conducted a screening survey that was distributed through popular social media platforms. The survey included questions about people's living environment, work arrangements, experience with virtual reality, and general anxiety. The goal of the screening survey was to recruit participants who lived in urban cities, did not own a VR headset, and had a relatively low anxiety rating.

After recruiting the participants, we distributed a video describing the study and asked them to set a time to meet with us via Zoom. Participants were required to watch the video before the meeting. At the meeting, we discussed the requirements for the study and answered questions. We sent an Oculus Go virtual reality headset to each participant. They received this headset towards the end of the first three weeks of the study and used it for the final six weeks. Before the start of each new 3-week phase, we sent instruction videos to participants explaining what they were expected to do during that period of the study. The videos included instructions about how to set up the VR headset, install applications, and select specific nature scenes, duration, and no background music for experiencing nature through VR. We also met (via Zoom) with the participants individually before the start of each 3-week phase to discuss their role in the study, troubleshoot, and answer questions. Participants could also reach us via email if they experienced any difficulties or had concerns.

On each weekday during the study, participants received an automated text message in the morning reminding them to complete the daily tasks. The daily text check-ins were then initiated by the participants at their convenience, anytime during the day by sending a text message to a given number. We used Twilio (Twilio Inc, 2021), a cloud communications platform, to automate the participants' text check-in process. After sending the initial text message, participants received questions via text messages regarding stress, focus, and creativity (see Section 3.4). After sending each question, the system waited for the participant to answer via text message before sending the next question. In addition to the daily reminder text, participants received another reminder text if they missed check-ins on two consecutive days.

3.3. Participants

For this study, we recruited 20 remote workers from urban and suburban areas in five U.S. states: Massachusetts, Washington, New York, Illinois, and Mississippi. We selected people who do not own a VR headset, live in urban or suburban areas, and performed all or some of their work from home. The recruited people were less likely to experience nature in their day-to-day life, therefore more likely to be benefited from VR nature experience and mindfulness practice. Another selection criterion was a general anxiety score below the clinical threshold (not higher than 50) on the State-Trait Anxiety Inventory (STAI) measure (range 20–80) (Spielberger, 2010). Although anxiety is more likely a dimensional construct without strict cut-off points, this cut-off has nevertheless been used in other studies (Kim et al., 2010). Our screening survey did not include a question about gender, as we did not use gender as a selection criterion.

Fifty-eight people applied (filled out the screening survey) to take part in the study. The first 20 people meeting the selection criteria were recruited to participate in the study (19 women and one man). Historically women participants are underrepresented in VR research (Peck et al., 2020; Stanney et al., 2020). Thus, our participant population presented an opportunity to contribute to VR literature by studying VR with more women participants. It is also important to consider the major impact of working from home during the pandemic specifically on women (Ibarra et al., 2020; Brower, 2021; Molla, 2021) and that anxiety is substantially higher in women than in men (Bekker and van Mens-Verhulst, 2007). This indicates that our study participants are directly included in the target audience for the interventions we investigate.

Participants were between the ages of 25–68 ($M = 43.45$ years, $SD = 12.85$). Fourteen participants (out of 20 participants) also participated in a semi-structured exit interview at the end of the study. The participants kept the VR headset as compensation for the study. They also received a $15 Amazon gift card after completing each 3-week phase of the study. Those who participated in the exit interview received an additional $15 Amazon gift card.

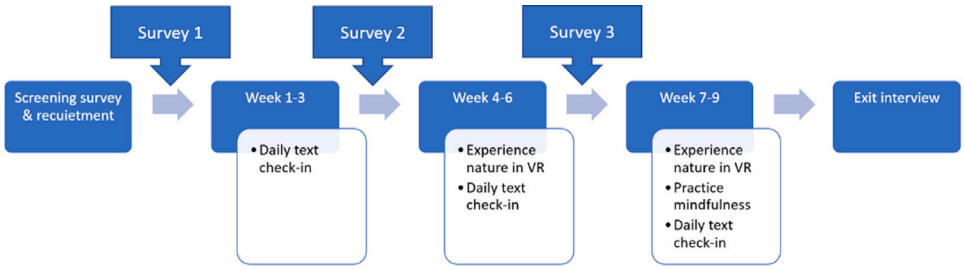

Fig. 1. Steps and timeline of the study.

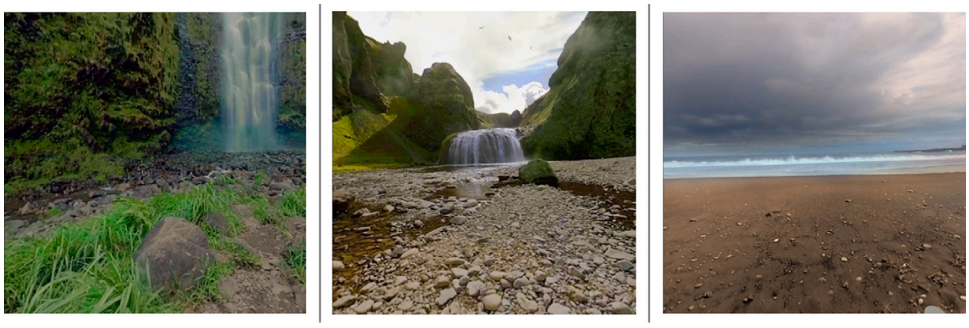

Fig. 2. Nature scenes participants used for virtual nature experience.

3.4. Measures

We tracked participants' creativity and self-assessed stress and focus over nine weeks. The participants reported their focus by responding to the question: "On a scale of 1 to 7 (1 being lowest and 7 being highest), how focused are you on your current task?". Similarly, to measure their stress we asked "On a scale of 1 to 7 (1 being very relaxed and 7 being very stressed), how stressed do you feel today?".

We used adapted versions of two different creativity measures, the Remote Associates Test (RAT) (Mednick, 1968) and the Alternate Uses Task (AUT) (Guilford, 1978), which measure participants' convergent and divergent thinking ability, respectively. We chose these measures because they are well-validated and widely used in the creative problem-solving literature (Carroll, 1968; Colzato et al., 2012; Mednick, 1968). The RAT measures creativity in terms of the ability to make associations where the participants are given three words and they need to come up with a word that connects all three given words. An example of a RAT question we asked is "Look at the three given words and find a fourth word that is related to all three: fly/clip/wall". In contrast, the AUT measures the ability to generate diverse ideas where the participants have to find as many uses for a given object as possible within a certain period of time. An example of an AUT question we asked is "Name all possible uses of the item mentioned below within 2 min. Please reply with only 1 use (1 or 2 words) per text message. Broom". Both measures were adapted to fit a short, mobile-friendly version for the current study.

3.5. Data collection

After the participants completed their daily activities, they were asked to check in via text messages using their smartphones. During the check-in process, they were asked four questions (see Section 3.4). The first two questions were intended to assess their stress and focus levels, and the last two questions were intended to assess their creativity in terms of convergent and divergent thinking. The timestamps and received text messages were stored in a cloud-based spreadsheet on Airtable (Airtable, 2021).

In the recorded online exit interviews we asked the participants open-ended questions about their general experience with the study, virtual nature experience, and benefits to their well-being. To achieve an understanding of the virtual nature experience we asked some questions on the VR experience such as: Tell us about the VR experience. Did you enjoy it? Do you feel that it was beneficial? How? Did you experience any discomfort? How was the VR equipment? We also asked some questions about the combined VR and mindfulness experience- Tell us about the combined VR and mindfulness experience. Did you enjoy it? Do you feel that it was beneficial? How? Which one did you like more? (VR/mindfulness) and why?

3.6. Data processing

During their daily text check-ins, participants reported their level of focus and stress with a number between 1 and 7 with 1 being the lowest level of focus and stress and 7 being the highest.

For the RAT, their responses were scored 1 (correct) and 0 (incorrect). The response times were also calculated as the time difference between the timestamps of RAT text sent and received.

For the AUT, participants' responses were scored on fluency and originality. The fluency score represents how many ideas a participant generated for a task. To measure fluency, the total number of uses mentioned by the participant for a given object was calculated. The originality score represents how unique the generated ideas are. To find the originality score, at first, the semantic similarity between the given object and each use named by the participant was calculated using spaCy (Honnibal and Montani, 2017), a library for natural language processing. Semantic similarity scores range from −1 to 1, with higher scores indicating higher similarity and therefore lower originality. The semantic distance score was calculated by subtracting the semantic similarity score from 1 which produced originality scores ranging from 0 to 2 with higher scores indicating higher originality. Maximum semantic distance scores were calculated from all the uses mentioned by a participant for a given object.

3.7. Data analysis

3.7.1. Daily check-ins

For analyzing the daily check-ins data, we used linear mixed models (using the open-source R package lme4 Bates et al., 2015) to assess the

relationship between intervention types and self-reported level of focus and stress, RAT response time, and AUT-related measures (total number of uses, maximum semantic distance). Due to the binomial distribution of RAT response correctness, we used a logistic mixed model to assess the relationship between RAT response correctness and intervention types. For all the models, interventions were included as a fixed effect, and participants were included as a random effect. Day number was treated as a competing exposure and was included as a fixed effect to control for its effect on dependent variables. An interaction term between intervention and day number was included; however, we note that we only include day number and interaction term in our models to control for the effects of time in the study. That is, including both the day number and the interaction term will help us understand if the intervention types have a main effect that explains unique variance above and beyond time in the study, but we do not have sufficient power to investigate any potential interactions in the current work (see Section 6 for more on this). Interventions and participants were treated as a factor and day were treated as a numeric. All the models are presented in Table 1. For each model, we performed the analysis of variance using Chi-square tests. We also compared each pair of intervention types by comparing estimated marginal means using the Tukey method. A comparison of intervention types is shown in Table 2.

3.7.2. Exit interviews

Two researchers first reviewed the autogenerated transcripts of the recorded interviews. Corrections were made where necessary. The researchers individually read through the transcripts and each generated a code-book with themes from the recorded responses. The themes from the separate code books were discussed as a team and were consolidated into 17 codes. The researchers independently coded all data, and then discussed the transcripts for participants with the least inter-coder agreement. Cohen's kappa was calculated with 97% inter-coder reliability. For quantifying the exit interview responses, we used a binary coding system (1/0) to indicate the presence or absence of a particular effect. For example, in the category positive VR experience, a rating of '1' by a coder would indicate a participant had a positive VR experience while a rating of '0' would indicate that the participant did not have a positive VR experience.

4. Results

We recorded a total of 812 check-ins out of the 900 expected check-ins during the 9 weeks of the study (20 participants × 9 weeks × 5 days a week). After cleaning the data and removing the non-relevant data points (non-relevant answers, answers during weekends, incomplete check-ins, etc.), 749 data points were extracted for analysis purposes.

4.1. Stress

We found a significant effect of intervention type on the stress level of the participants ($\chi^2 = 32.08$, p<0.001). The control variables were also significant: we found a significant main effect of the day ($\chi^2 = 5.95, p = 0.015$) as well as the interaction between day and intervention type ($\chi^2 = 9.5, p = 0.0087$). Post-hoc tests for the main effect of interest showed that VR nature experience and VR+mindfulness practice reduced stress compared to no intervention. Further, Cohen's effect size value ($d = 0.43$&$d = 0.60$) suggested low to moderate practical significance. However, the addition of mindfulness practice did not reduce stress significantly compared to only experiencing nature in VR (Table 2), thus suggesting that both intervention types involving VR had some benefit to stress.

4.2. Focus

We found that intervention type was a significant factor for predicting the focus level of the participants ($\chi^2 = 14.13$, p<0.001). This indicates that the focus level of the participants was influenced by the interventions. We did not find a significant main effect of day and also no interaction between day and intervention. Post-hoc tests showed that VR nature experience and VR+mindfulness practice improved focus levels compared to no intervention. Further, Cohen's effect size value ($d = 0.23$&$d = 0.31$) suggested small practical significance. However, the addition of mindfulness practice did not improve focus levels significantly compared to just using VR for experiencing nature (Table 2).

4.3. Creativity assessment

We explored the effects of different interventions on participants' creativity in terms of convergent and divergent thinking.

4.3.1. Convergent thinking

To assess participants' convergent thinking, we analyzed the response time and correctness probability of their reply to the remote associates test (RAT). We found that the intervention type was a significant factor for predicting the probability of getting the correct answer to a RAT question ($\chi^2 = 28.74$, p<0.001) as well as for the response time ($\chi^2 = 19.83$, p<0.001). This indicates that convergent thinking was influenced by the interventions. We did not find a significant main effect of day or interaction between day and intervention type. Post-hoc pairwise comparisons revealed that using VR for nature experience did not significantly improve convergent thinking ability (both in terms of increasing the probability of coming up with the correct answer and reducing the response time) but VR+mindfulness practice improved convergent thinking ability compared to no intervention and only experiencing nature through VR (Table 2). Cohen's effect size value ($d = 0.55$&$d = 0.48$) suggested small to medium practical significance for change in response time.

4.3.2. Divergent thinking

We assessed participants' divergent thinking ability in terms of fluency (number of uses) and originality (semantic distance) of their replies to the alternate uses task. We found that intervention type was a significant factor for predicting the number of uses ($\chi^2 = 34.44$, p<0.001) but not the maximum semantic distance. This indicates that the interventions influenced the divergent thinking ability of the participants in terms of fluency but not originality. In terms of control variables, we did not find a significant main effect of day, but we did observe a significant interaction between day and intervention type for the total number of uses ($\chi^2 = 14.18$, p<0.001) and maximum semantic distance ($\chi^2 = 8.02, p = 0.02$). Post-hoc analysis of the main effect of intervention type indicated that the number of uses decreased significantly for both experiencing nature through VR and VR+mindfulness practice compared to no intervention, but no significant difference was observed between the intervention types for maximum semantic distance (Table 2). Cohen's effect size value ($d = 0.31$&$d = 0.33$) suggested small practical significance for change in the number of uses (fluency). In sum, divergent thinking ability did not change significantly in terms of originality (semantic distance) between intervention types, but it actually worsened in terms of fluency (number of uses) for VR nature experience and VR+mindfulness practice.

4.4. Participant experience and perceived benefits

In this section, we discussed our findings from the qualitative analysis of the post-study (exit) interviews with 14 participants.

Table 1
Parameters of all the mixed-effects models (the estimates of the models are conditional effects corresponding to $day = 0$).

					Creativity							
					Convergent thinking (RAT)				Divergent thinking (AUT)			
	Focus (Scale 1–7)		Stress (Scale 1–7)		Correctness probability (logit)		Response time (Sec)		Total number of uses (Fluency)		Max. semantic distance (Originality)	
Predictors	Estimates	95% CI	Estimates	95% CI	Estimates	95% CI	Estimates	95% CI	Estimates	95% CI	Estimates	95% CI
(Intercept)	4.39	[3.82, 4.96]	4.14	[3.68, 4.59]	0.45	[−0.38, 1.28]	47.25	[28.30, 66.21]	9.20	[7.87, 10.53]	0.82	[0.79, 0.85]
No intervention												
VR only	0.13	[−0.29, 0.55]	−0.97	[−1.42, −0.52]	−0.54	[−1.43, 0.35]	−5.6	[−26.74, 15.55]	−0.49	[−1.4, 0.38]	−0.02	[−0.06, 0.02]
VR+Mindfulness	0.29	[−0.08, 0.65]	−0.86	[−1.25, −0.47]	0.41	[−0.41, 1.22]	−11.73	[−30.25, 6.78]	−2.16	[−2.93, −1.39]	0.04	[0.007, 0.07]
Day	−0.01	[−0.03, 0.01]	−0.04	[−0.07, −0.02]	−0.05	[−0.09, 0]	0.3	[−0.78, 1.38]	−0.05	[−0.1, −0.007]	0.0002	[−0.002, 0.002]
VR only:Day	0.01	[−0.02, 0.05]	0.06	[0.02, 0.09]	0.06	[−0.01, 0.14]	−0.03	[−1.77, 1.72]	−0.03	[−0.1, 0.05]	0.001	[−0.002, 0.004]
VR+Mindfulness:Day	0.006	[−0.03, 0.04]	0.03	[−0.006, 0.06]	0.08	[0.003, 0.15]	−0.98	[−2.59, 0.64]	0.10	[0.04, 0.17]	−0.003	[−0.006, −0.0002]
Random effects		σ		σ		σ		σ		σ		σ
Participants		1.18		0.84		1.44		32.38		2.79		0.04
Residual		1.1		1.18				55.54		2.31		0.1

Table 2
Weighted mean and standard deviation of measures for each intervention and pairwise comparison of estimated means for intervention types.

		No Intervention	VR only	VR+Mindfulness	No Intervention - VR only		No Intervention - VR+Mindfulness		VR only - VR+Mindfulness	
		Mean (SD)	Mean (SD)	Mean (SD)	Effect size (Cohen's d)	p	Effect size (Cohen's d)	p	Effect size (Cohen's d)	p
Focus (Scale 1–7)		4.26 (1.05)	4.54 (1.31)	4.64 (1.41)	0.23	**0.025**	0.31	**0.001**	0.07	0.70
Stress (Scale 1–7)		3.72 (0.97)	3.31 (0.92)	3.1 (1.11)	0.43	**0.001**	0.60	<0.001	0.21	0.21
Convergent thinking (RAT)	Correctness probability	0.5	0.51	0.69		0.89		<0.001		<0.001
	Response time (sec)	49.98 (42.92)	45.02 (33.99)	30.06 (28.7)	0.13	0.48	0.55	<0.001	0.48	**0.008**
Divergent thinking (AUT)	Total number of uses (fluency)	8.66 (2.87)	7.79 (2.82)	7.65 (3.25)	0.31	<0.001	0.33	<0.001	0.05	0.31
	Max semantic distance (originality)	0.82 (0.05)	0.81 (0.05)	0.83 (0.05)	0.13	0.79	0.25	0.62	0.39	0.29

4.4.1. VR experience

The VR experience of the participants was coded based on three categories: the effect of the VR equipment on the experience, the experience with the VR nature scene, and the effect of the study structure on the VR experience. When asked about the VR experience, 71%(10/14) participants described having a positive experience with the VR headset describing the experience using terms such as relaxing, calming, and ability to travel. For example, participant 12 mentioned that "for me being able to be in the scene and really be able to be present for ten minutes was great, but I loved, I loved VR". While 29%(4/14) had negative experiences due to factors such as technical difficulties in setting up the headset, the repetitive nature scene, and not being able to choose their own nature scenes. 64%(9/14) participants had a positive experience with the VR nature scenes; participant 12 shared: "I loved all of the scenes, especially the water and just the peacefulness and serenity", while 29%(4/14) had a negative experience. Participant nine describes it as "the clouds they're not moving and they were just like little specks on white things" and participant 10 also described the scenes as "some sort of streams dystopian science fiction world in which you're in nature, but it's never going to change". For 29%(4/14) of participants, the study structure contributed to a negative experience. For example, participant two expressed this sentiment by saying: "I would like to be able to choose. I think if I had been able to choose from one or two, from two or three different scenes every day? I think the variety would have kept me more interested".

4.4.2. Perceived VR benefits

During the exit interview, participants were asked if they experienced any benefits from the VR task. 64%(9/14) of participants reported feeling 'calm', 'relaxed', or 'refreshed' as a benefit of the VR nature experience and 50%(7/14) described the VR nature benefits as 'an escape'. For example, participant 14 stated, "I felt that calming and soothing, VR is kind of a nice way to escape out of the walls of your home". Some participants also shared that the VR experience allowed them to feel focused as participant 13 describes it, "I would feel just more relaxed and focused".

4.4.3. VR plus mindfulness experience

The VR plus mindfulness experience was coded into two main categories: Whether participants liked the combination of VR and Mindfulness and whether they favored one over the other. 50%(7/14) of participants liked the combination of VR and Mindfulness. Participants with a positive combined experience shared that the VR experience prepared them for the mindfulness practice. Participant 3 shared "having the nature first, let me really like relax into it and be in a better place to do the guided meditation". Factors contributing to a negative experience included the added time for the combined tasks and some participants preferring one practice over the other. Participant 13 shared, "I'd say the biggest challenge of that was just the added time. Because like I said, I mean 20 min is not that much, but I, like, it's funny how hard it is to find 20 min of time that I can just like completely be for myself uninterrupted". Participant one shared: "I could have done without the VR part of it. And the length of time was, it was hard to fit that into my schedule". Despite the added time, some participants experienced a benefit of the combined experience as described by participant 14: "honestly, before I would do it, I'd be like, Oh, I don't really have time to do this or I'm not in the mood to do this but then once you get into it, it just kinda, kinda resets like hitting the reset button, I guess". 21%(3/14) participants preferred mindfulness to VR and 21%(3/14) preferred VR to mindfulness.

4.4.4. Perceived benefits of VR plus mindfulness

The perceived benefits of VR and mindfulness were coded according to participants feeling 'calm' or 'relaxed' and feeling 'focused' or 'centered'. 86%(12/14) of participants reported feeling more calm and relaxed; "they both relaxed me", participant nine described, as well as participant eight who described feeling "grounded" and "I guess a little bit refreshed". 50%(7/14) of participants reported feeling more focused or centered after the combined experience. "It made me feel more focused, ready for the day at hand and the challenges that it was going to bring. And again, I mentally could check off that I did something to try to center myself a little bit before the start of an unpredictable day, which most of December was anyway", participant seven shared.

5. Discussion

This remote nine-week study examined how experiencing nature through a virtual reality device, and then also engaging in mindfulness practices, affected the focus, stress, and creativity of remote workers. The results showed that the VR nature experience increased participants' focus. However, adding mindfulness practices to the VR nature experience did not provide additional benefits. In addition to improving focus, the study also revealed that the VR nature experience decreased participants' stress levels. Similarly, adding mindfulness did not affect the stress level significantly highlighting the potential benefits of VR nature experiences on their own. In general, we can conclude that a 10-minutes daily experience of nature through a VR headset may increase focus and reduce stress for remote workers over time. These findings were further supported by participants' responses during their exit interviews. Most of the participants stated that the VR nature experience helped them to relax and some of them thought of it as an escape from the situation they are in.

In terms of creativity, we assessed both convergent and divergent thinking using adapted versions of the Remote Associates Test (RAT) and Alternative Uses Task (AUT), respectively. Results suggested that VR experiences did not improve convergent thinking. However, adding a daily mindfulness practice to the VR experience improved convergent thinking both in terms of the rate of getting correct answers and decreased response time. In contrast, neither the VR experience nor the mindfulness practice improved divergent thinking, as assessed by fluency and originality. The fluency scores were lower during the VR nature experience and combined VR mindfulness phase. This suggests that the same interventions may have different effects on different aspects of creativity. Further, this may be an artifact of our creativity measures since we adapted two measures that are more traditionally used in single-session experiments rather than over multiple months.

5.1. Implications for designing interventions

Our results are encouraging for a number of reasons. The brief daily VR and mindfulness interventions were well-received by participants, who remained engaged in the study for nine weeks, and told us in exit interviews that the interventions provided them with positive experiences. This is indeed good news because we expect that many workers will continue to work from home, partly because many firms see a number of advantages in working-from-home arrangements (Neeley, 2021; Barrero et al., 2021). The workers of these firms are likely to enjoy not having to spend time commuting (Kun et al., 2020), but they could still be at risk of not experiencing nature or interacting with co-workers often enough. Simple interventions like the ones we tested can be effective in supporting the general well-being of these remote workers, as well as their work productivity.

Designers can also use our results as an indication that VR nature experiences can reduce stress and improve focus for remote workers. Of course, we only tested one implementation of VR nature experiences, and all of our participants engaged in these experiences in a uniform

way, spending a few minutes on them each workday. Additional research can shed light on how to design VR experiences for different workers, where relevant variables to test include types of nature experiences (e.g. walking through nature vs. observing static or moving images), VR quality, and time spent in VR. In addition, some of our participants expressed a desire to control the details of interventions, like the time and duration of the intervention, selecting virtual nature scenes, and mindfulness practice options. It would be important to assess how personal user preferences, and the ability to control different aspects of the interventions, affect the outcomes of the interventions.

An additional important implication for design is that any particular intervention might have different effects on creativity depending on whether it is related to convergent or divergent thinking. Tools and techniques developed for enhancing the creativity of workers might be more useful if focused on enhancing either convergent or divergent thinking based on the types of jobs or tasks on hand.

We want to note that our decision to trade off statistical power (relatively small sample size) for increased ecological validity and longer-term observation allowed us to collect data under real-world conditions, over a relatively long period of time (9 weeks). Our study became part of our participants' everyday routines for multiple weeks. This gives us confidence that designs that are based on our implications could be well received by users, as well as applied in work-from-home settings using commercially available VR headsets.

As we discussed in the related work section, there is already substantial evidence for the therapeutic effects of both real and virtual nature exposure and the results from our study extend these results by demonstrating that daily brief (10 min) interventions over an extended period of time are sufficient for positive impact on stress, focus, and some aspects of creativity during a time of crisis like the COVID-19 pandemic.

6. Limitations

Conducting longitudinal VR studies remotely is challenging (Ratcliffe et al., 2021a,b). Even though on average, participants were highly compliant (daily task completion rate dropped below 70% for only one day of the study), there were some issues that may have impacted the study. One issue was that maintaining experimental control was a challenge. In the instructions for the participants we tried to specify all the factors that may influence the study (nature scenes, background music, duration, etc.), but we could not verify that all the participants were following these instructions. Another challenge was that our study was conducted in the US in a time frame that included the US presidential election, Christmas, Thanksgiving, New Year's Eve, and varying COVID-19 restrictions. All these events may have affected the participants differently, which may have introduced noise in the data.

We used self-reported measures instead of standard questionnaires or physiological measures for assessing perceived stress and focus. We chose this approach because it made it easier for participants to report their perceived focus and stress level using simple text messages on a daily basis for nine weeks. This experimental design decision indicates a trade-off between using validated measures and lowering barriers for participants to report data on a daily basis.

Our sample size was relatively small (n = 20). The fact that we see significant results despite having relatively low power suggests that the observed effects are robust for practical purposes. Some of the null effects may be significant if replications are completed with a larger sample, but this does not detract from the overall findings presented. We also observed some interactions with Day in the study that we did not follow up on within the current paper due to this limitation in sample size. Future work, however, should be designed with power in mind so that we can ensure that our null results are not a type 2 error and other factors like the age of participants and effects of time can be studied more intentionally. Moreover, the stability of our creativity measures within individuals over a longer period of time needs further investigation as well, particularly since these were adapted for quick, mobile-friendly usage (Baer, 1994; Magnusson and Backteman, 1978; Katrahmani et al., 2022). For example, a recent study found that the two measures of creativity used here are quite variable over time, indicating that these measures are not simply tracking a stable individual difference measure (Katrahmani et al., 2022). This variability suggests that we can expect to see some fluctuations in creativity scores (at least for these tasks) over time and that they may be influenced by various situational and cognitive-affective factors. However, we also note that it may be worthwhile using other creativity tasks that are specifically designed for longitudinal data collection, or ones that are more directly related to workplace creativity.

Another limitation of the study was that the order of interventions was not counterbalanced. In order to do that, some participants would have had to give up using VR headsets or mindfulness practice, or both in the later phases of the study. Since the pandemic already put a lot of mental pressure on people, we did not want to ask the participants to give up practices that might help them cope with the added stress. For this reason, we could not have both VR-only and Mindfulness only phases in our study. Since many researchers have investigated the effect of mindfulness practices on creativity and well-being (Brown et al., 2007; Keng et al., 2011), we decided not to include a phase in which the participants only focused on mindfulness practices without using the VR. For our analysis, we did not consider the novelty effect of using VR technology. Even though none of the participants owned a VR headset, we expect the novelty effect to be small because of repeated exposure to VR technology throughout the study (Huang et al., 2021).

An additional limitation of our study is that almost all of our participants were women (19/20), which may limit the generalization of our results. Additional work is necessary to assess how different people in different contexts would be able to benefit from VR nature experiences and mindfulness practices. However, considering the major impact of working from home during the pandemic specifically on women (Ibarra et al., 2020; Brower, 2021; Molla, 2021) and that anxiety is substantially higher in women than in men (Bekker and van Mens-Verhulst, 2007), we believe it is important to consider such interventions with population that is likely to benefit from them. It is also important to note that considering women are underrepresented in VR research (Peck et al., 2020; Stanney et al., 2020), we believe that the contribution of the study is important even if it cannot be generalized to all workers.

Despite these limitations, this study contributes to exploring how exposure to VR nature scenes and mindfulness practice can improve the focus, stress, and creativity of remote workers.

7. Conclusion

In conclusion, our study shows that experiencing nature through VR for as little as 10 min a day can help people focus on a task and also reduce stress, but it may not have any effect on convergent creative thinking. Adding mindfulness practice to the nature VR experience, may not affect focus or stress, but it can improve convergent creative thinking. Both VR nature experience and mindfulness practice may diminish some aspects of divergent thinking (fluency) and may not have any effects on other aspects (originality). Taken together, findings from this study can help researchers explore different ways in which VR interventions could be used to improve the well-being of remote workers.

CRediT authorship contribution statement

Nabil Al Nahin Ch: Conceptualization, Data curation, Writing, Data analysis. **Alberta A. Ansah:** Conceptualization, Data curation, Data analysis. **Atefeh Katrahmani:** Conceptualization, Writing. **Julia Burmeister:** Conceptualization. **Andrew L. Kun:** Conceptualization, Supervision. **Caitlin Mills:** Conceptualization, Supervision. **Orit Shaer:** Conceptualization, Supervision. **John D. Lee:** Conceptualization, Supervision.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Andrew L. Kun, Orit Shaer, John D. Lee reports financial support was provided by National Science Foundation.

Data availability

Data will be made available on request.

Acknowledgments

This work was in part supported by NSF grants CMMI- (University of New Hampshire: 1840085; Wellesley College: 1840031; University of Wisconsin-Madison: 1839484).

References

Airtable, 2021. Airtable. https://airtable.com. (Online Accessed 16 January 2022).
Amabile, T.M., 1982. Social psychology of creativity: A consensual assessment technique. J. Personal. Soc. Psychol. 43, 997.
Amabile, T.M., 1998. How to kill creativity. (Online Accessed 3 August 2021).
Anderson, A.P., Mayer, M.D., Fellows, A.M., Cowan, D.R., Hegel, M.T., Buckey, J.C., 2017. Relaxation with immersive natural scenes presented using virtual reality. Aerosp. Med. Hum. Perform. 88, 520–526.
Annerstedt, M., Jönsson, P., Wallergård, M., Johansson, G., Karlson, B., Grahn, P., Hansen, Å.M., Währborg, P., 2013. Inducing physiological stress recovery with sounds of nature in a virtual reality forest — Results from a pilot study. Physiol. Behav. 118, 240–250. http://dx.doi.org/10.1016/j.physbeh.2013.05.023.
Atchley, R.A., Strayer, D.L., Atchley, P., 2012. Creativity in the wild: Improving creative reasoning through immersion in natural settings. PLoS One 7, e51474.
Baer, J., 1994. Performance assessments of creativity: Do they have long-term stability? Roeper Rev. 17, 7–11.
Baer, R.A., 2003. Mindfulness training as a clinical intervention: A conceptual and empirical review. Clin. Psychol. Sci. Pract. 10, 125.
Baer, J., McKool, S.S., 2009. Assessing creativity using the consensual assessment technique. In: Handbook of Research on Assessment Technologies, Methods, and Applications in Higher Education. IGI Global, pp. 65–77.
Barbuto, A., Gilliland, A., Peebles, R., Rossi, N., Shrout, T., 2020. Telecommuting: Smarter workplaces.
Barrero, J.M., Bloom, N., Davis, S.J., 2021. Why Working from Home Will Stick. Technical Report, National Bureau of Economic Research.
Bates, D., Mächler, M., Bolker, B., Walker, S., 2015. Fitting linear mixed-effects models using lme4. J. Stat. Softw. 67, 1–48. http://dx.doi.org/10.18637/jss.v067.i01.
Batey, M., Chamorro-Premuzic, T., Furnham, A., 2010. Individual differences in ideational behavior: Can the big five and psychometric intelligence predict creativity scores? Creat. Res. J. 22, 90–97.
Beach, M.C., Roter, D., Korthuis, P.T., Epstein, R.M., Sharp, V., Ratanawongsa, N., Cohn, J., Eggly, S., Sankar, A., Moore, R.D., et al., 2013. A multicenter study of physician mindfulness and health care quality. Ann. Fam. Med. 11, 421–428.
Bekker, M.H.J., van Mens-Verhulst, J., 2007. Anxiety disorders: Sex differences in prevalence, degree, and background, but gender-neutral treatment. Gend. Med. 4, S178–S193.
Berman, M.G., Jonides, J., Kaplan, S., 2008. The cognitive benefits of interacting with nature. Psychol. Sci. 19, 1207–1212.
Berto, R., 2005. Exposure to restorative environments helps restore attentional capacity. J. Environ. Psychol. 25, 249–259.
Bishop, S.R., Lau, M., Shapiro, S., Carlson, L., Anderson, N.D., Carmody, J., Segal, Z.V., Abbey, S., Speca, M., Velting, D., et al., 2004. Mindfulness: A proposed operational definition. Clin. Psychol. Sci. Pract. 11, 230–241.
Bloom, N., Liang, J., Roberts, J., Ying, Z.J., 2015. Does working from home work? Evidence from a Chinese experiment. Q. J. Econ. 130, 165–218.
Bratman, G.N., Hamilton, J.P., Hahn, K.S., Daily, G.C., Gross, J.J., 2015. Nature experience reduces rumination and subgenual prefrontal cortex activation. Proc. Natl. Acad. Sci. 112, 8567–8572.
Broderick, P.C., 2005. Mindfulness and coping with dysphoric mood: Contrasts with rumination and distraction. Cogn. Ther. Res. 29, 501–510.
Brower, T., 2021. Women and the pandemic: Serious damage to work, health and home demands response. Forbes (Online Accessed 9 September 2021).
Brown, K.W., Ryan, R.M., 2003. The benefits of being present: Mindfulness and its role in psychological well-being. J. Personal. Soc. Psychol. 84, 822.
Brown, K.W., Ryan, R.M., Creswell, J.D., 2007. Mindfulness: Theoretical foundations and evidence for its salutary effects. Psychol. Inq. 18, 211–237.
Browning, M.H., Mimnaugh, K.J., van Riper, C.J., Laurent, H.K., LaValle, S.M., 2020. Can simulated nature support mental health? Comparing short, single-doses of 360-degree nature videos in virtual reality with the outdoors. Front. Psychol. 10, 2667.
Byrne, D.G., Davenport, S.C., Mazanov, J., 2007. Profiles of adolescent stress: The development of the adolescent stress questionnaire (ASQ). J. Adolesc. 30, 393–416.
Carroll, J.B., 1968. Reviews: Guilford, JP the nature of human intelligence. New York: McGraw-Hill, 1967. 538 + xii pp. $14.75. Am. Educ. Res. J. 5, 249–256.
Caspi, A., Sugden, K., Moffitt, T.E., Taylor, A., Craig, I.W., Harrington, H., McClay, J., Mill, J., Martin, J., Braithwaite, A., et al., 2003. Influence of life stress on depression: Moderation by a polymorphism in the 5-HTT gene. Science 301, 386–389.
Colzato, L.S., Szapora, A., Hommel, B., 2012. Meditate to create: The impact of focused-attention and open-monitoring training on convergent and divergent thinking. Front. Psychol. 3, 116.
Cropley, A.J., 2000. Defining and measuring creativity: Are creativity tests worth using? Roeper Rev. 23, 72–79.
Cropley, A., 2006. In praise of convergent thinking. Creat. Res. J. 18, 391–404.
Cubicle Ninjas, 2018. Guided relaxation VR. https://www.oculus.com/experiences/go/2052864981411233/?ranking_trace=0_2052864981411233_SEARCH_5db56e2a-98ed-49be-b600-0cb025a42c43. (Online Accessed 26 May 2021).
Czerwinski, M., Horvitz, E., Wilhite, S., 2004. A diary study of task switching and interruptions. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 175–182.
Dane, E., 2011. Paying attention to mindfulness and its effects on task performance in the workplace. J. Manag. 37, 997–1018.
Dane, E., Brummel, B.J., 2014. Examining workplace mindfulness and its relations to job performance and turnover intention. Hum. Relat. 67, 105–128.
Daudén Roquet, C., Sas, C., 2018. Evaluating mindfulness meditation apps. In: Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems. pp. 1–6.
Davidson, R.J., Kaszniak, A.W., 2015. Conceptual and methodological issues in research on mindfulness and meditation. Am. Psychol. 70, 581.
DeFilippis, E., Impink, S.M., Singell, M., Polzer, J.T., Sadun, R., 2020. Collaborating During Coronavirus: The Impact of COVID-19 on the Nature of Work. Technical Report, National Bureau of Economic Research.
Dimsdale, J.E., 2008. Psychological stress and cardiovascular disease. J. Am. Coll. Cardiol. 51, 1237–1246.
Dingel, J.I., Neiman, B., 2020. How many jobs can be done at home? J. Public Econ. 189, 104235.
Dodge, R., Daly, A.P., Huyton, J., Sanders, L.D., 2012. The challenge of defining wellbeing. Int. J. Wellbeing 2.
European Agency for Safety and Health at Work, 2011. Psychosocial Risks and Stress at Work. European Agency for Safety and Health at Work, Retrieved from: https://osha.Europa.Eu/En/Themes/Psychosocial-Risks-and-Stress.
Fink, G., 2016. Stress, definitions, mechanisms, and effects outlined: Lessons from anxiety. In: Stress: Concepts, Cognition, Emotion, and Behavior. Elsevier, pp. 3–11.
Fleury, S., Blanchard, P., Richir, S., 2021. A study of the effects of a natural virtual environment on creativity during a product design activity. Think. Ski. Creat. 40, 100828.
Galanti, T., Guidetti, G., Mazzei, E., Zappalà, S., Toscano, F., 2021. Work from home during the COVID-19 outbreak: The impact on employees' remote work productivity, engagement, and stress. J. Occup. Environ. Med. 63, e426.
Gasperin, D., Netuveli, G., Dias-da Costa, J.S., Pattussi, M.P., 2009. Effect of psychological stress on blood pressure increase: A meta-analysis of cohort studies. Cad. Saude Publica 25, 715–726.
Goertzel, M.G., Goertzel, V., Goertzel, T.G., 1978. 300 Eminent Personalities: A Psychosocial Analysis of the Famous. Jossey-Bass, San Francisco.
Goldberg, S.B., Imhoff-Smith, T., Bolt, D.M., Wilson-Mendenhall, C.D., Dahl, C.J., Davidson, R.J., Rosenkranz, M.A., 2020. Testing the efficacy of a multicomponent, self-guided, smartphone-based meditation app: Three-armed randomized controlled trial. JMIR Ment. Health 7, e23825.
Gómez, S.M., Mendoza, O.E.O., Ramírez, J., Olivas-Luján, M.R., 2020. Stress and myths related to the COVID-19 pandemic's effects on remote work. Manag. Res.: J. Iberoam. Acad. Manag.
González, V.M., Mark, G., 2004. "Constant, constant, multi-tasking craziness" managing multiple working spheres. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 113–120.
Good, D.J., Lyddy, C.J., Glomb, T.M., Bono, J.E., Brown, K.W., Duffy, M.K., Baer, R.A., Brewer, J.A., Lazar, S.W., 2016. Contemplating mindfulness at work: An integrative review. J. Manag. 42, 114–142.
Gorlick, A., 2020. The productivity pitfalls of working from home in the age of COVID-19. Stanf. News.
Grahn, P., Stigsdotter, U.A., 2003. Landscape planning and stress. Urban For. Urban Green. 2, 1–18.
Greenberg, J., Reiner, K., Meiran, N., 2012. "Mind the trap": Mindfulness practice reduces cognitive rigidity. PLoS One 7, e36206.
Guilford, J.P., 1950. Creativity. American psychology.
Guilford, J.P., 1968. Creativity, Intelligence, and Their Educational Implications. EDITS/Knapp, San Diego, CA.

Guilford, J.P., 1978. Alternate Uses. Sheridan supply Company.
Guite, H.F., Clark, C., Ackrill, G., 2006. The impact of the physical and urban environment on mental well-being. Public Health 120, 1117–1126.
Hammen, C., 2005. Stress and depression. Annu. Rev. Clin. Psychol. 1, 293–319.
Hartig, T., Evans, G.W., Jamner, L.D., Davis, D.S., Gärling, T., 2003. Tracking restoration in natural and urban field settings. J. Environ. Psychol. 23, 109–123.
Healthy Minds Innovations, Inc, 2019. Healthy minds program. https://apps.apple.com/us/app/healthy-minds-program/id1326310617#?platform=iphone. (Online Accessed 26 May 2021).
Herndon, F., 2008. Testing mindfulness with perceptual and cognitive factors: External vs. internal encoding, and the cognitive failures questionnaire. Personal. Individ. Differ. 44, 32–41.
Honnibal, M., Montani, I., 2017. spaCy 2: Natural language understanding with Bloom embeddings, convolutional neural networks and incremental parsing, to appear.
Houtman, I.L.D., Bongers, P.M., Smulders, P.G.W., Kompier, M.A.J., 1994. Psychosocial stressors at work and musculoskeletal problems. Scand. J. Work Environ. Health 139–145.
Huang, W., Roscoe, R.D., Johnson-Glenberg, M.C., Craig, S.D., 2021. Motivation, engagement, and performance across multiple virtual reality sessions and levels of immersion. J. Comput. Assist. Learn. 37, 745–758.
Hunter, P., 2019. Remote working in research: An increasing usage of flexible work arrangements can improve productivity and creativity. EMBO Rep. 20, e47435.
Ibarra, H., Gillard, J., Chamorro-Premuzic, T., 2020. Why WFH isn't necessarily good for women. Harv. Bus. Rev. 7.
Jiang, B., Li, D., Larsen, L., Sullivan, W.C., 2016. A dose-response curve describing the relationship between urban tree cover density and self-reported stress recovery. Environ. Behav. 48, 607–629.
Johnson, J.V., Hall, E.M., 1988. Job strain, work place social support, and cardiovascular disease: A cross-sectional study of a random sample of the Swedish working population. Am J Public Health 78, 1336–1342.
Kabat-Zinn, J., 2005. Coming to Our Senses: Healing Ourselves and the World Through Mindfulness. Hachette UK.
Kaplan, S., 1995. The restorative benefits of nature: Toward an integrative framework. J. Environ. Psychol. 15, 169–182.
Kaplan, R., 2001. The nature of the view from home: Psychological benefits. Environ. Behav. 33, 507–542.
Katrahmani, A., Ansah, A.A., Ch, N., Burmeister, J., Kun, A.L., Mills, C., Shaer, O., Lee, J.D., 2022. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, Vol. 66, SAGE Publications Sage CA, Los Angeles, CA, pp. 2290–2294.
Kaufman, J.C., Baer, J., Cole, J.C., Sexton, J.D., 2008. A comparison of expert and nonexpert raters using the consensual assessment technique. Creat. Res. J. 20, 171–178.
Keng, S.-L., Smoski, M.J., Robins, C.J., 2011. Effects of mindfulness on psychological health: A review of empirical studies. Clin. Psychol. Rev. 31, 1041–1056.
Kersemaekers, W., Rupprecht, S., Wittmann, M., Tamdjidi, C., Falke, P., Donders, R., Speckens, A., Kohls, N., 2018. A workplace mindfulness intervention may be associated with improved psychological well-being and productivity. A preliminary field study in a company setting. Front. Psychol. 9, 195.
Kim, W.-S., Byeon, G.-J., Song, B.-J., Lee, H.J., 2010. Availability of preoperative anxiety scale as a predictive factor for hemodynamic changes during induction of anesthesia. Korean J. Anesthesiol. 58, 328.
Kim, E.-J., Dimsdale, J.E., 2007. The effect of psychosocial stress on sleep: A review of polysomnographic evidence. Behav. Sleep Med. 5, 256–278.
Klainin-Yobas, P., Ramirez, D., Fernandez, Z., Sarmiento, J., Thanoi, W., Ignacio, J., Lau, Y., 2016. Examining the predicting effect of mindfulness on psychological well-being among undergraduate students: A structural equation modelling approach. Personal. Individ. Differ. 91, 63–68.
Korpela, K.M., 1989. Place-identity as a product of environmental self-regulation. J. Environ. Psychol. 9, 241–256.
Kulkarni, S., O'Farrell, I., Erasi, M., Kochar, M.S., 1998. Stress and hypertension. WMJ 97, 34–38.
Kun, A., Sadun, R., Shaer, O., Teodorovicz, T., 2020. Where did the commute time go. Harv. Bus. Rev. Available Online: https://hbr.org/2020/12/where-did-the-commute-time-go. (Accessed 3 January 2021).
Landsbergis, P.A., Schnall, P.L., Warren, K., Pickering, T.G., Schwartz, J.E., 1994. Association between ambulatory blood pressure and alternative formulations of job strain. Scand. J. Work Environ. Health 349–363.
Lazarus, R.S., Folkman, S., 1984. Stress, Appraisal, and Coping. Springer publishing company.
Lebuda, I., Zabelina, D.L., Karwowski, M., 2016. Mind full of ideas: A meta-analysis of the mindfulness–creativity link. Personal. Individ. Differ. 93, 22–26.
Lee, K.E., Williams, K.J.H., Sargent, L.D., Williams, N.S.G., Johnson, K.A., 2015. 40-Second green roof views sustain attention: The role of micro-breaks in attention restoration. J. Environ. Psychol. 42, 182–189.
Li, J., Ma, Y., Li, P., Butz, A., 2021. A journey through nature: Exploring virtual restorative environments as a means to relax in confined spaces. In: Creativity and Cognition. pp. 1–9.
Li, D., Sullivan, W.C., 2016. Impact of views to school landscapes on recovery from stress and mental fatigue. Landsc. Urban Plan. 148, 149–158.
Liszio, S., Graf, L., Masuch, M., 2018. The relaxing effect of virtual nature: Immersive technology provides relief in acute stress situations. Annu. Rev. Cyberther. Telemed. 16, 87–93.
Lundh, L.-G., Broman, J.-E., 2000. Insomnia as an interaction between sleep-interfering and sleep-interpreting processes. J. Psychosom. Res. 49, 299–310.
Magnusson, D., Backteman, G., 1978. Longitudinal stability of person characteristics: Intelligence and creativity. Appl. Psychol. Meas. 2, 481–490.
Mark, G., Iqbal, S., Czerwinski, M., 2017. How blocking distractions affects workplace focus and productivity. In: Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers. pp. 928–934.
Mark, G., Iqbal, S.T., Czerwinski, M., Johns, P., 2014. Bored mondays and focused afternoons: The rhythm of attention and online activity in the workplace. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. pp. 3025–3034.
Martindale, C., 1972. Father's absence, psychopathology, and poetic eminence. Psycho Rep. 31, 843–847.
Mayer, F.S., Frantz, C.M., Bruehlman-Senecal, E., Dolliver, K., 2009. Why is nature beneficial? The role of connectedness to nature. Environ. Behav. 41, 607–643.
Mednick, S.A., 1968. The remote associates test. J. Creative Behav.
Molla, R., 2021. For women, remote work is a blessing and a curse. Vox (Online Accessed 9 August 2021).
Neeley, T., 2021. Remote Work Revolution: Succeeding from Anywhere. HarperCollins.
Newbold, J.W., Luton, J., Cox, A.L., Gould, S.J.J., 2017. Using nature-based soundscapes to support task performance and mood. In: Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems. pp. 2802–2809.
Newbold, J.W., Rudnicka, A., Cook, D., Cecchinato, M., Gould, S., Cox, A.L., 2021. The new normals of work: A framework for understanding responses to disruptions created by new futures of work. Hum.-Comput. Interact. 1–24. http://dx.doi.org/10.1080/07370024.2021.1982391.
Ostafin, B.D., Kassman, K.T., 2012. Stepping out of history: Mindfulness improves insight problem solving. Conscious. Cogn. 21, 1031–1036.
Palanica, A., Lyons, A., Cooper, M., Lee, A., Fossat, Y., 2019. A comparison of nature and urban environments on creative thinking across different levels of reality. J. Environ. Psychol. 63, 44–51.
Palumbo, R., 2020. Let me go to the office! An investigation into the side effects of working from home on work-life balance. Int. J. Public Sect. Manag.
Parsons, R., Tassinary, L.G., Ulrich, R.S., Hebl, M.R., Grossman-Alexander, M., 1998. The view from the road: Implications for stress recovery and immunization. J. Environ. Psychol. 18, 113–140.
Peck, T.C., Sockol, L.E., Hancock, S.M., 2020. Mind the gap: The underrepresentation of female participants and authors in virtual reality research. IEEE Trans. Vis. Comput. Graphics 26, 1945–1954.
Peppercorn, S., 2020. How to stay creative when life feels monotonous. Harv. Bus. Rev. (Online Accessed 26 May 2021]).
Peters, A., 2015. Google is trying to improve its workplaces with offices inspired by nature. Fast Company.
Radikovic, A.S., Leggett, J.J., Keyser, J., Ulrich, R.S., 2005. Artificial window view of nature. In: CHI'05 Extended Abstracts on Human Factors in Computing Systems. pp. 1993–1996.
Ratcliffe, J., Soave, F., Bryan-Kinns, N., Tokarchuk, L., Farkhatdinov, I., 2021a. Extended reality (XR) remote research: A survey of drawbacks and opportunities. In: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems. pp. 1–13.
Ratcliffe, J., Soave, F., Hoover, M., Ortega, F.R., Bryan-Kinns, N., Tokarchuk, L., Farkhatdinov, I., 2021b. Remote XR studies: Exploring three key challenges of remote XR experimentation. In: Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems. pp. 1–4.
Reb, J., Narayanan, J., Chaturvedi, S., 2014. Leading mindfully: Two studies on the influence of supervisor trait mindfulness on employee well-being and performance. Mindfulness 5, 36–45.
Ren, J., Huang, Z., Luo, J., Wei, G., Ying, X., Ding, Z., Wu, Y., Luo, F., 2011. Meditation promotes insightful problem-solving by keeping people in a mindful and alert conscious state. Sci. China Life Sci. 54, 961–965.
Ritter, S.M., Damian, R.I., Simonton, D.K., van Baaren, R.B., Strick, M., Derks, J., Dijksterhuis, A., 2012. Diversifying experiences enhance cognitive flexibility. J. Exp. Soc. Psychol. 48, 961–964.
Routley, N., 2020. 6 charts that show what employers and employees really think about remote working. In: World Economic Forum. https://www.weforum.org/agenda/2020/06/coronavirus-covid19-remote-workingoffice-employees-employers.
Roux, A.V.D., 2003. Residential environments and cardiovascular risk. J. Urban Health 80, 569–589.
Rudnicka, A., Newbold, J.W., Cook, D., Cecchinato, M.E., Gould, S., Cox, A.L., 2020. Eworklife: Developing effective strategies for remote working during the COVID-19 pandemic. In: Eworklife: Developing Effective Strategies for Remote Working During the COVID-19 Pandemic. The New Future of Work Online Symposium.
Runco, M.A., Acar, S., 2012. Divergent thinking as an indicator of creative potential. Creat. Res. J. 24, 66–75.
Runco, M.A., Jaeger, G.J., 2012. The standard definition of creativity. Creat. Res. J. 24, 92–96.

Said-Metwaly, S., Van den Noortgate, W., Kyndt, E., 2017. Approaches to measuring creativity: A systematic literature review. Creat. Theor. Res. Appl. 4, 238–275.
Salehzadeh Niksirat, K., Silpasuwanchai, C., Mohamed Hussien Ahmed, M., Cheng, P., Ren, X., 2017. A framework for interactive mindfulness meditation using attention-regulation process. In: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. pp. 2672–2684.
Schnall, P.L., Landsbergis, P.A., Baker, D., 1994. Job strain and cardiovascular disease. Annu. Rev. Public Health 15, 381–411.
Shanahan, D.F., Bush, R., Gaston, K.J., Lin, B.B., Dean, J., Barber, E., Fuller, R.A., 2016. Health benefits from nature experiences depend on dose. Sci. Rep. 6, 1–10.
Shepherd, D.A., Cardon, M.S., 2009. Negative emotional reactions to project failure and the self-compassion to learn from the experience. J. Manage. Stud. 46, 923–949.
Spielberger, C.D., 2010. State-trait anxiety inventory. In: The Corsini Encyclopedia of Psychology. Wiley Online Library, p. 1.
Stanney, K., Fidopiastis, C., Foster, L., 2020. Virtual reality is sexist: But it does not have to be. Front. Robot. AI 7, 4.
Stansfeld, S.A., Fuhrer, R., Head, J., Ferrie, J., Shipley, M., 1997. Work and psychiatric disorder in the Whitehall II study. J. Psychosom. Res. 43, 73–81.
Steptoe, A., Brydon, L., 2009. Emotional triggering of cardiac events. Neurosci. Biobehav. Rev. 33, 63–70.
Sternberg, R.J., Lubart, T.I., 1999. The concept of creativity: Prospects and paradigms. Handb. Creat. 1, 3–15.
Taylor, A.F., Kuo, F.E., Sullivan, W.C., 2001. Coping with ADD: The surprising connection to green play settings. Environ. Behav. 33, 54–77.
Teodorovicz, T., Sadun, R., Kun, A.L., Shaer, O., 2021. How does working from home during COVID-19 affect what managers do? Evidence from time-use studies. Hum.-Comput. Interact. 1–26. http://dx.doi.org/10.1080/07370024.2021.1987908.
Terzimehić, N., Häuslschmid, R., Hussmann, H., Schraefel, M., 2019. A review & analysis of mindfulness research in HCI: Framing current lines of research and future opportunities. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems. pp. 1–13.
Toniolo-Barrios, M., Pitt, L., 2021. Mindfulness and the challenges of working from home in times of crisis. Bus. Horiz. 64, 189–197.
Torrance, E.P., 1966. The Torrance Tests of Creative Thinking-Norms-Technical Manual Research Edition-Verbal Tests, Forms A and B-Figural Tests, Forms A and B.
Twilio Inc, 2021. Twilio. https://www.twilio.com/. (Online Accessed 16 January 2022).
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. J. Environ. Psychol. 11, 201–230.
Urban, K.K., 2005. Assessing creativity: The test for creative thinking-drawing production (TCT-DP). Int. Educ. J. 6, 272–280.
Van Praag, H.M., 2004. Can stress cause depression? Prog. Neuropsychopharmacol. Biol. Psych. 28, 891–907.
Van Reeth, O., Weibel, L., Spiegel, K., Leproult, R., Dugovic, C., Maccari, S., 2000. Physiology of sleep (review)–interactions between stress and sleep: From basic research to clinical situations. Sleep Med. Rev. 4, 201–219.
Waters, W.F., Adams, Jr., S.G., Binks, P., Varnado, P., 1993. Attention, stress and negative emotion in persistent sleep-onset and sleep-maintenance insomnia. Sleep 16, 128–136.
White, M.P., Alcock, I., Grellier, J., Wheeler, B.W., Hartig, T., Warber, S.L., Bone, A., Depledge, M.H., Fleming, L.E., 2019. Spending at least 120 minutes a week in nature is associated with good health and wellbeing. Sci. Rep. 9, 1–11.
Wooller, J.-J., Barton, J., Gladwell, V.F., Micklewright, D., 2016. Occlusion of sight, sound and smell during Green exercise influences mood, perceived exertion and heart rate. Int. J. Environ. Health Res. 26, 267–280.
World Health Organization, et al., 1995. Constitution of the world health organization.
World Health Organization, et al., 2011. Occupational Health. Psychosocial Risk Factors and Hazards. World Health Organization, Retrieved from: http://www.who.int/occupationalhealth/topics/riskspsychosocial/en.
Yu, C.-P., Lee, H.-Y., Luo, X.-Y., 2018. The effect of virtual reality forest and urban environments on physiological and psychological responses. Urban For. Urban Green. 35, 106–114.