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Using natural intervention to promote subjective well-being of essential workers during public-health crises: A Study during COVID-19 pandemic

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ABSTRACT

Essential workers such as medical workers and police officers are first-line fighters during public-health crises, such as COVID-19 pandemic. Every time, they are under heavy stress both physically and mentally. The goal of the present study was to develop a novel nature-based intervention to promote their well-being. A representative sample of essential workers in China was recruited for a five-day intervention program, and were randomly assigned to two groups. The experimental group watched 2-min video clips of natural scenes every day, while the control group watched urban scenes. Results indicated that after five days, the natural stimuli intervention yielded overall improvements in various indices of subjective well-being. Furthermore, analyses of nested longitudinal data confirmed that everyday nature stimuli exposure provided both immediate and repeated restorative benefits. The proposed natural-based intervention is brief and easy-to-use, offering a cost-efficient psychological booster to promote subjective well-being of essential workers during this crisis time.

1. Introduction

Public-health crises always emerge with significant costs for human society. As of April 2021, more than one year after the coronavirus disease 2019 (COVID-19) outbreak, the confirmed cases and deaths are still on the rise. During crisis times like this, essential workers such as medical workers and police officers are playing crucial roles in the fight for the public well-being; however, they are in the face of heavy stress both physically and mentally. For example, during COVID-19, essential workers are exposed to a high risk of being infected as well as overtime and distressing work. Their work schedule always exceeded the coping capacity, thus causing overwhelming stress, burnout syndrome, emotional disorders, and a sharp decline in subjective well-being (e.g., Zhang et al., 2020). Therefore, there has been an urgent need for proper methods to promote essential workers’ well-being during public-health crises (Kang et al., 2020; Zhang et al., 2020).

The natural environment provides a potential avenue for intervention. Research has demonstrated the beneficial impact of exposure to the natural environment on physical health (e.g., lower prevalence of hypertension, skin allergies), mental health (e.g., lower depression and anxiety), and social well-being (e.g., reduction of socially excluded pain experiences; Markevych et al., 2017; Shanahan et al., 2016; Yang et al., 2020). The natural environment could be regarded as means to deal with the stress and emotional problems of urban life (e.g., Berman et al., 2008; Bratman et al., 2015; Chen et al., 2020). The aim of the present study was to develop and test a nature-based intervention as a psychological booster for the subjective well-being of essential workers in the context of COVID-19.

1.1. The restorative benefits of natural environment

Previous studies have documented the restorative benefits of exposure to nature, leading to enhanced well-being and better functioning (see Hartig et al., 2014 for a review). Two theoretical accounts, the Stress Reduction Theory (SRT) (Ulrich, 1983; Ulrich et al., 1991) and Attention Restoration Theory (ART) (Kaplan, 1995; R. Kaplan & Kaplan, 1989), have been proposed to explain the emotional and cognitive benefits of contact with nature.

The SRT suggests that nature’s restorative quality lies in the absence of physical and social stressors and in the appreciation of nature itself,
such as its beautiful scenery and reduction of noise annoyance (Hartig et al., 2014). Compared with city settings (e.g., traffic, pedestrians), exposure to nature decreases the perceptual salience of stressors, thus reducing the risk from surrounding environments as both psychologically and physiologically reduced stress (Ulrich, 1983; Ulrich et al., 1991). Later studies further confirmed that the effective time of emotional restoration could last for a long time after the immediate experience of stress reduction (Hartig et al., 1996; Laumann et al., 2003). The restorative effect also exists with regular exposure to natural landscapes. Researchers have demonstrated that more green space in neighborhoods is correlated with lower perceived stress and the reduction of the diurnal pattern of cortisol secretion may be the physiological mechanism underpinning this association (Roe et al., 2013; Thompson et al., 2012).

The ART, on the other hand, regards stress as reduced attentional capacity. The fascinating aspects of nature (compared with cities) are intrinsically easier to engage with, and require less effort, thus enabling rest and adjustment to inhibit continuous cognitive fatigue by direct attention (R. Kaplan & Kaplan, 1989). Consequently, cognitive performance could be improved due to the restoration from the natural environment (Berman et al., 2008; Hartig et al., 1991; Kaplan, 1995). Such benefits could still be immediate, since brief glances of natural components, as quick as 40s, induce significant attentional nourishment (Lee et al., 2015). A regular exposure to nature scenes can also yield positive change to cognitive capability (Hattie et al., 1997; Wilson & Lipsey, 2000).

As the SRT and the ART are not exclusive to each other, they combine to support a highly effective and complete restoration from nature than other environments (Kaplan, 1995; Korpela et al., 2008). For example, salient cognitive and affective restoration has been reported for watching natural videos using self-reported and physiological measurements in a laboratory design (van den Berg et al., 2003). Except for the natural videos, various media could yield restorative benefits, such as pictures (Valtchanov & Ellard, 2015), videos (van den Berg et al., 2003), virtual reality nature environments (Valtchanov et al., 2010), and real-life nature sceneries (Berman et al., 2008). Neuroscientific studies reveal the underlying mechanism of cognitive and affective restoration from nature. Chen et al. (2020) found closer brain functional connectivity during the contact with nature, compared to the real-life urban environment stimulation. Exposure to natural environments can also significantly reduce prefrontal cortex activity during processing negative information, compensate for cognitive decline with emotional repair, and reduce the risk of related psychological disorders (Tost et al., 2019).

Therefore, by virtue of its restorative benefits, the natural environment could be a source of relaxation and regeneration of mental fatigue and promote individual well-being (see Tost et al., 2015 for a review). Typically in the workplace, neurocognitive fatigue rises during direct attention in task performance, increasing stress in a vicious circle. The beneficial change occurs when viewing the natural spaces (Annerstedt et al., 2013; Lee et al., 2015). In conclusion, nature scenes add value to our urban environments. Their self-reported levels of subjective well-being were compared to their occupational characteristics. The sample had adequate representation of essential workers, we chose videos as the media. A group of COVID-19 essential workers watched short video clips of natural scenes every day. Their self-reported levels of subjective well-being were compared to a control group watching videos of urban scenes. We predicted superior psychological manifestations of subjective well-being within those who received nature-based intervention.

2. Methods

2.1. Participants

We recruited 92 essential workers (51 police officers and 41 medical workers, i.e., medical doctors and nurses) through the local government of a local city in Zhejiang Province. We collected the largest sample we were able to obtain to offset the expected high rate of nonresponse due to their occupational characteristics. The sample had adequate representativeness since we recruited essential workers covering all the seventeen police stations and fourteen public hospitals around the local city. All the participants were the local first-line fighters during COVID-19. The number of individuals to be sampled in each institution was determined based on its proportion of essential workers participating in the fight against the COVID-19 pandemic. The study was conducted in accordance with the Declaration of Helsinki and approved by the University Ethics Committee of Human Research. The study consisted of two phases, a seven-day experience sampling method (ESM) survey, whose results will be reported in another paper, and a five-day nature-based intervention. The participants received a maximum of 380 yuan as a reward for taking part in the whole project.

Due to participant dropout, the final sample size of the intervention study was 71, including 39 police officers (6 females) and 32 medical workers (19 females), with a mean age of 36.15 years (SD = 8.66). We conducted a post hoc power analysis using G*Power (Version 3.0; Faul & Erdfelder, 2002).
et al., 2007), which suggested that 26 participants per group were required to detect an effect size of 39% difference between conditions (Tabrizian et al., 2018) with 80% power and a 0.05 criterion of statistical significance. Most of the participants were experienced workers with an average occupational time of 12.35 years ($SD = 8.53$).

2.2. Design

The longitudinal study was performed using an online survey system. Data were collected around 13–14 weeks after the COVID-19 epidemic outbreak in Wuhan. The local government lowered the public health emergency alerts to Level III. The study period corresponded to the virus diminishing stage in China and the resumption of work and production. The essential workers returned to work after the isolation period, but were still vulnerable after the great distress and risks during the service of the COVID-19 epidemic outbreak.

The participants were randomized into two groups. The experimental group (37 participants, 16 medical workers) received natural intervention, while the control group (34 participants, 16 medical workers) received urban intervention. Participants were unaware of the purpose of the study, which was confirmed in a final survey after the 5-day intervention program.

The participants first completed a pre-study online survey that collected demographic information and several dispositional variables (see below for details), and then enrolled in the intervention study, which comprised three phases: pre-test, intervention, and post-test. The participants received an online survey at 20:00 p.m. every day, and were instructed to finish it in 4 h. On Day 0 (pre-intervention test) and Day 6 (post-intervention test), the participants completed both the Satisfaction with Life Scale (SWLS) (Diener et al., 1985) and the Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988), which measured their subjective well-being. In the pre-study survey, we collected the measures of demographic variables prior to the intervention study, but potentially served as control variables in the following analyses. Additionally, we also measured their personality traits with Big Five Inventory (Costa & McCrae, 1992), a 44-statement rated on a 5-point Likert scale (from 1 “not at all” to 5 “extremely”) assessing five distinctive personality traits, namely, Openness (Cronbach’s α = 0.77), Conscientiousness (Cronbach’s α = 0.46), Extraversion (Cronbach’s α = 0.63), Agreeableness (Cronbach’s α = 0.48), and Neuroticism (Cronbach’s α = 0.58). The scores were added to the following analyses.

We selected the short version of the 11-item PANAS using a 5-point Likert scale ranging from 1 (“disagree strongly”) to 5 (“strongly agree”), agree such that higher scales (averaged) suggest stronger connection to nature (Cronbach’s α = 0.79). Together with demographic data, they were not of primary interest in the present study, but potentially served as control variables in the following analyses to ensure that our intervention effects were not due to these confounding factors.

The pre-test, post-test, and daily survey of subjective well-being. A multidimensional construct of subjective well-being consists of three separate components: positive and negative affects, and cognitive evaluation of the quality of life (Diener, 1984; Diener et al., 1999). To measure affective status, we adopted the PANAS (Watson et al., 1988). We selected the short version of the 11-item PANAS using a 5-point Likert scale (from 1 “not at all” to 5 “extremely”; Thompson, 2007), including two independent subscales of positive affects (joy, confidence, attentive, calm, and vigorous; Cronbach’s α between 0.90 and 0.93) and negative affects (fear, sad, guilt, hostile, ashamed, and fatigue; Cronbach’s α between 0.72 and 0.89). We computed the average scores of the two subscales, and obtained two affective dimensions (i.e., positive affects and negative affects).

To measure life quality, we adopted the SWLS (Diener et al., 1985), with five statements on a 7-point Likert scale from 1 (“disagree strongly”) to 7 (“agree strongly”). We obtained the average score as an indication of how satisfied they were overall with their recent life in a

2.3. Measures and stimuli

The pre-study survey. In the pre-study survey, we collected the measures of demographic variables prior to the intervention study, including sex, age, occupation (police officers and medical workers) and occupational year (since the time becoming a member of the occupation), educational level (i.e., senior high school and lower, associate, bachelor, master, doctor, and higher), social economic status (measured by a ladder from 1 = lowest to 10 = highest in the society), living area (i.e., urban and rural), marital status (i.e., married, unmarried, divorced, or widowed), and monthly income (i.e., from below 2,000 to 100,000 yuan and above).

Fig. 1. The study procedure and measurements. Note. PANAS = The Positive and Negative Affect Schedule. Positive affects and negative affects were calculated averaged into following analysis. SWLS = The Satisfaction with Life Scale. Items ratings were averaged as life satisfaction. Both the PANAS and SWLS were measured in the pre-intervention test (Day 0) and post-intervention test (Day 6), while only PANAS was used during the daily intervention (Day 1 – Day 5). The screenshots were obtained from the videos used in the study.
conscious, cognitive judgment (Cronbach’s α between 0.83 and 0.92; Pavot & Diener, 1993; Shin & Johnson, 1978).

Before and after the 5-day intervention program, the participants completed the SWLS and the PANAS, assessing their experiences over the past five days (the pre-intervention test Day 0 and post-intervention test Day 6), which was regarded as the overall intervention effectiveness; while in the intervention phase (Day1 – Day 5), the daily PANAS tapped their instantaneous feelings to assess the daily intervention effectiveness. Instructions of the measures were different in the pre-test, post-test, and intervention phases.

Daily survey of working status. Besides the daily measures of subjective well-being, we also collected two variables regarding the participants daily working status: one is the working place (i.e., indoor or outdoor) and the other is the self-reported working intensity (5-point Likert scales from 1”extremely low” to 5”extremely high,” and 0 means off work as scheduled). Due to their career characteristics, they are always ready to respond to emergencies all the time. In times of COVID-19, their original work-life balance became skewed and non-resilient because of the long and tight schedule and emergencies at any times. The pre-study survey contained two questions asking about the participants’ daily working hours before and during COVID-19 (i.e., “how long is the working hour per day during the COVID-19 pandemic?” and “how long is the working hour per day under normal times before the COVID-19 pandemic?”). Results indicated that the average working hours during COVID-19 was 12.90 h (SD = 5.01) per day, which was significantly longer than before COVID-19 (M = 9.34 h, SD = 2.58). Yet, it is still difficult to precisely evaluate their daily working time due to their day and night shift arrangement. Therefore, self-reported working intensity, as a subjective perception variable, could be a better way to estimate their daily working status.

Intervention stimuli. We used five nature video clips and five urban video clips as the intervention stimuli. The participants watched one clip every day in a daily online survey. The clips were edited from the documentary videos of Tokyo from bilibili.com and background sounds were wiped. We tried our best to keep the diversity of contents comparable between natural and urban videos. The variety of natural scenes included vegetation and hydrological scenes as well as seasonal changes. The urban scenes were mainly in a modern architectural style with both tall, wide streetscapes and short, narrow streetscapes as defined by Harvey et al. (2015). The urban scenes we chose were clean and neat streetscape (like the sidewalks, travel lanes, streetlights and other fixtures), since we tried to prevent the potential confounding effect of pleasantness (Karmanov & Hamel, 2008). We evaluated the stimuli in a pilot sample of college students (N = 36) on the following four dimensions as stated in the ART, which were widely used in previous research (Kaplan, 1995; R. Kaplan & Kaplan, 1989): 1) being away, which refers to a feeling of change from everyday life to new sceneries; 2) soft fascination, which refers to the capability of nature to catch one’s involuntary attention without mental efforts; 3) coherence, which refers to the properties of coherence and scope in the environments; and 4) compatibility, which refers to the degree of harmony between the environment and the individual (Cronbach’s α = .72; Supplementary Table 2). The nature videos received higher ratings on all four dimensions than the urban videos (Supplementary Fig. 2), which is consistent with the characteristics of a restorative natural environment.

2.4. Data analytic strategy

We first assessed the balance in covariate distributions between the present sample and the missing data as well as the natural and urban groups. Then, we modeled the positive and the negative affects as response variables, respectively. Repeated measures ANOVA and independent sample t-test were used to compare the two condition groups on pre- and post-test differences using the SPSS 23.0 (2015) software. In R (4.0.1), regression analyses were performed for participants’ level of pre- and post-test data to explore the study group differences in overall intervention. We further analyzed the daily data to explore the instant effect of daily intervention and group differences. To address the correlation between daily observations within each participant, we adopted the multilevel models where we treated the daily observations as the first level and the participants as the second level; in other words, we treated the participants as random effects. Using R packages lme4, lmerTest, and MuMIn, we performed model fitting, inference, and selection, respectively. Finally, we conducted a 2 (condition: urban vs. natural-based intervention) \times 2 (time: pre-test for Day 1, post-test for Day 5) repeated measures ANOVA to test the overall effect of the study intervention. Additionally, by adding interaction terms to the model, we tested whether the effects were different in subpopulations, such as police officers and medical workers.

3. Results

3.1. Preliminary analyses

Of the 92 participants recruited, 21 did not participate in the intervention study, leaving 71 participants (16 medical workers) for the experimental group that received natural intervention, and 34 participants (16 medical workers) for the control group. Among them, five participants did not complete either the pre-test or the post-test; thus, the sample size for analyzing the pre-post intervention effect was 66. We found no significant differences in any covariates (including sociodemographic information and personality traits) between the missing and the present samples (Supplementary Table 1). Besides, there were no significant differences in demographic or baseline measures between two study condition (i.e., natural and urban group). Participant information and group comparisons are presented in Table 1. Some data were missing from the daily intervention evaluations due to nonresponse; however, no participant dropped due to this reason. The participants completed on average 4.65 (SD = 1.01) daily responses.

3.2. Overall intervention effectiveness

Descriptive data of the indexes of subjective well-being are presented in Table 2 and illustrated in Fig. 2. A 2 (condition: urban vs. natural-based intervention) \times 2 (time: pre-test, post-test) repeated measures ANOVA was conducted with three-dimensional subjective well-being as the dependent variable. There was a significant interaction between condition and time on positive affects, F(1, 64) = 5.58, p = .021, η²p = 0.08, as well as life satisfaction, F(1, 64) = 12.92, p = .001, η²p = 0.17, as compared to negative affects (Supplementary Table 3).

Table 1

| Variables | Natural Stimuli | Urban Stimuli | t value | p value |
|-----------|----------------|--------------|---------|---------|
| Occupation, police-officer | Male = 4 | Female = 20 | | |
| Occupation, medical-worker | Male = 10 | Female = 16 | | |
| Age | 37.91 (8.67) | 34.26 (8.21) | -1.753 | 0.084 |
| Educational level | 2.54 (.66) | 2.65 (.71) | 0.608 | 0.545 |
| SES | 4.74 (1.96) | 5.13 (1.31) | 0.928 | 0.357 |
| Occupation, year | 14.27 (9.02) | 10.87 (7.66) | -1.639 | 0.106 |
| Income level (monthly) | 3.77 (.69) | 3.61 (.92) | -0.798 | 0.428 |
| Subjective well-being | | | | |
| Positive affects | 3.05 (0.89) | 3.05 (0.94) | -0.002 | 0.998 |
| Negative affects | 1.52 (0.43) | 1.56 (0.52) | 0.307 | 0.760 |
| Life satisfaction | 4.13 (1.24) | 4.21 (1.55) | 0.235 | 0.815 |

Note. Group differences were measured using an independent sample t-test. Three participants did not respond to the baseline assessment.
Table 2
Change of indexes of subjective well-being before and after the study intervention.

| Subjective Well-being | Condition | Pre-test (SD) | Post-test (SD) | Change |
|------------------------|-----------|---------------|----------------|--------|
| Positive affects       | Nature    | 3.05 (0.89)   | 3.59 (0.89)    | ↑      |
|                        | City      | 3.05 (0.94)   | 3.13 (0.77)    | ↑      |
| Negative affects       | Nature    | 1.52 (0.43)   | 1.48 (0.44)    | ↓      |
|                        | City      | 1.56 (0.62)   | 1.72 (0.79)    | ↑      |
| Life satisfaction      | Nature    | 4.13 (1.24)   | 4.57 (1.25)    | ↑      |
|                        | City      | 4.21 (1.55)   | 3.46 (1.12)    | ↓      |

Note. Only significant change between pre- and post-test is noted. The upper arrow indicates an increase in a certain index of subjective well-being, and the lower arrow indicates the opposite.

Fig. 2. Intervention effectiveness measured by subjective well-being.

3.3. Instant benefits from daily intervention

Individual emotional responses from daily data are presented in Supplementary Fig. 3. Daily data contained repeated measurements of the same person. Hence, the independence assumption required by the paired t-test or the linear regression model was violated. To address the correlation between the measurements within each person, we adopted a linear mixed model, and treated the person as a random effect. We estimated and tested the coefficients of interest in the models that included and excluded the control variables (such as demographic covariates, working place, and working intensity) to evaluate the robustness of the results.

First, we examined the significance of the difference between the natural and the urban restorative effects. The dependent variables were

and there was a marginally significant interaction on negative affects, $F(1, 64) = 3.96, p = .051, \eta^2_p = 0.58$. Simple main effect analyses further suggested that the natural group showed a significant increase in positive affects, $p < .001$ and improvement of self-reported life satisfaction at marginal significance, $p = .06$, while no significant change of negative affects, $p = .57$. However, the control group illustrated a significant decrease in self-reported life satisfaction, $p = .003$ and an increase in negative affects, $p = .032$, while no significant change in positive affects, $p = .56$.

To further check whether intervention accounted for changes in subjective well-being, we performed multivariate linear regression analysis with change scores (post-test minus pre-test) as dependent variables. We put the control variables in the model, including demographic information and five personality traits. The results showed that natural-based intervention yielded significantly higher restorative effects of negative affects ($B = 1.10, t = 3.27, CI_{95\%} 0.42–1.77, p = .002$) and positive affects ($B = 0.47, t = 2.14, CI_{95\%} 0.03–0.91, p = .04$), and differed from the control group on lower negative affects ($B = -0.22, t = -1.91, CI_{95\%} -0.44 to -0.01, p = .06$) at marginal significance. The details are presented in Supplementary Table 3. In the subgroup analyses, we added the interaction between video types and occupations into the model. No difference in intervention effectiveness was found between the groups.

The restorative effects, that is, emotional changes that were defined as post-test value minus pre-test value. The covariate condition indicated whether the observation belonged to a natural or an urban group, and we were interested in its coefficient. After controlling the potential impact of sociodemographic variables and working status, the statistical results consistently indicated that compared to the urban stimuli, the natural stimuli had significantly higher restorative effects of positive affects ($B = 0.41, t = 3.41, CI_{95\%} 0.19–0.66, p = .001^1$) and lower restorative effects of negative affects ($B = -0.30, t = -4.82, CI_{95\%}, -0.41 to -0.18, p < .001$). Supplementary Table 4 provides detailed results of the minimum model and the best model after model selection.

Fig. 3 presents the group differences in daily change in subjective well-being after controlling for the impact of covariate working intensity, and visually verifies the conclusions we have drawn previously. In addition, we performed subgroup analyses, and found no significant difference between police officers and medical workers (Supplementary Table 4 and Supplementary Fig. 5). Supplementary Note 2 provides details of the statistical methods and models when analyzing the daily data.

Furthermore, we examined the natural and urban restorative effects in daily data. We used the change difference of self-reported positive and negative affects as the dependent variable (i.e., the restorative effects).

1 We adopted the methodology by Kenward & Roger, 1997 for accurate estimate for inferential statistics. Results were performed after model selection according to AIC.
Only significant change between pre- and post-test is noted. A lower arrow note change difference in subjective well-being within natural or urban group from Table 3 and urban restorative effects, respectively. The main statistical results term without intercept and any other covariates to examine the natural. We then fitted a multilevel model that only contained a random effect for the models are shown in Table 3. Results demonstrated that natural stimuli significantly reduced the negative affect (B = −0.21, t = −4.79, CI[95%] = −0.30 to −0.12, p < .001), while the urban stimuli significantly reduced the positive affects (B = −0.30, t = −3.26, CI[95%] = −0.47 to −0.11, p = .002). The participants in the nature group sustained positive affects (B = 0.05, t = 0.58, CI[95%] = −0.11 − 0.25, p = .561), while those in the control group did not report a significant decline in negative affect (B = 0.03, t = 0.63, CI[95%] = −0.06 − 0.12, p = .530).

Finally, we performed a 2 (condition: urban vs. natural-based intervention) × 2 (time: pre-test for Day 1, post-test for Day 5) repeated measures ANOVA to examine an overall effect of the 5-day study intervention. There was a significant interaction between condition and time on positive affects, F(1, 61) = 6.14, p = .016, η² = 0.091, as well as a main effect of time, F(1, 61) = 4.51, p = .038, η² = 0.069. Post hoc analyses revealed that the city group showed overall downward tendency on positive affects after the 5-day program, p = .002, while the nature group depicted stable positive affects during the 5 days, p = .802. Similar analyses were performed on negative affects, revealing an interaction between condition and time at marginal significance level, F (1, 61) = 2.82, p = .098, η² = 0.044, and a significant main effect of time concerning negative affects, F(1, 61) = 19.69, p < .001, η² = 0.244. Post hoc analyses on group difference suggested the negative affects increased among the city group at a marginal-significant level, p = .058, while an overall reduction of negative affects was found among nature group, p < .001.

4. Discussion

This study investigated the impact of a brief video-based natural intervention on subjective well-being in a sample of essential workers during the COVID-19 pandemic. The results indicated that the 5-day intervention using the natural stimuli (vs. urban stimuli) leads to either improved or sustained indexes of subjective well-being. Closer examinations of daily data further showed the immediate and stable restoration from natural stimuli. Our findings suggested that daily exposure to nature depicted a repeated reduction of negative feelings, which did not habituate over everyday intervention; and the positive feelings kept stabilized in the background of the pandemic. Taken together, everyday exposure to nature yielded significant restorative benefits, providing direct evidence for the Repeated Restoration Hypothesis.

In alignment with the study hypotheses, the natural environment facilitates a superior affective restoration. Two theories, SRT and ART, provide possible explanations for this finding. For those essential workers, working in busy and overcrowded information surroundings drains their mental resources, making them vulnerable to fascination. The natural stimuli, according to its restorative features (i.e., being away, soft fascination, coherence, and compatibility), capture involuntary attention in an automatic reflexive way, reducing the negative impact of limited resources (Berman et al., 2008; Kaplan, 1995; R. Kaplan & Kaplan, 1989). An alternative explanation is natural scenes act as a short and spontaneous micro-break from their demanding work (Jett & George, 2003; Kim et al., 2016). The daily intervention was conducted at 8:00 p.m. when many of the participants were off-work except for those with extended hours or on night duty. It would be more likely for them to be exposed to the nature intervention during a break. A break could be already restorative, while exposure to nature may further provide the value of added restoration on affective well-being than simply a break. And thus, in a skewed work-life balance, viewing a 2-min natural video attenuates the vicious circle between a tight working schedule and cumulative negative affects, boosting their waning capacity to achieve well-being. Therefore, we could expand the coping strategies on momentary recovery in the workplace by adding the restorative value of natural environment.

Table 3

| Subjective Well-being | Condition | B    | p-value | CI[95%] | Change  |
|-----------------------|-----------|------|---------|---------|---------|
|                       |           |      |         |         | Lower Bound | Upper Bound |
| Positive affects      | City      | −0.30| .002    | −0.47   | −0.11   |
| Negative affects      | Nature    | 0.05 | .561    | −0.11   | 0.25    |
|                       | City      | 0.03 | .530    | −0.06   | 0.12    |
|                       | Nature    | −0.21| <.001   | −0.30   | −0.12   |

Note. Only significant change between pre- and post-test is noted. A lower arrow indicates a decrease in a certain index of subjective well-being.
One intriguing and unexpected finding of the current study was that the control group who watched urban videos showed changes in subjective well-being in the opposite direction. Some previous studies have reported similar adversarial effects for urban stimuli (e.g., Takayama et al., 2014; Ulrich, 1983; Ulrich et al., 1991). The current study, using the pleasant urban scenes as the control, intentionally ruled out the confounding effect of pleasantness (Karmanov & Hamel, 2008); yet, the adversarial effect of urban stimuli remained and even repeatedly reduced the positive effects over daily exposure. One possible explanation is that the urban stimuli, even not unpleasant, still cost effortful processes requiring additional cognitive resources (Berman et al., 2008; Kaplan, 1983), and thus suffocated one’s subjective well-being. Another possibility is that there was a natural decline in the subjective well-being of the participants during the study period, perhaps due to the ongoing pandemic. From this perspective, the buffering role of nature-based intervention is particularly highlighted. After a period of intervention, natural environments offset the consequential well-being decline by the pandemic, and moreover, promote positive affects and happiness during the crisis time. Future research could further discern these two explanations by introducing a blank control group.

It is worth noting that the natural stimuli’s benefits seem to be on different indexes of subjective well-being in the overall and daily intervention effects. In the overall intervention, the natural stimuli manifested restorative benefits through promoting positive affects and life satisfaction; in the day-to-day patterns, the impact of natural stimuli was mainly manifested in the reduction of negative affects. One possible source of this inconsistency is the instruction of the measures. For the pre- and post-test, the participants were instructed to rate their well-being over the past five days, while for the daily measure, they were instructed to report instantaneous positive and negative affects. Previous studies have shown that self-reported affective states vary according to instructions related to different timeframes (i.e., momentary vs. past five days; Boyle et al., 2015; Fernandez & Kerns, 2008). Thus, the participants might have engaged in different mindsets when responding to questions regarding their levels of well-being either momentarily or averaged over the past five days, leading to seemingly inconsistent effects. Despite these issues, the overall results of the current study are consistent with previous clinical research showing the therapeutic benefits of nature-based intervention (see Annerstedt & Währborg, 2011 for a review) and demonstrating its usefulness for COVID-19 essential workers.

These findings have both theoretical and practical implications. From a theoretical perspective, we learn more about the direct relations between subjective well-being and exposure to nature. We provide additional supports for the instant restoration of the natural environment and demonstrate its reliability across time. More crucially, the current study provides direct evidence for the Repeated Restoration Hypothesis, showing that everyday natural restorative experiences repeatedly support emotional well-being in a relatively long term, and give rise to a superior cognitive judgment of life quality. From a practical perspective, the proposed intervention program was brief (daily 2-min video clips) and easy to realize, yet can activate both instant and repeated restoring benefits over time. It can be employed as a cost-efficient psychological booster for essential workers during crisis times or even their routine work. Nature stimuli effortlessly help the essential workers to get rid of their daily stress in and out of workplace, and promote instant restoration, offering sufficient time for self-refreshing. This finding supports the value of nature stimuli and reinforces the concept of health as an individual’s capacity to adapt to their environment (Lancet, 2009). Furthermore, the lack of significant subgroup differences suggests that it may be applicable to various types of essentials workers. Health policymakers may exploit this effect and introduce nature-based intervention programs to promote the mental health of essential workers.

Future research can expand on the current work in several directions. First, restricted by the time limit of our partnering institutions, we could, at most, test the intervention effectiveness over a five-day period, and long-lasting benefits are still be worthy of studying. Further research could design a longitudinal study with longer tracking to test the function of a brief natural video-based intervention, which could be performed during normal times. Besides, although we controlled the impact of working intensity during the analyses to daily data, the measure we used was a general self-reported scale. Future studies may employ more objective and comprehensive measures such as everyday working hours, significant stressor events, changes in working place, etc., to assess the impact of nuanced day-to-day workload fluctuations and how the natural interventions buffer daily workload. Finally, while the restorative benefits of nature have been widely acknowledged, its active ingredients still need to be clarified. Mechanisms such as natural variations (White et al., 2010), experiential diversity (Tost et al., 2019), colors (i.e., green and blue; Mytton et al., 2012) or a micro-break (Jett & George, 2003; Kim et al., 2016) may account for the improvement on subjective well-being. Disentangling the restoration of different natural components would realize the maximized benefits of nature-based interventions. More strict experimental control of difference between nature and city would be suggested. We suggest a further implication of portable devices in neurocognitive and physiological approaches to assist the study of nature-based intervention.

5. Conclusion

Our study highlights the restorative benefits of a brief nature-based intervention for essential workers during the COVID-19 pandemic. The results revealed both instant restoration and repeated improvement of subjective well-being, providing direct evidence for the Repeated Restoration Hypothesis. COVID-19 provides a starting point for inducing the nature-based intervention as a high-efficient and easy-to-access psychological booster for essential workers during public health crises.

Open science practice

Supplementary materials, study materials, data and analyses codes can be accessed from: https://osf.io/chn3k/

Statement of ethics

The study was approved by the University Ethics Committee on Human Research, and gained support from the local government. Data and results were approved for publication. Informed consent was obtained from all the participants.

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Author contributions

Chenhao Hu: Conceptualization, Methodology, Investigation, Formal analysis, Writing-Original Draft, Funding acquisition; Ke Zhu: Formal analysis, Writing-Review & Editing; Kun Huang, Bo Yu: Formal analysis; Wenchen Jiang: Investigation; Kaipeng Peng: Supervision; Fei Wang: Supervision; Methodology, Writing-Review & Editing, Funding acquisition. All the authors have read and approved the final paper.

Declarations of competing interest

None.
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Appendix A. Supplementary data

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