Expressive suppression moderates nature scene effect on acute stress recovery

Yu Hao [1]

[1] Department of Psychiatry, Icahn School of Medicine at Mount Sinai, New York, NY
Email: hannah.hao@mssm.edu

Abstract

Nature benefits stress recovery. However, few studies have examined if individual differences in emotion regulation moderate the restorative effect of nature. I investigated to what extent experiential, physiological, and neural components of stress recovery during nature scene viewing are moderated by individual differences in the habitual use of expressive suppression in daily lives. Thirty-three college students were induced acute stress by a standard laboratory stressor (mental arithmetic). Then they viewed nature scenes with different sunlight conditions and a blank screen as baseline control, immediately after which they rated their relaxation levels. Simultaneously recorded electroencephalography (EEG) signals were used to derive functional coupling between prefrontal and posterior cortical regions in alpha oscillation, an indicator of visual attention. Peripheral physiology, skin conductance (SCR) and heart-rate variability (HRV), indicating sympathetic and parasympathetic activities, respectively, were also recorded. Results showed that experiential and physiological outcomes of nature scenes differed by individual differences in expressive suppression. Specifically, high expressive suppression was associated with lower relaxation and HRV in some nature scenes. SCR is invariant across nature scenes or expressive suppression. Furthermore, visual perception of nature scenes may require more involuntary attention; therefore, EEG alpha coupling was reduced. Alpha coupling during nature scenes predicted subjective relaxation, depending on expressive suppression. The present study indicates that individuals high in expressive suppression may not benefit to the same degree as those lower in expressive suppression during nature scene exposure. Future studies on stress processing by integrating environment, brain, body, and individual traits are valuable.

Keywords: nature, stress recovery, expressive suppression, frontoparietal alpha synchronization, psychophysiology

1. Introduction

Stress recovery is crucial to psychological and physiological health. The natural environment can facilitate stress recovery by increasing parasympathetic activity and decreasing sympathetic activity (e.g., Brown et al., 2013; Ulrich et al., 1991). The "soft fascinations" incorporated in nature, such as blooming flowers, water bubbling over rocks or swaying branches of tress with sunlight, enable people to reflect with effortless attention. Despite the well-established restorative benefits of nature, it's unknown if nature promotes stress recovery in concert with individual differences in emotion regulation.

Some individuals tend to suppress the expression of their negative emotions which can increase their negative emotion and sympathetic activation (Gross, 2002; Gross & John, 2003). However, it's unknown if suppression alters the power of nature to facilitate stress recovery. To the best of my knowledge no one has investigated the interplay among nature, personal emotion regulation style, and responses to stress.

Studying the interaction of emotion regulation and exposure to nature on stress is essentially examining the interplay of top-down and bottom-up pathways of regulation. In addition to measuring a gradient of individual differences in expressive suppression, I experimentally manipulated components in nature scenes. As lighting brightness can affect self-regulation (Smolders & de Kort, 2014), I used animations of a forest with four sunlight conditions: constant bright or dark, and gradually increase or decrease brightness. I hypothesize that nature scenes with different sunlight conditions would have divergent effects on multi-methodological indicators during stress recovery, including subjective relaxation, peripheral physiology and brain activities. Moreover, individuals high in expressive suppression would not benefit to the same extent from the restorative effects of nature in comparison to individuals who do not rely on expressive suppression as a dominant emotion regulation strategy.

The beneficial, stress attenuating impacts of nature are believed to occur because natural elements evoke involuntary attention that requires little or no effort (Berman et al., 2008; Kaplan & Berman, 2010). Visuospatial attention is controlled by frontoparietal network through alpha rhythms (e.g., Capotosto et al., 2009; Lobier et al., 2018). Therefore, prefrontal-posterior coupling in alpha rhythm would show overall reduction compared with not viewing nature scenes. In addition, prefrontal-posterior coherence can also reflect internal regulation underlying emotional processing (Hao et al., 2019; Miskovic & Schmidt, 2010; Reiser et al., 2012). Therefore, in addition to my primary hypotheses, I also conducted an exploratory analysis to investigate if the interaction of alpha synchronization and expressive suppression would predict subjective relaxation.

2. Methods

2.1 Participants

Thirty-three college students participated in the study (mean age = 21.28, *SD* = 2.48, 16 females). They did not have any neurological or mental health issues. They were all right-handed and had a normal or corrected-to-normal vision. Two participants were dropped for the skin conductance response (SCR) analysis and one participant was dropped for heart-rate variability (HRV) analysis because of recording problems. Behavioral and electroencephalography (EEG) data were available for the whole sample size. Participants were requested to refrain from alcohol, caffeine, and other stimulants for four hours before the experiment. Informed consent was obtained from all participants and participation was compensated with course credit or $20. Cornell University Institutional Review Board approved the study.

2.2 Experiment

Participants were comfortably seated facing the monitor at about 50 cm and followed the instructions on the screen. At the beginning of the experiment, 7 minutes of resting state data were collected to assess participants' physiological baseline. In each trial, they experienced stress reactivity induced by a mental arithmetic task for 60 seconds and stress recovery phase when they viewed nature scenes for 30 seconds. This short-period stress recovery after viewing nature scene was demonstrated to be effective on reducing blood pressure and influencing brain activities (see Mochizuki-Kawai et al., 2020).

The nature scene depicted a forest. Four different stress recovery conditions of nature scenes only differed by sunlight: constant *bright*, constant *dark*, bright change to dark (*decrease*), and dark change to bright (*increase*), which were randomly presented. The start point of brightness in the *decrease* condition and the end point of the brightness in *increase* were the same as constant *bright* condition and the start point of darkness in the *increase* condition and the end point of the darkness in *decrease* were the same as constant *dark* condition. Sunlight brightness was linearly changed in the *increase* and *decrease* conditions. A *blank screen* condition was randomly presented to assess baseline recovery. Participants experienced each condition for 4 times in total and they rested for 1 minute after every 5 trials.

A mental arithmetic task was employed to induce acute stress. This stress induction protocol is routinely used in autonomic function testing and commonly provokes increased sympathetic arousal, greater self-reported stress and increased limbic and prefrontal region activations (Orem et al., 2019). During the task, a 3-digit number (e.g., 897) showed on the center of the screen, and a 2-digit number (e.g., 13, 17 or 23) appeared in the corner. Participants were instructed to subtract the small number from the big number and keep subtracting from the remaining value and reporting their answers orally. They were encouraged to do as many as possible in one minute. Participants stopped calculation once the screen changed to nature scene or blank. They were asked to watch the screen during these periods. Immediately after 30 seconds, one question appeared on the screen asking participants to rate their momentary feeling ("How relaxed are you feeling now?") on a Likert scale from not at all (=1), a little (=2), rather (=3) to very much (=4).

To assess individual differences in the use of expressive suppression in daily lives, I administered the Emotional Regulation Questionnaire (ERQ) (Gross & John, 2003). Four items measure expressive suppression with question like “I keep my emotions to myself”, on a Likert scale from strongly disagree (=1) to strongly agree (=7). The ERQ has demonstrated high internal consistency and test–retest reliability (Gross & John, 2003). In this study, the scale has a good internal consistency (Cronbach’s alpha = 0.81) and the mean score is 15.59 (SD = 5.36) in a range from 4 to 25.

2.3 Psychophysiological Measurements and Processing

EEG, SCR and electrocardiograph (ECG) were measured simultaneously during the experiments. Scalp potential was recorded by EEG using a 128-channel BioSemi system at a sampling rate of 512 *Hz*. EEG preprocessing and electrodes selection of calculating prefrontal-posterior coherence followed the methods in Hao et al. (2019, 2021), EEG was re-referenced to the algebraic average of left and right mastoids and was bandpass filtered between 0.1 and 55 *Hz*. Bad channels were identified and spherically interpolated. Abnormal signal segments were excluded before running Independent Component Analysis to remove artifacts due to eye movements, muscle, and cardiac activity. After removing the artifact components, the independent component source signals were transferred back to the original signal space, which was then used for the subsequent analysis.

The EEG signal was segmented into 2-second epoch with half overlap. Each segment was multiplied with a hamming window before the calculation of the Fourier transform. Denote the k-*th* segment of the i-*th* time series by , and its Fourier transform by . The cross-spectral is defined as

Where denotes complex conjugation.

The coherence between and is defined as

The imaginary coherence is defined as

I calculated EEG coherence between prefrontal (right: C16, C10 and C7; left: C29, C32 and D7) and posterior (right: B4, B11 and A28; left: A7, A15 and D31) regions in the alpha-band (8-13 *Hz*) oscillation. The first second of each stress recovery trial was removed from analysis. For each participant, I calculated coherence during resting state, averaged coherence during the stress reactivity period and similarly for each stress recovery condition.

SCR was collected with electrodes integrated in the BioSemi system. Continuous decomposition analysis was performed to decompose SCR signal into continuous tonic and phasic activity. To estimate skin conductance, I calculated the averaged phasic activity during resting, stress reactivity and each stress recovery condition.

ECG data from three BioSemi electrodes placed on left and right abdominal region and the region below the right collarbone. I calculated HRV using the Root Mean Square of the Successive Differences method which uses the R-R interval to estimate the time-domain HRV. Again, HRV during resting, stress reactivity and each stress recovery condition were calculated. When calculating the resting state condition of the above measures, data from the first and last 5 seconds were removed.

2.4 Statistical Analysis

The current study investigates 3 inter-related questions: i. do the nature scenes with varying sunlight conditions differentially facilitate acute stress recovery physiologically and experientially in different degrees? ii. do physiological and experiential outcomes of nature scenes differ by expressive suppression? iii. Are experiential outcomes of nature scenes predicted by the interaction of prefrontal-posterior alpha coherence and expressive suppression?

In order to show that the stress induction protocol was valid, sympathetic responses measured by SCR should elevate in stress reactivity phase and decline in stress recovery phase. I modeled stress phases (resting, reactivity and recovery in the *blank screen* condition) as an independent variable, SCR as dependent variable in a linear mixed model with each participant as a random effect and phase within each participant as a random effect.

To test the first hypothesis, linear mixed models were conducted to examine the effects of stress recovery conditions of four nature scenes and the blank screen on subjective relaxation, SCR, HRV and EEG coherence respectively, in which the stress recovery conditions were nested within individuals. I reported post-hoc pairwise comparisons to reveal each nature condition compared with the blank screen condition and with each other.

To test the second hypothesis, I examined if expressive suppression would moderate the effect of nature scene conditions on subjective relaxation, SCV, HRV and EEG coherence, respectively, using mixed models with nature scene conditions nested within individuals. I used the “emmeans” (Estimated Marginal Means) package in R (Russell et al., 2021) to compute the marginal means of linear relations between expressive suppression and stress recovery outcomes. I reported post-hoc pairwise comparisons to reveal if expressive suppression relations to each dependent variable are different from each other.

Last, to conduct the exploratory analysis, I examined interaction of expressive suppression and EEG coherence predicting subjective relaxation using a mixed model with each participant as the random effect.

SCR, HRV and EEG coherence were log-transformed. Gender was added as a covariate in all models and resting SCR (or HRV or EEG alpha coherence) was added when SCR (or HRV or EEG alpha coherence) was the main predictor. Significant results show effect sizes using proportion change of variance (PCV) of model residuals derived from comparing the model with and without the main predictor. *Tukey* method was used to correct for pairwise multiple comparisons in *post-hoc* analysis. In the figures, high and low expressive suppression were plotted ±1 SD from its mean for visualization purposes only.

3. Results

3.1 Validate stress induction protocol

Stress phase has a main effect on SCR, $F(2, 60) = 31.68$, $p < 0.0001$, $PCV = 13.10\%$. *Post-hoc* pairwise comparisons show that stress reactivity induced by mental arithmetic task significantly elevated SCR compared to resting state ($p < 0.0001$). Short period of stress recovery during the *blank screen* condition reduced SCR compared with stress reactivity phase ($p = 0.027$). Thus, the mental arithmetic task successfully induced acute stress and short period of rest reduced sympathetic responses.

3.2 Nature scenes differentially facilitate stress recovery

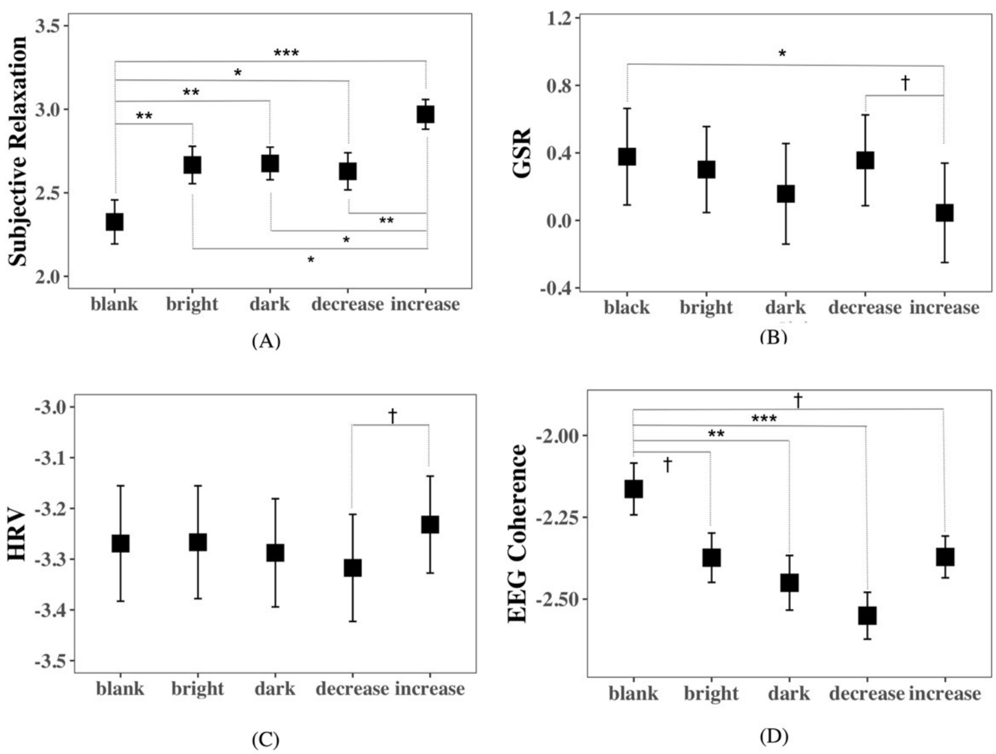
Nature scene significantly improves recovery from acute stress, as there is a main effect of stress recovery conditions on subjective relaxation, $F(4, 128) = 11.01$, $p < 0.0001$, $PCV = 23.26\%$ (Fig. 1A). *Post-hoc* pairwise comparisons show that participants rated greater relaxation in every nature scene condition compared with the *blank screen* condition: *blank-bright*: $p = 0.006$, *blank-dark:* $p = 0.004$, *blank-decrease*: $p = 0.019$, *blank-increase*: $p < 0.0001$. In addition, *increase* condition was more relaxing than *bright* condition, $p = 0.019$, *dark* condition, $p = 0.025$, and *decrease* condition, $p = 0.006$.

A significant main effect of stress recovery condition is also found on SCR, $F(4, 120) = 2.85$, $p = 0.027$, $PCV = 5.63\ \%$ (Fig. 1B). *Post-hoc* pairwise comparisons show that relative to the *blank screen* condition, *increase* condition reduced SCR: $p = 0.047$. In addition, *increase* condition has marginally lower SCR compared with *decrease* condition, $p = 0.074$.

No significant main effect of stress recovery condition is observed in HRV, $F(4, 124) = 1.97$, $p = 0.103$ (Fig. 1C). *Post-hoc* pairwise comparisons do not show any differences between *blank screen* and nature conditions; however, *increase* condition manifests marginally higher HRV compared with *decrease* condition, $p = 0.058$.

The above results demonstrate that short-term nature scene viewing is generally effective in facilitating stress recovery, promoting subjective relaxation, and differentially changing sympathetic and parasympathetic responses. Although 30 seconds of *blank screen* condition was not sufficient for participants to fully recover from stress physiologically, nature scenes, especially sunlight with increasing brightness can further reduce SCR and increase subjective relaxation.

Turning to EEG coherence between prefrontal and posterior regions in alpha oscillation, it shows significant main effect of stress recovery conditions, $F(4, 128) = 6.79$, $p < 0.0001$, $PCV = 14.92\%$ (Fig. 1D). *Post-hoc* pairwise comparisons show that EEG coherence generally reduced in every nature scene compared with the *blank screen* condition, *blank-bright*: $p = 0.056$, *blank-dark*: $p = 0.003$, *blank-decrease*: $p < 0.0001$, *blank-increase*: $p = 0.061$. *Post-hoc* analysis does not show any differences among nature scene conditions. These results indicate that nature scenes can induce visual attentional processing by loosening the bound between prefrontal and posterior cortical regions, allowing perceptual information to be processed in the brain.



Significance: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ and † $p < 0.10$.

Fig. 1. Subjective relaxation (A), skin conductance responses (B), heart rate variability (C), and EEG alpha coherence between prefrontal and posterior cortical regions (D) as functions of stress recovery conditions. *Note*: SCR, HRV and EEG are log-transformed values. Error bars represent standard errors.

3.3 Expressive suppression moderates effects of nature scenes on stress recovery

As indicated in the Introduction, an important limitation in prior work on coping with stress and in particular the potential role of nature as a coping resource, has been the absence of investigation of individual differences in emotion regulation that might moderate these processes.

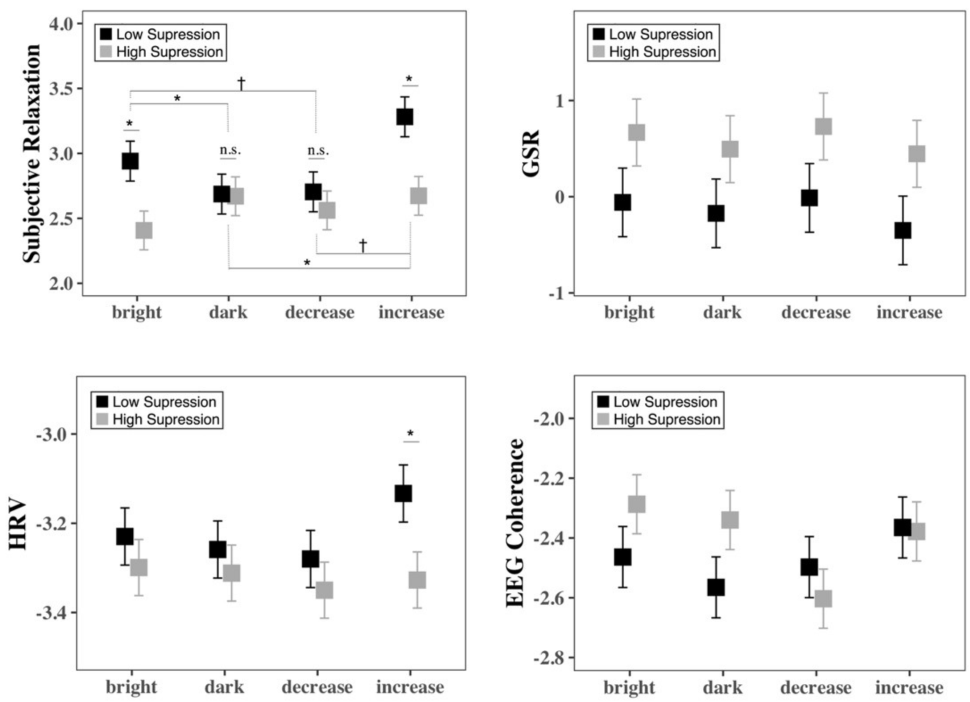
The present study shows that expressive suppression moderates nature scene effect on subjective relaxation after acute stress, $F(3, 93) = 5.33$, $p = 0.002$, $PCV = 11.94\%$ (Fig. 2A). Expressive suppression does not show a main effect, $F(1, 30) = 2.67$, $p = 0.113$. Participants with strong expressive suppression felt less relaxed than those who had lower expressive suppression in *bright* condition, $p = 0.023$, and *increase* condition, $p = 0.010$. In the *dark* condition and *decrease* condition, no individual differences were found, $p < 0.5$ for both cases. *Post-hoc* pairwise comparisons show that expressive suppression relation to subjective relaxation in *increase* condition is significantly different from *dark* condition, $p = 0.007$, and *decrease* condition, $p = 0.049$, and expressive suppression relation to subjective relaxation in *bright* condition is significantly different from *dark* condition, $p = 0.023$.

No significant interaction of expressive suppression and nature scene conditions is found in SCR, $F(3, 87) = 0.129$, $p = 0.942$ (Fig. 2B). Expressive suppression does not show a main effect, $F(1, 27) = 1.99$, $p = 0.169$. In all four nature scenes, there are nonsignificant trend of positive relations between expressive suppression and SCR, p values ranging from 0.147 to 0.221. This imply that overall, individuals differ in expressive suppression did not show significant different sympathetic responses in stress recovery viewing nature scenes.

Turning to HRV, there is a marginal interaction of expressive suppression and nature scenes, $F(3, 90) = 2.27$, $p = 0.085$, $PCV = 3.94\%$ (Fig. 2C). Expressive suppression does not show a main effect, $F(1, 28) = 1.21$, $p = 0.281$. Participants who had higher expressive suppression exhibited lower HRV in *increase* condition, $p = 0.049$. In other nature scene conditions, expressive suppression is not related to HRV, p values ranging from 0.469 to 0.583. *Post-hoc* pairwise comparisons show that expressive suppression relation to HRV in *increase* condition is not significantly different from other nature scene conditions.

Last, regarding EEG coherence, a marginal interaction of expressive suppression and nature scenes is also found, $F(3, 93) = 2.48$, $p = 0.066$, $PCV = 11.94\%$ (Fig. 2D). Expressive suppression does not show a main effect, $F(1, 29) = 0.31$, $p = 0.582$. In all four nature scenes, expressive suppression is not related to EEG coherence, although they show some opposite trends, p values ranging from 0.147 to 0.931. *Post-hoc* pairwise comparisons do not reveal any differences of expressive suppression relation to coherence across nature scene conditions.

As exploratory analysis, subjective relaxation during nature scenes is predicted by the interaction of EEG coherence and expressive suppression, $F(1, 126.34) = 14.25$, $p = 0.0002$, $PCV = 23.48\%$. For participants high in expressive suppression, relaxation ratings were not dependent on EEG coherence; whereas for participants who had lower expressive suppression, their relaxation levels were dependent on characters of nature scenes: when the nature scenes (e.g., with increasing sunlight) elicited relatively less alpha desynchronization (i.e., higher coherence), they felt more relaxed.



Significance: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ and † $p < 0.10$.

Fig. 2. Individual differences in expressive suppression modulate nature scene condition on subjective relaxation (A) and heart rate variability (B). (C) Expressive suppression moderate EEG coherence on subjective relaxation ratings. *Note*: HRV and EEG coherence are log-transformed values. Figures show the model estimates of dependent variables at high and low expressive suppression that are from ± 1 *SD* of its mean. Error bars represent ±1 pooled *SEM.*

4. Discussion

The nature scenes with varying sunlight conditions promoted acute stress recovery physiologically and experientially in different degrees. Among the four nature scenes, increasing brightness in simulated sunlight may have more salutogenic qualities. Lighting influences circadian rhythms because of its dynamic nature. For example, everyone recognizes short-term increased light at sunrise, implying waking up and decreased brightness like sunsets reminding them to rest.

Moreover, experiential and physiological outcomes of nature scenes differed by trait expressive suppression. Individuals with high expressive suppression rated their relaxation levels similarly regardless of which nature scenes they viewed. One study showed that expressive suppression efficacy did not change by voluntary attentional control over viewing emotional stimuli (Bebko et al., 2014); here, I show that involuntary attention captured by nature scenes also did not change the effect. There might be different reasons why expressive suppression hinders the nature scene effect. Individuals who use expressive suppression tend to actively diverse attention away from their emotions; therefore, they pay less voluntary attention to emotion (Boden & Thompson, 2015; Sheppes et al., 2014).

Similarly, high expressive suppression tended to show similar HRV across nature scenes while low suppression individuals had increased parasympathetic activities in the nature scene that was the most relaxing. On the other hand, SCR during stress recovery were invariant over the nature scenes or expressive suppression. Nature scenes might not equally promote parasympathetic responses during stress recovery for everyone; however, they could alleviate the negative impact of expressive suppression on sympathetic responses, suggesting the buffer role of nature (Wells, 2021).

Furthermore, these nature scenes induced prefrontal-posterior desynchronization in alpha oscillation, which predicted experiential outcomes of nature scenes together with expressive suppression. When nature scenes induced relatively less alpha desynchronization, more internal regulation processes may occur and subjective relaxation differed by expressive suppression; whereas when nature scenes induced more alpha desynchronization, external stimuli might play a predominant role on subjective experience.

Due to the relatively short period of nature exposure, the current study might underestimate the effects of nature and the interaction with expressive suppression, evidenced by lacking heightened HRV during nature viewing. Some studies found heightened HRV during a relatively longer period of exposure, e.g., 10 min in Brown et al. (2013) and 10 min in Ulrich et al. (1991), although 30-second could be effective on blood pressure and brain activities (see Mochizuki-Kawai et al., 2020). I did not have a control condition for non-nature scenes or purely lighting change without nature context. Nevertheless, the present study has shown multimethodological evidence of stress recovery with variation in nature scenes. Furthermore, these effects are influenced by individual differences in expressive suppression. We need to study the long-term benefits of repeated short-term stress recovery facilitated with nature, which mainly helps engineer the short-term environmental stimuli to influence people’s stress recovery and has significant practical value.

Acknowledgements

I thank G. W. Evans for critical feedback. This work is supported by Cornell Human Ecology Alumni Association grant, Cornell University Department of Design and Environmental Analysis dissertation funding, Cornell Human Ecology Alumni Association grant and the Orrilla Wright Butts, Home Economics Extension, Jean Failing and Virginia F. Cutler Fellowships to Y. Hao.

Open Practices Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The author has no competing interests to declare that are relevant to the content of this article.

References

Bebko, G. M., Franconeri, S. L., Ochsner, K. N., & Chiao, J. Y. (2014). Attentional deployment is not necessary for successful emotion regulation via cognitive reappraisal or expressive suppression. *Emotion*, *14*(3), 504–512. https://doi.org/10.1037/a0035459

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

Boden, M. T., & Thompson, R. J. (2015). Facets of emotional awareness and associations with emotion regulation and depression. *Emotion*, *15*(3), 399–410. https://doi.org/10.1037/emo0000057

Brown, D. K., Barton, J. L., & Gladwell, V. F. (2013). Viewing nature scenes positively affects recovery of autonomic function following acute-mental stress. *Environmental Science and Technology*, *47*(11), 5562–5569. https://doi.org/10.1021/es305019p

Capotosto, P., Babiloni, C., Romani, G. L., & Corbetta, M. (2009). Frontoparietal cortex controls spatial attention through modulation of anticipatory alpha rhythms. *Journal of Neuroscience*, *29*(18), 5863–5872. https://doi.org/10.1523/JNEUROSCI.0539-09.2009

Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. In *Psychophysiology*. https://doi.org/10.1017/S0048577201393198

Gross, J. J., & John, O. P. (2003). Individual Differences in Two Emotion Regulation Processes: Implications for Affect, Relationships, and Well-Being. *Journal of Personality and Social Psychology*. https://doi.org/10.1037/0022-3514.85.2.348

Hao, Y., Yao, L., & Evans, G. W. (2021). Neural Responses During Emotion Transitions and Emotion Regulation. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.666284

Hao, Y., Yao, L., Smith, D. M., Sorel, E., Anderson, A. K., Schumacher, E. H., & Evans, G. W. (2019). Prefrontal-posterior coupling mediates transitions between emotional states and influences executive functioning. *Scientific Reports*, *9*(1). https://doi.org/10.1038/s41598-019-44624-2

Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and Self-Regulation. *Perspectives on Psychological Science*. https://doi.org/10.1177/1745691609356784

Lobier, M., Palva, J. M., & Palva, S. (2018). High-alpha band synchronization across frontal, parietal and visual cortex mediates behavioral and neuronal effects of visuospatial attention. *NeuroImage*, *165*, 222–237. https://doi.org/10.1016/j.neuroimage.2017.10.044

Miskovic, V., & Schmidt, L. A. (2010). Cross-regional cortical synchronization during affective image viewing. *Brain Research*, *1362*, 102–111. https://doi.org/10.1016/j.brainres.2010.09.102

Mochizuki-Kawai, H., Matsuda, I., & Mochizuki, S. (2020). Viewing a flower image provides automatic recovery effects after psychological stress. *Journal of Environmental Psychology*, *70*. https://doi.org/10.1016/j.jenvp.2020.101445

Orem, T. R., Wheelock, M. D., Goodman, A. M., Harnett, N. G., Wood, K. H., Gossett, E. W., Granger, D. A., Mrug, S., & Knight, D. C. (2019). Amygdala and prefrontal cortex activity varies with individual differences in the emotional response to psychosocial stress. *Behavioral Neuroscience*, *133*(2), 203–211. https://doi.org/10.1037/bne0000305

Reiser, E. M., Schulter, G., Weiss, E. M., Fink, A., Rominger, C., & Papousek, I. (2012). Decrease of prefrontal-posterior EEG coherence: Loose control during social-emotional stimulation. *Brain and Cognition*, *80*(1), 144–154. https://doi.org/10.1016/j.bandc.2012.06.001

Russell, A., Lenth, V., Buerkner, P., Herve, M., Love, J., Singmann, H., & Lenth, M. R. V. (2021). *Package "emmeans." 34*(1), 216–221. https://doi.org/10.1080/00031305.1980.10483031>.License

Sheppes, G., Scheibe, S., Suri, G., Radu, P., Blechert, J., & Gross, J. J. (2014). Emotion regulation choice: A conceptual framework and supporting evidence. *Journal of Experimental Psychology: General*, *143*(1), 163–181. https://doi.org/10.1037/a0030831

Smolders, K. C. H. J., & de Kort, Y. A. W. (2014). Bright light and mental fatigue: Effects on alertness, vitality, performance and physiological arousal. *Journal of Environmental Psychology*. https://doi.org/10.1016/j.jenvp.2013.12.010

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

Wells, N. M. (2021). The Natural Environment as a Resilience Factor: Nature's Role as a Buffer of the Effects of Risk and Adversity. In A. R. Schutte, J. C. Torquati, & J. R. Stevens (Eds.), *Nature* *and Psychology: Biological, Cognitive, Developmental, and Social Pathways to Well-being* (pp. 195–233). Springer Nature. https://doi.org/10.1007/978-3-030-69020-5_7