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Beyond restorative benefits: Evaluating the effect of forest therapy on creativity

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ABSTRACT

This study had three purposes: (1) assessing physiological and psychological responses of a 3-day forest therapy workshop, (2) evaluating the effects of the forest therapy workshop on creativity, and (3) examining the relationship between change in emotions and improvements in creativity. We employed a within-subject design in the current study and recruited 23 participants from the attendees of the 2018 Da'an Forest Therapy Workshop in Taiwan. Physiological responses, heart rate, systolic blood pressure, and diastolic blood pressure were recorded, and participants' emotional states were measured. Furthermore, the Chinese Word Remote Associates Test (CWRAT) was used as the indicator of creativity. The study findings indicated the 3-day forest therapy workshop contributed to participants' physical and mental health by regulating physiological responses as well as increasing positive emotions and reducing negative emotions. In regards to the creativity enhancement, the forest therapy workshop improved participants' creative performances by 27.74 %, which indicates forest therapy is beneficial for high-level cognitive functioning. Moreover, we noted the change in creativity correlated significantly and negatively with change in the confusion–bewilderment emotion. This result indicates alleviation of confusion–bewilderment correlates with enhancement of creativity. In this study creativity enhancement was quantified in the forest therapy workshop, and an approach for measuring creativity in forest therapy studies was provided. This study extends typical stress-recovery forest therapy research by investigating high-level cognitive functioning (e.g., creativity). The contribution of this study is in the use of the creativity task in a forest therapy study, in addition to comparing the changes in creativity to changes in different aspects of mood.

1. Introduction

Urbanization, technological advancements, congested urban spaces, and fast-paced lifestyles have reduced the amount time people spend in natural environments. Studies have discovered people now spend 90 % of their lives indoors (Evans and McCoy, 1998). This trend has influenced the relationship between humans and nature. Moreover, city lifestyles have been reported to induce negative emotions, such as panic, anxiety, and depression (Dye, 2008). An increasing number of urban residents experience mental and physical health problems, such as depression and hypertension (Dye, 2008; Vining et al., 2008). Researchers suggest contact with nature is conducive to reducing physical and mental stress (Lee et al., 2012; Hartig et al., 1991, 2014; Kaplan, 1995; Ulrich et al., 1991). Natural environments reduce the number of sensory stimuli, minimize possible exposure to stressors, and provide adaptive resources, which are required for adaption to stress in life. Empirical studies have suggested urban green spaces can alleviate noise pollution from congested roads (Nilsson and Berglund, 2006), that plants can conceal unattractive structures in cities (Smardon, 1988), and that plants around a house may increase perceptions of privacy and reduce the sense of congestion for the residents of the house (Day, 2000). Kondo et al. (2018) review illustrated how a variety of physiological responses may be improved through different types of nature exposure (e.g. nature viewing, outdoor walks, outdoor exercise and gardening), while other empirical research has demonstrated physical health improvements, such as lowering heart rate, blood pressure and cortisol, as a result of exposure to nature (Hansmann et al., 2007; Lee et al., 2011, 2014; Ochiai et al., 2015a,b; Ottosson and Grahn, 2005; Van den Berg and Custers, 2011; Yamaguchi et al., 2006). These reductions indicate natural environments substantially reduce sympathetic nervous system activity, increase parasympathetic nervous system activity, and alleviate mental strain, which is why people tend to

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feel comfortable and relaxed in natural environments. Converging research highlights the benefits on health and well-being of interacting with nature. Accordingly, the idea of reconnecting with nature has been promoted by scholars (Balmford and Cowling, 2006; Saunders, 2003).

In several Asian countries (e.g., Taiwan, Japan, and Korea), forest therapy is a popular and cost-effective approach for health promotion and is widely promoted by the government. The term "forest therapy," derived from "Shinrin-yoku" (taking in the atmosphere of the forest or, literally, "forest bathing"), highlights the medically proven effects of exposure to forests (Ochiai et al., 2015b, p. 2533). In Korea, forest therapy is defined by law as "immune-strengthening and health-promoting activities utilizing various elements of the forest, such as fragrance and scenic view" (Jung et al., 2015, p. 274). In Taiwan, forest therapy is considered as recreational activities using forest resources to improve health and well-being. The "forest therapy program" developed by Taiwan forest therapy professionals consists of structured activities and interventions using various elements of forests to reduce participants' stress levels and to promote health. The forest therapy program has various forms such as two hour forest walks or multi-day workshops. Researchers place importance on evidence-based investigations to determine the efficacy of the program. Forest therapy research typically utilizes an evidence-based approach and field experiments to evaluate the health-related effects resulting from participants' experiences. Previous studies have demonstrated the restorative effects of forest therapy on mental health, whereby individuals' negative emotions were observed to decrease, and their positive emotions were noted to increase after immersion in forest environments (Lee et al., 2009, 2011; Lee et al., 2014; Morita et al., 2007; Park et al., 2011; Takayama et al., 2014). The mental stress recovery effects were further identified in middle-aged and elderly groups, (Chen et al., 2018; Ochiai et al., 2015a; Yu et al., 2017) as well as in individuals with chronic conditions (Mao et al., 2012; Ochiai et al., 2015b; Shin et al., 2013; Song et al., 2015a). Furthermore, forest therapy has been noted to improve comfort (Lee et al., 2009, 2011) and energy levels (Park et al., 2010; Yu et al., 2017). Studies have also determined a relationship between forest therapy and physical health, namely a reduced pulse rate, lower blood pressure (Lee et al., 2009; Mao et al., 2012; Ochiai et al., 2015b; Park et al., 2009, 2010; Song et al., 2015a, 2017; Tsunetsugu et al., 2007, 2013), increased parasympathetic nervous system activity, and decreased sympathetic nervous system activity (Lee et al., 2011, 2014; Park et al., 2007, 2008; Park et al., 2009, 2010). Li and colleagues conducted a series of studies and provided consistent evidence regarding the effects of forests on the immune system; these effects were mediated through increases in the number of NK cells and their activity, as well as changes in presence of anticancer proteins (Li, 2010; Li et al., 2007, 2008a; Li et al., 2008b). In addition, Song et al. (2015b) highlighted the physiological adjustment effect in the forest environment and their study found subjects with high initial blood pressure and pulse rate showed a decrease in these measures after walking in a forest environment, whereas those with low initial values showed an increase. Interestingly, this physiological adjustment effect was not observed in an urban setting and was specific to the forest environment (Song et al., 2015b). In other words, forest walking facilitates an adjustment of the physiological responses close to an appropriate level that benefits physical health and this physiological regulation should be considered as a health benefit of forest therapy.

Forest therapy primarily focuses on stress recovery, with the outcomes of exposure to nature mostly related to induced levels of restoration and increased positive affects (Hartig et al., 1991, 2014; McMahan and Estes, 2015). From the restorative perspective, it is suggested cognitive and attentional performance can be improved through interactions with nature (Berman et al., 2008; Kaplan, 1995; Kaplan and Kaplan, 1989). Stevenson et al. (2018) articulated cognitive performance (e.g. working memory, cognitive flexibility, attention control, visual attention process, processing speed and etc.) is sensitive to the restoration effect and improves after exposure to nature. Empirical studies have demonstrated the benefits of being in nature on cognition, including directed attention improvement (Berman et al., 2008, 2012; Tennessen and Cimprich, 1995), attentional capacity (Berto, 2005; Berto et al., 2008; Staats et al., 2003), and memory function (Pilotti et al., 2014). Consistent with this stance, participants of forest therapy may experience higher-level executive cognitive functioning, such as enhanced creativity. Furthermore, scholars describe a pathway that exposure to nature consistently resulted in a positive affect that consequently led to increased performance in creative problem-solving (Baas et al., 2008; Mikulincer and Sheffi, 2000; Pasanen et al., 2018). In other words, improvement of creativity through cognitive and attentional enhancement of being in nature (i.e. cold pathway) and increased creative performance via positive affect (i.e. hot pathway) were suggested in existing creativity literature. Both pathways (cognition to creativity and positive affect to creativity) illustrate time spent in nature influencing a person's creativity. Verily, a growing amount of evidence indicates being in natural environments promotes creativity. Recently a qualitative study investigated the influence of the natural environment on creativity, and it concluded nature plays a significant role in the preparation phrase (i.e. giving attention to a topic, gathering information and exploring aspects of said topic) and incubation phrase (i.e. conscious or unconscious cognitive processes enabling new ideas to emerge) of creative development (Plambech and Konijnendijk van den Bosch, 2015). Specifically, through the lens of Attention Restoration Theory (ART), nature experiences promote creativity by providing a break from effort-intensive preparation of a creative task and improving conscious work during the incubation period via recovery from fatigue (Plambech and Konijnendijk van den Bosch, 2015; van Rompay & Jol, 2016; Sio and Ormerod, 2015; Williams et al., 2018).

Scholars have indicated remote association is a critical part of the creative process. For example, Ghiselin (1952) analyzed the autobiographies of poets, novelists, and mathematicians and discovered these creative people shared the following characteristic in their creative process: they each had experience of synthesizing various concepts into their creation. In addition, Mednick (1962) outlined the associative theory of creative thinking, which defines creativity from the perspective of remote association as the process of associating certain things for achieving specific needs or practical goals. Adhering to this theory, Mednick developed the Remote Associates Test (RAT)(Mednick, 1962, 1968). RAT has been widely used as a measure of creative thinking and insightful problem-solving in various fields owing to its advantages, such as a short testing time, a simple-to-implement procedure, limited answer choices, and an objective scoring system (Ansburg, 2000; Cerruti and Schlaug, 2009; Fodor, 1999; Mikulincer and Sheffi, 2000; Ward et al., 2008; Weinstein and Graves, 2002; Zhong et al., 2008). In an outdoor and creativity study Atchley et al. (2012) applied RAT and observed a 50 % increase in the RAT score after 4 days of exposure to nature in a group of naive hikers. Based on the research methods employed by Atchley et al. (2012); Ferraro III (2015) investigated the influence of a 6-day outdoor trip and determined the experimental group's average score was 49 % higher than that of the control group. Their findings indicated immersion in a natural setting offers a cognitive advantage that implies the forest therapy workshop, in the study context, may improve creativity.

Existing literature highlights the restorative effects of forest therapy, and these benefits appear to enhance creativity. There is a growing interest in forest therapy research, and it should be noted the aforementioned forest therapy studies refer to a variety of interactions with nature, such as forest viewing, forest walking, or structured activities in forests, each of which depends on the context of the respective study. In the current study we conducted the investigation to gain a better understanding of physical and mental health benefits, as well improvements in creativity resulting from participation in the 3-day workshop-based forest therapy program. Our research questions were: What are the physical and mental health benefits from the 3-day forest therapy workshop? Does the forest therapy workshop improve creativity? What type of emotional change is associated with creativity enhancement (if any)? Following these questions, the three purposes of the study were: (1) assessing physiological and psychological (mood states) responses of the 3-day forest therapy workshop, (2) evaluating the effect of the forest therapy workshop on creativity, and (3) examining the relationship between changes in emotions and changes in creativity. This study extends stress recovery forest therapy research by evaluating creativity, thus providing insights into high-level cognitive functioning (e.g., creativity) improvement resulting from the 3-day forest therapy workshop.

2. Methods

2.1. Participants and the 3-day forest therapy workshop

The 3-day forest therapy workshop was implemented March 2018 in Da'an, Taiwan. We recruited research participants from the attendees of the 2018 Da'an Forest Therapy Workshop in Taiwan. Participants were recruited if they agreed to follow the experimental procedure, undergo tests throughout the experimental period, and comply with the test regulations. The 3-day forest therapy workshop involved 32 attendees in total, 24 of which agreed to participate in the study, but one participant left the workshop and only completed the pre-test. Therefore, we excluded that participant's response from our sample, resulting in 23 valid responses. However, we initially received 23 responses for the Profile of Mood States (POMS) scale but determined one response was invalid due to its fixed order responses, resulting in 22 valid responses for the POMS scale. Further, we found missing values in the tension–anxiety dimension of one survey, so the number of valid responses for this dimension was 21. Regarding the age of the participants, 6 were young adults (< 44 years; 26.1 %) and 17 were middle-aged to older adults (≥45 years; 73.9 %). The average age of participants was 52.0 ± 12.54 years old and their age ranged from 25 to 70. Eight participants were male (34.8 %).

The 2018 Da'an Forest Therapy Workshop aimed to promote the health of its attendees. During the workshop three speakers introduced the concept of forest therapy, detailed the relevant forest therapy cases, and hosted sensory experience activities that revealed the healing potential of forest therapy. Such therapeutic activities included forest walking; sitting and observing the forest; outdoor meditation; listening to the sound of running water; being alone; enjoying flowers, trees, and water; eating foods made from local forest ingredients; aromatherapy; and making bamboo handicrafts (see Table 1 for the schedule).

Table 1
Schedule of forest therapy in this study.

Day	Time	Program
Day 1	11:30 - 12:30	Registration/lunch
	12:30 - 14:00	Pre-test
	14:00 - 16:00	Introduction of forest therapy
	16:00 - 17:00	Walking in the forest
	17:00 - 19:00	Dinner
	19:00 - 20:00	Counselling
	20:00 -	Free time and sleeping
Day 2	8:00 - 8:50	Breakfast
	9:00 - 10:30	Health benefits of forest therapy
	11:00 - 12:30	Meditation and exercise in the forest
	12:30 - 14:00	Lunch break
	14:00 - 16:00	Forest therapy cases
	16:00 - 18:00	hand-making bamboo cutlery
	18:00 - 19:30	Dinner
	19:30 - 21:00	Nature and art therapy
	21:00 -	Free time and sleeping
Day 3	7:30 - 8:30	Breakfast
	8:30 - 10:30	Aroma therapy
	10:30 - 10:40	Break
	10:40 - 11:15	Reflection
	11:30 - 13:00	Lunch in the forest
	13:00 - 14:30	Post-test
	14:30 -	Going home

2.2. Research design

Following the pre-test and post-test experimental design of prior studies for investigating the benefits of forest therapy (Ochiai et al., 2015a, b; Yu et al., 2016; Yu et al., 2017), the present study employed a one-group pre-test and post-test design. The pre-test and post-test were conducted on the first day and the final day of the workshop, respectively. The same data collection process was utilized for both the pre-test and the post-test. Both the pre-test and the post-test were conducted at approximately noon to ensure consistency in test timing and to avoid the influence of biological rhythms on study variables. All participants were informed of the research objectives and methods and were asked to sign a consent form as proof of their consent to participate in the study. This study was approved by the Research Ethics Office of National Taiwan University (NTU-REC No. 201607HS008).

2.3. Physiological and physiological measurements

Participants' heart rates and blood pressures were measured using the electronic blood pressure monitor HEM-1000 (Omron, Japan), which has been widely used in forest therapy studies for examining the effects of forest therapy (Lee et al., 2009; Song et al., 2013). For assessing participants' mood states, we employed the Short Form of the Profile of Mood States (POMS-SF) scale (Shacham, 1983), which is most widely used in forest therapy studies for examining mood state changes (Lee et al., 2011; Park et al., 2010). This scale is used to measure the current emotional state in the following dimensions: tension–anxiety, anger–hostility, fatigue–inertia, depression–dejection, confusion–bewilderment, and vigor–activity. The POMS scale is scored on a 4-point Likert scale, ranging from 0 to 3 points, with 0 = never, 1 = sometimes, 2 = often, and 3 = always. The sum of points received for items in one dimension is the total score for that dimension; a high total score indicates a high level of that emotion represented in the dimension. The total mood disturbance (TMD) of participants was calculated to estimate the overall level of negative emotions.

2.4. Creativity measurement

This study employed remote association as the indicator of creativity based on the creativity indicators suggested by Atchley et al. (2012) and Ferraro III (2015). During a Remote Associates Test (RAT, Mednick, 1962, 1968), participants were presented with three remote words in each test item and were asked to provide a common word that linked the three words. For example, in the test items "same," "head," and "tennis," the participants were required to find a common word that links the three words, such as "match." The RAT is comprised of 30 test items, each of which is worth 1 point. The final RAT score is calculated based on the number of correct answers. In this study we used the Chinese Word RAT (CWRAT), adapted from Mednick (1962) by Huang et al. (2012). The CWRAT consists of two tests, test-A and test-B, which have been previously demonstrated to offer favorable reliability and validity, as well as to effectively measure an individual's remote association ability and creative potential (Huang et al., 2012). The two tests were used as the pre-test and the post-test in order to avoid a learning effect from repeating the same test form. Law requires the test to only be conducted by psychology professionals, such as counselors, medical specialists, and/or academic researchers. To meet this requirement, we invited a qualified psychologist to conduct the creativity tests and mark the responses. The CWRAT has 30 items in each of the two tests, with a three-word stimulus provided in each item. Participants were asked to provide a term that linked the three words and they had 10 min to complete the test. The responses were marked referring

Table 2
A comparison of pre-test and post-test results of physiological indicators.

Indicators		Mean(SD)				Z	*p*	ES
	N	Pre-test		Post-test				
HR (bpm)	23	82.35	(11.68)	82.30	(11.58)	−0.879	0.380	0.18
SBP (mmHg)	23	120.17	(15.18)	122.48	(13.60)	−1.142	0.254	0.24
DBP (mmHg)	23	69.78	(10.23)	71.83	(7.06)	−0.017	0.986	0.0035

Abbreviations: HR heart rate; SBP systolic blood pressure; DBP diastolic blood pressure.
Note: Wilcoxon signed-rank test, $^*p < 0.05$, $^{**}p < 0.01$.

to the standard answers; each item was worth 1 point, with 30 points obtained if correct responses were provided for each item.

2.5. Data analysis

Data was analyzed using descriptive statistics, nonparametric statistics, the Wilcoxon signed-rank test, and Spearman's rank correlation coefficient. Data are expressed in terms of mean ± standard deviation (SD). In all comparisons, a p value of < 0.05 was considered statistically significant and effect size (ES, calculated by dividing the absolute Z score by the square root of the number of pairs) was reported. Cohen (1988) suggested effect sizes can be referred to as small (= 0.2), medium (= 0.5), or large (> = 0.8).

3. Results

Overall physiological results are summarized in the Table 2. We found no significant difference in any of the physiological measures between the pre-test and post-test.

We further analyzed physiological adjustment effects. This study found the pre-test systolic blood pressure of participants significantly negatively correlated with the difference in systolic blood pressure between their pre-test and post-test ($r = -0.615, p = 0.002$; Fig. 1), as did their diastolic blood pressure ($r = -0.711$, $p < 0.001$; Fig. 2). Both figures illustrated potential outliers in the scatter plots, therefore we performed sensitivity analyses which tested the adjustment effects before and after excluding outliers across SBP and DBP following the guidelines by Aguinis et al. (2013). The results showed significantly negatively correlated with the difference in systolic blood pressure between their pre-test and post-test after excluding outliers ($r = -0.584$, $p = 0.005$) and as did their diastolic blood pressure

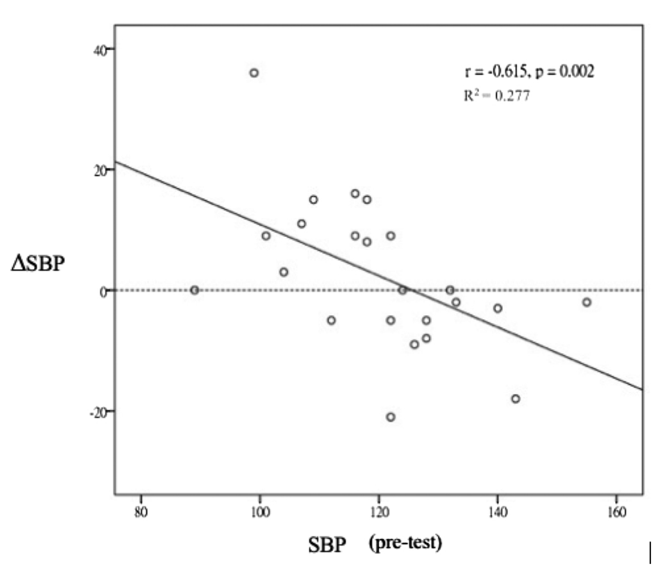

Fig. 1. Post-test and pre-test differences in systolic blood pressure versus initial systolic blood pressure.

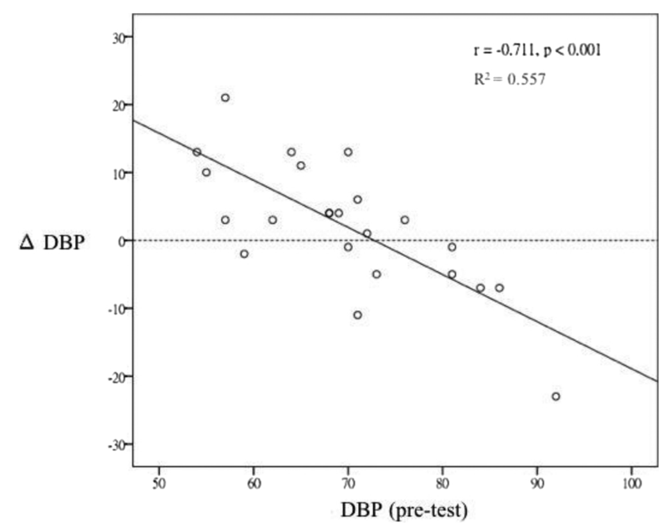

Fig. 2. Post-test and pre-test differences in diastolic blood pressure versus initial diastolic blood pressure.

($r = -0.670$, $p = 0.001$) (See Fig. S1). In addition, a significant negative correlation between the initial value and the degree of change in both systolic pressure and diastolic blood pressure was observed during the forest therapy workshop, which is consistent with the results of Song et al. (2015b).

For psychological responses we analyzed the valid responses and examined each dimension, obtaining the following results (see Table 3). Four of the negative subscales of POMS, "tension-anxiety," "anger-hostility," "depression-dejection," and "confusion-bewilderment," decreased from the pre-test to the post-test (all $p < 0.05$). The total mood disturbance (TMD) yielded a significant difference; conversely, the positive mood state "vigor-activity" significantly increased ($p < 0.01$). The effect of size of significant subscales ranged from 0.42 to 0.64. The creativity (CWRAT) measurement exhibited improvement after completion the forest therapy program.

Spearman's correlation analysis (Table 4) of the change in creativity and the change in emotions revealed the change in creativity correlated significantly and negatively with the change in confusion–bewilderment ($rho = -0.518$). This finding indicates reduced feelings of confusion and bewilderment associates with an enhancement in creativity.

4. Discussion

In this study, we examined the physiological responses, psychological responses, and creativity enhancement upon completing the 3-day forest therapy workshop. The results showed participants' heart rates, systolic blood pressures, and diastolic blood pressures experienced no significant changes, indicating the 3-day forest therapy workshop did not affect participants' recoveries from physical stress. Upon further analysis we have revealed that the physiological adjustment effect that participants with higher initial systolic blood pressure and diastolic blood pressure showed decreases after the 3-day forest therapy

Table 3
A comparison of pre-test and post-test results of psychological indicators and creativity.

subscales		N	Mean(SD)		Z	p	ES
			Pre-test	Post-test			
POMS	T-A	21[a]	3.10(2.79)	1.57(2.56)	−2.911	0.004**	0.64
	A-H	22[b]	2.55(1.90)	1.59(2.11)	−2.550	0.011*	0.54
	F-I	22	1.64(2.13)	1.41(2.38)	−0.740	0.459	0.16
	D-D	22	2.36(2.15)	1.36(2.70)	−1.975	0.048*	0.42
	C-B	22	2.86(1.39)	1.91(1.15)	−2.981	0.003**	0.64
	V-A	22	10.55(3.56)	12.45(3.23)	−2.668	0.008**	0.57
	TMD	21	1.90(10.71)	−4.10(11.63)	−2.880	0.004**	0.63
Creativity	CWRAT	23	13.48(5.00)	17.22(6.46)	−2.897	0.004**	0.60

Abbreviations: T–A, tension–anxiety; A–H, anger–hostility; F–I, fatigue–inertia; D-D, depression–dejection; C–B, confusion–bewilderment; V–A, vigor–activity; TMD, total mood disturbance (calculated by combining T–A + A–H + F–I + D-D + C–B − V–A); CWRT, Chinese Word Remote Associates Test.
NoteWilcoxon signed-rank test, *p < 0.05, **p < 0.01; (a) missing values in the tension–anxiety dimension; (b) an invalid POMS response.

Table 4
Spearman (rho) correlations of the change in creativity and changes in emotions.

	ΔA_T	ΔA_H	ΔF_I	ΔD_D	ΔC_B	ΔV_A	ΔTMD
ΔC	−.301	−.115	−.034	.093	−.518*	.231	.314
Sig.	.173	.609	.879	.680	.014	.302	.165

Note: *$p < 0.05$, **$p < 0.01$; N = 22.

workshop, whereas those with low initial values exhibited increases. Our finding suggests the 3-day forest therapy workshop had a physiological benefit by regulating participants' systolic and diastolic blood pressures. From a research design perspective the adjustment effect may cause non-significant results in physiological responses because the decreases (typically in subjects with high initial values) and the increases (typically in subjects with low initial values) offset one another in statistical analysis, thereby suggesting the selection of a homogeneous sample. Previous studies have suggested blood pressure decreases after visiting forests; however, the findings of prior research are not consistent with some empirical investigations (Tsunetsugu et al., 2007; Lee et al., 2011; Horiuchi et al., 2013). Inspired by the concept of "the law of initial value" (Leites, 1936; Hord et al., 1964; Wilder, 1967), Song et al. (2015b) proposed the physiological adjustment effect to explain the incongruity that could explain individual differences, that is, the different initial physical value of each participant.

The scores for the tension–anxiety, anger–hostility, depression–dejection, and confusion–bewilderment dimensions in the POMS scale were significantly lower after the 3-day forest therapy workshop, whereas those for the vigor–activity dimension were significantly higher, which is consistent with the findings of previous studies of forest therapy (Park et al., 2010; Yu et al., 2017). The lack of change in the fatigue–inertia dimension is consistent with the results of Ochiai et al. (2015a,b), who enrolled older women into forest therapy activities and determined no change in their POMS fatigue–inertia scores after the activities. Ochiai et al. attributed this to temporary fatigue resulting from exercise in the forest. It follows, then, this 3-day forest therapy workshop with a tight schedule and walking and exercise in the forest for participants mostly of a middle or senior age could have resulted in fatigue. Therefore, although the fatigue–inertia score was lower after the activities, the effect was nonsignificant. From the effect size analysis we found the 3-day forest therapy workshop to have a small effect on fatigue–inertia, a moderate effect on depression-dejection, and a large effect on the rest mood states. A conclusion we draw from this study is the 3-day forest therapy workshop contributed to an improvement in participants' mood states.

In regards to creativity, we revealed a significant difference with the post-test average score being 27.74 % higher than the pre-test average score, which is concordant with other outdoor and creativity studies (Atchley et al., 2012; Ferraro III, 2015). Therefore, our findings indicate this 3-day forest therapy workshop improves creative thinking by 27.74 %. In addition to the increased creativity resulting from forest therapy, we observed relief of negative emotions (e.g., confusion–bewilderment) was significantly associated with enhancement of creativity. Creativity literature illustrates how the cold pathway and hot pathway contribute to creative performance. The positive affect that results from time spent in nature leads to better creativity performances (Baas et al., 2008; Mikulincer et al., 2000; Pasanen et al., 2018). However, this study could not demonstrate that positive affect (e.g., vigor–activity) markedly and directly improves creativity; instead, our study observed alleviation of confusion–bewilderment correlated to enhanced creativity; so, participants performed better in creative tasks when they were calm. A similar idea was proposed by (Plambech and Konijnendijk Van Den Bosch (2015), that a calming experience and a feeling of peace are essential for people to generate new ideas and see ideas from a new perspective.

This study extends forest therapy research by investigating high-level cognitive functioning (e.g., creativity) and provides direction of how to investigate health benefits and physiological adjustment effects of forest therapy. Our study provides an approach for measuring creativity in forest therapy research, as creativity improvements upon completion of the forest therapy workshop were quantified. The relationship between negative emotions and creativity was identified, which contributes to the effect of exposure to nature on creativity. We recognize this study has several limitations. First, this study did not have a control group due to difficulty in repeating the same methodology in an urban setting, which may threaten the design's internal validity. Ideally, extraneous factors, which potentially influence results, should be controlled in the study protocol. Further, a statistical phenomenon is known as regression towards the mean (RTM) occurs in a repeated measurements design and often leads to an inaccurate conclusion that the intervention resulted in a treatment effect (Barnett, et al., 2005; Linden, 2013). RTM is a ubiquitous phenomenon in repeated data and is a risk that may lead to a false impression of treatment (e.g. the forest therapy workshop) efficacy in our study. RTM's effect can be alleviated through randomized controlled trial (RCT) with a control group design and use of analysis of covariance methods (Barnett, et al., 2005). The authors thus warn readers to cautiously evaluate research findings. We suggest a control group design and a randomized controlled trial (RCT) should be applied in a future study. Secondly, the characteristics of the sample must be considered. The participants in this study shared a special interest in forest therapy program, so we cannot assume the same effects observed in this study would be observed in different populations. Therefore, it is necessary to be cautious about applying these findings to different groups. Moreover, the results may be affected by other parameters, such as subjects' health conditions, preferences for nature, visit frequencies of forest environments, and environmental conditions. Future studies could benefit from understanding and planning for the potential influence of these variables. Lastly, in order to avoid a learning effect on the improvement of creativity performance, future study should add a practice test before pre-test to eliminate the potential bias.

In conclusion, this 3-day forest therapy workshop improved physical and mental health by regulating physiological responses and improving recovery from psychological stress. We found the forest therapy workshop improved participants' creative performances by 27.74 %. Moreover, creativity enhancement was associated with the alleviation of confusion–bewilderment.

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CRediT authorship contribution statement

Chia-Pin (Simon) Yu: Funding acquisition, Conceptualization, Methodology, Supervision, Writing - review & editing. **Hsuan Hsieh:** Investigation, Data curation, Formal analysis, Writing - original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ufug.2020.126670.

References

Aguinis, H., Gottfredson, R.K., Joo, H., 2013. Best-practice recommendations for defining, identifying, and handling outliers. Organ. Res. Methods 16 (2), 270–301.

Ansburg, P.I., 2000. Individual differences in problem solving via insight. Curr. Psychol. 19 (2), 143–146.

Atchley, R.A., Strayer, D.L., Atchley, P., 2012. Creativity in the wild: improving creative reasoning through immersion in natural settings. PLoS One 7 (12), e51474.

Baas, M., De Dreu, C.K.W., Nijstad, B.A., 2008. A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? Psychol. Bull. 134 (6), 779–806.

Balmford, A., Cowling, R.M., 2006. Fusion or failure? The future of conservation biology. Conserv. Biol. 20 (3), 692–695.

Barnett, A.G., van der Pols, J.C., Dobson, A.J., 2005. Regression to the mean: what it is and how to deal with it. Int. J. Epidemiol. 34, 215–220.

Berman, M.G., Jonides, J., Kaplan, S., 2008. The cognitive benefits of interacting with nature. Psychol. Sci. 19 (12), 1207–1212.

Berman, M.G., Kross, E., Krpan, K.M., Askren, M.K., Burson, A., Deldin, P.J., et al., 2012. Interacting with nature improves cognition and affect for individuals with depression. J. Affect. Disord. 140 (3), 300–305.

Berto, R., 2005. Exposure to restorative environments helps restore attentional capacity. J. Environ. Psychol. 25 (3), 249–259.

Berto, M.G., Jonides, J., Kaplan, S., 2008. The cognitive benefits of interacting with nature. Psychol. Sci. 19 (12), 1207–1212.

Cerruti, C., Schlaug, G., 2009. Anodal transcranial direct current stimulation of the prefrontal cortex enhances complex verbal associative thought. J. Cogn. Neurosci. 21 (10), 1980–1987.

Chen, H.T., Yu, C.P., Lee, H.Y., 2018. The effects of forest bathing on stress recovery evidence from middle-aged females of Taiwan. Forest 9 (7), 403.

Cohen, J., 1988. Statistical Power Analysis for the Behavioral Sciences. Lawrence Earlbaum Associates., Hillsdale, NJ.

Day, L.L., 2000. Choosing a house: the relationship between dwelling type, perception of privacy and residential satisfaction. J. Plan. Educ. Res. 19 (3), 265–275.

Dye, C., 2008. Health and urban living. Science 319 (5864), 766–769.

Evans, G.W., McCoy, J.M., 1998. When buildings don't work: the role of architecture in human health. J. Environ. Psychol. 18 (1), 85–94.

Ferraro III, F.M., 2015. Enhancement of convergent creativity following a multiday wilderness experience. Ecopsychology 7 (1), 7–11.

Fodor, E.M., 1999. Subclinical inclination toward manic-depression and creative performance on the Remote Associates Test. Pers. Individ. Dif. 27 (6), 1273–1283.

Ghiselin, B., 1952. The Creative Process. California Press, Berkeley: Univer.

Hansmann, R., Hug, S.-M., Seeland, K., 2007. Restoration and stress relief through physical activities in forests and parks. Urban For. Urban Green. 6 (4), 213–225.

Hartig, T., Mang, M., Evans, G.W., 1991. Restorative effects of natural environment experiences. Environ. Behav. 23 (1), 3–26.

Hartig, T., Mitchell, R., de Vries, S., Frumkin, H., 2014. Nature and health. Annu. Rev. Public Health 35, 207–228.

Hord, D.J., Hojnson, L.C., Lubin, A., 1964. Differential effect of the law of initial value (LIV) on autonomic variables. Psychophysiology 1, 79–87.

Horiuchi, M., Endo, J., Akatsuka, S., Uno, T., Hasegawa, T., Seko, Y., 2013. Influence of forest walking on blood pressure, profile of mood states and stress markers from the viewpoint of aging. J. Aging Gerontol. 1, 9–17.

Huang, P.-S., Chen, H.-C., Liu, C.-H., 2012. The development of chinese word remote associates test for college students. Psychological testing 59 (4), 581–607 in Chinese.

Jung, W.H., Woo, J.-M., Ryu, J.S., 2015. Effect of a forest therapy program and the forest environment on female workers' stress. Urban For. Urban Green. 14, 274–281.

Kaplan, S., 1995. The restorative benefits of nature: toward an integrative framework. J. Environ. Psychol. 15 (3), 169–182.

Kaplan, R., Kaplan, S., 1989. The Experience of Nature: a Psychological Perspective. CUP Archive., New York, NY.

Kondo, M., Jocoby, S.F., South, E.C., 2018. Does spending time outdoors reduce stress? A review of real-time stress response to outdoor environments. Health Place 51, 136–150.

Lee, J., Park, B.J., Tsunetsugu, Y., Kagawa, T., Miyazaki, Y., 2009. Restorative effects of viewing real forest landscapes, based on a comparison with urban landscapes. Scand. J. For. Res. 24 (3), 227–234.

Lee, J., Park, B.J., Tsunetsugu, Y., Ohira, T., Kagawa, T., Miyazaki, Y., 2011. Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. Public Health 125 (2), 93–100.

Lee, J., Li, Q., Tyrväinen, L., Tsunetsugu, Y., Park, B.-J., Kagawa, T., et al., 2012. Nature therapy and preventive medicine. In: Maddock, J. (Ed.), Public Health-Social and Behavioral Health. InTechOpen, pp. 325–350.

Lee, J., Tsunetsugu, Y., Takayama, N., Park, B.J., Li, Q., Song, C., Komatsu, M., Ikei, H., Tyrvainen, L., Kaawa, T., Miyazaki, Y., 2014. Influence of forest therapy on cardiovascular relaxation in young adults. Evid. Based Complement. Altern. Med. 1–7.

Leites, S., 1936. The initial state principle and its importance in physiology and pathology. Lancet 227, 1348–1351.

Li, Q., 2010. Effect of forest bathing trips on human immune function. Environ. Health Prev. Med. 15 (1), 9–17.

Li, Q., Morimoto, K., Nakadai, A., Qu, T., Matsushima, H., Katsumata, M., Shimizu, T., Inagaki, H., Hirata, Y., Hirata, K., Kawada, T., Lu, Y., Nakayama, K., Krensky, A.M., 2007. Healthy lifestyles are associated with higher levels of perforin, granulysin and granzymes A/B-expressing cells in peripheral blood lymphocytes. Prev. Med. 44 (2), 117–123.

Li, Q., Morimoto, K., Kobayashi, M., Inagaki, H., Katsumata, M., Hirata, Y., Hirata, K., Suzuki, H., Li, Y.J., Wakayama, Y., Kawada, T., Park, B.J., Ohira, T., Matsui, N., Kagawa, T., Miyazaki, Y., Krensky, A.M., 2008a. Visiting a forest, but not a city, increase human natural killer activity and expression of anti-cancer proteins. Int. J. Immunopathol. Pharmacol. 21 (1), 117–127.

Li, Q., Morimoto, K., Kobayashi, M., Inagaki, H., Katsumata, M., Hirata, Y., Hirata, K., Shimizu, T., Li, Y.J., Wakayama, Y., Kawada, T., Ohira, T., Takayama, N., Kagawa, T., Miyazaki, Y., 2008b. A forest bathing trip increases human natural killer activity and expression of anti-cancer proteins in female subjects. J. Biol. Regul. Homeost. Agents 22 (1), 45–55.

Linden, A., 2013. Assessing regression to the mean effects in health care initiatives. BMC Med. Res. Methodol. 13, 119–125.

Mao, G.X., Cao, Y.B., Lan, X.G., He, Z.H., Chen, Z.M., Wang, Y.Z., Hu, X.L., Lv, Y.D., Wang, G.F., Yan, J., 2012. Therapeutic effect of forest bathing on human hypertension in the elderly. J. Cardiol. 60 (6), 495–502.

McMahan, E.A., Estes, D., 2015. The effect of contact with natural environments on positive and negative affect: a meta-analysis. J. Posit. Psychol. 10 (6), 507–519.

Mednick, S.A., 1962. The associative basis of the creative process. Psychol. Rev. 69 (3), 220–232.

Mednick, S.A., 1968. The remote associates test. J. Creat. Behav. 2 (3), 213–214.

Mikulincer, M., Sheffi, E., 2000. Adult attachment style and cognitive reactions to positive affect: a test of mental categorization and creative problem solving. Motiv. Emot. 24 (3), 149–174.

Morita, E., Fukuda, S., Nagano, J., Hamajina, N., Yamamota, H., Iwai, Y., Nakashima, T., Ohira, H., Shirakawa, T., 2007. Psychological effects of forest environments on healthy adults: shinrin-yoki (forest-air bathing, walking) as a possible method of stress reduction. Public Health 121 (1), 54–63.

Nilsson, M.E., Berglund, B., 2006. Soundscape quality in suburban green areas and city parks. Acta Acust. United With Acust. 92 (6), 903–911.

Ochiai, H., Ikei, H., Song, C., Kobayashi, M., Miura, T., Kagawa, T., et al., 2015a. Physiological and psychological effects of a forest therapy program on middle-aged females. Int. J. Environ. Res. Public Health 12 (12), 15222–15232.

Ochiai, H., Ikei, H., Song, C., Kobayashi, M., Takamatsu, A., Miura, T., et al., 2015b. Physiological and psychological effects of forest therapy on middle-aged males with high-normal blood pressure. Int. J. Environ. Res. Public Health 12 (3), 2532–2542.

Ottosson, J., Grahn, P., 2005. A comparison of leisure time spent in a garden with leisure time spent indoors: on measures of restoration in residents in geriatric care. Landsc. Res. 30, 23–55.

Park, B.J., Tsunetsugu, Y., Kasetani, T., Hirano, H., Kagawa, T., Sato, M., Miyazaki, Y., 2007. Physiological effects of shinrin-yoku (taking in the atmosphere of the forest)—using salivary cortisol and cerebral activity as indicators. J. Physiol. Anthropol. 26 (2), 123–128.

Park, B.J., Tsunetsugu, Y., Ishii, H., Furuhashi, S., Hirano, H., Kagawa, T., Miyazaki, Y., 2008. Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in a mixed forest in Shinano Town, Japan. Scand. J. For. Res. 23 (3), 278–283.

Park, B.J., Tsunetsugu, Y., Kasetani, T., Morikawa, T., Kagawa, T., Miyazaki, Y., 2009. Physiological effects of forest recreation in a young conifer forest in Hinokage Town, Japan. Silva Fenn. 43 (2), 291–301.

Park, B.J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., Miyazaki, Y., 2010. The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. Environ. Health Prev. Med. 15 (1), 18–26.

Park, B.J., Tsunetsugu, Y., Lee, J., Miyazaki, Y., 2011. Effect of the forest environmental on physiological relaxation-the results of field tests at 35 sites throughout Japan. In: Li, Q. (Ed.), Forest Medicine. Nova Science Publishers, NY, pp. 55–65 ISBN 9781-62100-000-6.

Pasanen, T.P., Neuvonen, M., Korpela, K.M., 2018. The Psychology of Recent Nature Visits: (How) Are Motives and Attentional Focus Related to Post-Visit Restorative Experiences, Creativity, and Emotional Well-Being? Environ. Behav. 50 (8), 913–944.

Pilotti, M., Klein, E., Golem, D., Piepenbrink, E., Kaplan, K., 2014. Is viewing a nature video after work restorative? Effects on blood pressure, task performance, and long-term memory. Environ. Behav. 47 (9), 947–969.

Plambech, T., Konijnendijk Van Den Bosch, C.C., 2015. The impact of nature on creativity–A study among Danish creative professionals. Urban For. Urban Green. 14 (2), 255–263.

Saunders, C.D., 2003. The emerging field of conservation psychology. Hum. Ecol. Rev. 10 (2), 137–149.

Shacham, S., 1983. A shortened version of the Profile of Mood States. J. Pers. Assess. 47, 305–306.

Shin, Y.K., Kim, D.J., Kyunghee, J.C., Son, Y.J., Koo, J.W., Min, J.A., Chae, J.H., 2013. Differences of psychological effects between meditative and athletic walking in a forest and gymnasium. Scand. J. For. Res. 28 (1), 2012.

Sio, U.N., Ormerod, T.C., 2015. Incubation and cueing effects in problem-solving: set aside the difficult problems but focus on the easy ones. Think. Reason. 21 (1), 113–129.

Smardon, R.C., 1988. Perception and aesthetics of the urban environment: review of the role of vegetation. Landsc. Urban Plan. 15 (1-2), 85–106.

Song, C., Ikei, H., Lee, J., Park, B.J., Kagawa, T., Miyazaki, Y., 2013. Individual differences in the physiological effects of forest therapy based on Type A and Type B behavior patterns. J. Physiol. Anthropol. 32 (1), 14.

Song, C., Ikei, H., Kobayashi, M., Miura, T., Taue, M., Kagawa, T., et al., 2015a. Effect of forest walking on autonomic nervous system activity in middle-aged hypertensive individuals: a pilot study. Int. J. Environ. Res. Public Health 12 (3), 2687–2699.

Song, C., Ikei, H., Miyazaki, Y., 2015b. Elucidation of a physiological adjustment effect in a forest environment: a pilot study. Int. J. Environ. Res. Public Health 12 (4), 4247–4255.

Song, C., Ikei, H., Miyazaki, Y., 2017. Sustained effects of a forest therapy program on the blood pressure of office workers. Urban For. Urban Green. 27, 246–252.

Staats, H., Kieviet, A., Hartig, T., 2003. Where to recover from attentional fatigue: an expectancy-value analysis of environment preference. J. Environ. Psychol. 23 (2), 147–157.

Stevenson, M.P., Schilhab, T., Bentsen, P., 2018. Attention Restoration Theory II: a systematic review to clarify attention processes affected by exposure to natural environments. J. Toxicol. Environ. Health Part B 21 (4), 227–268.

Takayama, N., Korpela, K., Lee, J., Morikawa, T., Tsunetsugu, Y., Park, B.J., Li, Q., Tyrvainen, L., Miyazaki, Y., Kagawa, T., 2014. Emotional, restorative and vitalizing effects of forest and urban environments at four sites in Japan. Int. J. Environ. Res. Public Health 11 (7), 7207–7230.

Tennessen, C.M., Cimprich, B., 1995. Views to nature: effects on attention. J. Environ. Psychol. 15 (1), 77–85.

Tsunetsugu, Y., Park, B.J., Ishii, H., Hirano, H., Kagawa, T., Miyazaki, Y., 2007. Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in an old-growth broadleaf forest in Yamagata Prefecture, Japan. J. Physiol. Anthropol. 26 (2), 135–142.

Tsunetsugu, Y., Lee, J., Park, B.J., Tyrväinen, L., Kagawa, T., Miyazaki, Y., 2013. Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements. Landsc. Urban Plan. 113, 90–93.

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 (3), 201–230.

Van Den Berg, A.E., Custers, M.H., 2011. Gardening promotes neuroendocrine and affective restoration from stress. J. Health Psychol. 16 (1), 3–11.

Vining, J., Merrick, M.S., Price, E.A., 2008. The distinction between humans and nature: human perceptions of connectedness to nature and elements of the natural and unnatural. Res. Human Ecology 15 (1), 1–11.

Ward, J., Thompson-Lake, D., Ely, R., Kaminski, F., 2008. Synaesthesia, creativity and art: What is the link? Br. J. Psychol. 99 (1), 127–141.

Weinstein, S., Graves, R.E., 2002. Are creativity and schizotypy products of a right hemisphere bias? Brain Cogn. 49 (1), 138–151.

Wilder, J., 1967. Stimulus and Response: The Law of Initial Value. J. Wright Press, Bristol, UK.

Williams, K.J., Lee, K.E., Hartig, T., Sargent, L.D., Williams, N.S., Johnson, K.A., 2018. Conceptualising creativity benefits of nature experience: attention restoration and mind wandering as complementary processes. J. Environ. Psychol. 59, 36–45.

Yamaguchi, M., Deguchi, M., Miyazaki, Y., 2006. The effects of exercise in forest and urban environments on sympathetic nervous activity of normal young adults. J. Int. Med. Res. 34 (2), 152–159.

Yu, Y.M., Lee, Y.J., Kim, J.Y., Yoon, S.B., Shin, C.S., 2016. Effects of forest therapy camp on quality of life and stress in postmenopausal women. Forest Sci. Technol. 12 (3), 125–129.

Yu, C.P., Lin, C.M., Tsai, M.J., Tsai, Y.C., Chen, C.Y., 2017. Effects of short forest bathing program on autonomic nervous system activity and mood states in middle-aged and elderly individuals. Int. J. Environ. Res. Public Health 14 (8), 897.

Zhong, C.B., Dijksterhuis, A., Galinsky, A.D., 2008. The merits of unconscious thought in creativity. Psychol. Sci. 19 (9), 912–918.