



Physiological and Psychological Effects of Viewing Forests on Young Women

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Received: 14 June 2019; Accepted: 26 July 2019; Published: 27 July 2019



Abstract: Research Highlights: This study demonstrated that viewing forest landscapes induced physical and mental health benefits on young women. Background and Objectives: The health-promoting effects of spending time in forests have received increasing attention; however, there is a lack of evidence-based research investigating the effects of spending time in forests on women. This study aimed to evaluate the physiological and psychological effects of viewing forest landscapes on young women. Materials and Methods: The experiments were conducted in six forests and six city areas and included 65 women (mean age, 21.0 ± 1.3 years). Participants viewed a forest and a city area for 15 min, during which their heart rate variability and heart rate were measured continuously. Blood pressure and pulse rate were measured before and after the viewing. After the viewing, participants' psychological responses were assessed using the modified semantic differential method, Profile of Mood States (POMS), and the State–Trait Anxiety Inventory (STAI). Results: Compared with viewing city areas, viewing forest landscapes was associated with significantly higher parasympathetic nervous activity and lower sympathetic nervous activity and heart rate. Moreover, scores of the comfortable, relaxed, and natural parameters and vigor subscales of POMS were significantly higher with forest viewing. The scores of negative feelings, such as tension-anxiety, depression-dejection, anger-hostility, fatigue, and confusion, were significantly lower, as were scores for the total mood disturbance observed using POMS and the anxiety dimension observed using STAI. Conclusions: Viewing forest landscapes resulted in physiological and psychological relaxations in young women.

Keywords: shinrin-yoku; forest therapy; females; heart rate variability; blood pressure; pulse rate; semantic differential method; Profile of Mood State; State–Trait Anxiety Inventory; preventive medicine

1. Introduction

The highly urbanized and artificial environments that most people live in today are a contributing cause of stress state experienced by the current population. Humans have evolved over 6–7 million years [1]. If we define the beginning of urbanization as the start of the industrial revolution, less than 0.01% of our history has experienced urbanized surroundings, and humans have spent more 99.99% of their time in the natural environment. Our physiological functions have evolved in and have adapted to this environment [2–4]. When humans are exposed to a natural setting, physiological responses revert to their natural state, inducing a feeling of comfort and relaxation [4,5]. This tendency to be near nature implies that contact with nature may be an important component of well-being in humans [6].

With a recent increased interest within promotion of health and quality of life, attention has been focused on the role of "nature", especially forests, for enhancement of human health and well-being. This approach is known as "shinrin-yoku" or "forest bathing" and means "taking in the



forest atmosphere through all of our senses" [3,4]. It has been suggested that forest bathing, which is based on the proven positive effects of forests, such as inducing relaxation, can improve the health of both body and mind. An accumulation of data has resulted in the concept of "forest therapy"; this refers to evidence-based forest bathing with the aim of achieving preventive medical effects that render a state of physiological relaxation and boost weakened immune functions to prevent diseases [3].

Numerous studies have demonstrated the effects of forests in mitigating stress states and inducing physiological relaxation in healthy individuals [7–18]. Walking through a forest and/or viewing sceneries can reduce levels of salivary cortisol, a stress hormone [7–14,17], blood pressure [8,11,12,15,17], and pulse rate [8,10,11,13,15,17,18]. It can also increase parasympathetic nervous activity, which is enhanced during relaxation [8,10,12–18], and can suppress sympathetic nervous activity, which increases in stressful situations [8,12–18]. Moreover, there is a decrease in cerebral blood flow in the prefrontal cortex [8]. Forest therapy trips have been shown to increase natural killer cell activity and improve immune function, with these effects lasting for approximately 1 month [19–21]. In addition, recent studies have demonstrated positive physiological effects resulting from various activities in forests in elderly individuals and adults at risk of stress- and lifestyle-related diseases, such as high blood pressure, diabetes, and depression [22–30]. However, most studies involving forest therapy experiments have reported effects on male participants [7–17,19,20,26,27,30], with few focusing on women [18,21,25,31,32].

In a study of young women, Song et al. [18] reported that a brief walk in forests for 15 min increased parasympathetic nervous activity and reduced sympathetic nervous activity and heart rate. Ochiai et al. [31] investigated the effects of a one-day forest therapy program on middle-aged women and reported that the participants' pulse rates and salivary cortisol levels decreased following the program. Li et al. [21] examined the effects of a three-day, two-night trip to a forest on women and reported that natural killer cell activity increased and remained at a raised level for more than seven days after the trip. Lee and Lee [25] reported that walking in a forest for 1 h improved arterial stiffness and pulmonary function in elderly women. In a study of women with breast cancer, Kim et al. [32] reported that natural killer cell activation was enhanced following daily forest therapy for 14 days, with the participants living in accommodation in the forest. However, many of these studies were limited by their small sample sizes and lacked control conditions. They also incorporated an element of exercise, such as walking, so their findings may not have been the result solely of the health-giving properties of the forest environment. There is a need for evidence-based research of the influence of exposure to a forest environment on women, which excludes any element of exercise.

The aim of this study was to investigate the physiological and psychological effects of exposure to a forest environment on a large sample of young women who remained sedentary while viewing the landscape, comparing the effects with exposure to a city environment. In addition, the results obtained for viewing the forest landscapes in a sedentary state were compared with those reported in a previous study for participants walking in forest areas [18].

2. Materials and Methods

2.1. Participants

The experiments for this study were conducted between 2014 and 2017 in six forests and six city areas in Japan. In each region, we selected safe, well-maintained forest areas and city areas that were located either downtown or near a Japan Railway station. Twelve Japanese female university students participated in each set of experiments (a total of N = 72 participants). They were recruited via bulletin board advertising at the university, and were composed of students from various majors, with no related direct bias on the experiments. None of the participants reported a history of physical or psychiatric disorders. Errors in data collection resulted in the exclusion of the results of seven of the participants, so the analysis included data from 65 participants (mean age, 21.0 ± 1.3 years; Table 1). During the experiment, the participants were prohibited from consuming alcohol and tobacco, and caffeine consumption was controlled.

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the Center for Environment, Health, and Field Sciences, Chiba University, Japan (project identification code number: 5). Before starting each experiment, we explained the study aims and procedures to the participants and obtained their written informed consent.

Parameter	$Mean \pm Standard Deviation$		
Age (years)	21.0 ± 1.3		
Height (cm)	158.4 ± 5.7		
Weight (kg)	50.8 ± 6.7		
BMI ¹ (kg/m ²)	20.2 ± 2.3		

Table 1. Participant characteristics (N = 65).

¹ BMI: body mass index.

2.2. Experimental Design

To eliminate order effects, the 12 participants were randomly divided into two groups of six. One group first underwent the experiment in the forest area and the other in the urban area. The following day, the groups switched field sites, with the experiment conducted at a similar time of day to eliminate the influence of diurnal changes on physiological rhythms. Details of the experiment sites are summarized in Table 2.

After arriving at the field site, the participants waited in a waiting room. Each was taken singly to the experimental site, where she rested in a chair for 5 min. Before the viewing, her blood pressure and pulse rate were measured. The participant then remained in the chair and viewed the landscape for 15 min (Figure 1). During the viewing period, her heart rate variability (HRV) and heart rate were measured continuously. After the viewing, her blood pressure and pulse rate were measured again. Finally, the participant underwent the subjective psychological assessment and returned to the waiting room.





(b)

Figure 1. Viewing a forest area (a) and a city area (b).

	1	2	3	4	5	6
Location	Iwate Town, Iwate	Motosu City, Gifu	Shiso City, Hyogo	Daigo Town, Ibaraki	Hakone Town,	Oi Town, Kanagawa
	Prefecture	Prefecture	Prefecture	Prefecture	Kanagawa Prefecture	Prefecture
Dates	August 5, 6, 2014	August 12, 13, 2014	August 21, 22, 2014	August 6, 7, 2015	September 2, 3, 2015	September 5, 6, 2017
Forest Physiognomy	Secondary forest (red pine & oak) and artificial forest (larch)	Secondary forest (oak & cherry)	Secondary forest (oak & maple)	Secondary forest (red pine & oak)	Secondary forest (red pine & oak)	Secondary forest (oak) and artificial planting (ginkgo)
Weather	Day 1: sun	Day 1: sun	Day 1: sun	Day 1: sun	Day 1: rain	Day 1: sun
	Day 2: sun	Day 2: sun	Day 2: rain	Day 2: sun	Day 2: cloud	Day 2: cloud
Temperature (°C)	Forest: 26.4 ± 0.3	Forest: 29.1 ± 1.0	Forest: 23.5 ± 0.6	Forest: 31.9 ± 0.3	Forest: 25.2 ± 0.3	Forest: 24.7 ± 0.2
(mean ± SD ¹)	City: 30.1 ± 0.6	City: 30.5 ± 0.8	City: 31.9 ± 1.5	City: 36.6 ± 0.4	City: 28.0 ± 0.2	City: 27.2 ± 0.4
Humidity (%)	Forest: 84.9 ± 1.5	Forest: 74.4 ± 4.1	Forest: 93.5 ± 2.3	Forest: 60.7 ± 1.3	Forest: 78.9 ± 2.9	Forest: 79.2 ± 1.6
(mean ± SD)	City: 63.6 ± 2.8	City: 66.5 ± 5.7	City: 54.9 ± 3.9	City: 45.0 ± 1.1	City: 69.4 ± 1.4	City: 64.5 ± 1.1
Illuminance (lx)	Forest: 40	Forest: 4220	FForest: 70	Forest: 450	Forest: 120	Forest: 2070
(mean)	City: 8920	City: 5590	City: 6680	City: 11,230	City: 1360	City: 5010

 Table 2. Details of the experiment sites.

¹ SD: standard deviation.

2.3. Physiological Measurements

The physiological measurements made during the experiments were of HRV, heart rate, blood pressure, and pulse rate. HRV and heart rate were measured continuously with a portable Lead II electrocardiogram (Activtracer AC-301A, GMS, Tokyo, Japan) [33,34]. HRV was assessed from the periods between consecutive R waves (R–R intervals). Power levels for the high-frequency (HF, 0.15–0.40 Hz) and low-frequency (LF, 0.04–0.15 Hz) components of HRV were calculated using the maximum entropy method (MemCalc/Win, GMS, Tokyo, Japan) [35,36]. The HF power is considered to be an indicator of parasympathetic nervous activity and the LF/HF power ratio an indicator of sympathetic nervous activity [37,38]. To normalize the HRV parameters across the participants, the HF power and LF/HF ratio values were transformed to their natural logarithmic values (ln(HF) and ln(LF/HF), respectively) [39]. The average HRV and heart rate values during the viewing period were used in the analysis.

Systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse rate in the right upper arm were measured by an oscillometric method using a digital blood pressure monitor (HEM1020, Omron, Kyoto, Japan). Each was measured twice; if the two values of SBP differed by >10 mmHg and/or the DBP values differed by >6 mmHg, an additional measurement was made. The mean of the two or three measurements was used in the analysis.

2.4. Psychological Measurements

The psychological evaluations used the modified semantic differential method, the Profile of Mood State (POMS) and State–Trait Anxiety Inventory (STAI) questionnaires. The semantic differential method obtains a subjective assessment from the participant through a questionnaire comprising pairs of opposing adjectives, each evaluated on a 13-point scale [40]. Three pairs of adjectives were assessed in this study: "comfortable–uncomfortable", "relaxed–aroused", and "natural–artificial."

The POMS is a well-established measure of psychological distress derived from factor analysis, and its high levels of reliability and validity have been documented [41,42]. It simultaneously evaluates six moods: tension and anxiety (T–A), depression and dejection (D), anger and hostility (A–H), fatigue (F), confusion (C), and vigor (V). The total mood disturbance score was calculated as [(T–A) + (D) + (A–H) + (F) + (C) - (V)] [41]; this total score makes sense from a clinical perspective and intercorrelations among the six primary POMS factors suggest that it is highly reliable [42]. In this study, we used the Japanese version of the POMS in a short form with 30 questions [43] to reduce the burden on the participants.

STAI Form X was used to assess the participant's state anxiety level (i.e., how the respondent felt at the time the questionnaire was administered). STAI is a self-reported tool that asks 20 questions to measure the current presence and severity of symptoms of anxiety and a generalized propensity to be anxious [44,45].

2.5. Data Analysis

Because of errors in the data collection, the analysis included the blood pressure and pulse rate data for only 52 of the participants. The statistical analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Paired *t*-tests were used to compare physiological responses between the forest and city areas. The Wilcoxon signed-rank test was used to compare the psychological responses. For all the analyses, a *p*-value <0.05 was considered statistically significant. One-sided tests were used because it was hypothesized that the participants would be physiologically and psychologically relaxed by viewing forest landscapes.

In a further analysis, the HRV results of this study were compared with those of our previous study that examined the effect on the same 52 participants of walking in forests for 15 min [18]. The numbers of participants who indicated positive and negative responses were calculated for the present and previous results (for viewing and walking in forests, respectively). A positive response

was defined by an increase in ln(HF) and a decrease in ln(LF/HF) and a negative response as the opposite. The difference in the ratio of positive and negative responders between the present and previous studies was compared using the chi-squared test.

3. Results

There were significant differences in the participants' physiological and psychological responses to viewing the forest and city landscapes. The mean value of ln(HF) averaged over the entire viewing period was significantly higher for forest viewing than for city viewing (forest: $5.98 \pm 0.09 \text{ lnms}^2$; city: $5.46 \pm 0.10 \text{ lnms}^2$; p < 0.01; Figure 2). There was also a significant difference in the original, non-logarithmic HF values (forest: $505.36 \pm 46.75 \text{ ms}^2$; city: $313.34 \pm 27.24 \text{ ms}^2$; p < 0.01). These results indicate increased parasympathetic nervous activity. In contrast, ln(LF/HF) was significantly lower during forest viewing than during city viewing (forest: 0.77 ± 0.07 ; city: 1.14 ± 0.08 ; p < 0.01; Figure 3). There was also a significant difference in the non-logarithmic LF/HF ratio values (forest: 2.55 ± 0.21 ; city: 3.83 ± 0.30 ; p < 0.01). These results indicate reduced sympathetic nervous activity. In addition, the mean heart rate was significantly lower during forest viewing than during city viewing (forest: 1.14 ± 0.03 ; p < 0.01). These results indicate reduced sympathetic nervous activity. In addition, the mean heart rate was significantly lower during forest viewing than during city viewing (forest: 75.3 ± 1.0 bpm; city: 80.6 ± 1.1 bpm; p < 0.01; Figure 4).



Figure 2. Natural logarithm of the high-frequency power component of heart rate variability, an indicator of parasympathetic nervous system activity, while viewing forest and city areas. Data are shown as means \pm standard error (*n* = 65). ** *p* < 0.01, paired *t*-test (one-sided).



Figure 3. Natural logarithm of the heart rate variability low frequency/high frequency ratio, an indicator of sympathetic nervous system activity, while viewing forest and city areas. Data are presented as means \pm standard error (*n* = 65). ** *p* < 0.01, paired *t*-test (one-sided).



Figure 4. Heart rate during viewing forest and city areas. Data are shown as means \pm standard error (*n* = 65). ** *p* < 0.01, paired *t*-test (one-sided).

The present results were compared with results from our previous study in which participants walked in forests [18]. The numbers and ratios of participants who indicated positive and negative responses in forests are summarized in Table 3. In our previous results [18], 86.5% of the participants exhibited positive responses for ln(HF) during walking in forests, which was a greater proportion than that during viewing (75.4%) in the present study, although the difference was not statistically significant. The proportion of participants showing a positive response in ln(LF/HF) was similar between walking in forests (71.2%) and viewing forests (78.5%); again, there was no statistically significant difference.

	ln	(HF)	ln(LF/HF)		
	Positive Response	Negative Response	Positive Response	Negative Response	
Viewing (<i>n</i> = 65)	49 (75.4%)	16 (24.6%)	51 (78.5%)	14 (21.5%)	
Walking * (<i>n</i> = 52)	45 (86.5%)	7 (13.5%)	37 (71.2%)	15 (28.8%)	
Chi-squared	2.3 (<i>p</i> = 0.131)		0.8 (<i>p</i> = 0.363)		

Table 3. Numbers and proportions of participants who showed positive and negative responses in heart rate variability indices during walking in and viewing forests.

* The results for walking in forest and city areas were presented in our previous report [18].

The pulse rate after the viewing differed significantly between the forest and city areas (forest: 72.4 ± 1.1 bpm; city: 78.2 ± 1.3 bpm; p < 0.05). There was a significant decrease in pulse rate between the measurements before and after viewing the forest (before: 74.2 ± 1.2 bpm; after: 72.4 ± 1.1 bpm; p < 0.05) but not between before and after viewing city areas (before: 78.3 ± 1.3 bpm; after: 78.2 ± 1.3 bpm; p > 0.05).

There were no significant differences between the blood pressure measurements made after viewing the forest and city areas for either SBP (forest: $96.3 \pm 1.3 \text{ mmHg}$; city: $96.8 \pm 1.2 \text{ mmHg}$; p > 0.05) or DBP (forest: $54.9 \pm 1.1 \text{ mmHg}$; city: $55.5 \pm 1.0 \text{ mmHg}$; p > 0.05). However, there were significant increases between before and after viewing forests for SBP (before: $95.2 \pm 1.3 \text{ mmHg}$; after: $96.3 \pm 1.3 \text{ mmHg}$; p < 0.05) and DBP (before: $54.1 \pm 1.0 \text{ mmHg}$; after: $54.9 \pm 1.1 \text{ mmHg}$; p < 0.05) and DBP (before: $54.1 \pm 1.0 \text{ mmHg}$; after: $54.9 \pm 1.1 \text{ mmHg}$; p < 0.05), although not for before and after viewing city areas for SBP (before: $96.5 \pm 1.2 \text{ mmHg}$; after: $96.8 \pm 1.2 \text{ mmHg}$; p > 0.05) or DBP (before: $54.8 \pm 0.9 \text{ mmHg}$; after: $55.5 \pm 1.0 \text{ mmHg}$; p > 0.05).

Significant differences between the forest and city experiments were observed for all the psychological measures. Figure 5 shows the results for the modified semantic differential method. The subjective evaluations indicated that the participants felt significantly more "comfortable", "relaxed", and "natural" when viewing forests than when viewing city areas (all p < 0.01).



Figure 5. Subjective feelings after viewing forest and city areas, assessed using the modified semantic differential method. Data are shown as means \pm standard deviation (n = 65). ** p < 0.01, Wilcoxon signed-rank test (one-sided).

Significant differences between the forest and city viewings were observed for all the POMS subscales and for the total mood disturbance score (Figure 6). The subscale scores for the forest vs. the city areas were as follows: tension and anxiety subscale, 0.8 ± 0.2 vs. 2.5 ± 0.3 ; depression and dejection, 0.4 ± 0.1 vs. 0.7 ± 0.2 ; anger and hostility 0.1 ± 0.0 vs. 0.6 ± 0.2 ; fatigue, 1.8 ± 0.3 vs. 4.0 ± 0.4 ; and confusion, 4.0 ± 0.1 vs. 4.6 ± 0.2 . These negative mood state scores were all significantly lower after viewing in the forest than after viewing in the city (all p < 0.01, except for depression and dejection, p < 0.05). In contrast, the vigor subscale score after viewing the forest was 2.2 ± 0.3 , which was significantly higher than 0.6 ± 0.2 after viewing the city area (p < 0.01). The total mood disturbance score was significantly lower after viewing the forest area than after viewing the city area (forest: 4.8 ± 0.6 ; city: 11.9 ± 1.1 ; p < 0.01).



Figure 6. The participants' subjective feelings as measured by the six subscales and the total mood disturbance (TMD) score of the Profile of Mood States questionnaire after viewing forest and city areas. Data are shown as means \pm standard error (n = 65). ** p < 0.01, * p < 0.05, Wilcoxon signed-rank test (one-sided). T–A, tension and anxiety; D, depression and dejection; A–H, anger and hostility; F, fatigue; C, confusion; V, vigor.

Finally, the state anxiety score of the STAI was 34.8 ± 7.1 after viewing the forest area, which was significantly lower than 46.9 ± 7.5 after viewing the city area (p < 0.01; Figure 7).



Figure 7. The participants' levels of state anxiety after viewing forest and city areas, as measured by the state anxiety score of the State–Trait Anxiety Inventory questionnaire. Data are expressed as means \pm standard deviation (n = 65). ** p < 0.01, Wilcoxon signed-rank test (one-sided).

4. Discussion

This study assessed the physiological and psychological effects on young women viewing forest and city landscapes. Compared with viewing city areas, viewing forest landscapes resulted in significant increases in the participants' parasympathetic nervous activity while reducing their sympathetic nervous activity and heart rate. These findings were consistent with those of previous studies that investigated physiological responses to a forest environment in men [8,10,12–17,27,30]. The increase in parasympathetic nervous activity and suppression of sympathetic nervous activity suggested that viewing forest landscapes induced physiological relaxation.

The results were compared with those of a previous study in which the participants walked in a forest environment. The increase in parasympathetic nervous activity was observed with both walking in and viewing forests, but the proportion of participants who showed positive physiological responses was higher for walking in forests (n = 52, 86.5%) than for viewing forest landscapes (n = 65, 75.4%), although the difference was not statistically significant. In previous studies using larger samples of young men, there was a significant difference in numbers showing positive responses between walking in forests (n = 485, 65.2%) [46] and viewing forests (n = 625, 79.2%) [47]. This suggested that, for young men, viewing forest landscape could provide greater contentment than walking in a forest. This was opposite to the trend seen in the present study for women. However, the number of female participants in the two studies was small; this should be re-examined after accumulating further data for women.

There were no significant differences between viewing the forest and city environments in the changes in the participants' blood pressure. The mean SBP values were 95.2 ± 1.3 mmHg before viewing the forest area and 96.5 ± 1.2 mmHg before viewing the city area; and DBP values were 54.1 ± 1.0 mmHg and 54.8 ± 0.9 mmHg, respectively. Blood pressure in the range 120-129/80-85 mmHg is widely regarded as normal, with <120/80 mmHg often cited as the optimal blood pressure [48], although this remains controversial. At present, hypotension has not been clearly defined. The mean blood pressures of the participants in this study seemed to be very low, which meant the participants may have benefited from an increase in blood pressure closer to an appropriate level, as was observed after viewing forest landscapes but not after viewing city areas, demonstrating that these effects were specific to the forest environment. This was consistent with the finding of a previous study, which reported that participants with initially high blood pressure showed an increase [49]. These findings suggest that a forest environment can be used to help achieve an appropriate blood pressure. They also suggest that it is necessary to evaluate the health-related effects of forests according to the characteristics of the individual participants.

The psychological evaluations were generally in accordance with the physiological responses. Scores for the comfortable, relaxed, and natural parameters, as well as the vigor subscale of the POMS, were significantly higher after viewing a forest landscape than after viewing a city area, whereas the scores for the subscales for negative feelings, including tension–anxiety, depression–dejection, anger–hostility, fatigue, and confusion, were significantly lower, as was the total mood disturbance score and the STAI anxiety dimension score. These results, which demonstrate the psychological benefits of viewing a forest, are to some extent consistent with previous findings of the effects on men of viewing forest scenery or walking in forests [12,14,50–52].

Differences in the resulting physiological responses between forest and city environments may be influenced by various physical factors, such as: temperature, humidity, atmospheric pressure, and wind speed, as well as by differences in stimuli affecting the five senses. Park et al. [51] reported significant differences in environmental variables such as air temperature, relative humidity, radiant heat, and two indices of thermal comfort (predicted mean vote (PMV) and predicted percentage dissatisfied (PPD)) between forest and city environments during the summer in Japan. The findings of this study indicate that forests have significantly lower temperatures, radiant heat, PMV and PPD, and higher humidity compared to city areas. These differences in environmental variables and thermal comfort were significantly related to the psychological responses of participants, and suggest that these factors contribute to why people feel more comfortable in forests versus city areas [51]. However, studies focusing on the influence of environmental factors on human physiological responses are lacking, and in the future, an approach from this point of view is necessary.

Most people live in an urban, artificial environment [53,54] and are constantly exposed to stressors, and urban living is associated with the increased risk of health problems and higher mortality rates [55–58]. The proper management and prevention of stress is considered to be important for health. The physical and mental benefits resulting from time in forests could therefore be clinically significant, and we believe that forests can provide effective and beneficial opportunities for stress management and health promotion in modern life. Further studies are needed to study the factors related to forests that bring about these effects and the underlying physiological mechanisms, as well as to establish how the forest environment can be used to optimize physiological benefits.

The results of this study provide evidence that viewing forest landscapes, which is a form of forest therapy, induces physiological and psychological relaxation in young women. However, the study had limitations. First, the participants were limited to healthy female university students in their 20s. To generalize the findings, further studies are needed that include other demographic groups, including participants of different ages. Second, the physiological indices used only measured autonomic nervous activity. For a more complete picture, a comprehensive examination using multiple indices, such as brain and endocrine activity, is necessary. Third, this study was conducted within representative forests of each region to validate the physiological and psychological effects of viewing forest landscapes. Because experiments were conducted at six different sites, differences pertaining to region might have affected the results. Therefore, future examination of the effects resulting from variable forest characteristics are needed. These limitations should be considered in future research.

5. Conclusions

This study revealed the following noteworthy findings regarding the effects of viewing forests on young women when compared with viewing city areas: higher parasympathetic nervous activity; lower sympathetic nervous activity; lower heart rate; feeling more "comfortable", "relaxed", and "natural", as assessed by the modified semantic differential method; improved mood state, as assessed by the POMS; and lower anxiety levels, as assessed by the STAI. In conclusion, viewing forests induced physiological and psychological relaxation in healthy young women.

Author Contributions: Conceptualization, Y.M.; methodology, C.S., H.I., T.K. and Y.M.; formal analysis, C.S. and H.I.; investigation, C.S., H.I., T.K. and Y.M.; data curation, C.S., H.I., T.K. and Y.M.; writing—original draft preparation, C.S.; writing—review and editing, Y.M.; visualization, C.S.; supervision, Y.M.; project administration, T.K. and Y.M. All authors have read and approved the final version submitted for publication.

Funding: This research received no external funding.

Acknowledgments: We appreciate Yuko Tsunetsugu of the University of Tokyo for support during the data collection phase of this study.

Conflicts of Interest: The authors declare no conflict of interest.

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