Peer-reviewed version available at Forests 2019, 10, 827; doi:10.3390/f10100827

Article

The Effect of Recreation in a Snow-Covered Forest Environment on the Psychological Relaxation of Young Females

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Abstract: Forest recreation can be successfully conducted for the purpose of psychological relaxation, as has been proven in previous scientific studies. During the winter in many countries, when snow cover occurs frequently, forest recreation (walking, relaxation, photography, etc.) is common. Nevertheless, whether forest therapy conducted in a forest environment with a snow cover will also have a positive effect on psychological indicators remains unknown. Furthermore, male subjects frequently participate in forest therapy experiments, whereas females are rarely involved. Thus, in this study, the effectuality of forest recreation during winter and with snow cover was tested on 32 young females. For these reasons, the experiment involved 15-minute periods of relaxation in a forest environment or in an urban environment, in addition to a pre-test under indoor conditions. Four psychological questionnaires (POMS, PANAS, ROS, SVS) were administered to participants before and after interventions. Results showed that participants' levels of negative mood, as measured by different aspects of the POMS questionnaire (tension-anxiety, anger-hostility, depression-dejection, confusion, fatigue), decreased after exposure to the forest environment. In contrast, both tension-anxiety and anger-hostility increased in the urban environment. The indicator of negative affect from the PANAS questionnaire also increased after exposure to the urban environment, whereas the indicator of positive affect based on PANAS was higher in the forest environment than in the urban environment. Restorativeness and subjective vitality exhibited higher values after exposure to the forest environment in comparison to those from the control and pre-test. The changes in these indicators demonstrates that forest recreation in the snow during winter can significantly increase psychological relaxation in young females, as well as showing that recreation can be successfully conducted under these winter conditions.

Keywords: deciduous forest; female; forest bathing; forest therapy; Positive and Negative Affect Schedule; Profile of Mood States; Restorative Outcome Scale; restoration; Shinrin-Yoku; snow covered forest; Subjective Vitality Scale; winter.

1. Introduction

Forest recreation is an activity in which one engages for pleasure, and it is done without the confines of buildings, in a natural forest environment [1]. One specific form of this activity is forest recreation for the purpose of health improvement, mainly called forest therapy (or forest bathing, or

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Shinrin-yoku). The importance of forest recreation for health improvement has increased in recent years, as manifested by, inter alia, an increase in the number of scientific publications regarding this issue (based on Google Scholar search data). This popularity is not without base; many of these scientific papers report various positive influences of forest recreation interventions on humans with stress symptoms, both psychological and physiological [2-10]. Many positive outcomes have been reported in both males and females, including lowered negative and heightened positive mood states [11], lowered pulse rate and blood pressure [12], reduced rates of hormones involved in stress [13], increased immunological activity, and increased levels of cells responsible for cancer resistance [14]. This beneficial impact on health has been observed in Scandinavian and Asian countries, and various strategies, including forest therapy roads [15] and the forest garden Nacadia® [16], have been introduced to facilitate using the forest and nature for health recreation purposes. Knowledge concerning the management of forest environments to best achieve the purpose of forest recreation, and knowledge regarding how and when to organise forest recreation, is crucial for interested subjects (e.g. forest owners, foresters, and therapists).

Previous research has confirmed that forest recreation may also be successfully conducted during the winter and still exhibit beneficial effects on mental health. In a previous study of ours, psychological relaxation was observed in male and female participants; however, the study was conducted during a period without snow cover, and any additional effects of snow cover have not been examined before [17]. Participants in preference tests positively evaluated winter landscapes of forests with snow, but the potential of this environment to induce psychological relaxation has not been determined [18]. Thus, the effectuality of forest recreation on psychological relaxation was tested in the current study. Snow in a forest may influence visual properties of the landscape: the ground is covered, plants growing on the forest floor are not visible, the branches of standing trees are covered, and the dominant colour of scenery is changed from green and brown to white. Furthermore, a layer of snow can affect the process of visual stimulation. In other studies, different indices of greens induced different effects on relaxation, with lower amounts of observed greens resulting in lower levels of relaxation in participants [19]. Thus, hypothetically, a forest covered by snow might not have the same restorative effect because greens are hidden. A lack of relaxing effect of the forest environment on respondents may therefore be expected if the forest is snow-covered. Nevertheless, standing trees continue to fill the forest environment, regardless of snow, and this could still stimulate relaxation. One of the aims of this study was therefore to test the influence of a forest with snow cover on psychological relaxation. Effects were tested with the participation of young females – a group which has not frequently been represented in research regarding forest recreation. This study thus provided a good opportunity to examine the influence of the forest environment on psychological relaxation in this under-represented group.

Overall, the purpose of this work was to test the hypothesis that short periods of forest recreation could induce the psychological relaxation of participants in a forest environment with snow cover. If this hypothesis is confirmed, this would suggest that forest recreation could also be successfully conducted under snowy winter conditions. To examine the hypothesis, an experiment was designed with an urban environment as a control and a snow-covered forest environment as an experimental group.

2. Materials and Methods

2.1. Participants

A group of 34 female students from the University of Warmia and Mazury in Olsztyn participated in this study. Females were selected over males because it is common in Poland that in the winter, females spend their free time, as well as much of their time spent with children, on walks. For this reason, we suggested that this form of activity related to staying in forest areas should be examined by this experimental study involving females. Students were recruited from one study course at the University (a non-forestry course) and participation in the study was voluntary. Participants reporting menstruation (two persons) were not involved in the research. A female

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researcher (A.O.) performed this exclusion, asking participants this question in a discreet, kind, and private way. A female researcher (A.O.) asked in a discreet, kind, and private way if they wished to take part in the study. These two women did not want to participate in the research voluntarily. Qualified participants (32 females; mean age = 20.97 years, S.D. = 0.63) were randomly assigned to one of two groups (16 persons in each): experimental group (group 1) and control group (group 2). Before the experiment, participants from each group were informed that they would be asked to contribute to a research study of 'forest recreation' and informed consent was obtained. The purpose of the study was explained thoroughly after the experiment, because the authors of the research wished to omit the effect of suggestion on participants. All procedures performed in this study were in accordance with the ethical standards of the Polish Committee of Ethics in Science and with the 1964 Helsinki Declaration and its later amendments.

2.2. Study sites

Before the experiment, all participants completed research questionnaires under indoor conditions, in one of the classrooms at the University in Olsztyn city (north-eastern Poland). This place was also a gathering point. Afterwards, the experiment was conducted in a forest environment at the forest point (group 1) and in an urban environment at the urban point (group 2). The participants reached each of these two areas by walking. The locations of the indoor, forest, and urban environments are shown in Figure 1. The distance from the gathering point to either the urban point or the forest point was approximately 1 km, which required 20 minutes of walking for participants in each group. The roads to both points were constantly flat, without any hills or other hindrances.

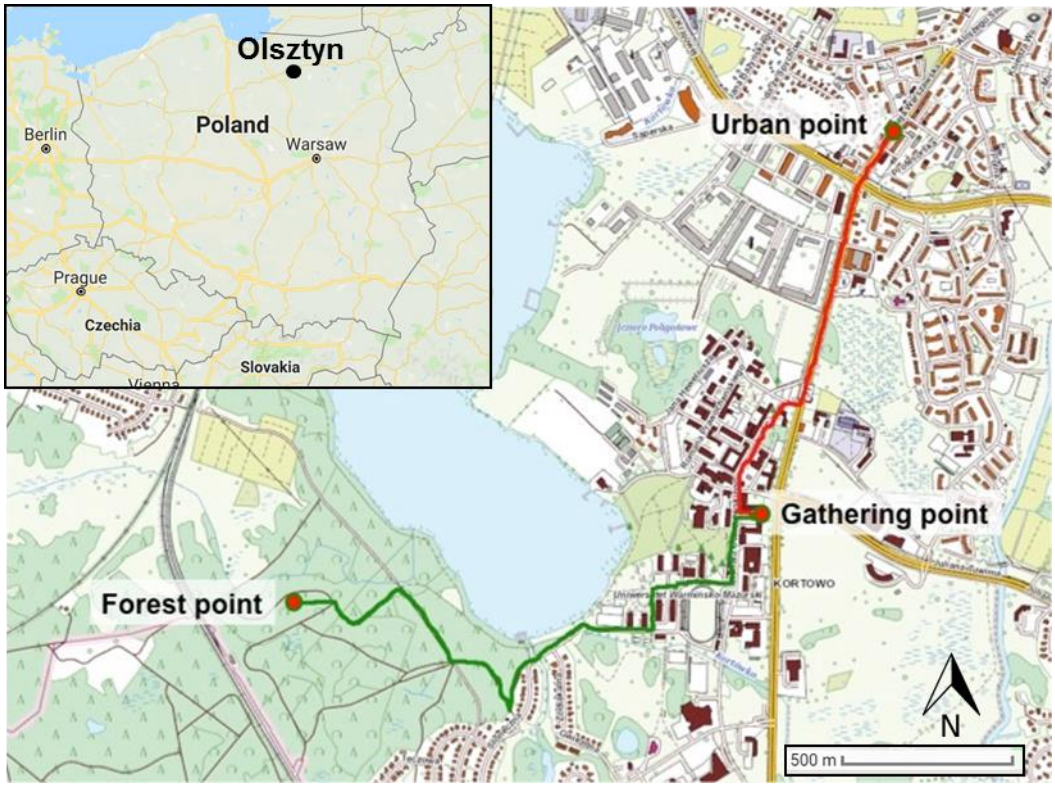

Figure 1. Map of experimental locations.

The indoor environment was quite warm (21.5°C), exhibited no noise from outside, and was also without any potted plants. The forest environment was located a 20-min walk from the gathering point. A deciduous, broadleaved urban forest was selected, consisting of European beech (*Fagus sylvatica* L.), Pedunculate oak (*Quercus robur* L.), Common aspen (*Populus tremula* L.), and Black alder (*Alnus glutinosa* [L.] Gaertn.). Larger shrubs or dead wood did not interrupt the view in

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this area, although in some places there was Norway spruce (*Picea abies* [L.] H. Karst) in the shrub layer. The ground was mainly covered by snow during the experiment, and small amounts of snow were also visible on trunks. The urban environment (urban point) was also a 20-min walk from the gathering point, near the centre of Olsztyn. A particular place was selected without visible tree trunks and crowns, and without any greens. In the city environment, the snow dissolved and was not visible during the experiment. The forest environment and urban environment used in the experiment are shown in Figure 2.

Figure 2. Photos showing the urban (A) and forest (B) views used for the viewing session. Photos of the research group during viewing sessions in the urban environment (C) and forest environment (D).

During the field experiment, the level of noise was measured with the application 'Sound level analyser (SLA)' using an iPhone 6. This method of noise measure has been scientifically tested and shown to give excellent results [20]. The mean sound level (±S.D.) in the urban environment was 66.61 ± 5.38 dB, whereas the mean sound level in the forest environment was 37.18 ± 5.23 dB.

Meteorological data was not recorded in the forest and urban environments; however, information regarding temperature, humidity, and wind speed was available from the nearest area recorded by a meteorological station. On the day of experiment, meteorological conditions were noted from the meteorological station in Olsztyn-Mazury (location: 53°28'50.0"N, 20°56'10.9"E). The temperature was -0.5°C, humidity was 100%, cloudiness was 100%, atmospheric pressure was 995 hPa, and the speed of the west wind was 9 km/h. No snow precipitation was observed, but snow cover occurred on the ground and dissolved during the day in the city.

2.3. Psychological measurements

In the current study, four psychological questionnaires were used to measure the reactions of participants to the investigated environments. The Profile of Mood States (POMS) is a valid and reliable measure of negative mood states, such as psychological distress, as well as positive mood

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states, such as vigour [21]. This tool has been used previously to measure participants' responses to forest environments (e.g. Lee et al. [22]). POMS measures six different mood states: tension-anxiety, depression-dejection, anger-hostility, vigour, fatigue, and confusion. Occasionally, a short version of this questionnaire is used. In this research, the regular Polish version with 65 items was applied [23]. The Positive and Negative Affect Schedule (PANAS) is another reliable and valid instrument for measuring negative (10 items) and positive (10 items) affects [24]. Its original version is in English [25], but the Polish edition was applied in the current study [26]. PANAS has also previously been used for forest environment assessment (e.g. Takayama et al. [27]). The Restorative Outcome Scale (ROS), which measures the restorative phenomenon, is a valid and reliable scale [28, 29] that has been used to measure restorativeness induced by the forest environment [27]. A Polish adaptation with six items was successfully developed and used in this study [17]. The Subjective Vitality Scale (SVS), which measures a participant's level of vitality, is another scale that has been shown to be reliable and valid [30]. The Polish adaptation, consisting of four items [17], was used in the current work.

In all four questionnaires that were used, the time frame 'during present moment' was applied, which allowed the measurement of participant reactions to different environments over a relatively short time. All scales used in this study involved the Likert scale, with the response to each item noted by participants as one of a continuous series of numbers. To assess items in the POMS scale, a 0 to 4 Likert scale was used. For PANAS, a 1 to 5 scale was used, and for ROS and SVS, a 1 to 7 scale was used.

The raw data from each questionnaire were applied in all further calculations. The internal consistencies and numbers of items for each scale and subscale are included in Table 1. Most of the scales used exhibited good internal consistency, with the exception of the POMS subscale 'confusion', where internal consistency was lower (but still acceptable).

Table 1. Verification of internal consistency and number of items for each (sub)scale.

Scales and Subscales	Number of Items	Crobach's Alpha
POMS		
Tension-Anxiety	9	0.854
Depression-Dejection	15	0.891
Anger-Hostility	12	0.867
Vigour	8	0.829
Fatigue	7	0.883
Confusion	7	0.794
PANAS		
Negative	10	0.881
Positive	10	0.832
ROS	6	0.921
SVS	4	0.807

POMS: Profile of Mood States; PANAS: Positive and Negative Affect Schedule; ROS: Restorative Outcome Scale; SVS: Subjective Vitality Scale; n = 32.

2.4. Procedure

Meeting with participants was planned for 6th March 2018, at 9:00. At this time, while at the gathering point, participants were randomly divided into one of two groups (experimental and control). Each group then completed the questionnaires at the gathering point, a classroom at the University. Afterwards, participants were asked to walk to the urban point or to the forest point, with researchers to guide this walk (two researchers per group). At the destination point, participants were asked to stand in a line, 1 meter apart from one another. Each participant was placed with a proper view throughout the urban or forest environment. The viewing property for each participant was the same. While standing as described, participants were asked to relax and observe the view for 15 minutes. Talking was not allowed. Relaxation during standing was applied

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because during the winter in Poland, it is too cold to relax in a seated position. After 15 minutes of relaxation, participants were asked to fill out the questionnaires once again. The procedure followed for the experiment is also described in Table 2.

Table 2. Procedure followed during the experiment.

Date	Time	Activity	
2018/03/06 (Thu.)	09:00	Meeting in the gathering point and orientation	
	09:15~09:30	Random division into two groups	
		Group 1 (control)	**Group 2 (forest)**
	09:30~09:45	Filling in questionnaires (pretest)	Filling in questionnaires (pretest)
	09:45~10:05	Walk to the city	Walk to the forest
	10:05~10:10	Standing in a row in urban point	Standing in a row in forest point
	10:10~10:25	Standing and viewing at the urban environment	Standing and viewing at the forest environment
	10:25~10:40	Filling in questionnaires (posttest)	Filling in questionnaires (posttest)
	10:40~11:05	Return to the campus	Return to the campus
	11:05	End of the experiment	

2.5. Data analysis

Means and S.D. values were calculated in Excel (Microsoft, USA). A parametric, mixed-design ANOVA was conducted to analyse the interactions and main effects of the POMS, PANAS, ROS, and SVS scores as pre–post indicators of the psychological restorative effect of exposure to the urban versus forest environment. After ANOVA, *post-hoc* comparisons using the LSD test were conducted, a method that has also been used in previous studies [31, 32]. For each analysis, effect size η^2 was calculated, with effects set as: small = 0.10; medium = 0.30; and large = 0.50. All statistical analyses were conducted using SPSS Statistics Version 24 (IBM, USA).

3. Results

3.1. POMS

Two types of psychological restorative effects were considered: the effect of different conditions (urban vs. forest environment) and effect of exposure to a different environment (pre vs. post). These two factors were analysed using a mixed model ANOVA to compare the changes in the POMS scores and to analyse the interactions between factors (Table 3). For four of the six POMS indicators (tension-anxiety, depression-dejection, anger-hostility, confusion), interactions between conditions and time were found. Regarding main effects, conditions had a significant effect on anger-hostility and time had a highly significant effect on fatigue.

The results of the LSD comparisons showed that tension-anxiety and anger-hostility were significantly increased after participants in the urban group were exposed to the urban environment (urban: pre vs. post; Table 4). In contrast, tension-anxiety, depression-dejection, anger-hostility, fatigue, and confusion significantly decreased in the forest group after exposure to the forest environment (forest: pre vs. post). All POMS indicators were similar in both the urban and forest groups before the intervention (pre: urban vs. forest). After the intervention, all POMS indicators

(except vigour) showed significantly lower values in the forest group than in the urban group (post: urban vs. forest).

Table 3. Results for mixed-model ANOVAs investigating POMS scores.

POMS	Main Effect								Interaction			
	Conditions: Urban vs. Forest				Time: Pre vs. Post				Conditions × Time			
	F	p		η2	F	p		η2	F	p		η2
Tension-Anxiety	3.680	0.065	-	0.109	0.025	0.875	-	0.001	18.056	0.000	***	0.376
Depression-Dejection	0.881	0.355	-	0.029	0.386	0.539	-	0.013	7.315	0.011	*	0.196
Anger-Hostility	4.500	0.042	*	0.130	1.185	0.285	-	0.038	16.198	0.000	***	0.351
Vigour	0.023	0.879	-	0.001	1.572	0.220	-	0.050	1.775	0.193	-	0.056
Fatigue	2.587	0.118	-	0.079	9.827	0.004	**	0.247	3.263	0.081	-	0.098
Confusion	0.718	0.404	-	0.023	0.273	0.605	-	0.009	9.172	0.005	**	0.234

***: p<0.001, **: p < 0.01, *p < 0.05, -: not significant, mixed-design (split-plot) ANOVA; POMS: Profile of Mood States; n = 32.

Table 4. Results of multiple comparisons of POMS scores for urban versus forest environments, as well as before and after environmental exposure.

	Urban						Forest					
	Pre		Post				Pre		Post			
	Average	S.D.	Average	S.D.	p		Average	S.D.	Average	S.D.	p	
Tension-Anxiety	0.85	0.36	1.33	0.73	0.007	**	0.99	0.81	0.47	0.46	0.004	**
Depression-Dejection	0.71	0.56	0.95	0.55	0.151	-	0.85	0.72	0.48	0.54	0.025	*
Anger-Hostility	0.85	0.48	1.38	0.76	0.001	**	0.88	0.67	0.57	0.39	0.047	*
Vigour	1.93	0.78	1.91	0.71	0.956	-	1.75	0.72	2.15	0.73	0.077	-
Fatigue	1.81	0.88	1.59	0.84	0.355	-	1.65	1.13	0.82	0.91	0.002	**
Confusion	1.17	0.63	1.47	0.87	0.087	-	1.33	0.65	0.91	0.77	0.018	*
	Pre						Post					
	Urban		Forest				Urban		Forest			
	Average	S.D.	Average	S.D.	p		Average	S.D.	Average	S.D.	p	
Tension-Anxiety	0.85	0.36	0.99	0.81	0.522	-	1.33	0.73	0.47	0.46	0.000	***
Depression-Dejection	0.71	0.56	0.85	0.72	0.505	-	0.95	0.55	0.48	0.54	0.029	*
Anger-Hostility	0.85	0.48	0.88	0.67	0.902	-	1.38	0.76	0.57	0.39	0.000	***
Vigour	1.93	0.78	1.75	0.72	0.500	-	1.91	0.71	2.15	0.73	0.360	-
Fatigue	1.81	0.88	1.65	1.13	0.633	-	1.59	0.84	0.82	0.91	0.026	*
Confusion	1.17	0.63	1.33	0.65	0.541	-	1.47	0.87	0.91	0.77	0.039	*

***: p<0.001, **: p < 0.01, *p < 0.05, -: not significant, ANOVA-LSD test; n = 32, POMS: Profile of Mood States.

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3.2. PANAS

A mixed-model ANOVA of the PANAS data was conducted, with conditions differences and time differences used as two factors (Table 5). The results showed that an interaction occurred in the case of 'PANAS negative affect'. Regarding main effects, no statistically significant differences were found for conditions or time. The results of the multiple comparisons tests (Table 6) showed that in the case of the urban group, there was a marginal ($p = 0.044$) difference in negative affect between pre- and post-test (negative affect was slightly higher after exposure to the urban environment). When comparing the urban and forest groups after the intervention (urban: pre vs. post), a marginal effect on 'PANAS positive' was observed ($p = 0.033$), with positive affect slightly increased in the forest environment; however, this is likely an effect of non-conservative comparison.

Table 5. Results for mixed-model ANOVAs investigating PANAS scores.

PANAS	Main Effect								Interaction			
	Conditions: Urban vs. Forest				Time: Pre vs. Post				Conditions × Time			
	F	p		η2	F	p		η2	F	p		η2
Negative	0.461	0.503	-	0.015	0.541	0.468	-	0.018	4.999	0.033	*	0.143
Positive	1.624	0.212	-	0.051	0.696	0.411	-	0.023	3.371	0.076	-	0.101

***: p<0.001, **: p < 0.01, *p < 0.05, -: not significant, mixed-model ANOVA; n = 32, PANAS: Positive and Negative Affect Schedule States.

Table 6. Results of multiple comparisons of PANAS scores for urban versus forest environments, as well as before and after environmental exposure.

	Urban						Forest					
	Pre		Post				Pre		Post			
	Average	S.D.	Average	S.D.	p		Average	S.D.	Average	S.D.	p	
PANAS Negative	1.43	0.42	1.79	0.64	0.044	*	1.59	0.72	1.41	0.51	0.297	-
PANAS Positive	2.73	0.69	2.56	0.74	0.484	-	2.65	0.63	3.08	0.62	0.069	-
	Pre						Post					
	Urban		Forest				Urban		Forest			
	Average	S.D.	Average	S.D.	p		Average	S.D.	Average	S.D.	p	
PANAS Negative	1.43	0.42	1.59	0.72	0.453	-	1.79	0.64	1.41	0.51	0.069	-
PANAS Positive	2.73	0.69	2.65	0.63	0.753	-	2.56	0.74	3.08	0.62	0.033	*

***: p<0.001, **: p < 0.01, *p < 0.05, -: not significant, ANOVA-LSD test; n = 32, PANAS: Positive and Negative Affect Schedule.

3.3. ROS

In the case of the ROS, a mixed-model ANOVA was used to investigate restorativeness of the two environments, with conditions and time as factors. This analysis was similar to those conducted for data from the POMS and PANAS questionnaires (Table 7). An interaction was observed between conditions and time. Regarding main effects, a significant of environment was observed. The results of multiple comparisons LSD tests (Table 8) showed that in the forest group, there was a significant increase in ROS scores after exposure to the forest environment (forest: pre vs. post). Furthermore, in the forest group, values of ROS were higher after exposure to the forest environment than they were in the urban group after exposure to the urban environment (post: urban vs. forest).

Table 7. Results for mixed-model ANOVAs investigating ROS scores.

ROS	Main Effect								Interaction			
	Conditions: Urban vs. Forest				Time: Pre vs. Post				Conditions × Time			
	F	p		η2	F	p		η2	F	p		η2
	12.284	0.001	**	0.291	0.220	0.643	-	0.007	8.885	0.006	**	0.228

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Peer-reviewed version available at Forests 2019, 10, 827; doi:10.3390/f10100827

***: p<0.001. **: p < 0.01. *p < 0.05. -: not significant; mixed-model ANOVA; n = 32;
ROS: Restorative Outcome Scale

Table 8. Results of multiple comparisons of ROS scores for urban versus forest environments, as well as before and after environmental exposure.

	Urban						Forest					
	Pre		Post				Pre		Post			
	Average	S.D.	Average	S.D.	p		Average	S.D.	Average	S.D.	p	
ROS	4.00	1.25	3.30	1.41	0.086	-	4.31	1.19	5.27	0.94	0.021	*
	Pre						Post					
	Urban		Forest				Urban		Forest			
	Average	S.D.	Average	S.D.	p		Average	S.D.	Average	S.D.	p	
ROS	4.00	1.25	4.31	1.19	0.468	-	3.30	1.41	5.27	0.94	0.000	***

***: p<0.001, **: p < 0.01, *p < 0.05, -: not significant, ANOVA-LSD test; n = 32, ROS: Restorative Outcome Scale.

3.4. SVS

A mixed-model ANOVA was conducted to compare changes in SVS scores and to analyse the interaction between factors and main effects, as was done for POMS, PANAS, and ROS data (Table 9). As with ROS data, an interaction was observed between conditions and time for SVS score data. When main effects of the conditions and time differences were analysed, a statistically significant effect of conditions was confirmed, and the time effect was not significant. The results of LSD comparisons (Table 10) showed that in the forest group, SVS scores significantly increased after exposure to the forest environment. Furthermore, after exposure to the forest environment, SVS scores were higher than after exposure to the urban environment.

Table 9. Results for mixed-model ANOVAs investigating SVS scores.

SVS	Main Effect							Interaction			
	Conditions: Urban vs. Forest				Time: Pre vs. Post			Conditions × Time			
	F	p		η2	F	p		η2	F	p		η2
	5.524	0.026	*	0.155	1.103	0.302	-	0.035	4.527	0.042	*	0.131

***: p<0.001. **: p < 0.01. *p < 0.05. -: not significant; mixed-model ANOVA; n = 32; SVS: Subjective Vitality Scale.

Table 10. Results of multiple comparisons of SVS scores for urban versus forest environments, as well as before and after environmental exposure.

	Urban						Forest					
	Pre		Post				Pre		Post			
	Average	S.D.	Average	S.D.	p		Average	S.D.	Average	S.D.	p	
SVS	3.86	1.52	3.55	1.29	0.452	-	4.08	1.23	5.00	1.12	0.032	*
	Pre						Post					
	Urban		Forest				Urban		Forest			
	Average	S.D.	Average	S.D.	p		Average	S.D.	Average	S.D.	p	
SVS	3.86	1.52	4.08	1.23	0.635	-	3.55	1.29	5.00	1.12	0.002	**

***: p < 0.001, **: p < 0.01, *p < 0.05, -: not significant, ANOVA-LSD test; n = 32, SVS: Subjective Vitality Scale.

4. Discussion

4.1. Mood states

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Consistent with previous studies [2, 5, 10, 11, 14, 17, 33, 34], this study confirmed that short periods of forest recreation in a snow-covered forest (in this case: 15 minutes of relaxation in this environment) have a significant effect on mood states of participants. The negative indices of mood states, including tension-anxiety, anger-hostility, depression-dejection, confusion, and fatigue, decreased after exposure to the forest environment. This confirms our hypothesis, that this type of intervention results in a positive outcome. The positive index of mood states (vigour) did not increase after exposure, but neither did it decrease significantly. This is not consistent with a previous study [14] or another study conducted only with females [4]. Lower levels of indicators of negative mood have many positive outcomes, confirming that brief forest recreation during the winter, when snow has occurred, can be successfully conducted for the purpose of stress reduction in females. Females may, however, react differently to the forest environment than do men [17], which indicates the need for further testing of these effects on both sexes.

The effect of lowering negative mood states is useful information for therapists who work with individuals living with high levels of stress, such as a highly stressful work environment. The positive effect of nature therapy on this topic is already known [6-9], but a novel element of this study was the addition of snow cover. As snow occurs in the winter in many countries, the way in which this element affects individuals requires examination. A positive effect of forest recreation was still observed with snow cover in this study, and there are several hypotheses as to why this effect was observed. It is possible that snow in the forest environment does not obstruct the view that is generally visible in this environment. Some authors suggest that some fractal dimensions are responsible for the existence of the effect of visual stimulation on mood states. For example, some kinds of natural fractals might, hypothetically, induce this positive effect [35, 36] and in a snow-covered forest, these fractal dimensions are still perceivable to respondents. This stimulation during forest recreation is crucial, and this reaction of humans is possibly some special effect connected to the biophilia hypothesis [37], which states that people evolved in a natural environment, and hence feel healthy in a natural environment like a forest [38].

4.2. Positive and Negative Affect

Previous studies have indicated that subjects exhibit a significant decrease in negative affect after forest recreation and a significant increase in positive affect [17, 27]. In the current study, an effect on positive affect was observed, as this indicator increased in the forest environment. Negative affect did not decrease in the forest environment after the experiment, however, although it did increase after exposure to the urban environment. These two indicators, positive and negative affect, are important in psychological research, as their usage gives researchers and therapists information concerning the mental state of participants and patients [24].

The interpretation of results regarding negative affect is similar to that of the negative mood states of POMS – any negative symptoms are not necessary, so any decrease in this effect is welcome. In this case, a lowering effect on this indicator was unfortunately not observed. In the urban environment, an increase in negative affect was observed, possibly due to the higher level of noise in that environment [39]. Further research should compare environments with more similar levels of noise. In the case of positive affect, a difference was observed when comparing forest and urban environments. In the forest environment, this indicator had higher values, suggesting that in the forest environment, successful recreation could be conducted with positive effects. Because positive affect increased in the forest environment, this tendency might be explained by the biophilia hypothesis [37, 38].

4.3. Restorative outcome

Our findings are consistent with those of previous studies [17, 27], showing that restorativeness significantly increased after exposure to the forest environment. The phenomenon of restoration in the natural environment has been previously described. This effect is frequently explained by Attention Restoration Theory [40], which states that the mental refreshment of humans, as measured by level of restoration, increases in natural environments. This theory suggests that this mental

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restoration might be a natural tool of the human nervous system, meant to naturally maintain alertness in non-safe environments, such as the forest, as opposed to safe places, such as houses and caves. Increasing thinking capacity in a natural environment could be a natural adaptation to hunting or foraging. Perhaps restoration is a mechanism in humans predisposed to save calories [41], although this hypothesis requires further investigation.

4.4. Subjective vitality

Consistent with previous studies [17, 27], this study's findings suggest that short, 15-min periods of relaxation in a snow-covered forest during winter can have psychological benefits for subjective vitality levels. Vitality is a concept that can be measured objectively using physiological reactions or subjectively using psychological reactions [30]. In the case of the current work, subjective methods were used. The importance of factors that increase vitality is great, as a high level of vitality is connected with better accomplishments of subjects [42], and anything that increases human performance is important for society. Based on the current study, snow cover should not be a barrier to increasing vitality during recreational stays or walks in the forest. Thus, successful forest recreation in snow-covered forests may be a good activity for people interested in increasing their personal effectiveness by stimulating an increase in their own vitality.

5. Conclusions

This study examined the effect of a snow-covered forest environment during winter on young females' psychological relaxation, with the urban environment as a control. The results showed that participants' levels of negative mood indicators (tension-anxiety, anger-hostility, depression-dejection, confusion, fatigue) decreased after exposure to a forest environment with snow cover. Furthermore, some of these indicators increased in the urban environment (tension-anxiety, anger-hostility). An indicator of negative affect increased after exposure to the urban environment, whereas an indicator of positive affect was higher in the forest environment than in the urban environment. Restorativeness and subjective vitality exhibited higher values after exposure to the forest environment in comparison to both the control and pre-test. This indicates that forest recreation, during winter and with snow cover, continues to have a significant influence on the psychological relaxation of young females. These findings are import for forest therapy practitioners, as well as for individuals who want to obtain the positive effects of forest recreation. Such recreation could be successfully conducted during winter in a forest with snow cover, and there should still be a positive effect on psychological parameters.

This study has several limitations. First, in this study, the psychological effect of relaxation while simply standing in the forest environment was measured. These effects should be measured during other activities in a forest with snow cover. In fact, some reports indicate that being involved in certain activities may harm the positive effects of nature relaxation [43]; it is therefore worth examining why some activities induce relaxation and some do not. Second, only young females were involved in this study. Future studies should investigate how recreation in a snow-covered forest influences younger and older females, as well as how this activity influences males of different ages. Third, only psychological measurements were used in this case; the physiological effects of this activity were not considered. Fourth, different respondents went to each research site. The respondents at each research point can therefore not be compared directly, meaning that the differences among individuals in the two respondent groups could have caused the significant differences observed between the urban and forest environments. In future studies, this occurrence could be eliminated by exposing respondents from the two groups to both environments in reverse order. Fifth, as respondents walked to each point on foot, they would have viewed surrounding scenery before getting to either experimental point. It is therefore possible that the time period during which respondents were exposed to the stimulus was not exactly 15 minutes in length. It is worth mentioning, however, that the walks to the two analysed environments were conducted through either the urban environment or the forest (Figure 1), so only one environment was able to influence each group. Sixthly, in the planned experiments, a carryover effect could possibly have

occurred, as the positive effect of forest recreation on health can persist for a longer period of time in subjects, and the tests had to be carried out as soon as possible (due to periodic snowfall only). Conducting a crossover study could therefore be burdened with a carryover effect and the use of this research system was abandoned. Thus, a parallel study was carried out in which the carryover effect was avoided. In addition, such a study can be carried out in a relatively short time. This study did not compare the effects of forest recreation to the effects of conventional recreation (active control), which would not take place under forest conditions. This is a limitation of the current research and should be investigated in future work. Seventh, In this study, it was assumed that snow was present in the forest landscape if 90% of the ground's surface was covered by it. It is not known, however, what amount of snow affects the psychological reactions of subjects. This requires future research. Eight, in the described research, it was tested whether the forest environment with the existing snow cover affects the psychological relaxation of the subjects. Indeed, it has been shown that in a forest environment with a snow cover causes a psychological relaxation effect. The aim of the study was not to compare the forest with the snow cover with the forest environment without snow cover, however in future studies, this type of comparison could be done (including the same participants) to find out whether the snow cover in the forest environment affects another way on the subjects than the forest environment without snow cover. Ninth, it will also be important, however, to examine how different seasons, during which forest stands in the temperate climate zone change, can affect the intensity of the psychological relaxation of subjects. Research regarding this should be carried out in the future. Tenthly, this paper focuses on examining the impact of a forest environment on the psychological relaxation of young adult students. In the future, it is worth investigating how forest recreation, also conducted in winter, can affect people of different ages and from other demographic groups (e.g. older people, working, etc.). Eleventh, this study did not include men, so future studies concerning recreation in a forest environment with snow cover present should include this group. Twelfth, it is also possible that spending too much time in the forest may have a negative effect, depending on the temperature. For this reason, encouraging people to move around to stay warm may be less stressful. The effect of ambient temperature should be examined in future research. All these limitations could likely be overcome in further experiments in the area of forest recreation research. Future studies should also test the effect of forest recreation on males and on different age groups (e.g. on elderly participants).

Author Contributions: E.B. conceived and designed the experiment, conducted data analysis, and prepared the first version of the manuscript. A.Ł. consulted on the design of the experiment, and reviewed and edited the manuscript. A.O. and S.B. were responsible for the implementation of field research and minor editorial comments on the text. L.B. contributed to publication by editing the content and English of the manuscript. N.T. contributed to publication by reviewing and editing the manuscript.

Funding: The publication process was supported by funds of the Poznań University of Life Sciences. The publication id co-finansed within the framework of Ministry of Science and Higher Education programme as "Regional Initiative Excellence" in years 2019-2022, project number 005/RID/2018/19.

Acknowledgments: The authors of this article thank Dominik Dobrzyński for technical assistance during the research.

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

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