



# the **TREE LINE**

the official monthly  
publication of the

**BONSAI SOCIETY of PORTLAND**

## Upcoming Events

Summer  
2018

August 11 12-4pm **BSOP Summer Picnic**, Milwaukie Center Picnic Area

September 9 10-2 **Mentorship 102A**, Milwaukie Center

September 14-16 **Northwest Bonsai Rendezvous** Milwaukie Center

September 30 10-2 **Mentorship 102B**, Milwaukie Center

September 25 6-9pm **BSOP monthly meeting**, Milwaukie Center

## Words From Your President

Some of you and maybe most of you remember the Sonny and Cher song; “The Beat Goes On.” Well I say we get together and do our own version and call it; “The Heat Goes On.” Enough already! I am sure you too feel the same. I love the heat but when I go into the garden to water I hear the trees squealing out... water, watterrrrr, please, water. That too reminds of the little shop of Horrors...” Feed me Seymour.” I blame the weather service, they are the ones who tell us what it is going to be. Maybe if they said it was going to be 82 degrees it would. Well, enough music, movie and weather trivia and enough hot weather.

Well the big news is of course is that as I am writing this we are exactly 49 days away from opening the doors to our 4 year project that we termed “The Rendezvous.” Can you believe it. With Jan Hettick in the lead we have already exceeded our breakeven point, filled all our workshops and are over 75% filled on the Rodeo workshops. Nearly every exhibit tour is filled also and, and, one of the things I am most pleased about is that the BSOP membership has registered for over 45% of all registrants. That is unprecedented. The percentage is usually about 15%. We have accomplished a lot of firsts on this brand-new convention concept. So, thanks to all of you that have been involved in getting us there and who will be volunteering during the Rendezvous. We could not do it without you!

Last, Mentorship 101 is nearing half full so if you are interested in taking part in this go on line and sign up. The BSOP website is easy to navigate but if you are having problems, feel free to contact me. Your 101 instructor artists will be: Brandon Myren, Joanne Raiton, Steve Wilcox and myself. The trees will be the best they have been thanks to the generosity of Bill and Bob, Knopp allowing the BSOP access to a substantial amount of pre-bonsai trees. Also, we are changing the syllabus to a more exact “need to know” format.

I hope to see you all soon at the August 11 picnic or at the Rendezvous.

As always thank you for your trust. *Lee*

# Programming Report

Wasn't Whack-n-Chat a blast?! I enjoyed watching and experiencing the energy of the room as we worked. Thank you to everybody who brought trees, tools, enthusiasm and constructive feedback to our June 26 meeting. Several kind folks were bold enough to introduce themselves to me and I am delighted to have new names to put to familiar faces.

Up next is the Summer Picnic on August 11 near the Milwaukie Center. Join us in the North Clackamas Park picnic shelter for family fun in a potluck format. President Lee Cheatle will be serving up delicious hamburgers and hot dogs while games, raffles, and tree displays delight us all. Please see the BSOP website and emails for details.

I hope your summer is well, your watering is sufficient, and you're able to find respite from our regional heat and wildfires.

*Reid Parham*, Program Facilitator

## Volunteers (Still) Needed!

The 2018 NW Bonsai Rendezvous is just around the corner! So much hard work has gone on to make this a memorable, informative and FUN event. Thanks to all of you who have stepped forward to volunteer! This is a huge undertaking and I'm proud to say that our membership has really been generous with their volunteer commitments. Thank you!

### **BUT WE'RE NOT THERE YET!**

Approximately 25% of the volunteer slots are still open. Please take a minute and see if there is a volunteer shift that you can sign up for. There are so many benefits that go with volunteering at this Bonsai Convention; free access to the Exhibit, the opportunity to do some shopping at our world-class Marketplace, observing a presentation, etc. We just ask that you try to arrive no more than ½ hour before your shift and depart ½ hour after.

We welcome all members, spouses, friends and adult children! Bonsai expertise is not required. Let your family see why you're so passionate about this club and art form.

Please click on this link:

<https://www.signupgenius.com/go/20f0445ada62ba3fb6-2018>

If there is a green "SIGN UP" icon next to the shift, that means there are openings. Be sure to scroll through all the pages to see what is needed on Saturday and Sunday. Click on the icon, go to the bottom and click on "SUBMIT and SIGNUP"; enter your info and you're set! We'll send out a reminder prior to the event.

Please feel free to contact me with any questions; Patrice Morrow/ Volunteer Coordinator

Volunteer Coordinator  
Tm4170399@aol.com  
503-954-2038

Thank-you, *Patrice*



# BONSAI SOCIETY of PORTLAND

## POT LUCK SUMMER PICNIC

**Saturday, August 11, 2018 - 12:00 AM -4:00 PM**

MILWAUKIE CENTER PICNIC GROUNDS  
5440 SE Kellogg Creek Drive, Milwaukie  
(West of the Building)

BSOP MEMBERS, GUESTS, CHILDREN, AND GRANDCHILDREN WELCOME

**PLEASE RSVP BEFORE 8/8** Click on following link.

[https://docs.google.com/spreadsheets/d/1swWLVhccn-etKHSCMTquXz4KY0ZkDk\\_AOpPfSdqKPZY/edit#gid=0](https://docs.google.com/spreadsheets/d/1swWLVhccn-etKHSCMTquXz4KY0ZkDk_AOpPfSdqKPZY/edit#gid=0)

Or contact Lee Cheadle: [leecheadle@msn.com](mailto:leecheadle@msn.com) 503-312-4921

BURGERS AND DOGS PREPARED BY LEE CHEATLE  
(serving from 12:30 to about 3:00 pm)

DRINKS AND EATING UTENSILS WILL BE PROVIDED  
(alcoholic beverages are not allowed in the park)

SUGGESTED POT LUCK DISHES AS BASED ON YOUR LAST NAME:

A-D SIDE DISHES

E-H CHIPS & DIPS

I-L DESSERTS

M-P SALADS

Q-Z ANY OF THE ABOVE



### **ACTIVITIES:**

- **SWAP MEET - Bring your bonsai related items to trade or sell; trees, tools, pots, books, etc.** (Plan to handle your own transactions. No cashier will be provided, no split to the club.)
- **SHOW & TELL - Bring Your Trees to display and chat about**
- **Having Fun is Mandatory!!! Seriousness Not Allowed!**



Satsuki azalea  
"Hanagasa"  
Ron Yasenchak



Satsuki azalea  
"Yama no Hikari"  
Ron Yasenchak

**July Haiku**  
Lovely blossoms fall  
Suddenly spring is over  
Hear the new leaves call  
*Ron Yasenchak*



Larch and Hawthorn  
Art Of Bonsai In  
Wales in Newport,  
South Wales  
From [bonsai4me.com](http://bonsai4me.com)

## Rendezvous Volunteer Tee Shirts

Counting down to the Rendezvous – only six weeks away. The pressure is on!

Volunteer tee shirts are now available to order. Purchase of these shirts is strictly optional. You do not need a tee shirt to work your volunteer shift. But they are certainly one of a kind. You won't see your neighbors in one... unless you can talk them into joining us.

Delivery of the shirts will be at the Rendezvous, when you check in for your first shift. The shirts are Gildan Heavy Cotton, 90% cotton/10% polyester. The shirts will have the Rendezvous logo in white print on forest green. The back is plain. Men's sizes only, from small to 3XL. Priced at \$20 each. Order at the August 11 picnic or on the BSOP website under Resources, and log into Member Services. Or contact Patty at [verdillia@comcast.net](mailto:verdillia@comcast.net). Deadline for ordering is August 12, 2018. Don't delay!



## Mid-season Pruning

There will always, always, be a place for a Japanese Maple on my bench. If I could have but one tree, that might be it. It would be a tough battle though, with pines. The varieties and types of maples abound, and there are lots of techniques out there for handling them. The goal for refining any Japanese Maple is to create a light and airy feeling full of grace and suppleness, even when growing a rather masculine or stumpy shohin, the branches are still delicate. These trees naturally grow in the mountains of Japan. We have our own vine maples which grow from the sea to the cascade crest and they will help inform the graceful shape of a maple. I was recently in downtown Lake Oswego and saw perhaps the largest specimen of Japanese Maple that I have ever seen with a trunk diameter probably over 24 inches. It was like unto a towering oak. The reason I mention it is to say that we can find substantial examples of mature trees to observe and learn from.

I have several varieties of Japanese maples. Without a doubt, my favorite is just the plain, standard species with its delicate and lovely green leaves. I have about a dozen from shohin to medium and large size trees that I am growing from scratch. Other varieties include a Shishigashira (Lion's Mane) that was begun by Edris Stryker, and a red Deshojo developed by Anne Spencer. Lastly, I have a pair of Okushimos that were started from cuttings. All of these trees have their pluses and minuses, and their own unique growth habits. So that is the subject of this month's Branch Tips.

The standard operating procedure for Japanese Maple care when I first started, that was touted in all of the books, was to entirely defoliate the tree in late spring or early summer. The goal was to create a second flush of growth with shorter internodes and smaller leaves. There are several problems with this technique. First of all, if your tree is not strong enough, you might kill it, or at the least lose some branches. Enough said there. Secondly, if you have pencil size trunks and you perform this technique, they will remain pencil size indefinitely. No one ever told me to do it AFTER you get it to the size you want. This is a maintenance technique, not a development one. And thirdly, you risk burning the trunk or branches and doing permanent damage to the tree. So, entire defoliation is a bad idea. I can't think of a situation where I would recommend it.

Then along came Boon and offered a big upgrade to this technique. Instead of removing all of the leaves, remove one leaf from every pair across the tree, cutting across the petiole. You can leave both leaves on weak interior shoots. If you have particularly strong leaves, you can cut the outer portions off to reduce the solar surface area. The effect is two fold; first, since you have only removed half of the foliage, the tree is not forced into making new shoots and is happy to live the remainder of the season with what it has, and secondly, it reduces the amount of sugars and starches being produced. This keeps the branches from thickening too much and becoming coarse, preserving the light and airy feeling that we cherish so much in maples. Be

sure to be aware that although all maples have an opposite branching habit, they alternate in orientation. This is to say that one set of buds aligns vertically, the next set horizontally. Ideally, they would all align laterally, so keep this in mind when pruning. If the internodes are really short, then you have some options to choose the orientation that you need. This has become my de facto standard technique for maintaining already developed maples, and many other deciduous trees as well.

So this technique is all well and good for regular, species maples, but the varieties that I mentioned above present some unique growth habits that require us to alter our technique. The general idea is to create a short internode (recalling Dennis Vojtilla's rule of thumb – about  $\frac{3}{4}$  to 1 inch) and we do this by pruning back to the first set of leaves on a maple. Since they produce opposite pairs of leaves, there is always a fork or bifurcation at any node we prune to. When we come to a species like Shishigashira, which grows very slowly, the nodes may only be  $\frac{1}{8}$  inch apart, or virtually absent. If we continually cut back to the first node, we get nowhere and the nodes are too close. Here we do the opposite of all of your bonsai training. We cut the leaves on the inner shoots closest to the trunk and leave the pair of leaves at the point where we want the next set of branching, which is most often the very last pair. This can be tedious work, but leads to a ramification that develops more quickly and is more maintainable in the long run.

Out next guest on the turntable is the Deshojo variety. This is an older cultivar and has beautiful deep coral foliage in the spring as shoots emerge that contrasts beautifully with the mature white bark. There is nothing quite like it. Alas, the foliage the rest of the year causes one to wonder why you are growing it in the first place. It's sort of a mottled, drab, greenish affair. It also happens to be a fairly weak grower, like many of the special varieties. It often has droopy foliage and only a few elongating shoots. For this specimen, I still remove every other leaf, but I leave more leaves in the weaker areas, like the lower branches and interior shoots. I wire up the weak shoots so that they can get more light and gain enough strength to hold themselves up and I make sure to not remove any leaves, except to shorten the overall length. This process has really improved the overall health and strength of the tree.

I can detect no graft union in either the Deshojo, or Shishi but they are often propagated by this method. Most special varieties do not propagate true from seed, and they often have a weaker growth habit necessitating the need for the graft onto the stronger, species stock. An exception to the rule are the two Okushimo trees that I have been growing, like forever. Both were from a set of about ten, two-year old rooted cuttings by Wright's Nursery, which is no longer in existence. Two each of five species. I won them in a raffle at my very first convention, in 1990, before I was even a member of BSOP. Maples are difficult to root from cuttings so these are very much an anomaly. That is born out by the fact that the other eight trees died within two years. That may also reflect in my lack of skill, but I did keep everything else alive. These two grow really slowly. I had them in the ground for several years and they barely grew. I gave one to my grandfather and it passed back to me when he died. They have the strangest leaves, which are not to everyone's taste. But I like 'em. Since they were grown from cuttings, the roots emerged on just one side, so I have in-arch grafted species roots to fill in the bases. In all that time, these trees are still only an inch and half in diameter. They are growing stronger than ever though. They really want to send all the energy to just a few shoots, so I use pruning to redirect that strength more evenly.

Lastly I would like to mention our own native Vine Maple. I love these guys too. These are the closest relatives to Japanese Maples outside of Japan. Try the same techniques, but a few words of caution. They prefer dappled sunlight in the summer. They naturally grow in the margins of the forest to deeper shade. I keep mine in full sun in the spring until sometime in June, then it's under cover. These trees are coarser than their Japanese cousins, so they tend to get very thick and long internodes if allowed to rage on.

When I prune in late spring to early summer, I sometimes cut off entire nodes because they have gotten too long or heavy. I take off every other leaf on the rest. During this pruning I make sure to space out the remaining leaves such that there is equal distribution to light. This requires a little thinking ahead and watching the area as much as an individual shoot. There is also a large discrepancy in leaf size, so I often resort to cutting off the exterior leaf mass to make them more equal.

I even showed this tree in the fall after cutting the leaves down to size but matching the overall leaf shape with five points. No one noticed! In situations where the whole shoot has been pruned, the tree responds with new shoots. In the long distant past when I entirely defoliated the vine maples, they just sat there the rest of the season and waited until the next spring to grow again. Be aware of that thought, but temper it with the fact that I did not fertilize much and they were very small trees growing on a rock – not many resources. Now that the tree is in refinement, that drastic technique is not needed.

So jump in and prune your maples to direct development and protect them a bit after you do so. Stay cool.

*Scott Elser*



Elongating species Japanese Maple in development. Let it grow!



Okushimo. These leaves are certainly unique



Deshojo Maple. Note the red leaves, just like spring growth, that emerged after flush pruning.



Shishigashira before pruning. Note the extremely short internodes – really isn't one.



Shishi after pruning. We cut the leaves nearest the trunk. Since we have another branch nearby, we eliminate the weak shoot. For scale, see my fingers!



Vine Maple. The overall size of the larger leaf has been reduced to match the smaller leaf.



Japanese Maple by  
Mike Fieldhouse  
Art Of Bonsai In Wales  
in Newport, South  
Wales  
From [bonsai4me.com](http://bonsai4me.com)

# Effects of Visual Stimulation with Bonsai Trees on Adult Male Patients with Spinal Cord Injury

Hiroko Ochiai, <sup>1,†</sup> Chorong Song, <sup>2,†</sup> Harumi Ikei, <sup>2,3,†</sup> Michiko Imai, <sup>4</sup> and Yoshifumi Miyazaki<sup>2</sup>.

## Abstract

Nature therapy has been demonstrated to induce physiological relaxation. The psychophysiological effects of nature therapy (stimulation with bonsai trees) on adult male patients with spinal cord injury (SCI) were examined. Oxyhemoglobin concentration changes in the prefrontal cortex were measured using near-infrared spectroscopy, and heart rate variability was analyzed. Psychological responses were evaluated using the modified semantic differential method and Profile of Mood States (POMS) subscale scores. Visual stimulation of adult male patients with SCI elicited significantly decreased left prefrontal cortex activity, increased parasympathetic nervous activity, decreased sympathetic nervous activity, increased positive feelings, and resulted in lower negative POMS subscale scores. Nature therapy can lead to a state of physiological and psychological relaxation in patients with SCI.

**Keywords:** spinal cord injury, nature therapy, bonsai trees, visual stimulation, near-infrared spectroscopy, heart rate variability

## 1. Introduction

Stress appears to be increasingly present in our modern and demanding industrialized society. Every aspect of our bodies and brains can be virtually influenced by stress induced by living in an urban environment [1]. Early human civilizations lived in natural settings, demonstrating that we can adapt to nature. Congruent with this viewpoint, individuals living in modern societies who are experiencing stress have become interested in several types of natural therapy [2]. For example, psychological evaluations of the effects of horticultural therapy on the elderly have been previously reported [3,4].

The progress and development of research involving nature and forest medicine has advanced in recent years with the development of medical equipment related to the natural and life sciences. For example, oxyhemoglobin (oxy-Hb) concentrations in the prefrontal cortex were measured using a portable near-infrared spectroscopy (NIRS) device, which revealed that foliage plants can have physiological relaxation effects in male participants [5]. Heart rate variability (HRV) was measured, which revealed that visual stimulation with roses increased parasympathetic nervous activity [6] and that fresh pansies decreased sympathetic nervous activity [7]. Furthermore, salivary cortisol levels were measured after the participants were subjected to gardening activity, which demonstrated decreased stress levels [8]. A review by Song et al. presented scientific data to elucidate the physiological relaxation effects of nature therapy on the activities of the central nervous system, autonomic nervous system, endocrine system, and immune system [9]. The results from these experiments are based on advances in various physiological indicators from the viewpoint of evidence-based medicine in Japan. Nature therapy has the potential to be more widely adopted as preventive medicine in the future.

One potential application of nature therapy is its use for patients with spinal cord injury (SCI). SCI is a devastating event for individuals, and they frequently develop motor and sensory impairments, as well as autonomic dysfunction. Previous studies have reported that

autonomic nervous activity plays a major role in social cognition and that difficulties in the ability to interpret social information are commonly observed in a variety of mental disorders, which in turn correlate with poor autonomic nervous system regulation [10]. Depressive disorders are the most frequent concern following SCI and significantly affect rehabilitation, community integration, quality of life (QOL), and health-related outcomes [11,12,13]. A clinical practice guideline published in 1998 noted that 25% of men and 47% of women with SCI experienced some form of depressive disorder [14].

Considering this high prevalence of psychological distress, it is especially important to highlight that according to research, most patients with SCI felt that their emotional needs were not sufficiently addressed by their rehabilitation team [15]. Recent meta-analyses have reported medium-to-large effect sizes for psychological interventions for post-SCI depression, and there is sufficient evidence specifically supporting the use of cognitive behavioral therapy interventions [16]. However, these methods require the intervention of an expert psychiatrist.

An advantage of nature therapy such as viewing bonsai trees is that it allows for routine, self-induced mental relaxation. Such therapy is also accessible for individuals who are unable to perform certain activities (e.g., walking more than a mile or doing vigorous activities). If the physical and mental stress of patients with SCI can be reduced via intervention with nature therapy, this therapy can be recommended to such patients to promote improved health. Similarly, nature therapy can be used as a preventive medicine therapy for healthy but stressed individuals. Relaxing effects have been reported regarding exposure to forest, urban green space, flowers and plants, and so on. Nature therapy is defined as “a set of practices aimed at achieving ‘preventive medical effects’ through exposure to natural stimuli that render a state of physiological relaxation and boost the weakened immune functions to prevent disease” [9].

Although previous analytical studies have pointed out the relevance of nature therapy and relaxation in healthy adults, there is no previous research on adult patients with SCI. To the best of our knowledge, this is the first study to examine the physiological and psychological effects of nature therapy in adult male patients with SCI and clarify its effectiveness in reducing daily stress.

In this study, 24 Japanese adult male patients with chronic-stage SCI were exposed to 10-year-old cypress bonsai trees as visual stimuli. Bonsai is miniature natural landscapes in pots using trees and other plants. They are a famous art form unique to Japan.

## 2. Materials and Methods

### 2.1. Experimental Design

All participants gave their informed consent for inclusion before they participated in the study. 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). In total, 24 Japanese male patients with spinal cord injury aged 25–79 years (mean age,  $49.0 \pm 16.4$  years) were included in this study. They had a height of 162–182 cm ( $171.4 \pm 5.6$  cm) and weight of 52–94 kg ( $67.2 \pm 9.2$  kg). The patients had no psychiatric disorders, which comprised part of the inclusion criteria for the study, and they were in the chronic stage of their condition (i.e., >1 year after the lesion developed). They were diagnosed with spinal cord injury by a doctor and their damage was located below C7. The patients were able to independently move around in wheelchairs.

The experiments were conducted in an experimental room at Chiba University. The room temperature was maintained at  $23.7 \pm 1.3$  °C, and the relative humidity was maintained at  $50.5 \pm 7.4\%$ . The patients moved into the experimental room and the experiments were separately carried out for each patient.

Miniature potted 10-year-old Japanese cypress bonsai trees were used as visual stimuli. Eight cypress trees, approximately 55 cm in height, were grouped together in a  $40 \times 20 \times 5$  cm ceramic pot (Figure 1A). Before visual stimulation, these miniature trees were covered by a corrugated cardboard box (rest condition). After a 60-s rest period, the patients viewed the miniature potted trees (visual stimulation) or nothing (control) for 60 s each; all patients were made to experience both experimental conditions. Distance from the patients' eyes to the trees was 60–63 cm. The order of conditions (i.e., visual stimulation vs. control) was randomized. The patients practiced the procedure, using visual stimulation with a potted plant, once beforehand.

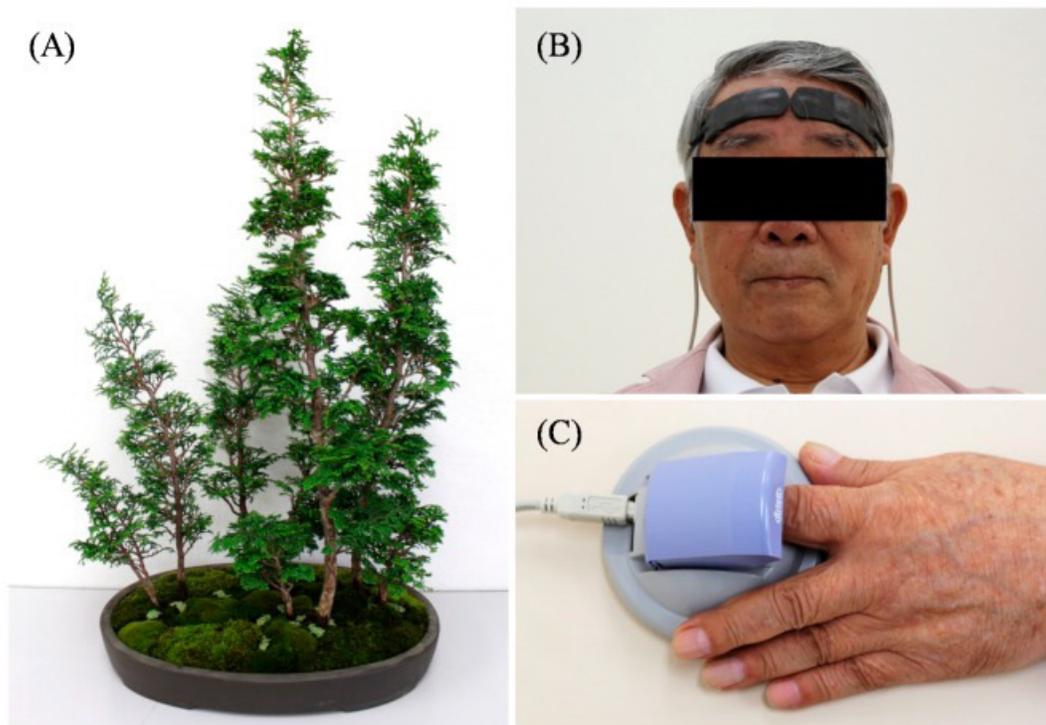


Figure 1. Bonsai trees and physiological measurement apparatuses. (A) Japanese cypress bonsai trees; (B) Participant undergoing near-infrared spectroscopy (NIRS) measurement; (C) Participant undergoing heart rate variability (HRV) measurement.

## 2.2. Physiological Indices

Changes in oxy-Hb concentrations on the surface of the prefrontal cortex were measured using a two-channel near-infrared spectroscopy device (NIRS; Pocket NIRS Duo, DynaSense, Hamamatsu, Japan). NIRS probes were placed bilaterally and symmetrically on the forehead. Two sensors were placed over the frontal region, with one sensor placed on the left side of the forehead and the other placed on the right side of the forehead (Figure 1B) [17]. To analyze the NIRS response, change in the oxy-Hb concentrations in the prefrontal cortex during visual stimulation was measured. The difference between this and the value from 10 s prior to

stimulation was analyzed. It is well established that oxy-Hb concentration reflects the activation of neural regions [18].

The patients placed their left forefingers on the sensor of an accelerated plethysmograph (ARTETT, U-Medica Inc., Osaka, Japan) (Figure 1C). Heart rate variability (HRV) was analyzed. HRV was converted by a 60/a-a interval; the sampling frequency was 1000 Hz. The power levels of the high-frequency (HF) (0.15–0.40 Hz) and low-frequency (LF) (0.04–0.15 Hz) components were calculated using the maximum entropy method [19,20]. HF power was considered to reflect parasympathetic nervous activity, and the LF to HF ratio was considered to reflect sympathetic nervous activity [21,22]. In general, parasympathetic nervous activity is enhanced during relaxation and sympathetic nervous activity is enhanced at the time of awakening or in situations of stress.

### 2.3. Psychological Indices

The modified semantic differential (SD) method and Profile of Mood States (POMS) subscale scores were used to evaluate psychological responses following visual stimulation. The modified SD method uses three pairs of adjectives anchoring 13-point scales: “comfortable to uncomfortable,” “relaxed to awakening,” and “natural to artificial” [23]. The scores were determined for the following six POMS subscales: “tension-anxiety (T-A),” “depression (D),” “anger-hostility (A-H),” “vigor (V),” “fatigue (F),” and “confusion (C).” A short form of POMS with 30 questions was used to decrease participant burden [24,25,26]. The “total mood disturbance (TMD)” score was calculated by [(T-A + D + A-H + F + C) – V]. A high TMD score indicates an unfavorable psychological state.

### 2.4. Statistical Analysis

We used paired *t*-tests to compare physiological indices and the Wilcoxon signed-rank test to compare psychological test scores. All statistical analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Data are expressed as means ± standard error (mean ± SE). For all cases,  $p < 0.05$  (one-sided) was considered statistically significant. One-sided tests were used because we hypothesized that the patients would be relaxed after viewing the bonsai trees.

## 3. Results

Oxy-Hb concentrations of the left and right prefrontal cortices were measured using a two-channel NIRS device. Change in the oxy-Hb concentration of the left prefrontal cortex was significantly lower when the patients viewed the bonsai trees (visual stimulation) than when they viewed nothing (control) (visual stimulation =  $-0.20 \pm 0.02 \mu\text{M}$ ; control =  $0.17 \pm 0.02 \mu\text{M}$ ;  $p < 0.05$ ; Figure 2A). Oxy-Hb concentration of the right prefrontal cortex did not significantly differ between visual stimulation ( $0.00 \pm 0.01 \mu\text{M}$ ) and control ( $0.09 \pm 0.01 \mu\text{M}$ ; Figure 2B) conditions.

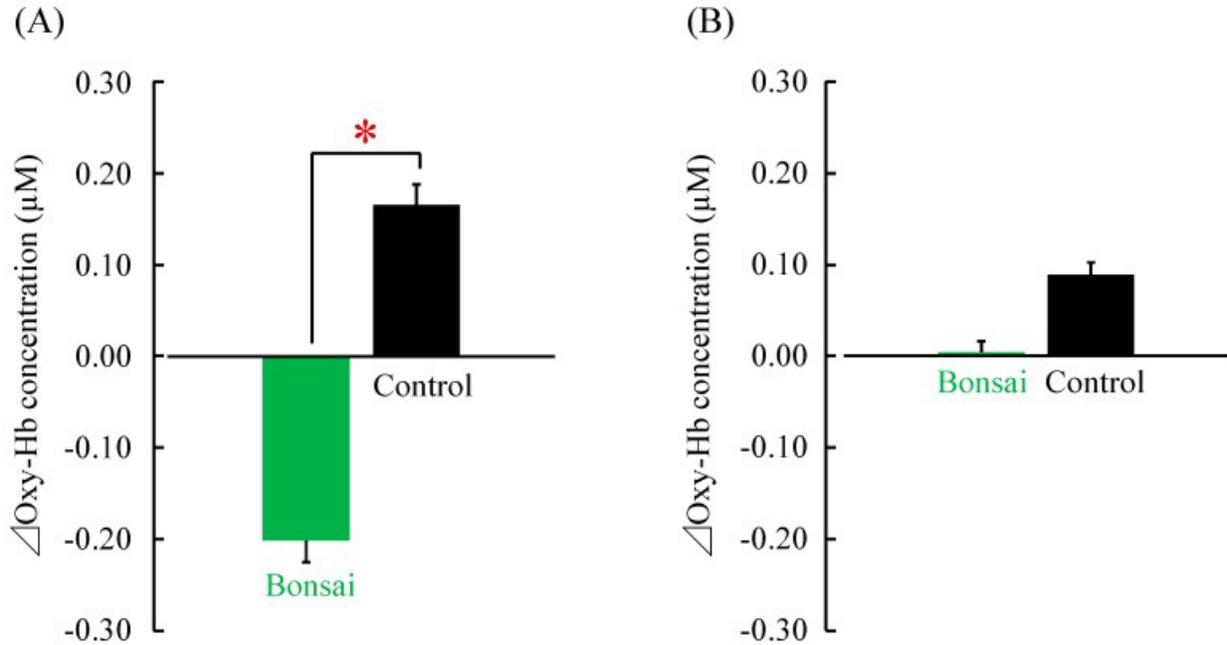


Figure 2. Mean oxy-Hb concentrations in the prefrontal cortices. (A) Changes in the left prefrontal cortex when viewing bonsai trees vs. control; (B) Changes in the right prefrontal cortex.  $N = 24$ , mean  $\pm$  standard error. \*  $p < 0.05$ , paired  $t$ -test.  $\Delta$ , change.

The average power of the high-frequency (HF) components of HRV, which is related to parasympathetic nervous activity, increases when we feel relaxed [21,22]. This value was significantly greater when the patients viewed the bonsai trees compared with the control condition (visual stimulation =  $5.45 \pm 0.23 \text{ lnms}^2$ ; control =  $4.95 \pm 0.21 \text{ lnms}^2$ ;  $p < 0.01$ ; Figure 3A). The average low-frequency (LF) to HF ratio of HRV, which is related to sympathetic nervous activity, increases when we feel stressed [21,22]. This ratio was significantly lower when the patients viewed the bonsai trees compared with the control condition (visual stimulation =  $0.85 \pm 0.04$ ; control =  $0.95 \pm 0.06$ ;  $p < 0.01$ ; Figure 3B).

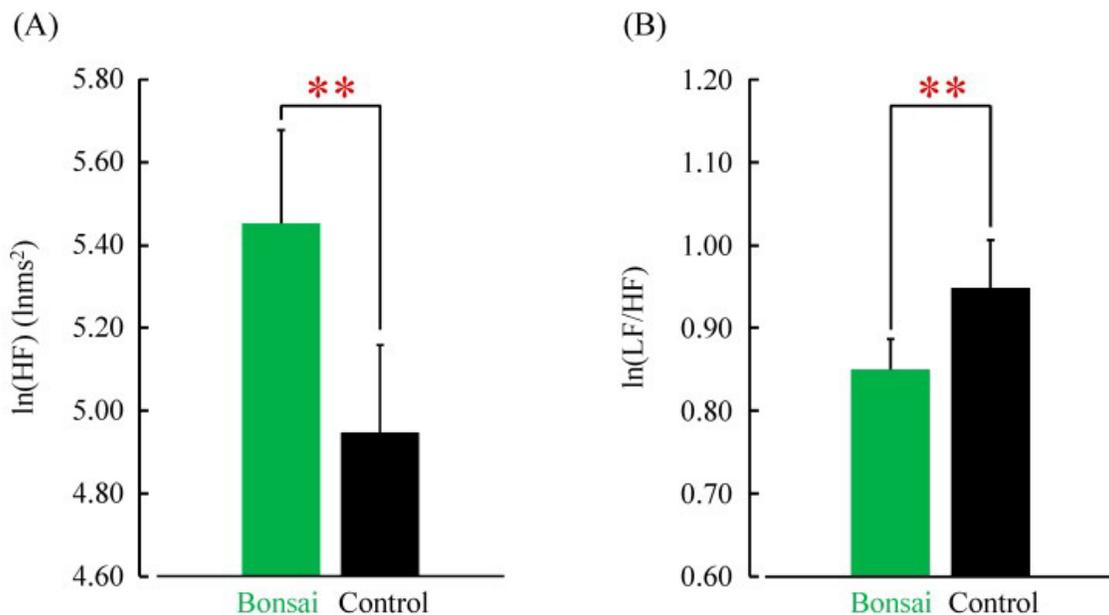


Figure 3. Autonomic nervous activity when viewing bonsai trees vs. control. (A) Parasympathetic nervous activity: mean natural logarithm (ln) of the high-frequency (HF) component; (B) Sympathetic nervous activity: mean natural logarithm (ln) of the ratio of low-frequency (LF) to HF (LF/HF).  $N = 24$ , mean  $\pm$  standard error. \*\*  $p < 0.01$ , paired  $t$ -test.

Figure 4A shows the results of the modified SD (semantic differential) method. Subjective evaluations indicated that the patients felt significantly more “comfortable,” “relaxed,” and “natural” when viewing the bonsai trees compared with the control condition ( $p < 0.01$ ). The Profile of Mood States (POMS) was used to gauge the patient’s psychological response to stimuli (Figure 4B). Negative POMS subscale scores of “tension-anxiety,” “depression,” “confusion,” “anger-hostility,” and “fatigue” were significantly lower when viewing the bonsai trees compared with the control condition ( $p < 0.05$ ). On the other hand, the scores of “vigor,” a positive subscale, were significantly higher when viewing the bonsai trees compared with the control condition ( $p < 0.01$ ). The scores of global “total mood disturbance” were significantly lower when viewing the bonsai trees compared with the control condition ( $p < 0.01$ ); indeed, negative emotions were significantly reduced when the patients were exposed to natural stimuli.

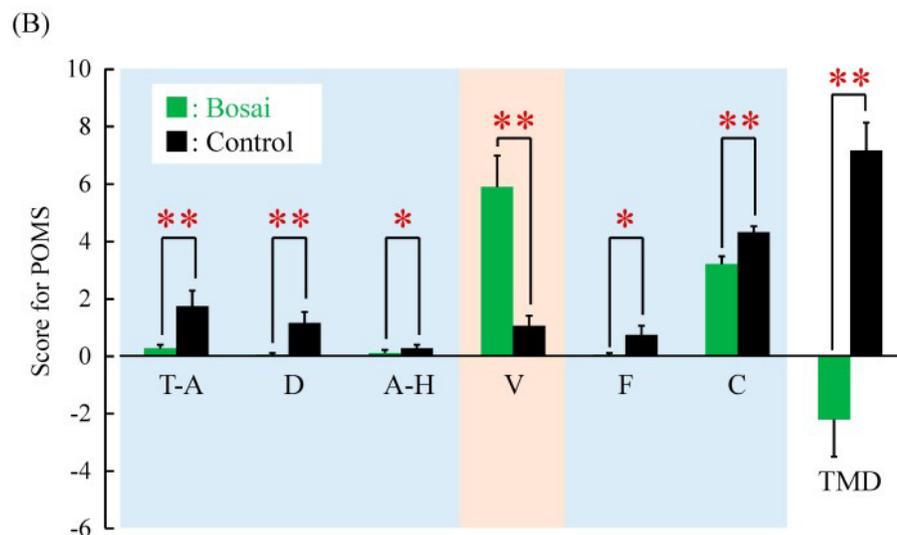
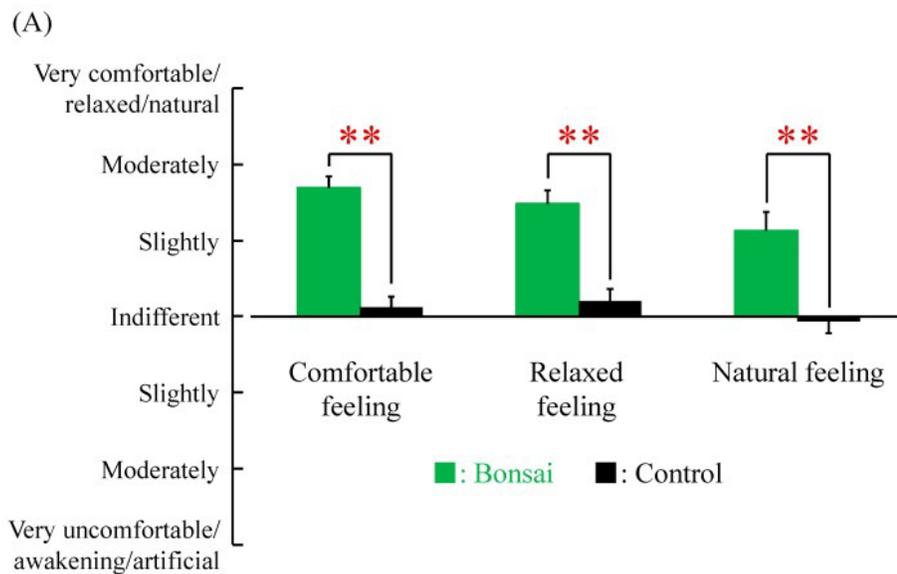


Figure 4. Questionnaire results. (A) Subjective feelings measured using the modified semantic differential method after viewing the bonsai trees vs. control.  $N = 24$ , mean  $\pm$  standard error.  $** p < 0.01$ , Wilcoxon signed-rank test; (B) Scores on the Profile of Mood States after viewing the bonsai trees vs. control. T-A, tension-anxiety; D, depression; A-H, anger-hostility; V, vigor; F, fatigue; C, confusion; and TMD, total mood disturbance.  $N = 19$ , mean  $\pm$  standard error.  $* p < 0.05$  and  $** p < 0.01$ , Wilcoxon signed-rank test.

## 4. Discussion

Research demonstrates that oxygen consumption, regional cerebral blood response, and oxy-Hb supply are increased in highly activated neural regions [18]. A lower oxy-Hb concentration indicates that the quantity of oxygen transmitted to the prefrontal cortex tissue is small. The lower prefrontal cortex activity found in the current study is consistent with that reported in previous studies [27,28], showing that low oxy-Hb concentrations represent the calming of brain activity. For example, in the dorsolateral prefrontal cortex, hemispheric specialization of emotional processing has been proposed by functional magnetic resonance imaging. In particular, the activation of the left prefrontal cortex has been associated with positive mood and the processing of positive stimuli, whereas the activation of the right prefrontal cortex has been linked to negative mood and the processing of negative stimuli [29]. However, the precise details of the function of the right and left prefrontal cortex as measured using the NIRS device remain unknown. In this experiment, the activity of the left prefrontal cortex was suppressed, whereas that of the right prefrontal cortex did not change when the patients viewed the bonsai trees. Based on these results, we can only conclude that the patients were in a relaxed state when they viewed the bonsai trees.

Patients with SCI have reduced autonomic flexibility, as measured using HRV, and exhibit reduced autonomic modulation during emotion recognition tasks [10]. However, in the current study, the patients with SCI showed significantly higher parasympathetic nervous activity and significantly lower sympathetic nervous activity when exposed to a natural stimulus. These results demonstrate that in patients with SCI, the autonomic nervous system responds to natural stimuli in a similar manner to that in healthy adults [9,30].

Patients with SCI report pain-related disability, depression, fatigue, pressure sores, spasticity, and issues with bladder and bowel management [31]. These conditions often induce negative mood states in patients with SCI; thus, emotional support is an important factor influencing the rehabilitation process [32]. The focus of rehabilitation for such patients has shifted from medical management to QOL issues, and exposure to natural stimuli represents one way to improve QOL in patients with SCI.

Viewing bonsai trees simulates “forest therapy,” a therapeutic activity that has become popular in Japan, and utilizes the scientifically proven effects of walking through and viewing forests [33,34]. Indeed, forest therapy is increasingly recognized as a relaxation and stress management strategy with demonstrated clinical efficacy. Forest therapy suppresses sympathetic nervous activity, increases parasympathetic nervous activity, and reduces cortisol levels and cerebral blood flow in the prefrontal cortex [9]. Forest therapy has also been shown to increase human natural killer cell activity and improve immunity [35,36,37], and these effects have been proven to last for at least seven days [36,37]. In addition, psychological studies have demonstrated the benefits of forest environments on subjective measures of stress, cognitive function,

and mood [38]. There is a difference between forest therapy and this experiment; namely, one is performed in the field and the other indoors. The field experiment reveals the general influence of nature on humans through their five senses. On the other hand, we can pick up the effect of stimulating a single sense in the indoor experiment and clarify its influence. Here, we chose vision as one of the senses that we use in the forest, and we clarified the influence of visual stimulation by bonsai trees.

In the current study, the same psychophysiological effects of visual stimulation with bonsai trees were shown in adult male patients with SCI as in healthy adults. We consider it an important point that a relaxation effect could also be obtained in SCI patients by applying nature therapy, because it is difficult to perform forest therapy with SCI patients with restricted activities. Further, these findings may help promote the development of the environment, which is beneficial to the physical and mental health of individuals with disability.

The main limitation of the present study was its small sample size. Also, the results of the present study cannot yet be extrapolated to females. On the other hand, we compared only the condition of viewing miniature potted trees (visual stimulation) with viewing nothing (control) in this study, but it would be useful to investigate a third condition with a non-nature object. Furthermore, a short-term stimulus was used; the results were compared before and after only 60 s of stimulation with bonsai trees. In addition, we do not know for how long the effect of this natural therapy may last. Future studies examining the duration of effects following exposure to natural stimuli are required.

## 5. Conclusions

In conclusion, the current study revealed that visual stimulation with bonsai trees in adult male patients with SCI elicited the following: (1) significantly suppressed left prefrontal cortex activity; (2) significantly increased parasympathetic nervous activity and decreased sympathetic nervous activity; (3) significantly increased “comfortable,” “relaxed,” and “natural” feelings as assessed using the modified SD method; and (4) significantly decreased negative and increased positive POMS subscale scores. The findings of this study can be applied to SCI patients by taking advantage of their natural surroundings to ensure improved health and reduced mental stress. Generally, considerably less practice is supported by research, and the reality is that little research is applied in practice. We can say that this study is useful because in practice the effects are proved by research data.

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## Author Contributions

Hiroko Ochiai contributed to data acquisition, interpretation of results, and manuscript preparation. Chorong Song and Harumi Ikei contributed to the experimental design, data acquisition, statistical analysis, and interpretation of results. Michiko Imai conceived the study and participated in the interpretation of results. Yoshifumi Miyazaki conceived and designed the study and contributed to the interpretation of results and manuscript preparation. All authors have read and approved the final version submitted for publication.



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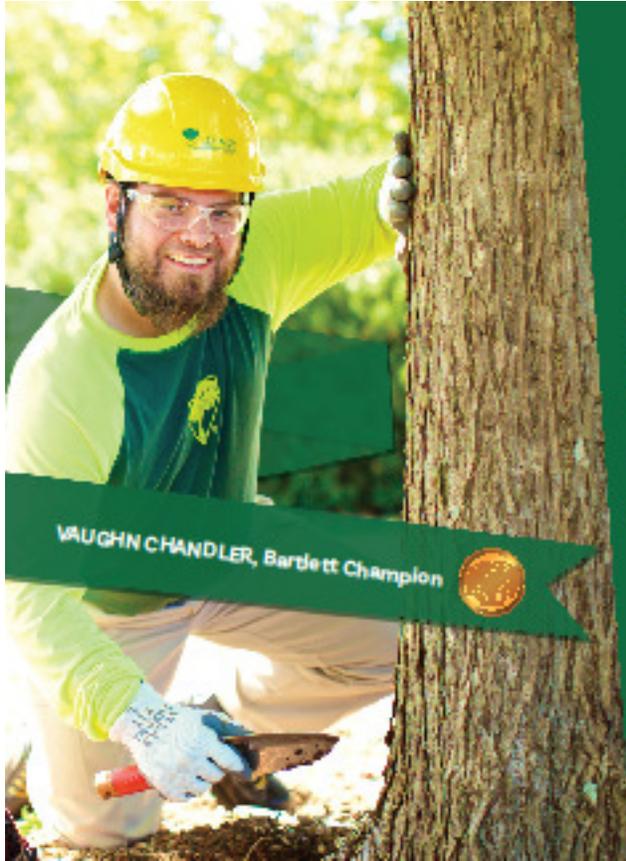
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