Better Nature: Improved Interactions with Nature May Reduce Psychophysiological Stress in Chinese Adults

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Abstract. Reducing stress associated with technology and the use of electronics is a major issue among Chinese adults. However, no studies have investigated the effect of tactile stimulation of the feet. In this study, we investigated psychophysiological techniques for controlling stress by having participants touch natural materials with the sole of the foot. The study included 90 young Chinese adults with a mean (±SD) age of 21.2 ± 2.7 years. A crossover design was used to examine psychological and physiological differences between touching grass with the sole of the foot and touching wood (control) for 10 minutes. Physiological assessments included blood pressure measurements and electroencephalography, and psychological assessments included the Semantic Differential Method (SDM) and State-Trait Anxiety Inventory (STAI). We observed significant decreases in systolic and diastolic blood pressures in the experimental condition compared with the control condition, along with increases in alpha and beta activities. SDM results indicated that participants were moderately comfortable, very relaxed, and experienced reduced anxiety after stimulation with grass compared with after the control condition. Mean attention and relaxation scores were also significantly higher in the experimental condition than in the control condition. Thus, our results suggest that touching grass with the sole of the foot can lower psychophysiological stress in adults.

Modern work and living places have shifted from outdoors to indoors, and most individuals spend almost 90% of their time in an indoor environment. Although technological advancements (e.g., mobile phones, computers) have allowed university adults to remain connected, excessive use of electronic devices can substantially increase stress and anxiety (Brod 1984). In addition to...
relative to touching marble. Despite these findings, evidence-based studies regarding the effects of tactile stimulation remain lacking. Previous research has indicated that active involvement with greenery (i.e., planting) exerts greater effects on cognition than control conditions that do not involve greenery (Lee et al. 2013). Additional studies have indicated that engaging in planting activities reduces psychophysiological stress relative to that experienced during a mental task (Lee et al. 2015). Although such studies have clearly indicated the positive health effects of involvement with nature, there is a dearth of scientific evidence regarding the physiological and psychological effects of nature-based tactile stimulation. Previous studies have relied on physiological and psychological indices such as heart rate, heart rate variability, and Profile of Mood States–based methods (Hassan et al. 2018c). However, no studies have used the SDM, STAI, or electroencephalography (EEG). EEG is accurate, relatively noninvasive, nonfatiguing, and reasonably inexpensive. In addition to revealing variations in brainwave activity, EEG can be used to investigate the effects of various sensory inputs such as hearing, taste, vision, and smell (Hassan et al. 2018a). Furthermore, EEG devices are now being used in experiments involving brain–computer interfaces (Hassan et al. 2018a), and in the management of stress, anxiety, and other psychiatric diagnoses (Nishimura and Mitsukura 2013). EEG is normally divided into delta waves (equal to 4 Hz), beta waves (above 13 Hz), theta waves (4 to 8 Hz), alpha waves (8 to 13 Hz), and gamma waves. Higher mental stress or workload is associated with the disappearance of alpha waves and the emergence of beta waves (Nishimura and Mitsukura 2013). Some studies have also reported that alpha waves decrease and theta waves increase as work pressure or stress increases (Ajiro et al. 2009).

In 1996, Brookings et al. used EEG to examine differences in levels of workload or stress that cannot be identified using other devices, observing that EEG activity differs based on exposure to different environments, making this approach more accurate for estimating neurophysiological behaviors in humans (Ajiro et al. 2009). In the present study, we aimed to investigate both physiological and psychological responses to touching grass with the sole of the foot by measuring blood pressure, EEG, and emotional responses.

Methods

Participants. A total of 90 Chinese adults (mean age ± SD: 21.2 ± 2.7 years) were recruited for this study. No participants reported a history of physical or mental health disorders. Participants with any psychophysiological health problems were excluded during the selection process. We also controlled for tobacco and alcohol intake. Before the experiment, the participants were fully informed regarding the research methodology, following which they provided written informed consent. This study was approved by the local ethics committee of College of Architecture and Urban Planning, Tongji University (China).

Protocol. A within-subject design was used to evaluate physiological differences between the two tasks. All participants were divided into two groups of 45 students: Group A and Group B. On the first day, participants in Group A touched grass with the toes of both feet for 10 min, while participants in Group B touched wood with the toes of both feet for 10 min. On the next day, each group performed the opposite task. Both tasks were performed in a sitting position and at the same time of day (Fig. 1).

Materials. A very common ornamental grass grown in China was used as a base material for tactile stimulation. The experimental method was taught to each participant before the start of the experiment. A wooden plank of almost the same size and length was used as a control material. Both materials were prepared and adjusted based on the size of the human foot. The experiment was performed in a laboratory room situated at Building #5 of the College of Landscape Architecture. The experiment was performed under silent conditions, and all recording instruments were placed behind the participants to avoid any disturbance during the experiment. The experiment was performed during the winter, and the room was maintained at a temperature of 26°C. Calm lighting conditions were selected, and hanging curtains were used to cover the windows near the experimental location to shield the environment from direct sunlight.

Measurements. After a brief explanation of the experimental details in a large lecture hall, each participant was sent to the experimental room. The physiological recording device contained blood pressure and EEG headset devices. Both were attached to the participant’s arm and head. After a 5-min rest period in a seated position, participants performed the given task for 10 min. Systolic blood pressure, diastolic blood pressure, and pulse rate were recorded using an Omron sphygmomanometer (HEM-7011; Omron, Shanghai, China) both before and after each activity. EEG data were acquired using a MindWave-EEG headset (NeuroSky Beijing Oriental Creation Technology Co., Ltd., Beijing, China). This EEG headset can record brainwaves from the human forehead at the FP1 position (frontal lobe) located above the eye (Robbins and Stonehill 2014). It is primarily divided into four different parts: a Bluetooth device, an ear clip, a sensor arm containing the EEG electrode, and a headband. Basically, to detect and filter EEG signals, the device is fitted with two dry sensors. Electrical signals captured from the forehead can be identified by the sensor tip. This sensor also detects the ambient noise produced by the movement of human muscles and bulbs, electrical sockets, and other electrical devices. The ear clip behaves as a reference and ground that allows the chip (ThinkGear) to filter out the electrical noise (Vourvopoulos and Liarakapis 2014). The device records the raw signal in power spectrum form (e.g., high alpha and beta), along with signals associated with attention or meditation. The raw EEG data are collected at a rate of 512 Hz (Salabun 2014), while the measured values are obtained each second. The device also contains a small microchip that transfers and processes the electrical signals directly to the computer via Bluetooth. Raw EEG data indicated high alpha and beta activity were obtained at 1-min intervals at each site, and overall averages over the 10-min task were compared between the two conditions. The headset contains an EEG e-Sense Metric that can also group brainwave frequencies into attention and meditation categories. According to the EEG e-Sense Metric, meditation and attention data range from 1 to 100 (0 to 20: very low; 20 to 40: slightly low; 40 to 60: natural state; 60 to 80: slightly high; 80 to 100: very high) (Salabun 2014). Psychological status was assessed using the STAI (Hidano et al. 2000) and SDM (Osgood et al. 1957) questionnaires. SDM scores are calculated along a 13-point self-rating scale based on different factors: “comfortable/uncomfortable,” “relaxed/alert,” and “natural/artificial.” Previous studies have indicated that the SDM is valid and reliable for the assessment of mood. The 20-item STAI is a self-rated questionnaire designed to assess participants’ feelings (e.g., “I feel nervous,” “I feel anxious,” etc.) across four scales. STAI scores were calculated by summing ratings for each of the 20 items, with lower scores considered indicative of lower anxiety. The participants
Moreover, mean beta activity was higher levels observed in the control condition. Beta activity began to decrease as participants began to touch the grass, relative to levels observed under control conditions. Participants felt moderately comfortable and were more relaxed than those who touched wood (Basar 2012). In contrast, decreases in alpha activity in the control group indicated that participants were under stress during the task. Increased alpha brain power is known to reflect conditions of relaxation, euphoria, an increased ability to recall memories, and reductions in anxiety or stress. Our results are consistent with the findings of a previous study, which reported that certain antianxiety medications (i.e., benzodiazepines) also reduce alpha activity. The fact that interaction with grass exerted effects similar to those of an antianxiety medication has interesting implications for the treatment of psychological disorders (Puri et al. 2013). Previous studies have reported that alpha waves are associated with relaxed wakefulness (Klemm 1966). Feelings of happiness are associated with increases in alpha activity, while feelings of unhappiness are associated with decreases in alpha activity. Research has indicated that humans begin producing alpha waves at the start of sleep and upon waking early in the morning (Keefe et al. 1971). Interestingly, the intake of some plants has similar effects on the production of alpha waves (e.g., cannabis) (Struve et al. 2003). Similarly, overall beta wave activity was higher after 10 min of touching grass than after 10 min of touching wood, suggesting that concentration was stronger in the experimental group than in the control group. In the control group, participants experienced a sharp increase in beta activity soon after they began touching the grass, relative to levels observed under control conditions, suggesting that touching grass exerted positive effects on relaxation. These findings are in accordance with those of previous studies, which reported that engaging in horticultural activities significantly reduced systolic and diastolic blood pressures compared with levels observed during a mental task (Hassan et al. 2018b). Similar findings were obtained in a previous study in which participants engaged in plant-based activities (i.e., transplanting an indoor plant) (Lee et al. 2015). The advantages of physical activity in the treatment and prevention of high blood pressure have been well documented (Alsairafti et al. 2010): Individuals who regularly engage in physical activity have lower systolic and diastolic blood pressures than those who rarely engage in such activity (Knowles et al. 2013). Taken together, these findings suggest that physical activity that involves touching grass with the toes of both feet may decrease the risk of future hypertension in young adults. To determine whether touching grass affects brain activity, we recorded EEG in the present study. EEG offers an innovative and modern scientific approach to examining stress and can reveal changes in normal brainwave patterns during contact with external stimuli (Jing and Takigawa 2000). Higher alpha activity was observed in the experimental group than in the control group, indicating that participants who touched grass were more relaxed than those who touched wood (Basar 2012). In contrast, decreases in alpha activity in the control group indicated that participants were under stress during the task. Increased alpha brain power is known to reflect conditions of relaxation, euphoria, an increased ability to recall memories, and reductions in anxiety or stress. Our results are consistent with the findings of a previous study, which reported that certain antianxiety medications (i.e., benzodiazepines) also reduce alpha activity. 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In the control group, participants experienced a sharp increase in beta activity soon after they began touching the wood. Beta brainwaves dominate during states of alertness (Neuper and Pfurtscheller 2001), relaxation (Vijayalakshmi et al. 2010), and during highly mental activities, decreasing during states of drowsiness (Hauri 1981). Naturally, beta brainwaves are prominent
during different tasks such as playing sports, during speech, and during attentive listening. Our EEG results indicated that relaxation and attention levels were higher when participants touched grass than in the control condition, consistent with the previous finding that walking in a bamboo forest increased scores for both relaxation and attention (Hassan et al. 2018c). Thus, touching grass significantly alleviated stress levels compared with the control condition. STAI and SDM results indicated that touching grass exerted beneficial effects on mental stress, while touching wood enhanced mental stress. Such findings suggest that touching grass with the toes represents an easy and attainable method for connecting with nature to enhance mental health and quality of life in modern adults. However, the current study possesses some limitations of note, including the fact that only young Chinese adults were involved. Future studies should examine participants of all ages using a more specific control group.

**Conclusion**

Our findings provide scientific evidence that—relative to a control task—touching grass reduces psychophysiological stress by lowering blood pressure, increasing relaxation, and decreasing anxiety.
Fig. 5. Participants scoring for comfortable, natural, and relaxed feelings before and after touching grass and control. N = 90, mean ± SD, *P < 0.01 by Wilcoxon signed-rank test.

Fig. 6. Comparison of State-Trait Anxiety Index before and after grass and control tasks. N = 90, mean ± SE, paired t test.

References Cited


