The Effects of Indoor Plants on Directed Attention and Mood of High School Students

Abstract

Studies have shown that outdoor natural environments and window views of nature are conducive to directed attention restoration. Many classroom environments are not able to augment their restorativeness through windows or direct natural interaction. Indoor plants may bring the restorative characteristics of natural environments inside the classroom. The literature is mixed in terms of the benefits of indoor plants, though some studies suggest that indoor plants can increase positive mood and directed attention. In the present field experiment, high school students' mood, directed attention capabilities, creative thinking, and opinions of the environment were measured in a classroom without plants. Plants were then gradually added to the classroom, and students were measured again in the same manner. Results suggest that indoor plants can increase the restorativeness of a classroom and that the restorativeness of a classroom has a strong effect ($p < 0.01$) on student mood. No significant positive effects of the environment on directed attention or creative thinking abilities were noted.

1. Introduction

While humans have interacted with nature for thousands of years, nature's physiological and psychological benefits have only been empirically studied in recent decades. There are two popular theories supporting this recent research. One theory, Attention Restoration Theory (ART), asserts that natural environments help to restore directed attention because nature is innately fascinating and draws upon involuntary attention, not voluntary (directed) attention, giving directed attention a chance at restoration (Kaplan, 1995). ART builds upon William James' distinction between two types of attention (1982). The other influential theory supporting natural environment research is similar to ART, yet is more focused on emotions and stress-reduction. This theory, postulated by Ulrich (1983), suggests that an environment with moderate complexity and depth, a focal point, and natural contents like vegetation and water can create positive emotions, sustain involuntary attention, restrict negative thoughts, and reduce physiological arousal in people.

Research supporting these theories is prominent. One study found that not only walking in nature, but viewing photos of natural scenes also improved directed attention as measured by the Attention Network Task (Berman, Jonides, & Kaplan, 2008). Berto (2005) confirmed Berman, et al. (2008)'s finding that viewing pictures of natural scenes enhances cognitive ability while using a different task, the Sustained Attention to Response Task (Manly, Davison, Heutink, Galloway, & Robertson, 2000), which measures sustained attention through response inhibition. Additionally, patients recovering from surgery in a hospital recovered better with a view of a natural setting compared to an urban setting (Ulrich, 1984).

While there is a good understanding of the benefits of nature outdoors, there is little existing evidence of the benefits of indoor plants. Additionally, the results from research

examining the effects of passively engaging with indoor plants are very mixed. The research lacks congruity in almost all aspects, from the reporting of results, to the exposure times allowed for participants to interact with the plants (Bringslimark, Hartig, Patil, 2009). Lohr, Pearson-Mims, and Goodwin (1996) found that people in a plant condition felt more "attentive or concentrating" after performing a productivity task compared to participants in a no plant condition. Those in the plant condition also had a lower systolic blood pressure during the task, and their blood pressure recovered faster than their no plant counterparts after the task. Plants were also found to increase the attention capacity of university students after performing a proofreading task, but scores did not improve for students in the no-plant group (Raanaas, Evensen, Rich, Sjøstrøm, Patil, 2004). A Shibata & Suzuki study suggests mood is not affected by indoor plants, and that plants only insignificantly increase scores on a key response task, which is a simple task that assesses directed attention capabilities (2001). Another study by the same researchers found that in an environment with indoor plants, task performance significantly increased for females on a creative task, but not for males. The difference in performance was not related to mood states, while the difference in performance disappeared when evaluations of the environmental factors were removed from analysis (Shibata & Suzuki, 2002). These two Shibata & Suzuki studies suggest that mood may not be a factor in the task performance benefits of indoor plants.

The specific task used for assessment of the effects of indoor plants is evidently very important. Shibata & Suzuki (2004) suggested that the compatibility between the specific demands of a task and the environment are very important in determining the benefits of an environment on task performance, and also cited a difference in mood among participants in a room with a plant or a magazine rack as compared to a room with no object ($p < 0.05$). Larsen,

Adams, Deal, Kweon, & Tyler (1998) examined the effects of no plants, a moderate amount of plants, and a high density of plants on participants' performance on a productivity task, while measuring emotions. They found that as the number of plants increased, scores on a productivity tasked significantly decreased. They noted higher mood with the presence of plants as compared to a lack of plants.

The present study builds upon the existing literature regarding the benefits of indoor plants on task performance and mood. The subjects are high school students, a group that has not been used frequently in studies of the benefits of indoor plants. It is also in a high school setting, a setting rarely studied in indoor plant research. It fills in gaps in our understanding of the role of task-environment compatibility, as it features a creative task in addition to a simple working memory task. It is also a field experiment, which has a greater external validity in terms of the classroom setting than the true experiments commonly performed in indoor plant research. A higher positive mood, augmented working memory capacity, and increased creative performance are expected with the presence of plants. Additionally, the plant condition is anticipated to be perceived as more restorative, and restorativeness is predicted to be positively associated with working memory capacity, creative thinking and mood.

2. Method

Participants

Forty-nine (M = 17, F = 32) of the 63 high school students recruited in three social studies classes participated in the study. Participants were recruited during their classes by their teacher and were given informed consent forms. Those that did not return the forms did not participate in the study. Candy was given to students for their participation.

Setting and Intervention

All three classes in which the study was conducted were held in the same classroom in a suburban American high school. The three classes were 44 minutes long each. The classroom had a large window on its side. It had standard fluorescent lighting and was painted a light blue.

Figure 1

Figure 2

The walls contained various student works, maps, and posters (see Figs. 1 & 2). In the plant condition, 8 plants were added to the room. One was a large Chinese Evergreen, *aglaonema*, placed on the floor, and two were smaller Chinese Evergreens placed as per Fig. 1. Three plants were Spider Plants, *chlorophytum comosum,* as shown in Fig. 2. The other two plants were Snake Plants, *sansevieria trifasciata,* as shown in Fig. 1.

Background Information

Student ID numbers were collected in order to track subject attendance between the no plant and plant condition and to statistically utilize the repeated-measures design of the experiment. Gender and age were also recorded.

Mood Scale

A 5-point Likert-type mood scale (Lundquist, Kjellberg, Holmberg, 2002) was used to assess mood in both conditions. The scale presents a list of 14 adjectives such as "concentrated" and "under stress" that students rank on a scale of 1 (very little or not at all) to 5 (very much) as descriptions of their present mood state. The Lundquist scale was designed for quick administration in studies of the classroom environment. It produces two factors: *task orientation*, which essentially describes positive mood, and *inattentiveness*¸ which essentially describes negative mood.

Environmental Appraisals

Environmental appraisals were measured by the Perceived Restorativeness Scale (PRS) (Hartig, Korpela, Evans, & Gärling, 1997). The scale is based off the Kaplans' Attention Restoration Theory, and rates the perception of restorativeness of an environment in all four constructs of ART: being away, fascination, compatibility, and coherence/extent. The PRS creates two factors, a "General PRS" factor, which includes being away, fascination, and compatibility and a "Coherence/Extent" factor which is negatively related to restorativeness (higher scores indicate lower perceived restorativeness). It is a Likert-type 7-point scale from 0 (little or not at all) to 6 (completely).

Reverse Digit Span Task

The visual reverse digit span task was used to assess working memory capacity. Digits were displayed on a projected screen for 800ms in succession, followed by a 10s "Trial _" slide

that told participants which trial was next and gave participants a chance to recall the digits presented, and then rewrite them in reverse order on spaces provided on the questionnaire sheet. There were 14 trials total, starting at 3 digits per trial. Trials increased by one digit in length every other trial. The 14th and final trial, Trial N, was 9 digits long.

Remote Associates Task

The Remote Associates Task (RAT) (Mednick & Mednick, 1962) was used to assess creative thinking. The task presents three target words (e.g., *aid, rubber, wagon*) that, when combined with a subject-generated key word (e.g., *band*), form three different compound words or phrases. 10 problems were presented per version. The task is a finite measure of convergent creativity, graded on a correct/incorrect basis.

3. Procedure

The study employed a repeated measures design. Participants were first measured in a classroom without plants, and then 8 days later were measured again in the same room with plants. In both measurements, the researcher entered the room approximately 7 minutes into each of the three class periods to allow time for the environment to have an effect on participants. The entire procedure took approximately 13 minutes each time, and students returned to their normal class after all questionnaires were collected. Plants were added gradually the week after the first measurement to mitigate Hawthorne effects were participants to realize they were being manipulated. Two questionnaires were produced with two different versions of the RAT, since RAT answers would be remembered in the plant condition from the no-plant condition. The two versions of the questionnaire were randomly distributed to students that had returned consent forms, and then directions were read aloud for the Lundquist mood scale, the PRS, and the RAT. Once students indicated that they had finished all aspects of the questionnaire except the reverse

digit span task, they were directed to the projector screen in the front of the room, at which time directions were spoken aloud for the reverse digit span task. Participants were instructed not to write down the digits while a trial was being presented so that the task drew on working memory. In the no plant condition, questionnaires were collected after reverse digit span completion. In the plant condition, to avoid experimental reactivity of participants, an additional dummy task was added after the reverse digit span task in order to create an excuse for the repeated measure of an otherwise similar task just 8 days after initial measurements. The numbers used for the reverse digit span task were changed in the plant condition, and participants were given a different version of the RAT.

4. Results

Of the 49 students that participated, three were excluded from analyses because they were not present for both measurements, leaving 32 females, mean age 15.09 (SD = 0.69), and 14 males, mean age 15.00 (SD = 0.55) that were included in analyses. After no plant measurements were taken, the researcher noticed an error in one of the RAT problems. For analysis, the incorrect problem from one version of the RAT and one similar in difficulty from the other version were excluded, leaving 9 as the maximum score on the RAT.

Paired *t*-test was used to compare performance on the reverse digit span task between plant (M = 7.72, SD = 2.46) and no plant (M = 5.98, SD = 1.97) conditions. The difference was found to be very significant ($p < 0.01$).

Wilcoxon signed-rank test was used to compare nonparametric data in both conditions (see Fig. 3). The room with plants was ranked as more restorative under the general factor of the PRS, though marginally significantly (Z = 715, p = 0.06), and was also ranked as more restorative under the compatibility subscore of the PRS (Z = 528, p = .05). Additionally,

participants performed better on the RAT in the plant condition, though insignificantly ($Z = 531$, $p = 0.10$).

Simple regression analyses were run to examine interactions between variables. Rankings on the General component of the PRS predicted scores on the Reverse Digit Span Task, though not significantly ($R^2 = 0.08$, $F(1, 44) = 4.02$, $p = 0.05$), and in the negative direction ($\beta = -0.05$). In both the plant and no-plant conditions, task orientation was significantly explained by rankings on the general PRS ($R^2 = 0.16$, $F(1, 44) = 8.11$, $\beta = 0.14$, $p < 0.01$) and ($R^2 = 0.20$, $F(1, 44) = 10.71$, $\beta = 0.16$, $p < 0.01$), respectively. Additionally, in the plant condition inattentiveness was positively predicted by the Coherence/Extent factor of the PRS ($R^2 = 0.24$, $F(1, 44) = 14.15$, $\beta = 0.38$, $p < 0.05$). The same relationship existed in the no-plant condition, though less strongly ($R^2 = 0.10$, $F(1, 44) = 4.90$, $\beta = 0.31$, $p = 0.03$).

No significant differences in performance, mood, or regard for the environment as individual measures were noted among genders, although when the data was split into male and female groups, there were differences in interactions among variables. In the no plant condition, the prediction of task orientation by rankings on the general factor of the PRS was significant for females ($p = .01$), though not for males ($p = .13$). For males, scores on the coherence/extent factor of the PRS negatively predicted scores on the reverse digit span task in the no plant condition ($R^2 = 0.26$, $F(1, 12) = 4.21$, $\beta = -0.51$, $p = 0.06$), though the relationship was insignificant for females ($R^2 = 0.04$, $F(1, 30) = 1.32$, $\beta = 0.21$, $p = 0.26$). In the no plant condition, there was little relationship between inattentiveness and scores on the RAT for females ($R^2 = 0.02$, $F(1, 30) = 0.76$, $\beta = -0.16$, $p = 0.40$), though the relationship was nearly significant for males ($R^2 = 0.26$, $F(1, 12) = 4.29$, $\beta = 0.51$, $p = 0.06$). In the plant condition, there was a nearly significant negative relationship between scores on the general factor of the PRS and

performance on the reverse digit span task ($R^2 = 0.12$, $F(1, 30) = 4.06$, $\beta = -0.35$, $p = 0.05$), though the relationship was insignificant for males ($R^2 = 0.04$, $F(1, 12) = 0.44$, $\beta = -0.19$, $p = 0.52$).

Measure	No-Plant M (SD)	Plant M (SD)
Task Orientation	20.52 (4.33)	19.57 (4.68)
Inattentiveness	15.98 (4.32)	15.67 (3.96)
General PRS	23.65 (12.01)	26.02 (13.10)
Coherence/Extent PRS	7.28 (4.42)	7.37 (5.16)
Being Away PRS	2.52 (2.45)	2.94 (2.45)
Fascination PRS	9.44 (5.27)	10.15 (6.07)
Compatibility PRS	11.70 (5.97)	12.94 (6.29)
RAT	4.78 (1.65)	5.30 (1.40)

Figure 3

5. Discussion

This field experiment explored the effects of indoor plants on the mood, working memory capacity, and creative cognition of high school students. The results are a microcosm for the lack of congruity in the existing indoor plant literature. In accordance with Shibata & Suzuki's 2002 study in which an increase in task productivity was noted in a plant condition, participants performed better in the plant condition on the reverse digit span task, though, contrary to expectations, performance was negatively related to perceived restorativeness. This negative relationship does not support Kaplan's ART (1985), as the reverse digit span task is a measure of working memory that is mediated by directed attention, which according to ART, should have been augmented in a more restorative room. It is possible that the environment was overwhelming for those students that ranked it as restorative, and it actually distracted them from the relatively monotonous work of memorizing digits. Shibata & Suzuki's "task-environment compatibility" hypothesis is supported by this research, as improvement on the RAT in the plant condition was minimal, while the reverse digit span saw significant improvement. This

improvement may have simply been related to the In accordance with Ulrich's stress-reduction theory (1983), the restorativeness of the environment, as ranked by the PRS on both the general and coherence/extent factor, had a strong positive effect on task orientation and inattentiveness, respectively, in both the room with plants and without plants. It is possible that students were not entirely truthful in their responses on the PRS, and were ranking their opinions of the content of the class rather than the physical content of the classroom. Regardless, it could be difficult for young high school students to rank their high school classroom as a place where they "could find ways to enjoy" themselves.

While there were no differences in performance noted among genders often cited in the literature (e.g., Kim & Mattson, 2002, Shibata & Suzuki, 2002, Shibata & Suzuki, 2004) there were some differences in interactions among variables that cannot be explained by present theories. For example, the significant prediction of positive mood, as measured by the task orientation factor of Lundquist's mood scale, by rankings of restorativeness, as ranked on the general factor of the PRS, for females but not for males suggests that either females responded differently to the environment, or possibly were more truthful in their opinions of the environment. Conversely, the coherence/extent factor of the PRS only had a significant effect on inattentiveness for males. The literature suggests that restorative environments may affect females more than males.

6. Conclusion

This study is an important addition to the literature because of its ability to demonstrate that a few plants can improve the restorativeness of a classroom. While the literature has proven that plants in a room can improve perceived restorativeness, mood, and directed attention in a true-experimental design with college-aged students, few studies have shown that plants can be

practically utilized to benefit high school students in a classroom. While this study does not produce evidence that plants create improvements in student working memory capacity or creativity, it does suggest that plants can improve the restorativeness of an environment, and that perceived restorativeness of a classroom has a strong effect on the mood of high school students. Additionally, this research does cite a gender difference that is beginning to arise out of various indoor plant studies. More research is needed before a comprehensive theory regarding gender differences in environmental perception can be formulated.

References

Berman, M. G., Jonides, J., Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science, 19*(12), 1207-1212.

Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology*, *25,* 249-259.

Berto, R., (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology, 25,* 249-259

Dijkstra, K., M. E. Pieteterse, Pruyn, A. (2008). Stress-reducing effects of indoor plants in the built healthcare environment: The mediating role of perceived attractiveness. *Preventative Medicine, 47,* 279-283.

Hartig, T., Evans, G. W., Jamner, L. D. Davis, D. S., & Garling, T. (2003). Tracking resoration in natural and urban field settings. *Journal of Environmental Psychology, 23,* 109-123.

Kaplan, R. (1995). The restorative benefits of nature: toward an integrative framework. *Journal of Environmental Psychology, 15,* 241-248.

Kim, E., Mattson, R. H. (2002). Stress recovery effects of viewing red-flowering geraniums. *Journal of Therapeutic Horticulture, 13,* 4-12.

Larsen, L., Adams, J., Deal B., Kweson, B. S., & Tyler, E. (1998). Plants in the workplace: the effects of plant density on productivity, attitudes, and perceptions. *Environment and Behavior*, *30,* 261-281.

Lohr, V. I., Pearson-Mims, C. H., & Goodwin, G. K. (1996). Interior plants may improve worker productivity and reduce stress in a windowless environment. *Journal of Environmental Horticulture*, *14,* 97-100.

Raanaas, R. K., Evensen, K. H., Rich, D., Sjøstrøm, G., Patil, G. (2011). Benefits of indoor plants on attention capacity in an office setting. *Journal of Environmental Psychology, 31,* 99-105.

Shibata, S., & Suzuki, N. (2001). Effects of indoor foliage plants on subjects' recovery from mental fatigue. *North American Journal of Psychology, 3,* 385-396.

Shibata, S., & Suzuki, N. (2002). Effects of indoor foliage plants on task performance and mood. *Journal of Environmental Psychology, 3,* 385-396.

Shibata, S., & Suzuki, N. (2004). Effects of an indoor plant on creative task performance and mood. *Scandinavian Journal of Psychology, 3,* 385-396.

Ulrich, R. S., (1983). Aesthetic and affective response to natural environments. In: I. Altman, & J. F. Wohlwill (Eds.), *Human behavior and the natural environment* (pp. 85-125). New York: Plenum.

Ulrich, R. S., (1984). View from a window may influence recovery from surgery. *Science, 224,* 420-421.