HortScience 40(5):1354–1359. 2005.

# Human Response to Window Views and Indoor Plants in the Workplace

**Chen-Yen Chang[1] and Ping-Kun Chen[2]**
*Department of Horticulture, National Chung Hsing University, 250, Kuokuang Road, Taichung, Taiwan 40227*

*Additional index words.* workplace, window, plants, state-anxiety, biofeedback

*Abstract.* **The purpose of this paper was to report the effects of window views and indoor plants on human psychophysiological response in workplace environments. The effects of window views and indoor plants were recorded by measuring participant's electromyography (EMG), electroencephalography (EEG), blood volume pulse (BVP), and state-anxiety. Photo Impact 5.0 was used to simulate the environment in an office, where six conditions were examined: 1) window with a view of a city, 2) window with a view of a city and indoor plants, 3) window with a view of nature, 4) window with a view of nature and indoor plants, 5) office without a window view, and 6) office without a window view and indoor plants. Participants were less nervous or anxious when watching a view of nature and/or when indoor plants were present. When neither the window view nor the indoor plants were shown, participants suffered the highest degree of tension and anxiety.**

Environmental psychology, horticulture, outdoor recreation, and other human–environment interaction fields of study have long been interested in the influence of nature and plants on human well-being. In the 1970s, researchers exploring the psychological role of nature applied psychometric measures to investigate the environmental perception and cognitive states of human subjects in natural environments (Kaplan, 1973; Ulrich, 1979). Since the 1970s, however, some researchers have begun to investigate the effects of landscapes and/or views of nature on the participants' biological, as well as psychological responses to different environments (Ulrich, 1981, 1983, 1986; Ulrich and Simons, 1986). Studies found that exposure to environments with plants can have both physiological and psychological benefits (Hartig et al., 1991; Ulrich and Simons, 1986; Ulrich, 1981; Ulrich, 1991; Ulrich and Parsons, 1992). In addition, experiences in nature and/or wilderness environments can help with stress management and be restorative (Kaplan and Kaplan, 1989). The soft beauty in nature enhances mental health in terms of recovery from mental fatigue, and generates opportunities for cognitive restoration (Herzog et al., 1997).

Traditionally, research methods for evaluating environmental perception, cognition, and other human–environment interaction effects have been based upon psychology. Visual stimuli studies have shown that different landscapes (i.e., urban versus natural) and scenes of various environments can induce different psychological and physiological effects in viewers (Ulrich, 1983). Compared to participants in urban and nonnatural environments, those who are immersed in nature or surrounded by plants tend to receive more positive psychological stimulation and exhibit abilities to recover faster from illness (Herzog et al., 1997; Kaplan, 1973; Ulrich, 1981; Yang and Brown, 1992). It has also been shown that nature has positive effects upon other psychological and physiological states of well-being. For example, views of nature evoke higher aesthetic responses and more positive feelings of well-being than do views of nonnatural environments. Nature also is important in encouraging feelings of attachment to particular places and types of environments (Kaplan, 1973; Ulrich, 1981).

Researchers such as Chang and Perng (1998), Chang and Tzeng (1998, 1999), Chang and Uan (1999), and Ulrich (1981, 1986) have been exploring and determining the influence of visual stimuli upon physiological response and condition. The present study extends this line of research by focusing upon the connection between conditions of the workplace and human psychological and physiological response. The purpose was to explore the effects of window views of natural versus urban visual content and the presence of indoor plants on participants' physiological and state-anxiety well-being. Specific hypotheses tested included the following:

1) Participants' physiological reactions vary significantly ($p < 0.05$) when viewing different window views and indoor plant environments.
2) Participants' state-anxiety levels change significantly when viewing different window views and indoor plant environments.
3) Certain combinations of views from the window and of indoor plants provide more positive physiological and psychological well-being in office workplaces than other combinations.

## Conceptual Background

Theories concerning conditions of the workplace and human psychological and physiological response posit that windows in the workplace provide workers relief from stress, and higher satisfaction with the working environment. Kaplan (1995) points out that employees' with views of nature, such as flowers and trees, are more satisfied and less stressed than those who see only buildings outside their windows or lack window views entirely. A small portion of nature in the view is often sufficient to help (Honeyman, 1992). The duration of viewing nature does not have to be long, either. Even viewing artificial nature helps with stress and anxiety relief (Ulrich, 1991).

To measure biological response to workplace and other environments, biofeedback is monitored to detect the physiological conditions of research participants. Biofeedback is a result of monitoring a bodily function, such as muscle tension, skin temperature, brain waves, skin electric reaction, blood pressure, and heart rate. It is used in biofeedback therapy, a process of treating illness by revitalizing body functions. For example, emotional and cognitive responses are initiated by the cerebral cortex and limbic system, which in turn stimulate the hypothalamus–pituitary gland and lead to reactions of the autonomic nervous system, thus producing physiological reactions. However, the physiological reactions to the environmental stimuli may be undetectable by human consciousness or observation. Biofeedback instrumentation measures used in psychological studies can identify certain changes and conditions of body functions and well-being that may be outside the conscious awareness of human beings and therefore, may not be identified or assessed with validity using only verbal and observational measures (Ulrich, 1986). Biofeedback testing is necessary to objectively detect and monitor the direction and intensity of these physiological reactions (Shiu and Wang, 1993).

An index measure of state-anxiety was selected to determine change in psychological condition. State-anxiety is a short-term emotional state stimulated by a certain situation or environment (Spielberger et. al., 1983). Its occurrence and intensity are mainly related to a person's cognitive response that corresponds to the stressful and nervous feelings caused by certain stimuli. The discontinuousness of state-anxiety is associated with the disappearance of stimuli. As a result, state-anxiety seems an appropriate index measure of participants' psychological reaction caused by visual stimuli that is changed (stimulated) within a study environment (i.e., office workplace).

## Methods

*Study area and participants.* The research was conducted in the psychophysiological laboratory of the Department of Horticulture, National Chung-Hsing University, located in Taichung, Taiwan in 2002. One of several ongoing studies to investigate both psychological and physiological responses in humans to differing landscape and environmental conditions (Chang and Perry, 1998; Chang and Tzeng, 1998, 1999; and Chang and Van, 1999). The participants were the volunteer students form the Horticulture department in the National Chung-Hsing University. Although the sample

Received for publication 19 Sept. 2004. Accepted for publication 16 Dec. 2004. William E. Hammitt contributed considerably to the practical implications portion of the discussion.
[1]Professor, Department of Horticulture, National Taiwan University.
[2]Master.


Fig. 1. (**A**) Workplace office environment with six difference window view and plant simulations that respondents viewed. (**B**) Arrangement of indoor and outdoor plants in simulated workplace.

consisted of students, studies have shown that students can represent the public on research involving visual stimuli (Kaplan & Herbert, 1987). Participants in this study were selected via a convenience sample. In total, 38 students participated in the study, including 10 males (26.4%) and 28 females (73.6%). All of the participants were in good health condition evaluated by asking the questioning items of "Twelve hours before this test, do you have more nicotine, alcohol than usual?", "Twelve hours before this test, did you have any drugs?", "One week before this test, did you have any sickness?", "Do you feel uncomfortable during this test?", and "Do you feel sleepy or unable to concentrate during this test?" at the time of laboratory testing, a necessary when monitoring physiological measures.

*Workplace stimuli.* Using the computer software Photo Impact 5.0, six different office environments were simulated, each containing various degrees and combinations of window views and indoor plants. The six combination slides that participants viewed were the following (Fig. 1):

1) office without a window view and no indoor plants,
2) office without a window view but indoor plants present,
3) office with a window view of a cityscape but no indoor plants present,
4) office with a window view of a cityscape and with indoor plants,
5) office with a window view of nature but no indoor plants present,
6) office with a window view of nature plus the presence of indoor plants.

Participants were tested in the research laboratory (7 ×5 m) with room temperature constantly maintained at 25 degrees centigrade. They were seated on a couch at a 3-m distance from the viewing screen. The biofeedback recording devices were placed behind the participants to decrease the disturbance of the machines to the participants.

*Experimental procedures.* An experimental design was developed to evaluate the possible effects of office environments on participant's psychophysiological condition when viewing the six combinations of workplace stimuli. Different plant and window view combinations were considered sources of stimuli to stimulate participant's physiological response. The physiological resonse that resulted from viewing the slides, and from the interaction between the sympathetic nervous system and the parasympathetic nervous system, was recorded by a biofeedback device that was connected to each participant. To record continuous and on-going changes in physiological condition, we used the Procomp$^{+}$/Biograph V2.0 Biofeedback System made by Thought Technology Ltd., a system with a multi-modality 8-channel system that sends resulting information directly to the computer via a fiber-optic cable. Computer analysis software and precise sensors are included as part of the system.

A full interpretation of the testing procedure was given to the respondents before the test. During attaching the electrodes, the function and the application of the biofeedback instrument were explained to the respondents. The whole testing procedure was explained before the test started to prevent the respondents nervous. The biofeedback instruments recorded the respondents' responses continuously. The data while the respondents viewing the testing slides were collected.

While participants were being continuously monitored for physiological reaction during slide viewing they were asked to complete the State–Anxiety Inventory. There were two parts to the procedure. First, participants were asked to use adjectives to describe the office shown in the picture to help them immerse in the environment. Participants then proceeded to view the testing slides and collecting their physical reactions. After that, they start to complete the State–Anxiety Inventory. The viewing period of each image is 15 s, there is a blank blue slide showing 5 s in between the testing images. A natural scenery slide showing 24 s before each testing slide was used as the baseline visual stimulus. The same steps were repeated until all six workplace environments were tested. Figure 2 shows the timeline of the testing procedure. To prevent the order effects from viewing of the office scenes, three different sets of slides, shown slide orders randomly, were used during the experiment.

*Psychophysiological measurements.* Three instrument-related measures were monitored to determine change in physiological condition during the viewing of the six simulated office workplace environments.

*Electroencephalography (EEG).* Recording of brain waves involved placing electrodes on the scalp, through which the brain waves, produced by the cerebral cortex, were amplified and recorded by the electroencephalograph. Electrolytic glue with electrolytes was used

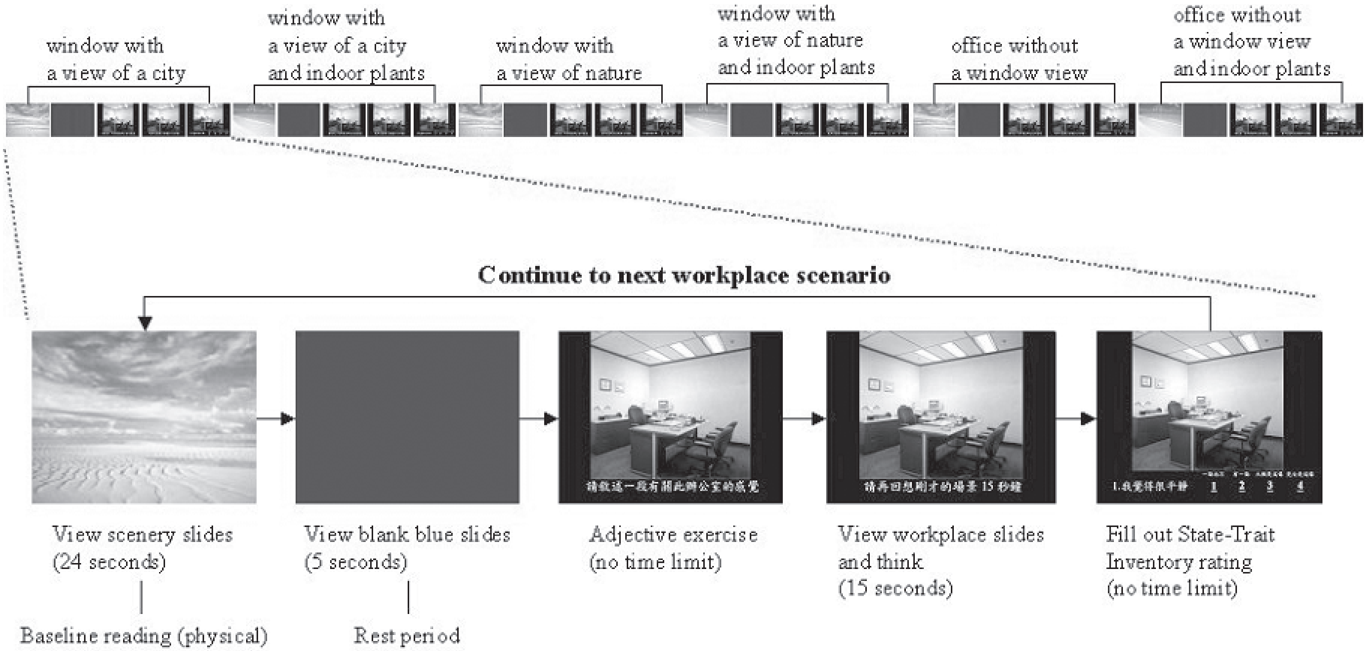


Fig. 2. The timeline of the testing procedure.

to attach the electrodes to the scalp. There were two kinds of electrodes that receive brain waves. The activated electrode, also called the investigating electrode or the relevant electrode, is an elastic cap placed on the scalp to record the brain waves. In addition, a clip on each earlobe, the base electrode, also called the inactivated electrode or the irrelevant electrode, provides a reference point for the brain activity. The medial prefrontal cortex is the main position where the EEG is performed. For the convenience of the experiment, the electrodes were attached, at equal distance, at the front, back, left and right of forehead. EEG-a and EEG-b were individually recorded. EEG-a is a measure of alpha wave activity of the left side of the brain, while EEG-b records the right side of the brain. The higher readings of the collected data indicate the respondents in a more relaxed but still wakeful condition. Relaxed wakefulness is the term often used to characterize the state during which alpha activity is predominant (Cacioppo et al., 2000).

*Electromyography (EMG)*. Compared to other muscles, the facial muscles on the forehead can better reflect mental and emotional tension or stress. Muscles on the forehead are not postural muscles, and can more easily detect the change in physiological reaction due to the visual stimuli. In addition, tension felt by the forehead extends to other parts of the body, even while other parts of the body are relaxed (MOE Electronics Research and Production, 1997). To monitor EMG, three electrodes are placed 1.5 inches above the eyebrows; the middle one is the reference, a reference point of the other two electrodes, called source 1 and source 2. By using the potential difference between the reference and source 1 as well as source 2, unrelated information is eliminated (Peek, 1995). An increase in EMG amplitude indicates the level of muscle tension increase.

*Blood volume pulse (BVP)*. Also called photoplethysmography, bounces infrared light against a skin surface and measures the amount of reflected light. This amount will vary with the amount of blood present in the skin. At each heart beat (pulse), there is more blood in the skin—blood reflects red light and absorbs other colors—and more light is reflected. Between pulses, the amount of blood decreases and more red light is absorbed. This measure is an indication of vasomotor activity and of sympathetic arousal. The BVP signal is a relative measure. It does not have a standard unit (Thought Technology, 2001). From the BVP signal, the software calculated the heart rate and inter-beat interval. The pulse percentage was used in this study. The higher the pulse percentage shows a higher tension condition.

EEG was used to record bioelectrical responses, alpha activity occurs when a person is resting quietly. Beta activity occurs when a person is alert and aroused (Carlson, 1988). Generally, higher alpha EEG activity is more associated with relaxed conditions than with states of stress (Fazio and Cooper, 1983). We state generally because both increases and decreases in EEG responses have been reported in the literature, and interpreted as representing different physiological conditions (Parsons et al., 1998). Restorative environments and experiences in natural areas provide for recovery from stress (Korpela et al., 2001) and, thus, should result in higher alpha EEG activity.

EMG have been used to investigate patterns of facial muscle response during the expression of different emotions, the differential patterns while viewing pictures of positive and negative stimuli, and to investigate gradients of muscular tension during motivated behavior

Table 1. Mean and standard deviation (SD) of respondents' response values when looking at different pictures of workplace environments. Note: The EEG-a, EEG-b, and EMG is measured with µV. The BVP signal is a relative measure. It does not have a standard unit. For State–Trait Anxiety, there are 20 questions (e.g., I fell calm; I feel frightened; I feel nervous; etc) based on four rating scales. Thus, individual State–Trait Anxiety scores can range from 20 to 80; the higher the value, the lower the state-anxiety level. O = without a window view, OP = without a window view + indoor plants, C = window with a view of a city, CP = window with a view of a city + indoor plants, N = window with a view of a nature, NP = window with a view of a nature + indoor plants.

| Measurement | O | OP | C | CP | N | NP | F | Pairwise comparisons |
|---|---|---|---|---|---|---|---|---|
| EEG-a | 0.13 (0.21) | 0.09 (0.17) | 0.19 (0.26) | 0.06 (0.17) | 0.18 (0.26) | 0.16 (0.25) | 3.32** | O*CP; CP*N; CP*NP; CP*C N*OP; OP*C |
| EEG-b | 0.16 (0.24) | 0.12 (0.22) | 0.13 (0.19) | 0.09 (0.19) | 0.14 (0.25) | 1.11 (2.36) | 6.29*** | O*NP; CP*NP; N*NP; OP*NP; NP*C |
| EMG | 0.20 (0.17) | 0.23 (0.17) | 0.15 (0.18) | 0.23 (0.17) | 0.25 (0.19) | 0.21 (0.19) | 4.65** | O*CP; O*N; O*OP; O*NP; CP*C; N*NP; N*C; OP*NP; OP*C; NP*C |
| BVP | 14.67 (0.22) | 14.16 (0.24) | 15.25 (0.22) | 11.58 (0.25) | 9.80 (0.21) | 11.66 (0.17) | 16038.01*** | O*CP; O*N; O*OP; O*NP; O*C; CP*N; CP*OP; CP*NP; CP*C; N*OP; N*NP; N*C; OP*NP; OP*C; NP*C |
| State-anxiety | 53.97(11.37) | 55.45(9.72) | 63.45(8.87) | 69.00(6.15) | 68.82(8.11) | 69.50(8.98) | 27.50*** | O*CP; O*N; O*NP; O*C; CP*OP; CP*C; N*OP; N*C; OP*NP; OP*C; NP*C |

**,***Significant at < 0.01 or 0.001 (two-tailed).

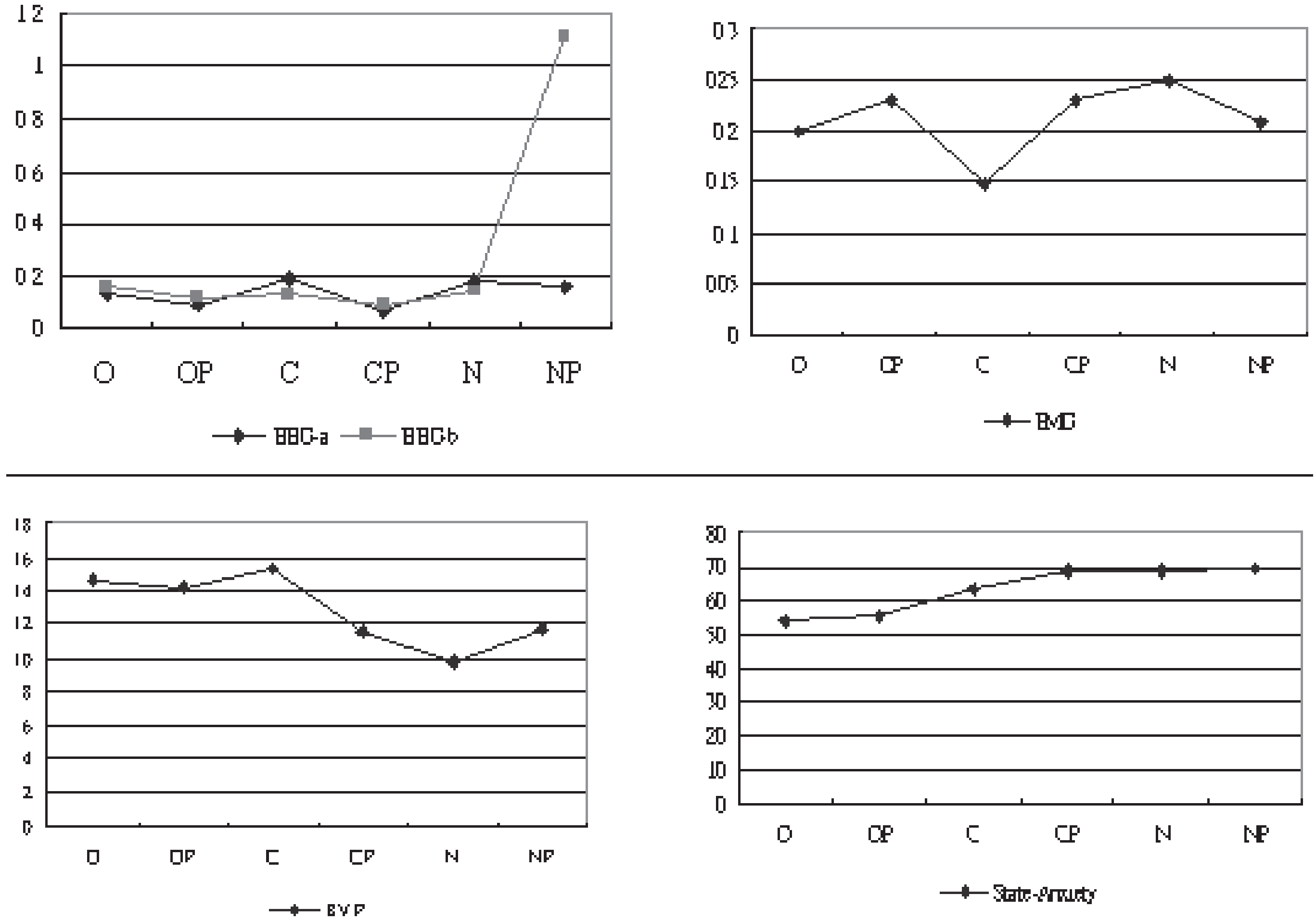


Fig. 3. Mean plot of respondents' response values when looking at different pictures of workplace environments.

(Andreassi, 2000). Research by Cacioppo et al. (1990) asked female students to view slides of social scenes (i.e., a person expressing emotion) and nature scenes (i.e., a mountain) that were pleasant, neutral, and unpleasant. Results from this experiment indicated that facial EMG responses can vary with emotional stimuli even though the muscle activity is too small to show up as overt changes in facial expressions.

Ulrichet al. (1991) found a significantly greater reduction in muscle tension and that stress recovery was faster and more complete with exposure to natural than to urban settings. Davis and Thaut (1989) reported a significant increase in EMG response when subjects listened to a tape of preferred music that was perceived as stimulating and pleasant.

BVP, cardiovascular responsiveness to stress is currently receiving a great deal of attention (Andreassi, 2001). Research on the effects of stressors on the cardiovascular system suggests that there is a strong and concerted change of the sympathetic nervous system in response to potent stressors. The effects of an increase in sympathetic activation on the cardiovascular system produce concurrent increases in heart rate and blood pressure.

*State–anxiety*. Psychological reactions were measured by the State–Anxiety Inventory, designed by Spielberger et al. (1983) to detect an individual's feelings at a certain period in time. The inventory consisted of 20 questions (e.g., I feel calm; I feel frightened; I feel nervous; etc). Participants rated each of the 20 items as to how they felt when viewing each office scene, based on the following four point scale: 1 = not at all, 2 = somewhat, 3 = moderately, 4 = very much. Participants' state-anxiety score was determined by summing their ratings for the 20 item inventory. Thus, individual State–Anxiety scores could range from 20 to 80, the higher the value, the lower the state-anxiety level.

Differences in physiological and psychological effects as a result of viewing the six workplace slides with various combinations of window views and indoor plants were analyzed by using analysis of variances (ANOVA), by SPSS v.10.0.

## Results

The six scenes were the independent variables and the EEG, EMG, BVP, and State–Anxiety values were the dependent variables (Table 1). Results of the ANOVA indicate that

Table 2. Mean and standard deviation (SD) of respondents' response values when looking at different workplace environments views. Note: The EEG-a, EEG-b, and EMG is measured with μV. The BVP signal is a relative measure. It does not have a standard unit. For State–Trait Anxiety, there are 20 questions (e.g., I fell calm; I feel frightened; I feel nervous; etc) based on the 4 rating scales. Thus, individual State–Trait Anxiety scores could range from 20 to 80; the higher the value, the lower the state-anxiety level. O = without a window view, OP = without a window view + indoor plants, C = window with a view of a city, CP = window with a view of a city + indoor plants, N = window with a view of a nature, NP = window with a view of a nature + indoor plants.

| Measurement | O+OP | C+CP | N+NP | F | Pairwise comparisons |
|---|---|---|---|---|---|
| EEG-a | 0.11 (0.14) | 0.13 (0.17) | 0.17 (0.21) | 3.19$^{*}$ | (O+OP)$^{*}$(N+NP) |
| EEG-b | 0.14 (0.20) | 0.11 (0.15) | 0.62 (1.18) | 6.70$^{**}$ | (O+OP)$^{*}$(N+NP), (C+CP)*(N+NP) |
| EMG | 0.21 (0.16) | 0.19 (0.15) | 0.23 (0.18) | 3.25$^{*}$ | (C+CP)$^{*}$(N+NP) |
| BVP | 14.42 (0.21) | 13.42 (0.23) | 10.73 (0.18) | 222733.57$^{***}$ | (O+OP)$^{*}$(C+CP), (O+OP)$^{*}$(N+NP), (C+CP)$^{*}$(N+NP) |
| State–Anxiety | 54.71 (9.13) | 66.22 (6.25) | 69.16 (6.97) | 44.27$^{***}$ | (O+OP)$^{*}$(C+CP), (O+OP)$^{*}$(N+NP) |

$^{**,***}$Significant at < 0.01 or 0.001 (two-tailed).

office workplace environments do influence people's physiological condition (Table 1). Mean values for EEG-b indicate that scenes having a window with a view of nature plus indoor plants had the greatest effect (EEG-b = 1.11, SD = 2.36) (Fig. 3); while simply having a window view, whether of nature or a cityscape, had higher EEG-a effects (Table 2). Also, office space with window views of nature produced the lowest BVP in participants' (mean = 9.80; SD = 0.21). In general, our data indicate that a window view results in more positive effect in an office workplace than indoor plants, and that a window with a view of nature has more effect than one of a cityscape.

The test for differences in psychological state among the six workplace environments support hypothesis two; that window scenes and the presence of indoor plants can significantly change the anxiety level of participants ($F = 27.50$, $df = 5$, $p < 0.001$; Table 1). Concerning participants' mean scores of state-anxiety, window with a view of nature + indoor plants (mean = 69.50), window with a view of a city + indoor plants (mean = 69.00), and window with a view of nature (mean = 68.82) resulted in the highest state-anxiety values, indicating that participants were less anxious in those environments. As found in the physiological data, an office with a window view has more of a psychological effect than the presence of indoor plants

Hypothesis three states that certain window views and indoor plant combinations will have more of a positive (desired) psychophysiological effect than other combinations. The data in Tables 1 and 2 partially support this hypothesis. A window with a view of nature plus indoor plants produced the most positive response among combinations, illustrated by higher brainwave activity (EEG-b = 1.11, Table 1) and by state–anxiety level (mean = 69.50, Table 1).

Table 2 compares the psychophysiological effect of different windows. Window with a view of nature had the best effect on EEG-a, EEG-b, BVP, and State-Anxiety. Only EMG showed a lower effect compared to window with a view of a city; window with a view of a city also had the worse effect on EEG-b.

## Discussion

Environmental psychologists, horticulturalists, and associated researchers concerned with human–environment interactions have argued that humans respond more positively to the content of natural environments than to that of urban environments. Kaplan and Kaplan (1989) have provided a conceptual basis to support the argument; Hartig et al. (1991) have provided empirical, psychological support, Ulrich (1984) and Ulrich and Parsons (1992) have provided physiological evidence; and Kaplan et al. (1998) have provided design implications in landscaped and natural environments. Mounting evidence indicates that when in natural environments, and/or even when viewing natural environments, that humans react positively in terms of 1) aesthetic and affective response (Ulrich 1983), 2) psychological well-being (Ulrich 1979), 3) psychophysiological effects (Ulrich 1981), and 4) stress recovery (Ulrich and Simons 1986). Human response to vegetation, the color green, indoor plants, and plant-scapes viewed through the window have all been hypothesized to be a benefit to humans (Ulrich 1991). However, few studies have manipulated and/or simulated combinations of indoor plants and window views in the office workplace to research the combined effects on people.

An obvious question to ask is, "why study the workplace and the influence of plants and window views on the psychophysiological condition of people in this specific environment?" One reason is that for many people, the office workplace is where they spend at least one-third of their time; ≥8 h of the 24-h day. The office workplace is often a stressful, tension-filled, and fatiguing environment with few elements of nature other than the presence of indoor plants and some window views. Yet, past psychophysiological data and our study findings indicate that the presence of indoor plants and landscape window views serve more of a purpose than just providing interior and architectural design pleasantries, respectively. And, they serve more of a purpose than the providing of stimuli in an otherwise artificial, stimulus-deprived environment (Ulrich 1991). A criticism of Ulrich's classic article in *Science* (Ulrich 1984) was that the reported health benefits of viewing nature through the hospital window was not due to nature but the effects of a window (regardless of the nature view) in an otherwise stimulus-deprived environment. Ulrich (1991), and Ulrich and Parsons (1992) have addressed this criticism by manipulating the content viewed through the window and demonstrating that the viewing of natural environments is the key component to human response.

Our data supplements the work of others concerning the importance of viewing nature, even through windows in the everyday office workplace. Windows in the workplace had more of a psychophysiological influence than the presence of indoor plants, and natural landscape views had more effect than cityscape window views. How can these findings be used by horticulturists to influence the psychophysiological well-being of office workers? First, we would suggest that horticulturists and landscape designers need to view the plants and landscapes around buildings from the perspective of an inside-out view, and not just from an outside perspective. Plant selection and landscape design needs to be considered with the view outward from windows just as much as with the aesthetic view around the outside of buildings. After all, workers spend <5 min viewing nature, plants, and landscapes as they enter work buildings, but spend 8 h within the office workplace where window views may or may not be present. In industrial parks, university campuses, and other more open environments that will accommodate large trees, the planting of bigger trees and faster growing trees that can be viewed from windows on the third, fourth, and fifth floors of buildings is recommended. Clearing of horticulturally less desirable native trees during construction so that more interesting and unique landscape stock may be designed for the exterior of buildings may not be the wisest decision from the perspective of having a natural view from windows 50 to 80 ft off the grounds. As demonstrated with empirical, psychophysiological data, a brief view out the window from one's desk of the natural environment may be more important to the well-being of office workers than the expensive landscape designs that architects require at the entrance and foundation of buildings. At the other extreme, in urban environments where buildings are close and tight spaces do not allow for the planting of large trees, flower gardens, indoor plants, and window boxes are recommended (Kaplan, 1973, 1983).

## Literature Cited


Andreassi, J.L. 2000. Psychophysiology, human behavior, and physiological response. 4th ed. Lawrence Erlbaum Associates, Mahwah, N.J.

Cacioppo, J.T., L.K. Bush, and L.G. Tassinary. 1990. Microexpressive facial actions as a function of affective stimuli: Replication and extension. Personality Soc. Psychol. Bul. 18:515–526.

Cacioppo, J.T., L.G. Tassinary, and G.G. Berntson. 2000. Handbook of psychophysiology. 2nd ed. Cambridge University Press, Cambridge, U.K.

Carson, N.R. 1988. Foundations of physiological psychology. Allyn and Bacon, Boston, Mass.

Chang, C.Y. and J.L. Perng. 1998. Effect of landscape on psychological and physical responses. J. Therapeutic Hort. 1:73–76.

Chang, C.Y. and T.H. Tzeng. 1998. Research of influences of hospital environment on patient's physical and psychological reactions. J. Chinese Soc. Hort. Sci. 46:231–246.

Chang, C.Y. and T.H. Tzeng. 1999. Influence of landscape environment on EMG. Museum Bul. 13:99–111.

Chang, C.Y. and L.L. Uan. 1999. Influences of landscape types on recovery of concentration and EMG. J. Landscape 7:1–22.

Davis, W.B. and M.H. Thaut. 1989. The influence of preferred relaxing music on state anxiety, relaxation, and physiological responses. J. Music Therapy 26:168–187.

Fazio, R. H., and J. Cooper. 1983. Arousal in the dissonance process. In: J.T. Cacioppo and R.E. Petty (eds.). Social psychophysiology. The Guilford Press, New York.

Hartig, T., M. Mang, and G.W. Evans. 1991. Restorative effects of natural environment experiences. Environ. Behavior 28:44–72.

Herzog, T.R., A.M. Black, and D.J. Knotts. 1997. Reflection and attention recovery as distinctive benefits of restorative environments. J. Environ. Psychol. 17:165–170.

Honeyman, M.K. 1992. Vegetation and stress: A comparison of varying amounts of vegetation in countryside and urban scenes, p. 143–145. In: D. Relf (ed.). The role of horticulture in human well-being and social development. Timber Press, Portland, Ore.

Kaplan, R. 1973. Some psychological benefits of gardening. Environ. Behavior 5(2):145–162.

Kaplan, R. 1983. The role of nature in the urban context. In: I. Altman and J.F. Wohlwill (eds.). Behavior and the natural environment. Plenim Press, New York.

Kaplan, R. and E.J. Herbert. 1987. Culture and sub-culture comparisons in preferences for natural setting. Landscape Urban Planning

14:281–293.
Kaplan, R. and S. Kaplan. 1989. The experience of nature: A psychological perspective. Cambridge University Press, New York.
Kaplan, S. 1995. The restorative benefits of nature: Toward an integrative framework. J. Environ. Psychol. 15:169–182.
Korpela, K.M., T. Hartig, F.G. Kaiser, and U. Fuhrer. 2001. Restorative experiences and self-regulation in favorite places. Environ. Behavior 33:572–589.
MOE Electronics Research and Production. 1997. Biofeedback manual. MOE Electronics Res. and Prod., Soquel, Calif.
Parsons, R., K.G. Tassinary, R.S. Ulrich, M.R. Hebl, and M. Grossman-Alexander. 1998. The view from the road: Implications for stress recovery and immunization. J. Environ. Psychol. 18:113–139.
Peek, C.J. 1995. A primer of biofeedback instrumentation, p. 45–95. In: M.S. Schwartz et al. (eds.). Biofeedback practitioner's guide. 2nd ed. The Guilford Press, New York.
Shiu, B. and S. D. Wang. 1993. Psychosomatic disorder—The basis and clinical cases of somatoform. Ho-Chi Publ. Co. Ltd., Taipei.
Spielberger, C.D., R.L. Gorsuch, P.R. Vagg, and G.A. Jacobs. 1983. Manual for the State–Trait Anxiety Inventory. Consulting Psychologists Press, Palo Alto, Calif.
Thought Technology. 2001. Tech note 009. Thought Technology Ltd., New York.
Ulrich, R.S. 1979. Visual landscape and psychological well-being. Landscape Res. 4:17–23.
Ulrich, R.S. 1981. Natural versus urban scenes: Some psychophysiological effects. Environ. Behavior 13:523–556.
Ulrich, R.S. 1983. Aesthetic and affective response to natural environment, p. 85–125. In: I. Altman and J.F. Wohlwill (eds.). Behavior and the natural environment. Plenim Press, New York.
Ulrich, R.S. 1986. Human responses to vegetation and landscape. Landscape Urban Planning 13:29–44.
Ulrich, R.S. 1991. Psychophysiological indicators of leisure, p. 73–89. In: B.L. Driver, P.J. Brown, and G.L. Peterson (eds.). Benefits of leisure. Venture Publishing Inc, State College, Pa.
Ulrich, R.S. and R. Parsons. 1992. Influences of passive experiences with plants on individual well-being and health, p. 93–105. In: D. Relf (ed.). The role of horticulture in human well-being and social development. Timber Press, Portland, Ore.
Ulrich, R.S. and R.F. Simons. 1986. Recovery from stress during exposure to everyday outdoor environments, p. 115–122. Proc. 17th Annu. Conf. Environ. Design Res. Assn.
Ulrich, R.S., R. Simons, B.D. Losito, E. Fiorito, M.A. Miles, and M. Zelson. 1991 Stress recovery during exposure to natural and urban environments. J. Environ. Psychol. 11:201–230.
Yang, B.E. and T.J. Brown. 1992. A cross-cultural comparison of preferences for landscape styles and landscape elements. Environ. Behavior 24(4):471–507.