Influences of Foliage Plants on Human Stress during Thermal Biofeedback Training

SPECIAL NEEDS

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Summary. **Twelve 20-minute thermal biofeedback sessions were conducted with 26 university students. Visual stimuli were provided by a living foliage plant, a life-sized color photograph of that plant, *or* a metal stool (control). Of the participants, 38% responded positively to the presence of a live plant or plant photograph, while 23% showed lower stress in the control room. Stress reduction, as indicated by higher skin temperatures, occurred within the first 5 to 8 minutes of a 20-minute thermal-biofeedback session. A nonplant visual stimulus was not part of the experiment. The results are not intended as comparative, nor do they attribute unique or superior effects to plants. Due to the small number of participants, no significant results were obtained, but the trends were important and are being reported to help further research in this area.**

Recently, researchers have addressed the influence of plants on an individual's well-being. Plants have had a positive effect on the way an indoor environment is perceived (Laviana et al., 1983). Recovery from stress occurred in 4 to 6 min when participants passively viewed

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videotapes of natural scenery (Ulrich and Simmons, 1986). Passive viewing of live plant materials exhibited a therapeutic effect on patients in hospital settings(Talbott et al., 1976; Ulrich, 1983). Doxon et al. (1987) reported significantly improved systolic and diastolic blood pressure, electrodermal response, and finger skin temperature measures of adults with developmental disabilities actively working in a greenhouse rather than a training center. Owen (1994) found significantly reduced systolic blood pressure and improved psychological well-being in adults walking through a botanical garden.

Humans react daily to 50 to 200 stress-related incidents (Danskin, 1989). These small events may have a greater cumulative effect on our psychological and physical health than major life events, such as the death of a relative (Mason, 1984). One method of assessing stress is through thermal biofeedback, which measures skin temperature of the fingers or toes (Fischer-Williams et al., 1981). When relaxed, individuals learn in training to increase the blood flow to the extremities. This increased blood flow increases finger skin temperature and is indicative of reduced stress on the vital organs (Green and Green, 1977).

A study was conducted to examine the influences of a foliage plant or a life-sized color photograph of the same plant used as a visual focus during thermal biofeedback sessions. Passively viewing a live plant or a plant photograph was expected to decrease the stress equally of participants learning thermal biofeedback methods compared to human responses in the control room. A nonplant visual stimulus was not part of the experiment. The results are not intended to be comparative, nor do they attribute unique or superior effects to plants.

Thirty university students (ages 18 to 34), randomly selected from respondents to an advertisement placed in a university newspaper, participated in 20-min sessions twice a week for 6 weeks. The study was conducted in a classroom climatically controlled to maintain a temperature of 26 ± 2C. A minimum air temperature of 23.4C is necessary for thermal biofeedback research (S. Fahrion, unpublished data). The classroom contained three 1.5 × 2.5 × 3.5-m compartments constructed to separate the treatments.

Each session consisted of three participants individually assigned to a treatment room. One treatment room contained a foliage plant, *Tripogandra multiflora*, grown in a 25 -cm hanging basket, selected for its vivid, predominately green color and inconspicuous flowers. A second treatment room had a 40.5 × 50.8-cm color photograph of that plant. The live plant and photograph were set on a metal stool. The third treatment room was the control and contained a metal stool

Each participant was given about 15 min to adjust from outdoor weather conditions to the indoor controlled climate before beginning the session. Three model T5 temperature biofeedback trainers, which measure skin temperature to 0.1F. were cross-calibrated and used for the study. Room air temperature was recorded to adjust for any variation it might cause in skin temperature, then a thermistor was attached with adhesive tape to the ventral pad of the most distal phalange of the middle finger of the nondominant hand of each participant (Green and Green, 1977;A. Rathbun, unpublished data). Four minutes were allowed for the participants to stabilize skin temperature before pretaped recordings were played of autogenic training phrases developed by Johannes Schultz in 1930 and revised by Green and Green in 1966. These tapes provided a consistent audio background of relaxation instructions. Skin temperatures were recorded at 1-min intervals for 20 rein, including the 4-min stabilizing period. During the experimental period, participants were not informed of their skin temperatures.

Participants were asked to keep their eyes open during the sessions to help them concentrate on their environment and avoid drowsiness (Green and Green, 1971). They were asked to focus on the area directly in front of them in which the treatment was located. To prevent tem-

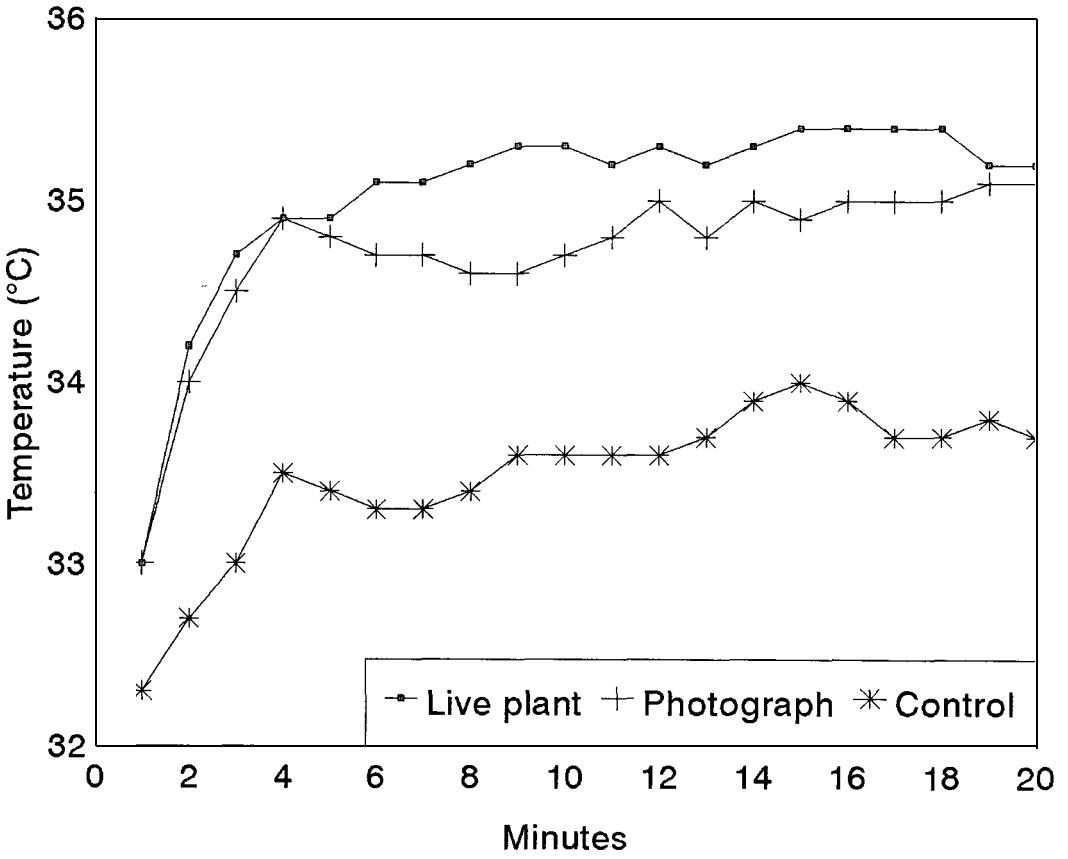


Fig. 1. *Thermal biofeedback readings of a participant with initially high skin temperatures reacting favorably to a live plant and photograph.*

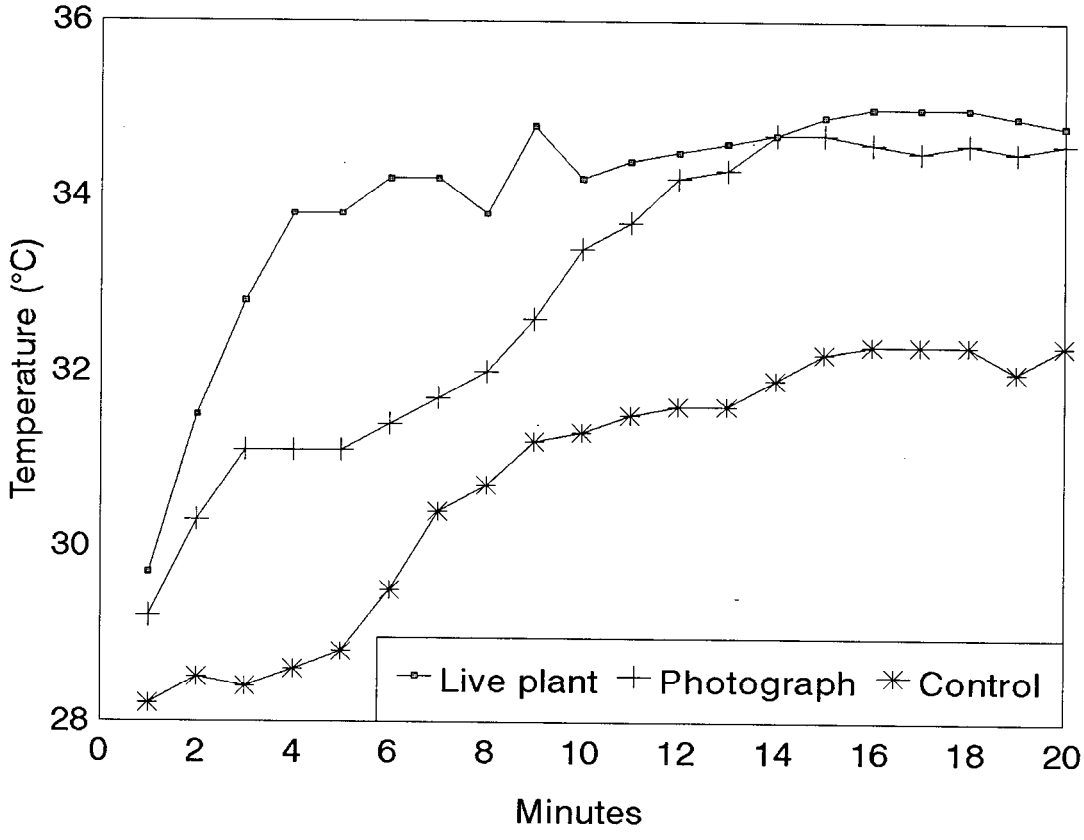
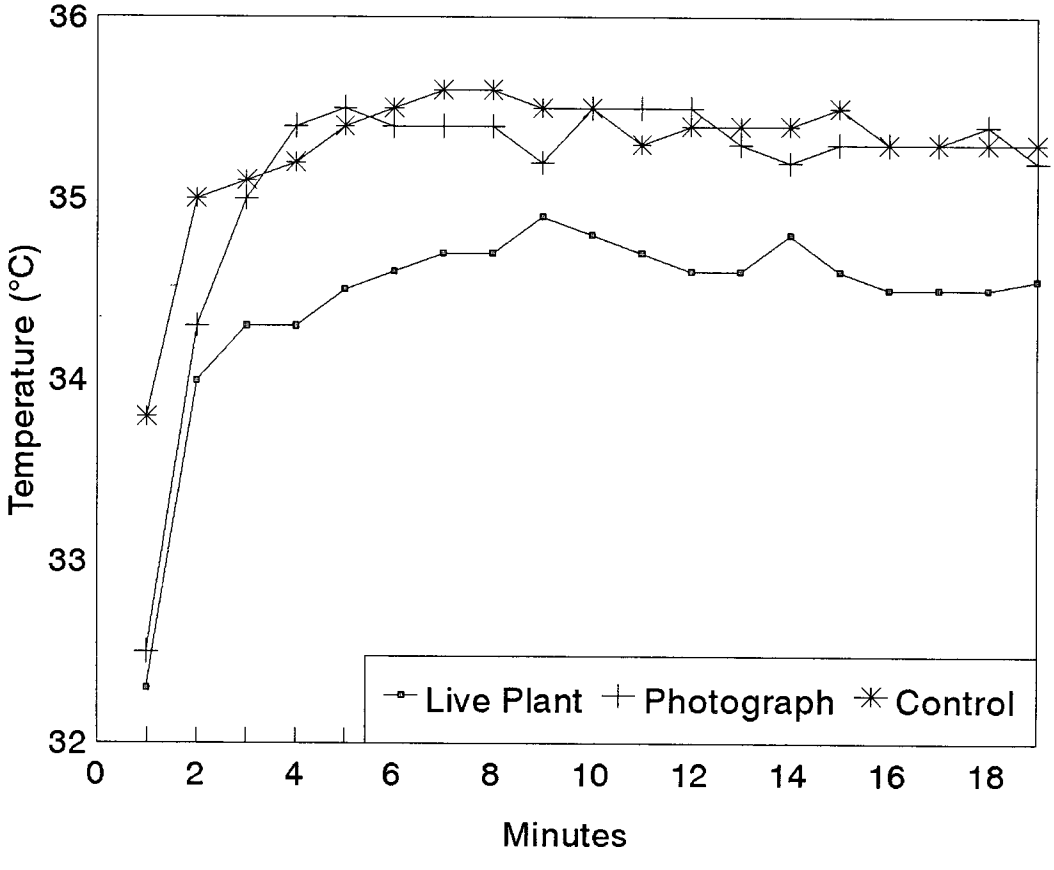


Fig. 2. *Thermal biofeedback readings of a participant with initially low skin temperatures reacting favorably to a live plant and pbotograph.*

perature changes due to body movement, participants were instructed to keep both feet flat on the floor, avoid crossing arms or ankles, and to keep the thermistor from touching anything (Danskin and Crow, 1981).

A baseline (B) and treatment (T) research design was used in the following sequence: B (first session), 3T (randomized treatments, second to fourth session), B (fifth session), 3T (randomized treatments, sixth to eighth sessions), B (ninth session), 3T (randomized treatments, tenth to twelfth session). During the baseline session, participants were in empty rooms. During the three treatment sessions, each participant was placed at random in rooms with the live plant or a plant photograph or in the control room.

Baseline (empty room) skin temperature comparisons were made to determine if participants were responding consistently over time to the presence or total absence of room furnishings.



Results

An analysis of variance was conducted for final skin temperature, which was calculated by averaging the skin temperature readings taken at 18 and 19 min to account for the fact that some participants anticipated the end of the session and, by the 20-min mark, skin temperatures were beginning to decrease. In this study, four participants were unable to complete the required sessions. Analysis of 26 participants completing the study indicated they were able to learn relaxation techniques as judged by significantly

Fig. 3. *Thermal biofeedback readings of a participant with initially high skin temperatures reacting unfavorably in the presence of a live plant.*

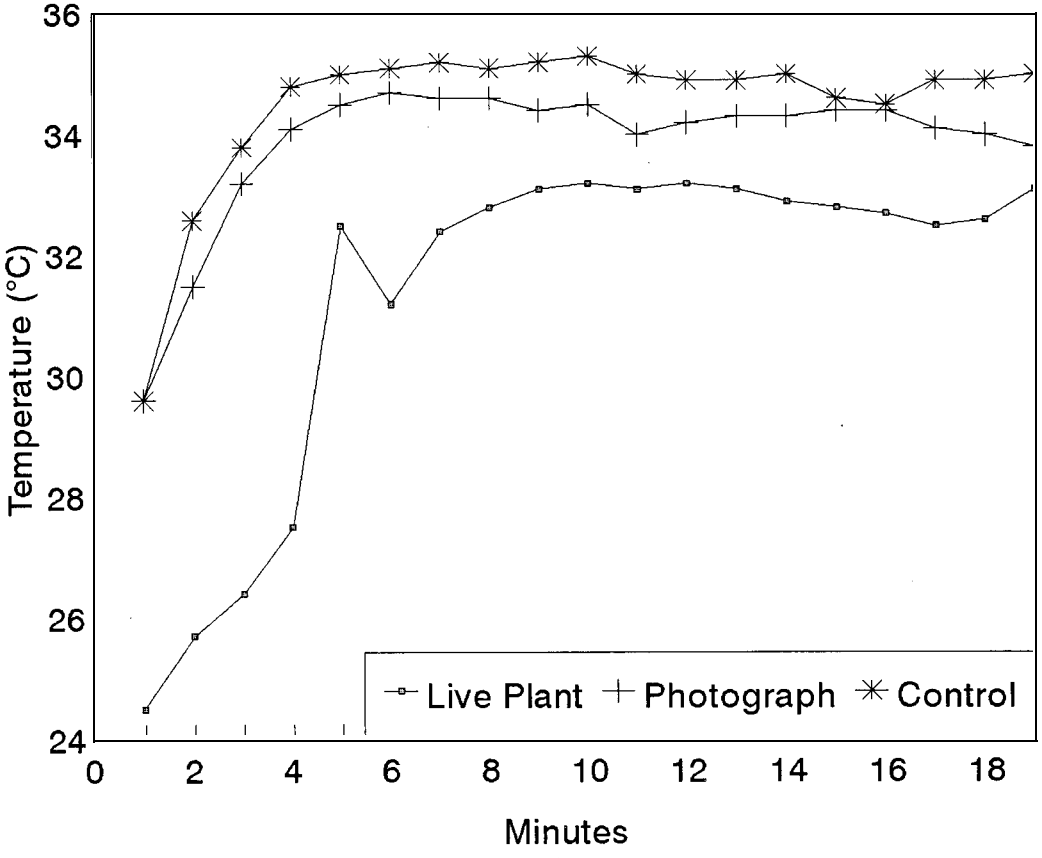


Fig. 4. ***Thermal biofeedback readings of a participant with initially low skin temperatures reacting unfavorably in the presence of a live plant.***

higher final skin temperatures than initial skin temperatures.

Ten of the twenty-six participants consistently reacted positively to the presence of plants or plant photo, as evidenced by higher skin temperatures, compared to the metal stool. Figures 1 and 2 show examples of individuals reacting positively to the plant or photograph. Participants' skin temperature increases occurred within 4 min with the live plant or plant photograph treatments. This is consistent with other research describing a positive physiological response to plants within 3 to 6 min (Ulrich and Simons, 1986). For six of the participants, the live plants were less effective in reducing stress than the metal stool or plant photographs, as shown by a slightly lower temperature during the first 4 min of the sessions and the final temperature. In Figs. 3 and 4, responses of two individuals are less positive to the live plant. Although the rise in temperature was slower initially to the photograph, by the end of 4 rein, the responses to the stool and the photograph were essentially the same. A third group consisted of 10 participants who responded the same to live plant, photograph, or metal stool. Their skin temperatures during the control (metal stool) sessions were similar to those during the treatment sessions. Due to the small number of participants, no significant results were obtained, but the trends are important and are being reported to help further research in this area.

Means for final skin temperature from baseline sessions were nonsignificant. They decreased from 35. SC initially to 35.0C for the final two sessions.

Participants were inside small closed rooms. Observing their actions once the rooms were closed would have been disruptive. After several sessions, participants began to make comments concerning their inability to remain awake. Participants also stated that if they didn't have anything to look at, they were more apt to close their eyes. During several sessions, participants expressed disappointment when placed in the empty room or the one with the metal stool. The attachment of the thermistor and knowing that temperatures were being recorded increased stress. The live plant or photograph appeared to help most of the participants who responded to visual stimuli to reduce initial stress before biofeedback audio tapes and to achieve a higher skin temperature by the end of the 20-min session. The plant and photograph may have helped to promote a sense of a more comfortable environment and resulted in a release of anxiety (Mattson, 1982; Ulrich, 1983).

In summary, the stress -reducing potential of plants or their images was confirmed with some participants. Further research is necessary to understand this and other physiological effects of live plants and plant photographs on humans.

Literature Cited

Danskin, D.G. and M.A. Crow. 1981. Biofeedback: An introduction and guide. Mayfield Publ. Co., Palo Alto, Calif, p. 22-37.

Danskin, D.G. 1989. The Doctor told me that my stress caused my _____. Univ. Counseling Serv., Kansas State Univ., Manhattan.

Doxon, L.E., R.H. Mattson, and *A.P. Jurich. 1987.* Human stress reduction through horticultural vocational training. HortScience 22:655–656.

Fischer Williams, M., A.J. Nigl, and D.L. Sovine. 1981. The development of biofeedback. A textbook of biological feedback, Human Sciences Press, New York. p. 21-37.

Green, E.E. and A. Green. 1977. Beyond biofeedback. Delacorte Press, Seymour. p. 21-57.

Laviana, J.E., R.H. Mattson, and R.H. Rohles. 1983. Plants as enhancers of the indoor environment. Proc. 27th Annu. Meeting Human Factors Sot., Norfolk, Va. p. 738-741.

Mason, L.J. 1984. Stress reduction, p. 127-130. In: E. Bauman, L. Piper, A.I. Brint, and A. Wright (eds.). The holistic health handbook. Stephen Greene Press, Lexington, Mass.

Mattson, R.H. 2982. A graphic definition of the horticultural therapy model. In:R.H. Mattson and J. Shoemaker (eds.) Defining horticulture as a therapeutic modality. Part 2: Models in horticultural therapy. Kansas State Univ., Manhattan. p. 48-51.

Owen, P.J. 1994. The influence of a botanical garden experience on human health. MS thesis. Kansas State Univ., Manhattan.

Talbott, J.A, D. Stern, J. Ross, and C. Gillen. 1976. Flowering plants as a therapeutic/environmental agent in a psychiatric hospital. HortScience 11:365-366.

Ulrich, R.S. and R.F. Simons 1986. Recovery from stress during exposure to everyday outdoor environments, p. 115–122. In: J. Wineman and R. Barnes (eds.). Proc. 17th Annu. Conf. Educ. Design Res. Assn., Washington, D.C.

Ulrich, R.S. 1983. View through a window may influence recovery from surgery. Science 224:420-421.