MEASUREMENT OF PHYSIOLOGICAL STRESS BY PERSONALITY TYPE OF DEVELOPMENTALLY DISABLED ADULTS IN HORTICULTURAL TRAINING

by

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INTRODUCTION

Mounting levels of stress in the modern work world have been shown by medical researchers to have a detrimental effect on the health and productivity of workers. As stress rises, the incidence of hypertension, mental disorders, ulcers, and other stresss related diseases rises also (1).

The work of Hans Selye has provided the basis of much recent research on stress (2). Selye defined stress as a "complex, interrelated process which includes the occurance of a stressor, how it is perceived by the organism, under what circumstances the stressor occurs, how the organism characteristically reacts, and what resources the organism has available for dealing with the stressor."

Recent refinements in physiological research indicate that everyone has different responses to stress. Friedman and Rosenman (3) developed the theory of Type A and Type B behavior. They proposed that people with Type A personalities have higher sympathetic nervous sytem response levels and greater reactions to stress than persons with Type B personalities.

Over 1400 physiological responses to stress have been identified, according to Danskin and Crow (4), of which fewer than 20 have been widely documented. Although different people exhibit different physiological responses to the same stressor, an individual may show the same response with perhaps different intensity to a given stressor at different times. Also, an individual may show different physiological responses to different stressors. Therefore, measurement of a single indicator of stress is not an adequate indicator of stress in all situations or for all individuals.

The workplace is the main source of stress in many lives. Among the developmentally disabled, the worksite effects of stress may be accentuated in the pre-vocational setting, as this is frequently the first such structured and competitive environment they have encountered. They have not yet developed the coping mechanisms typically used by the general population to manage stress.

While training programs provide activity, material needs, self-esteem, a creative outlet and independence, the stressful effects of such programs should also be considered. Stress can be dangerous to persons with high levels of sympathetic nervous system response and high risk of hypertension, the most common stress-related disease. A training program which minimizes stress, while maximizing the benefits of work, is desirable for developmentally disabled adults (5).

Working with plants and soil has been used to relieve stress since earliest recorded history (6). Today, modern office spaces and interior environments are plantscaped to reduce absenteeism and increase productivity. It is possible that working in a greenhouse environment can have stress reducing effects on developmentally disabled clients. If this is so, pre-vocational training in a horticultural environment would be preferable to an environment without plants.

This study measured four physiological measures of stress in a greenhouse and pattern sorting area of the training center. These measurements were blood pressure, heart rate, finger skin temperature, and electro-dermal resistance. Because previous research has studied the stress produced by an activity or by an environment, rather than the effect of an activity within an environment, this study is more comprehensive than previous research. This study has attempted to answer the question, "Is work in the greenhouse less stressful than work at the training center?" This is a starting point for more detailed research into the nature of horticultural therapy.

Statement of Hypotheses

The five hypotheses of this study, stated in the null form, were:

1. No differences exist between the levels of physiological stress experienced by subjects working in the greenhouse and the training center.

2. No differences exist in physiological stress levels experienced by subjects in early morning and late morning.

3. No differences exist in physiological stress levels experienced by subjects with high risk of hypertension and low risk of hypertension.

4. No differences exist in physiological stress levels experienced by subjects with Type A nervous system response and Type B nervous system response.

5. No differences exist in physiological stress levels experienced by subjects before and after training.

REVIEW OF RELATED LITERATURE

Early Research on Stress

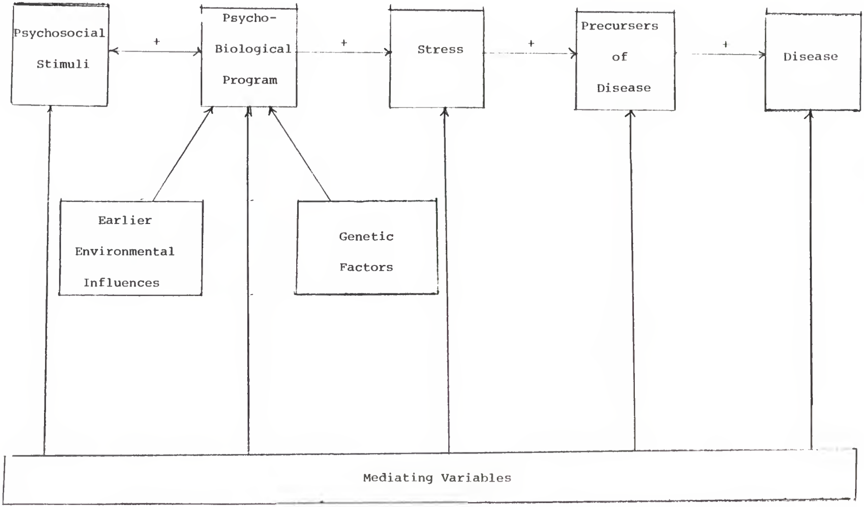
As early as 1930, researchers were attempting to define stress and determine its effects. Kuno (7) discussed "the peculiarity of sweating in the palms, soles, and axillae in being related to psychological and sensory processes rather than to heat regulation." Landis and Hunt (8) declared this relationship to be firmly established as a result of their work with correlations of mental state and galvanic skin response.

Research into the effects of stress produced conflicting results until differences in an individual's degree of sympathetic nervous system response was taken into account. By 1968, researchers had found that different kinds of stressing situations may lead to different autonomic nervous system responses in a single organism. For example, there may be only minimal response to bright lights flashing, but extreme response to loud noise (9). There may be an increase in blood pressure when looking at a face which is perceived as threatening, and sweating of the palms when hearing threatening words. Shapiro, Tursky, and Schwartz (10) noted in 1970 that social situations, emotions and coping ability have been shown to affect different aspects of the stress response. In 1974, Friedman and Rosenman (11) developed their theory of Type A and Type B personality. An individual with a Type A personality has a greater response to stress than a person with a Type B personality. Therefore, the person with a Type A personality is more prone to stress-induced illness.

Models of Stress

Levi (12) formulated a graphic model of the relationship of stimuli, stress and disease (see Figure 1). He studied stress in a variety of work and non-work situations. In this model, psychosocial stimuli (factors in the environment which can be perceived as stressful) and the psychobiological program (the makeup of an individual) interact to produce stress. For stress to occur, stimuli must be acting on the individual and must be perceived as stressful by that individual. Levi's model breaks down stress inducing factors into those which are subject specific (stress caused in an individual due to association with past events) and those which are non-specific (affecting every subject to one degree or another). Non-specific stressors which are short-term in their effect include failure, work load, pacing and distraction, and fear inducing situations. Combat, hazardous duty, confinement and isolation, and prolonged performance are long-term, non-specific stressors. Variables, which can mediate the effects of stressors at any step from the impingement of the psychological stimuli on the psychobiological program through the actual disease process, include habituation, adaptation, learning and coping, constitution and genetic factors, and group interaction. Habituation occurs as the stressor becomes the normal condition and is incorporated into the psychobiological program. Adaptation is a change in the behavior

Figure 1. The relationship of stimuli, stress, and disease. [Adapted from Levi (12)]

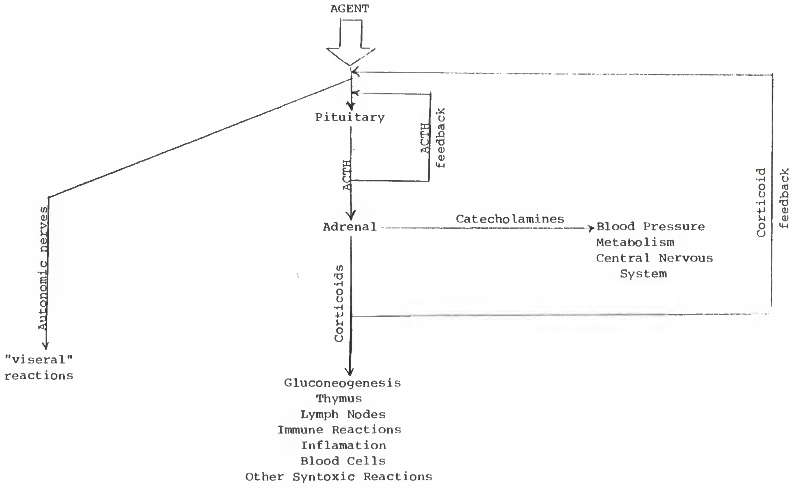


of the organism to conform to the pattern of stress. Learning and coping are skills which are acquired for dealing with stress, while constitution and genetic factors are predetermined abilities. Group interaction is the effect of other organisms on the stressed organism. All of these mediating variables can either increase or decrease the level of stress felt by the organism and the severity of the disease resulting from stress.

The Selye model (13) elaborated the reaction of the body to stress. This model (see Figure 2) demonstrates that stress is a complex interaction. It includes two hormonal pathways and one nervous system pathway for the expression of stress by the body, and two feedback loops, which can either dampen or augment the effects of stress. Selye also pointed out that the body will react to stress only if it is perceived as such. An individual who is not aware of a dangerous situation, for example, is not stressed by it. Selye also pointed out that repeated stress which is not mediated by successful coping mechanisms can lead to illness. With repeated exposure and reaction to stress the body's defences are chronically exhausted and disease occurs. Successful coping mechanisms can prevent disease by preventing the stressor from being seen as such.

Olton and Noonberg (14) listed the functions mediated by the sympathetic nervous system which are affected by stress. They include increased airway size in the lungs, increased blood pressure, blood vessel constriction, erection of hair on the skin, increased heart rate, increased internal anal sphinctor tone, local sweating, increased pupil

Figure 2. The reaction of an organism to stress. [Adapted from Selye (13)]



size, and decreased stomach motility and secretions. Of these, the current study examines heart rate, blood pressure, blood vessel constriction in terms of finger skin temperature, and electro-dermal resistance, which is related to local sweating and the muscle contractions which raise the hairs on the skin. These were chosen as the least invasive measures, and those most likely to insure the cooperation of the developmentally disabled subjects. Any or all of these can indicate stress in a given individual, depending on their constitution and genetic makeup. Even small fluctuations can indicate a change in the state of arousal so these measures give an accurate means of measuring the level of stress felt by research subjects.

Individualized Stress Reactions

Light (15) defined those individuals with greater than average fluctuations in arousal indicators as high sympathetic nervous sytem responders and those with lower than average response as low sympathetic nervous system responses. She has shown that individuals with high sympathetic nervous system response levels and numerous risk factors of hypertension tend to retain sodium, a possible precursor of disease. If sodium retention does lead to hypertension, which has been suggested by medical doctors, this could be a mechanism by which disease is caused by stress. The sodium retention effects stabilize from two to three hours following introduction to a new environment, and do not increase with repeated exposure.

Stress has also been shown to be related to performance. For example, Kleinman and Stein (16) have shown that persons with many spontaneous fluctuations in electro-dermal activity react more slowly to complex tasks. It can be seen from Levi's model that pacing and distraction is a stress-inducing factor. If stress leads to reduced reaction times on complex tasks for which there is a time limit, there can be an increased level of stress, forming a negative feedback loop.

Stoyva (17) pointed out the weakness of much previous stress research, which was done by comparing a "stressed" group with a "non-stressed" group. This is weak because individuals in the two groups varied in constitutional makeup and predisposition, and the exact nature, timing, and magnitude of the stress varied from individual to individual. By testing each individual in each environment, this study sought to eliminate the biological and experiential variation of using two groups. The tests were done in each environment with as short a period as was practical to reduce the chance of other variables affecting the outcome of the tests.

Few studies have been done with the developmentally disabled. Wallace and Fehr (18) have shown that children with Down's Syndrome have slower reaction times, show reduced skin resistance and fewer heart rate fluctuations in a baseline period, and fewer skin resistance fluctuations during stimulation than "normal" children. In order to monitor stress in this study, an individual baseline was established. Also for this reason, four indicators of stress were selected for monitoring, so that differences would have a greater chance of being detected.

Stress Reduction Through Horticulture/Nature

Kenny (19) listed three ways of dealing with anxiety. He recommended short bursts of hard physical exercise, doing something well, and working with someone familiar who provides encouragement. He pointed out that gardening requires physical exercise and can be easily mastered. By working with a professional horticultural therapist, horticultural training in a psychiatric hospital can provide all three anxiety reducing activities. Other psychological benefits of gardening, according to Kaplan (20), are that horticulture provides a non-discriminating, non-threatening environment, and requires involuntary, intense concentration which provides a rest from whatever worries a person has. Horticulture is a surrogate for escaping to nature.

Horticulture also provides opportunities to express nurturance and creativity, according to Relf (21). Being responsible for the nurturance of a plant leads to greater satisfaction with life for nursing home residents.

Therapists at the Menninger Foundation have observed a reduction of tension and anxiety in their psychiatric patients when they work in horticultural activities (22). In horticulture, there is predictable, continuous change and patients can see that change need not be destructive while they learn new coping techniques (23).

In a survey of members of the American Horticultural Society, the most frequently named reason for gardening was that it provided a setting for peace and tranquility (24). Similarly studies with animals have shown that stroking a pet can reduce blood pressure of research subjects over stting quietly or talking with humans (25).

In this thesis, four different physiological measures of stress were studies to see if a similar reduction in stress levels can be achieved through horticultural activities. Such studies can provide information to guide individuals toward reducing the stress levels experienced in everyday life, thus reducing the incidence of stress induced illness.

METHODOLOGY

This study was concerned with the physiological stress levels experienced by adult developmentally disabled subjects during pre-vocational training.

Subjects

The subjects were all 22 members of the work activities (pre-vocational training) group at Big Lakes Developmental Center, a four-county training center based in Manhattan, Kansas. Each subject was randomly assigned to either the greenhouse or the "pattern sorting area" at the training center for training during part of the study. Two of the subjects were advanced to the work readiness (vocational training) group before the completion of the study and were not included in the data. One subject was transferred before the final resting measures were taken. Data on that subject was included, with only two measures included in the baseline averages. Thus the final sample size was 20.

Instrumentation

Risk factors were assessed using American Heart Association guidelines (see Appendix A). Family history of heart disease was obtained by interviews with subjects, guardians, or family members, and/or medical records.

Blood pressure was recorded using a mercury column sphygnomanometer. Heart rate was recorded by the examiner, feeling the wrist pulse, timed by a stopwatch. Electro-dermal response (EDR) was recorded using a galvanometer, and measured using finger electrodes. Finger skin temperature was recorded using a remote sensing electronic thermometer with a sensor attached to the subject's middle finger. These terms are defined below:

Blood Pressure -- divided into systolic blood pressure (SBP), the pressure of the blood as it passes through the arteries during the contraction of the heart, and diastolic blood pressure (DBP) the pressure within the arteries between contractions of the heart (26).

Heart rate -- the number of contractions of the heart in one minute (26).

Electro-dermal response (EDR) -- the resistance of the skin's surface to the conduction of a small electric current. Related to galvanic skin response, but with a measurable baseline (27).

Skin temperature -- the temperature, in degrees Fahrenheit, on the surface of the skin, measured on the middle finger of the right hand (27).

The term developmentally disabled refers to those persons who, for various reasons, function at a lower level than their chronological age would indicate that they should. The sample studied included mainly persons with Down's Syndrome and organic brain dysfunction.

Research procedures

The researcher took subjects individually into a quiet room where the monitoring equipment was demonstrated and explained, prior to data collection. They were read an advised consent form (see Appendix B) and all agreed to participate. The electrodes from the galvanometer and the thermister of the digital readout thermometer, as well as the cuff of the sphygnomanometer were attached to the subject. The subject was allowed to observe the readouts and make adjustments on the equipment if desired. Subject and researcher were seated in a relaxed position and all questions were answered freely. This allowed subjects to become confortable with the equipment and procedures.

Subjects were randomly assigned to either the greenhouse or the pattern sorting area of the training center for training. All subjects were familiar with both areas before the study. All subjects were taken to the greenhouse in groups of four to six. In the greenhouse, subjects spent three hours standing by a potting bench mixing soil, repotting plants, learning to identify plants, watering, washing pots, and cleaning up. The physiological measures were taken each hour during this three hour period, and measures from the first hour were discarded. On alternate days, subjects stayed in the training center, where they sorted three types of paper from recycled clothing patterns into different baskets while seated, carried baskets of patterns to their work area, and removed sorted paper from their work area to large collection bins. Physiological measures were taken every hour, and the measures from the first hour were discarded. Measures on each client were taken in each environment, and the difference in each physiological measure for each individual was compared, in early and late morning both before and after training. The before training measures were recorded in March and those after training were recorded in June.

To establish baseline and sympathetic nervous system response levels, tests were repeated in the same quiet room as the introduction to the equipment following the completion of the tests within the work environments. At this time the subjects were most relaxed with the equipment and researcher, so that baseline levels would not reflect stress induced by unfamiliarity. For the baseline, readings on the equipment were recorded each minute for ten minutes while the subject relaxed in a comfortable chair. Subjects were instructed not to talk during these tests. Not all subjects followed those instructions, but there was generally not a great deal of talking. These tests were repeated on three different days and averaged to provide the subject's resting level on each physiological measure.

During the last test, an accomplice opened and slammed the door of the room, producing a loud, unexpected noise. When measures returned to normal the researcher activated a flash attachment, producing a sudden flash of bright light in the room. Reaction levels to each stimulus were recorded. A level of change above the sample average on any physiological measure, following these sudden stimuli, indicated a high level of sympathetic nervous system response, or Type A personality. These tests were done last so that the anxiety of anticipation of such stimuli would not contaminate other tests. In classifying the subjects into nervous system response groups, it was noticed that subjects seemed to be distinctly classifiable. That is, if they had a higher than average response on one measure, they had a higher than average response on at least one other. In addition, there was a subjective difference between high and low responders. High responders generally jumped, or showed some other outward sign of being startled, while low responders did not show such outward signs.

Following the first round of tests, the subjects underwent three months training in their assigned work areas. The training in both areas involved basic work readiness activities and individual skills. The physiological tests were repeated after the training period.

Research Design

All subjects were tested in both environments, and their scores were matched on a subject-by-subject basis to dilute the effect of natural physiological variation. This experiment was designed to test the effect of a situation on an individual, and no attempt was made to make the environments equivalent in any way, thus differences cannot be assigned to any single factor or attribute of the environment.

Data Collection

Subjects worked in each environment for three hours, performing activities specific to the environment. Pulse, blood pressure, EDR, and finger skin temperature were measured each hour. Only the measures taken during hours two and three were used to determine the levels of stress within that environment. The physiological tests following the three month training period followed the same procedure.

Training consisted of three hours supervised work in the assigned environment each day, five days a week. The subjects worked on specific skills in that environment, similar to Big Lakes Developmental Center training procedures. Examples of skill areas emphasized were attention to task, appropriately timed bathroom breaks, arriving on time at the work station, and returning from break promptly.

The physiological stress indicators for the resting measures were recorded in a quiet, non-stressful environment and were taken following all other tests when the subjects were most familiar with the equipment and procedures. Measures taken before the readings stabilized were rejected and the remaining measures used to compute the average resting measure.

The degree of startle response was determined on each instrument following a loud noise and a flash of light to classify the level of sympathetic nervous system response for each subject. Any subject with a startle response greater than the population mean on any single measure was classed as a high level responder (Type A personality). Those with all responses lower than the sample average were called Type B personalities. Subjects with a high risk of hypertension had three or more of the following: 1) incidence of heart disease in the family, 2) overweight, 3) smoking, 4) diabetes or gout, 5) age over 40.

Data Analysis

For statistical analysis, the following number of subjects were identified in each group:

1) high risk, Type A (n=4)

2) high risk, Type B (n=7)

3) low risk, Type A (n=6)

4) low risk, Type B (n=3)

Analysis of data was accomplished using the General Linear Models program of Statistical Analysis Systems (28). An ANOVA was used to compare baseline with greenhouse and training center means.

To examine the changes from one condition to another, a paired t-test was run on all combinations of variables for which the difference would have meaning. There were 20 such combinations, and differences were compared for each risk and type and for combinations of risk and type on all dependent variables, resulting in 1800 paired t-tests. Because of the number of paired t-tests, which greatly increased the chances of a Type I error, a MANOVA was used to examine the relationship of independent variables and a t-test was used to compare means within each independent variable.

Only when the MANOVA or t-test were significant for more than one dependent variable was a significant difference on the paired t-test used to reject the null hypothesis. There was no independent variable for which all dependent variables showed significant differences on all tests but, if differences in some independent variables showed on either the MANOVA or the t-test and on the paired t-test, and the direction of none of the tests was different, the null hypothesis was rejected. For some independent variables the evidence neither fully supported nor suggested the rejection of the null hypothesis.

RESULTS

Baseline Measures

As shown in Table 1, the subject baseline measures for pulse, DBP, and EDR were lower than the range for a normal population; the SBP measures were in the lower portion of the range; and the finger skin temperatures were in the upper portion of the range. Thus arousal levels were lower for this sample than for the population as a whole. The subjects were sedentary and ranged in age from early twenties to late fifties. They had few of the expected physical attributes of individuals who fall into the lower portion of the range for these physiological measures. Subject baseline measures were significantly lower than those at either the greenhouse or the training center.

Location

In the greenhouse, subject SBP, DBP, EDR, and finger skin temperature were significantly lower than readings taken at the training center (Table 2). These MANOVA and t-test results indicate that any significant differences found on the paired t-test in Table 3 are probably valid. Subject SBP, DBP, and EDR all indicate lower stress in the greenhouse than in the training center. These lower physiological effects were significant in some subsets of independent variables for each of these indicators. For example, in Table 3, the DBP is significantly lower in the early morning before training.

In Appendix C, within the greenhouse environment, subject DBP is significantly lower in early morning before training for Type A high risk subjects. The SBP is also significantly lower in both early and late morning after training for Type B low risk subjects. Furthermore EDR is significantly lower in late morning after training for Type A low risk subjects.

Subject Response

As shown in Table 2, low risk subjects had significantly higher pulse rates and SBP than high risk subjects. However, examination of the significant differences found in the paired t-tests show no consistent direction in the differences between risk groups, and no consistent differences for any location, time, or training.

The t-test indicated that Type B subjects had significantly higher mean pulse rates and lower mean SBP than Type A subjects (Table 2). The paired t-test showed differences in the reactions of Type A and Type B subjects to training, with type A subjects showing significantly higher SBP and DBP, and significantly lower finger skin temperature before training than after (see Table 4). More differences among the Type A than among Type B groups are significant both before and after training, as shown in Appendix C.

Time of Day

Early morning measures of SBP, DBP, and pulse were significantly higher than late morning measures, as seen in Table 2. Finger skin temperatures were significantly lower in early morning. On the paired t-test shown in Table 5 pulse rates and finger skin temperatures were higher in early morning than in late morning in the training center after training.

Training

Mean pulse rates were significantly lower after training than before (Table 2). All other physiological measures were lower but not significant. The paired t-tests in Table 4 show that, for type A subjects, SBP and DBP were significantly higher before training and finger skin temperature was significantly lower for measurements taken in early morning at the training center. For Type B subjects, finger skin temperatures was significantly lower before training than after. More differences between before and after training are significant for Type A personalities than Type B personalities, as seen in Appendix C.

Interactions

The MANOVA showed significant interaction of personality type and location for pulse (see Appendix D). The paired t-test showed that the pulse was higher in the greenhouse for Type B personalities and lower for

Type A personalities. These results were not significant for paired t-test.

The MANOVA also showed a significant interaction of risk level and location for SBP. SBP was higher in the training center for low risk individuals and higher in the greenhouse for high risk individuals. These differences were not significant on the paired t-test.

There was a significant risk, location, time interaction on the MANOVA, and a significant risk, type, location interaction. These interactions could not be interpreted with the paired t-test.

Table 1. Means of pulse, blood pressure, electrodermal response and finger skin temperature under baseline conditions compared to normal resting ranges and to means for other locations. Based on ANOVA.

	Physiological measurements				
Location	Pulse (Beats/ min.)	SBP (mm Hg)	DBP (mm Hg)	EDR (μohms)	Skin Temp. (^{o}F)
Normal population Range (26, 27)	65-72	110-130	60-80	1.5-3.5	70-90
Baseline	64.5b*	115.79a	59.87a	.21b	88.15a
Training Center	71.9a	116.75a	60.80a	.41a	85.67ab
Greenhouse	74.1a	115.11a	59.38a	.25ab	83.59b

* means in each column followed by the same letter are not significantly different on the Duncan's test.

Table 2. Means of physiological responses of subjects for location risk, personality type, time, and training.

		Physiological Measurement				
Source of Variance	Condition	Pulse (beats/ min.)	SBP (mm Hg)	DBP (mm Hg)	EDR (μohms)	Skin Temp. (^{o}F)
Location:	Greenhouse	74.1	115.11	59.37	.25	84.88
	Training Center	71.9	116.79*	60.80*	.43*]	86.62*
Risk:	High	71.1	114.26	60.51	.35	84.87
	Low	74.9]	117.60]	59.59	.33	86.64
Personality type:	A	71.9	117.17	61.13	.39	86.59
	B	74.6]	114.50]	58.82	.27	84.73
Time:	Early AM	74.4	117.27	61.55	.30	82.73
	Late AM	71.6]	114.59*]	58.53*]	.37	88.72*
Training:	Before	73.88	116.35	60.58	.37	86.18
	After	72.16*	115.51	59.60	.31	85.32

* indicates a significance on the MANOVA at the .05 level or greater
] indicates a significant difference on the t-test at .05 level or greater

Table 3. Comparison of the means of the differences between the training center and the greenhouse for 20 subjects.

		Training Center-Greenhouse Change in Physiological measurements**				
Time in AM	Training	Pulse (beats/ min.)	SBP (mm Hg)	DBP (mm Hg)	EDR (μohms)	Skin Temp. (°F)
Early	Before	-0.96	5.75	4.51*	.20	2.42
Early	After	-0.09	2.40	1.62	.38	2.70
Late	Before	-4.57	1.44	2.25	.03	5.29*
Late	After	-2.94	2.39	0.24	.12	-0.77

* indicates a significance on the paired t-test at the .05 level or greater

** (-)=increased stress for pulse, SBP, DBP, & EDR in greenhouse
(+)=increased stress for skin temperature in greenhouse

Table 4. Comparison of the means of the differences between before and after training by personality type.

Location	Time	Pulse (beats/ min.)	SBP (mm Hg)	DBP (mm Hg)	EDR (μ ohms)	Skin Temp. (°F)
		Before-After Change in Physiological Measurements				
		Type A (n=10)				
Training Center	Early	3.43	9.96*	6.16*	-0.33	-11.27*
Training Center	Late	4.50	1.75	3.41	-0.06	0.09
Greenhouse	Early	3.41	0.86	2.21	0.01	-5.25
Greenhouse	Late	6.09	0.64	1.96	0.07	-6.14
		Type B (n=10)				
Training Center	Early	-0.75	-1.58	1.58	-0.12	-3.13
Training Center	Late	-0.33	2.08	4.91	0.02	-3.51
Greenhouse	Early	1.00	0.83	-0.25	0.10	-8.58*
Greenhouse	Late	1.33	5.08	2.33	0.07	-9.59*

* indicates a significance on the paired t-test at the .05 level or greater

Table 5. Comparison of the means of the differences between early morning and late morning for twenty subjects.

Early-Late Change in Physiological measurements

Location	Training	Pulse (beats/ min.)	SBP (mm Hg)	DBP (mm Hg)	EDR (μ ohms)	Skin Temp. (°F)
1) Training	Before	3.75	3.37	1.93	.06	-3.22
Center	After	4.50*	1.09	2.22	.26	2.16*
2) Greenhouse	Before	0.14	-0.94	-0.32	-.11	-0.36
Greenhouse	After	1.65	1.07	0.84	.01	-1.31

* indicates a significance on the paired t-test at the .05 level or greater

DISCUSSION

Although the literature states that all physiological indicators of stress are linked and do not vary independently, that did not hold true for this sample. There were numerous cases of one measure rising as another fell. While most of these measures were not significant, and thus the effect did not interfere with the interpretation of the data using the criterion established for this study, it is interesting that this population did not follow the usual pattern. This could be a property of the developmentally disabled. It is something which warrants further study.

The relative size of the different risk/type groups was unexpected. It was anticipated that the high sympathetic nervous system responders (Type A) would have a large number of high risk individuals, if only because family history of heart disease is included as a determining factor of risk of hypertension and high responders are believed to come from families with similar response levels. Friedman and Rosenman (3) showed that high responders are more likely to suffer from heart disease. That this is not true of this sample could be a chance occurance due to the small sample size, a property of the developmentally disabled population, or evidence against high responders having a high risk of hypertension.

The baseline was significantly lower than all environments and combinations of independent variables, showing that there is stress associated with work for this population. The baseline measures for this sample were consistently lower than or in the lower portion of the range for the baseline of a normal population (27). The data was not compared statistically to any other population baseline, as a sample of 20 is too small to make strong conclusions about the developmentally disabled population, but there were some differences which were apparent by comparison. Pulse rates in the 50's were not uncommon, and blood pressures below 120/60 were the rule. The individuals tested were not athletes, and do not get a great deal of physical activity. Most EDR measures did not even approach the normal range, and the finger skin temperatures fell in the upper portion of the normal range. It would appear that Wallace and Fehr's (18) conclusions that children with Down's Syndrome show reduced skin resistance hold for this population and these measures also. This could be because the neurological condition which results in the developmental disability is either blocking out the stimulation which could cause arousal, or is blocking the expression of that arousal through these measures, which are mediated by the central nervous system.

SBP, DBP and EDR measurements suggest lower stress levels in the greenhouse when compared to the training center. Finger skin temperatures were lower in the greenhouse, indicating higher stress there than in the training center. Some of the activities in the greenhouse involve having the hands in cold water, which would reduce skin temperature without an increase in stress. This artificial reduction would make skin temperature measurements invalid, when comparing the greenhouse and training center, but would not affect the other comparisons, because the effect would be randomized for time, risk level, personality type and before and after training.

When finger skin temperature measures are rejected in comparing the greenhouse and training center environments, the null hypothesis that there is no difference in stress levels between the greenhouse and training center can be rejected. This would indicate that the greenhouse is less stressful than the training center. This effect was present in at least one measure for each type/risk group except Type B, high risk, where the effect is not significant because of the large variance of the group. Stress was lower in the greenhouse in both early and late morning and both before and after training.

The analysis of the data indicated that low risk subjects had higher mean stress levels than high risk subjects but, in the analysis of the differences in the paired t-tests, no consistencies were found. More of the paired t-tests show higher stress levels for the high risk subjects, but there is no pattern. The null hypothesis that there is no difference between high risk and low risk subjects cannot be rejected.

Some inconsistencies exist in the analysis of personality type data, but a pattern emerged. Type A personalities have higher levels of stress in early morning than late morning in the training center. Type B personalities had less change from early to late morning in the training center. This indicates that Type B personalities are less affected by the work environment than Type A personalities. This could be expected, as the definition of a Type A personality is that they have a higher level of sympathetic nervous system response to stress-producing situations.

Type A personalities were less stressed following training than before. Type B personalities showed significant differences only on finger skin temperature, and generally showed little change due to training. This result could be because of greater anxiety on the part of Type A personalities before they learn what they are to do, while Type B personalities are less affected by the stressful situation of a new work position.

Stress levels were higher in early morning than late morning for all measures except finger skin temperature for Type A high risk subjects in the training center after training. Because of the weight of evidence showing higher stress levels in early morning, it is suggested that stress is reduced as the morning progresses, even though the one significant measure in the opposite direction prevents rejection of the null hypothesis. This opposition is caused by a large increase among Type A high risk subjects, a group with a cell size of 4. It appears that, as the day progresses a habituation or adaptation process takes place. The subjects accept the work situation as normal and/or adapt their behavior to it, and therefore it is no longer as stressful. It is interesting to note that these effects showed up as significant only after training. The ability to adapt or become habituated to the work environment may be one of the benefits of training.

Overall tests showed that there was less stress after training than before, but this effect showed up in only one measure for Type B personalities on the paired t-test, which is insufficient evidence for the rejection of the null hypothesis for Type B personalities. The null hypothesis that there is no difference between before and after training can be rejected for Type A personalities. This indicates that training is effective in reducing the stress levels of Type A personalities but has no effect on Type B personalities.

In summary, this study indicates that there is stress associated with the work environment. This stress is lower in the greenhouse than in the training center. Training can reduce the effects of stressful environments for Type A personalities, but has little or no effect on the physiological stress levels of Type B personalities. It appears that habituation or adaptation takes place as the day progresses, particularly among Type A personalities. There is no difference in the effect of stress on individuals with a high risk of hypertension compared to individuals with a low risk of hypertension.

Suggestions for Future Research

This study is only the beginning of what could be extensive research in this field. More information needs to be collected on the developmentally disabled so that a population baseline can be compiled. Other studies could examine larger samples of the developmentally disabled, which would allow for more detailed examination of the interactions of personality type, risk level, and environment. Further research could be done examining various factors of the environment, including light levels, temperature, CO_2/O_2 levels, and other factors which vary between the greenhouse and training center. These studies could be done in combination with attitudinal studies to see if perception of stress is the same as physiological indication of stress.

All of the above could be done with other populations. Comparisons as were done in this study have not been done with normal population samples, or with any other special populations. If the reactions of all populations are the same as was indicated by this study for the developmentally disabled, the information could have far-reaching effects. Stress could be reduced in a variety of situations by providing an opportunity to work within a greenhouse-like environment.

Individuals, who have chosen to work in a horticultural environment, whether professional horticulturalists or home gardeners, could be profiled to see if there is a typical profile of physiological response among those who enjoy horticultural activity.

As interest rises in this field, and stress reduction becomes more essential and accepted within the work environment, such research needs to be done.

Practical Applications

Results of this research apply to the field of horticultural therapy. This study provides some empirical evidence indicating that a greenhouse environment is less stressful than a training center environment. Training in a greenhouse environment could lead to healthier, more productive workers. Certain work skills taught to pre-vocational clients can be taught anywhere, and can perhaps be taught more pleasantly in the greenhouse environment.

The results of this study could be used in assigning individuals to a work environment. Type B personalities are less affected by stressful environments than Type A personalities. Working in a greenhouse is less stressful than working in a training center. Based on the results of this study, stress levels could be reduced if persons with high levels of sympathetic nervous system response were assigned to work in horticultural environments, or other less stressful environments.

Trainers should bear in mind that, while training can decrease the levels of stress experienced by Type A personalities, it had little or no effect on Type B personalities. Individuals with Type B personalities do experience stress, and means of relieving it should be examined. Also performance expectations can be made to rise gradually as the level of anxiety over the new work environment decreases for Type A personalities.

Problems in getting to work could be due to the stress of starting work. Anything which could make the transformation from home to work less stressful could lead to healthier, more productive employees.

The ramifications of this study are widespread. With more and more attention being paid to the effects of stress in the workplace, and more effort going into stress reduction programs, the possibilities of horticultural environments should not be overlooked. It could be that alternating horticultural work assignments with more stressful activities could effectively reduce stress levels among not only developmentally disabled pre-vocational training clients, but for other individuals as well. The potential stress reduction uses of horticulture are widespread, and can lead to many exciting new ideas.

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APPENDIX A

American Heart Association Guidelines for Risk of Hypertension

The presence of any of the following will increase an individual's chance of heart disease:

Male sex

Age over 40

Overweight

Smoking

Incidence of heart disease in the family

Diabetes or Gout

APPENDIX B

Informed Consent Information

Informed Consent Statement

You have been asked to be in a research study. This study is being done by Lynn Ellen Doxon. She is a graduate student in Horticultural Therapy at Kansas State University. This research will help us understand how your body works, and if it works differently in different places. We wil do tests while you relax in the office, then while you work in the workshop, then while you work in the greenhouse.

This research will not hurt you in any way. We will tape sensors to the skin surface to see what is happening in your body.

You do not have to be in this study if you do not want to. If you don't want to that is O.K. After the research starts, you may still leave and go back to work if you want to. You will not be punished in any way. I hope you will stay the whole time, but if you want to leave, it is O.K.

When we do the tests we will tape sensors to your fingers, hands or arm. Then you will do the things you usually do, if you are in the workshop or the greenhouse. We will take several tests all during the morning. One morning we will do it in the workshop and another morning we will do it in the greenhouse.

I do not have any money or anything else to give you if you help with this research. I hope you will help me anyway. I will be very grateful for your help.

These tests are not tests anyone can do better than anyone else. However, some people do not want anyone else to know about their bodies, so I promise I will not tell anyone how you do.

Do you have any questions?

If you want to be in the research, please sign below.

Subjects: I have been told about this research, and I understand what will happen. I want to be in it.

Signature____Date__________________

Parent or Guardian: I have read the orientation statement above and have been fully advised of the methods to be used on my child in this study. I understand the potential risks, as described, and hereby assume them on behalf of my child.

Signature____Date__________________

Please turn in one copy and keep the other for your records.

BIG LAKES DEVELOPMENTAL CENTER, INC.

Human Rights Committee

November 18, 1983

PRESENT: Dennis Hemmendinger (Staff Psychologist), Candie Vlcek (Children's Services Director), Don Fallon (Lutheran Campus Minister), Lynn Doxon (Horticultural Student), Laura Baker (Horticultural Therapist), Richard Mattson (Horticultural Professor)

Lynn explained some modifications of the measurements as Dr. Dave Danskin had suggested to her. The rest of the study was explained to the committee by Lynn. Candie asked about the assignment of individual clients to experimental groups, and Lynn explained how she will coordinate the process with Laura Baker (Horticultural Therapist, Big Lakes staff). The procedure for data collection was explained by Lynn. It was explained that Lynn will be responsible for all the collection of data. The appropriate permission forms were reviewed and approved as appropriate.

Don brought up the significance of the difference in supervisors in the two experimental settings. Dennis suggested the possibility of exchanging the two experimental settings so that patterns would be sorted in the greenhouse and plants would be worked with at the Adult Training Center. The problems of such a procedure appeared too great to make it possible.

Richard said funding from Department of Education, Projects with Industry will be applied for to help support the effort. He hopes the study might result in eventual horticultural placements for local developmentally disabled individuals.

Lynn said March 1, 1984, is the projected date to begin the study. The group assignments will be done in January, 1984, and Laura will then begin taking people to the greenhouse so they will be used to it by March.

Don stressed that he finds that the pressure for completion of the task and the particular supervisor's personality are important influences on the individual's felt level of stress.

Submitted by,

Dennis Hemmendinger

Dennis Hemmendinger, Ph.D.
Psychologist

APPENDIX C

Paired t-tests by Type/Risk Group

Comparison of the means of the differences of physiological measures by personality type/risk group.

Loc. Time	Training	Physiological measurements: Pulse (beats/ min.)	SBP (mm Hg)	DBP (mm Hg)	EDR (µohms)	Skin Temp. (°F)
Base-TC Early,	Before					
Type A	High Risk	-10.00*	- 6.75	-10.75*	-0.45	7.48
Type A,	Low Risk	-11.29*	- 4.12	- 4.43	-0.26	7.44*
Type B,	High Risk	- 9.50*	3.67	- 0.17	-0.26	3.90
Type B,	Low Risk	- 7.33	-14.33	- 4.33	-0.07	1.98
Base-TC,Early,	After					
Type A,	High Risk	- 5.00	5.75	- 2.00	-0.54	- 4.00
Type A,	Low Risk	- 9.43*	3.29	- 0.86	-0.83*	- 3.62
Type B,	High Risk	- 9.33*	3.17	3.33	-0.40	- 0.77
Type B,	Low Risk	-10.00	-17.00*	- 4.67	-0.16	0.40
Base-GH,Early,	Before					
Type A,	High Risk	- 2.25	1.25	- 1.00	0.08	7.83
Type A,	Low Risk	-14.86*	3.86	- 1.14	-0.21	0.49
Type B,	High Risk	-12.83*	- 2.33	- 0.50	-0.17	9.18*
Type B,	Low Risk	-12.00*	- 1.33	1.00	0.80	12.98*
Base-GH Early,	After					
Type A,	High Risk	- 3.00	3.25	2.00	-0.18	- 0.58
Type A,	Low Risk	- 7.29	3.57	0.29	0.05	- 1.59
Type B,	High Risk	-14.83*	- 2.33	0.00	-0.31*	2.39
Type B,	Low Risk	- 8.00	0.33	0.00	0.02	2.60
Base,Early-Late						
Type A,	High Risk	5.00	- 0.25	- 0.75	0.04	0.58
Type A,	Low Risk	- 0.57	3.00	- 1.28	-0.54	- 1.27
Type B,	High Risk	- 4.40	0.00	- 1.00	-0.01	- 0.84
Type B,	Low Risk	- 0.33	1.33	1.33	0.03	1.19
Base-TC, Late,Before						
Type A,	High Risk	-11.75*	3.75	- 2.25	-0.57	- 1.32
Type A,	Low Risk	-11.29*	- 6.43	- 1.00	0.55	2.93
Type B,	High Risk	- 3.00	3.80	- 0.40	-0.08	7.64*
Type B,	Low Risk	4.00	-11.00	- 5.33	-0.11	0.49
Base-TC, Late, After						
Type A,	High Risk	- 0.75	- 0.75	0.00	-0.28	4.77
Type A,	Low Risk	-13.29	1.57	3.57	0.13	- 3.34
Type B,	High Risk	4.20	9.40	7.00*	-0.20	0.71
Type B,	Low Risk	- 3.67	-12.33	- 2.67	0.05	- 0.97

Loc.	Time	Training	Pulse (beats/ min.)	SBP (mm Hg)	DBP (mm Hg)	EDR (µohms)	Skin Temp. (^{o} F)
Base-GH, Late, Before							
	Type A,	High Risk	- 6.50	1.75	- 0.50	-0.23	7.70
	Type A,	Low Risk	-16.14*	- 1.00	0.43	0.22	1.96
	Type B,	High Risk	- 9.40	- 1.40	- 0.20	-0.29	11.01*
	Type B,	Low Risk	- 8.33	- 4.67	0.00	0.09	11.23
Base-GH, Late, After							
	Type A,	High Risk	- 4.75	1.75	2.00	-0.33	- 0.43
	Type A,	Low Risk	- 5.71	0.28	1.86	0.47	- 2.19
	Type B,	High Risk	-10.20*	0.40	1.80	-0.19	0.85
	Type B,	Low Risk	- 6.33	3.33	2.67	0.11	- 0.72
TC-GH, Early, Before							
	Type A,	High Risk	7.75	8.00	9.75*	0.52	0.36
	Type A,	Low Risk	- 3.57	8.00	3.29	0.04	- 6.94
	Type B,	High Risk	- 3.33	- 6.00	- 0.33	0.08	5.28
	Type B,	Low Risk	- 4.67	13.00	5.33	0.15	10.99
TC-GH, Early, After							
	Type A,	High Risk	2.00	- 2.50	4.00	0.36	3.41
	Type A,	Low Risk	2.14	0.29	1.14	0.87	2.03
	Type B,	High Risk	- 6.50	- 5.50	- 3.33	0.09	3.17
	Type B,	Low Risk	2.00	17.33*	4.67	0.18	2.20
TC-GH, Late, Before							
	Type A,	High Risk	5.25	- 2.00	1.75	0.35	9.03
	Type A,	Low risk	- 4.86	5.43	1.43	-0.34	- 0.97
	Type B,	High Risk	- 6.33	- 4.00	0.50	-0.09	2.38
	Type B,	Low Risk	-12.33	6.33	5.33	0.19	10.74
TC-GH, Late, After							
	Type A,	High Risk	- 4.00	2.50	2.00	-0.05	- 5.20
	Type A,	Low Risk	7.57	- 1.29	- 1.71	0.34*	1.15
	Type B,	High Risk	-12.67	- 7.33	- 4.67	0.03	0.70
	Type B,	Low Risk	- 2.67	15.67*	5.33	0.16	0.26
TC, Early-Late, Before							
	Type A,	High Risk	3.25	10.25	7.75	-0.09	- 8.21
	Type A,	Low Risk	- 0.57	0.71	2.14	0.27	- 5.77
	Type B,	High Risk	1.33	- 2.17	- 2.50	0.06	1.36
	Type B,	Low Risk	11.00	4.67	0.33	-0.67	- 0.30
TC, Early-Late, After							
	Type A,	High Risk	9.25*	- 6.75	1.25	0.29	9.36*
	Type A,	Low Risk	- 4.43	1.29	3.14	0.42	- 0.99
	Type B,	High Risk	7.17*	3.83	1.17	0.20	0.47
	Type B,	Low Risk	6.00	6.00	3.33	0.14	- 0.18

Loc.	Time	Training	Pulse (beats/ min.)	SBP (mm Hg)	DBP (mm Hg)	EDR (ohms)	Skin Temp. (F)
GH,	Early-Late,	Before					
	Type A,	High Risk	0.75	0.25	- 0.25	-0.27	0.46
	Type A,	Low Risk	- 1.86	- 1.86	0.28	-0.10	0.19
	Type B,	High Risk	- 1.67	- 0.16	- 1.67	-0.12	- 1.54
	Type B,	Low Risk	3.33	- 2.00	0.33	0.04	- 0.56
GH,	Early-Late,	After					
	Type A,	High Risk	3.25	- 1.75	- 0.75	-0.13	0.75
	Type A,	Low Risk	1.00	- 0.28	0.28	-0.11	- 1.87
	Type B,	High Risk	1.00	2.00	- 0.17	0.14	- 1.99
	Type B,	Low Risk	1.33	4.33	4.00*	0.12	- 2.12
TC,	Early,	Before-After					
	Type A,	High Risk	5.00	12.50	8.75*	-0.09	-11.48*
	Type A,	Low Risk	1.86	7.43	3.57	-0.57	-11.06*
	Type B,	High Risk	1.16	- 0.50	3.50	-0.14	- 4.67
	Type B,	Low Risk	- 7.67*	- 1.33	2.67	0.05	- 1.46
TC,	Late,	Before-After					
	Type A,	High Risk	11.00	- 4.50	2.25	0.29	6.09
	Type A,	Low Risk	- 2.00	8.00	4.57	-0.42*	- 6.28*
	Type B,	High Risk	7.00	5.50	7.17	-0.01	- 5.56
	Type B,	Low Risk	- 7.67*	- 1.33	2.67	0.05	- 1.46
GH,	Early,	Before-After					
	Type A,	High Risk	- 0.75	2.00	3.00	-0.25	- 8.42
	Type A,	Low Risk	7.57	- 0.28	1.43	0.26	- 2.09
	Type B,	High Risk	- 2.00	0.00	0.50	-0.14	- 6.78
	Type B,	Low Risk	4.00	1.67	- 1.00	-0.06	-10.38
GH,	Late,	Before-After					
	Type A,	High Risk	1.75	0.00	0.50	-0.11	- 8.14
	Type A,	Low Risk	1.43*	1.28	1.42	0.25	- 4.15
	Type B,	High Risk	0.67	2.17	2.00	0.13	- 7.24
	Type B,	Low Risk	2.00	8.00	2.67	0.02	-11.95

Type A, High Risk, n=4
Type B, High Risk, n=7

Type A, Low Risk, n=6
Type B, Low Risk, n=3

* indicates a significant difference between this mean difference and the overall mean difference.

Appendix D

MANOVA Interactions

Level of significance and comparison of means of significant MANOVA interactions

Interaction			N	Variable		Level of significance
Type *	Loc.			Pulse		.0034
A	GH		44	71.32		
A	TC		44	72.52		
B	GH		36	77.50		
B	TC		36	71.22		
Risk *	Loc.			SBP		.0001
High	GH		40	114.68		
High	TC		40	112.85		
Low	GH		40	114.55		
Low	TC		40	120.65		
Risk *	Loc.	* Time		Pulse		.0033
High	GH,	Early	20	72.65		
		Late	20	72.85		
	TC,	Early	20	72.35		
		Late	20	66.70		
Low,	GH,	Early	20	79.05		
		Late	20	71.85		
	TC	Early	20	73.55		
		Late	20	75.15		
Risk *	Type	* Loc.		SBP	DBP	SBP=.0004 DBP=.0058
High	A,	GH	16	119.12	61.75	
		TC	16	120.63	66.13	
	B,	GH	24	113.38	59.21	
		TC	24	107.67	57.25	
Low	A,	GH	28	113.96	59.00	
		TC	28	117.07	60.04	
	B,	GH	12	115.92	57.42	
		TC	12	129.00	62.58	

MEASUREMENT OF PHYSIOLOGICAL STRESS BY PERSONALITY TYPE OF DEVELOPMENTALLY DISABLED ADULTS IN HORTICULTURAL TRAINING

by

LYNN ELLEN DOXON

B.S. University of California 1974

AN ABSTRACT OF A MASTER'S THESIS

Submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Horticulture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1985

Physiological stress levels experienced by twenty developmentally disabled subjects were compared while they worked in a greenhouse or sorted paper for recycling in a pre-vocational training center. Pulse, blood pressure, electro-dermal resistance, and finger skin temperature measurements were taken in early and late morning both before and after a three month training period.

Based on startle response measurements of four physiological stress indicators and American Heart Association guidelines, the subjects were classed into four groups as follows: Type A (high sympathetic nervous system response levels), four subjects with high risk and six with low risk of hypertension; Type B (low sympathetic nervous system response levels), seven subjects with high risk and three with low risk of hypertension. MANOVA, t-test, and paired t-tests were calculated. Null hypotheses were rejected only when the MANOVA and t-test were significant for at least some of the dependent variables and these differences were supported by the paired t-test.

Subjects working in the greenhouse were found to be in a less stressful environment than at the training center. Less stress occurred in the late morning than in early morning. Type A subjects were found to have greater differences in their response to early and late morning than Type B subjects. Three months of training was found to decrease the level of stress for Type A subjects, but not Type B subjects.

This study provides empirical evidence that a greenhouse is a less stressful environment than a training center. Pre-vocational training in the greenhouse could lead to healthier, more productive workers. Type B subjects are less affected by stressful environments than Type A subjects. Higher stress in Type A subjects may be decreased by alternating horticultural tasks with other training tasks.