# CHAPTER I
## Introduction

A convergence of environmental health recommendations suggests that the physical surrounding in which people spend time has an effect on their overall wellbeing (Kaplan, S., 1995; Ulrich, et al., 1991; Rubin, Owens, and Golden, 1998; Sundstrom, Bushby, and Asmus, 1996, Parkay and Hass, 2000). To date, much environmental research has centered on the negative effects of various environmental exposures, such as linking poor design of interior spaces that humans occupy with delirium, elevated blood pressure, increase in intake of pain drugs and stress (Wilson, 1972; Ulrich 1984, 1992). There is however, a growing body of evidence which suggests that built environments, particularly in healthcare and education arenas can be psychologically and physiologically supportive and promote well-being (Doxon, Mattson, and Jurich 1987; Ulrich, et al., 1991; Zhan, 1992; Relf (1999). Zahn (1992) emphasizes the importance of environments that foster human health and well-being by stating that, "Health [and well-being] is a life experience that encompasses the whole person and incorporates the relationship between the person and the environment." (p.798)

The therapeutic aspects of contact with nature and plant life have been well-documented (Kaplan, R. 1983: Lewis, 1996; Ulrich and Parsons, 1992). The use of green plants in interior spaces for customers, tourists, employees, and students in locations like hospitals, hospices, healthcare facilities and campuses indicates that plants are valued both "passively" and "actively" by an increasing number of people for their aesthetics and positive effects (Sempik, Aldridge, and Becker, 2003). "Research by urban foresters and environmental psychologists has provided strong indications that, rather than being a

luxury of the rich, the existence of plants in a human's immediate surroundings fills as strong a basic need for good psychophysiological health as does food for physical health" (Relf, 1999, p. 11). This paper gives particular emphasis to the effects of passive visual experiences with plants/nature on stress reduction and devotes less discussion to the benefits of active contact with plants/nature.

Stress is inherent in every day life but stress is particularly manifest in college students (Tristan, Bright, Sutherland, and Duguay, 2002; Murphy and Archer, 1996; Zitzow, 1984; Mason, 1984) and is dramatically influenced by academic related tasks such as taking tests (Sapp, 1993; Payne, 2003), managing time, meeting deadlines as well as family disruptions, roommate issues, and dating relationships. Stress manifests itself in a student's life physically, emotionally, behaviorally and mentally (Texas State University Counseling Center 2005). As early as 1960, stress was labeled as an occupational hazard to students: "Academic work is subject to certain occupational hazards, and particularly to some sources of unusual physical and emotional stress, of which the student ought to be aware." (Fisher and Noble, 1960 p.118). "Solving a math problem or discerning the meaning of a passage of text can be an invigorating experience if we are allowed to do it. But if the environment is hostile, we must constantly struggle to focus on what we intend to do. Then the pleasurable tasks become onerous, and the mental facility that screens out conflicting stimuli becomes fatigued. The inability to eliminate distractions can lead to reduced competence, irritability, loss of judgment, and antisocial behavior – the price we pay for an environment at odds with our chosen goals" (Lewis, 1996, p.118). Zitzow (1984) using a college adjustment rating scale suggested that the top six sources of stress, reported by college students, were academic in nature,

with pressure to earn good grades ranking number one, and studying for tests ranking number two. "Men and women both face certain pressures upon entering academic life, such as the mental stresses induced by tests, papers, grades, career selection, social judgment, and physical exhaustion . . . both anxiety and depression are common by-products of stress in college life." (Myer, 1981 p.1)

Stress as a by-product of lifestyle may result in decreased effectiveness. "Engaging in unhealthful behaviors as a result of stress, or not engaging in healthful behaviors because of stress, may result in disease or trauma." (Herbert and Cohen, 1994 p.330) Hence restoration from stress could increase students' ability to cope with pressures of college life and ultimately improve their ability to perform and contribute.

The stress-reducing benefits of passively viewing plants in natural settings are well documented (Ulrich, 1984; Honeyman, 1992; Tristan, Bright, Sutherland and Duguay 2002). Views of nature or plants provide restoration from stress because of a combination of beneficial effects. Plants increase positive feelings; reduce stress related feelings, such as fear, anger, or sadness; hold interest and may block stressful thoughts. (Ulrich, Parsons, 1992 p.11) As Ulrich et al, (1991) states, "Recovery from stress, as with recovery from overload, is likely to be facilitated by experiences with natural environments." (p.123) Relf, (2000) supports that notion by stating that "Landscape architects, urban foresters, and horticulturists are beginning to use research data to explain the real value of plants . . . [to the health] well-being and quality of life in their communities." (p.1) However, many college students labor in windowless rooms with few opportunities to view nature.

Creating educational facilities that are conducive to learning depends on more than merely constructing space sufficient for students and faculty. As Lovins (2005) states, "building environments should delight when entered, [provide] pleasure when occupied, and [occupants should feel] regret when departed." (p.2) While learning and teaching is predicated upon effective communication, the local environment sets the stage for optimizing communication, and as a result, learning.

This chapter will provide the statement of the problem, the purpose of the study, and the theoretical perspective. It will also outline the research questions which this study will attempt to answer including the null hypothesis. Also included are some definitions of terms which may need further clarification to the reader. Factors which limit or delimit the study are also included.

## *Statement of the Problem*

This study focuses on the influences of visual contacts with plants on the psychological and physiological well being of college students. Stoneham (2002) suggests important research remains to be accomplished on restorative environments,

> . . . research has tended to focus on intervention and activities rather than the setting within which those things occur. There has been an increasing focus on the role of landscape as a restorative setting. . . . However, there is a need for more research to look at how landscape settings [plants] can influence such issues as behavior, personal development, and social interaction and how this applies to different settings such as schools, residential homes, and public green space. (p.157)

In response to Stoneham's invitation to research, this study will investigate the role that plants may play as an environmental variable.

### *Purpose of the Study*

The purpose of this study is to determine whether live plants placed into a university testing center will reduce stress and enhance test performance in Math 101 students.

### *Theoretical Perspective*

Creswell (2000) defines a theoretical perspective as "a theory [of] interrelated . . . constructs formed into propositions or hypothesis, that specify the relationship among the variables." (p.120) An exploration of the effects that nature and plants, the dependent variable, have on people is foundational to this study. Additionally, stress, the independent variable needs to be investigated as a possible cause which may negatively affect student outcomes. This discussion is couched into a historical perspective which conveys the importance of human contact with nature/plants and their stress relieving potential.

Gardening remains the number one leisure activity in the U.S. According to a 2002 National Gardening Survey, eight out of ten households in America, or 85 million households, participate in gardening activities. Americans spend $39.6 billion on gardens which is an increase of five percent over 2001 (Easterling, 2003).

In a questionnaire in which Dunnett and Qasim (2000), asked garden owners to describe those things which provided their satisfaction, the number one reason was to

"create a pleasant environment". The number two reason was "providing relaxation". Seventy-six and seventy-four percent of respondents, respectively. (p.43)

" . . . In the modern world, people are bombarded constantly with so much noise, movement, and visual complexity that their surroundings can overwhelm their senses and lead to damaging levels of psychological and physiological excitement" (Relf, 1999 p.11). As a teacher who is concurrently a, nontraditional student or adult learner, stress is a real issue. If chronic stress impedes performance and nature and plants relieve stress, (Ulrich and Simons, 1996) it follows that introducing plants into an environment should improve performance on stressful tasks (mathematics examination), in stressful environments (university testing center).

In the United States during the mid-nineteenth century a visionary landscape architect Fredrick Law Olmstead, (as cited in Lewis, 1996) "anticipated the intense growth of metropolitan areas and recognized that human benefit would accrue from setting aside land to remain forever green." (p.29) Olmstead believed that vegetation could be used to relieve the negative stress of city life and bring the beauty of nature to all, whether rich or poor. According to Lewis, Olmstead also believed in the restorative quality of nature. He stated that, "scenery works by an unconscious process relaxing and unbending of faculties made tense by the strain, noise and artificial surroundings of urban life." (p.29)

Olmstead (as cited by Lewis, 1996), theorized that parks and planned environments produced strong social benefits by bringing different cultural groups together in a healing environment. He believed that nature had a good effect on the psyche and behavior of men. According to Olmstead, this moral influence was especially

necessary where dwellings crowded together in large cities which produced "morbid conditions of body and mind", and casual "nervous feebleness or irritability, and various functional derangements". (p.29) By bringing members of an industrialized society into contact with nature and each other in a carefully planned environment, he felt he could increase their aesthetic sensitivity, their physical well-being and their civilized appreciation of others by bringing people in close contact with nature.

Ulrich and Parsons (1992) said Olmstead believed that environments containing nature "employs the mind without fatigue and yet exercises it; tranquilizes it yet enlivens it; and thus through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system." (p. 95)

Although Olmstead (as cited by Lewis, 1996, Evans and Cohen, 1987) first coined the tranquility hypothesis around the turn of the century, it may have more application today, in an ever increasing fast-paced world, because environments with high levels of visual complexity, noise, intensity, and movement can overwhelm and fatigue human senses or lead to a detrimentally high level of psychological excitement.

The underlying premise of this human-nature connection is as Ulrich (1999), states "….humans may have a biological prepared disposition that motivates them, following a stressful experience, to seek-out, approach, and spend time in nature settings with restorative properties." (p.52)

Plants, sunlight, and other natural elements have historically been incorporated into healthcare settings to create and enhance a therapeutic atmosphere for patients (Lewis, 1996, Gerlach-Spriggs, Kaufman and Warner, 1998, Cooper-Marcus and Barnes, 1999). In pivotal study by Ulrich (1984) in a healthcare setting, recovering gall bladder

patients recovered faster from their surgery, required less pain medication and were nicer to their caretakers when they had a room with a window view of the hospital landscape, as opposed to a brick wall. These often quoted findings are important because they help quantify what has historically been only an intuitive argument. Ulrich (1980) states,

> Although many are eager to extol the importance of plants, and while most planners and politicians probably feel that vegetation contributes to environmental quality, few can articulate the benefits in any precise manner…Intuitive arguments in favor of plants often make little impression on financially pressed local or state governments…Faced with urgent problems such as inner city poverty, politicians may dismiss planting programs as unwarranted luxuries, or overlook them altogether. (p.27)

Others including administrators in university settings may also overlook the benefits of including nature and plants into built environments because of costs. This study dispelled that way of thinking.

Some public health measures have sought to reduce risk by removing possibilities for exposure to certain risks, like second-hand smoke. Alternatively and preventatively, public health practioners are increasingly introducing variables into the built environment which may improve people's experience and performance. This preventative way of thinking about built environments is a critical shift that has been propagated by Frumkin (2001) which links human health to our proximal environment. And who suggests that health can, in part, be maintained through contact with nature, which includes plants, animals, and wilderness experiences.

Speaking specifically about academic settings, Burnett (as cited in Cooper-Marcus, and Barnes, 1999) states,

> When dealing with our brightest minds, we develop an academic setting that is conducive for learning. When we want to create a company that promotes loyalty and trust and lets employees know we care, we create a corporate campus that offers a setting for growth of the mind. But in life-and-death situations to cure the mind and body we have dropped all emphasis on the environment and digressed dramatically. (p.572)

A re-emphasis on academic environments, conducive for adults to learn in is a theme of this study. According to Knowles, Holton and Swanson (1998), "Adult learners are precisely those whose intellectual aspirations are least likely to be aroused by the rigid, uncompromising requirements of authoritative, conventionalized institutions of learning." (p.38) Many students labor in windowless rooms with few opportunities to view nature. This is particularly true of the BYU-Idaho student testing center, which can be a stressful environment hosting stressful events. Additionally a growing number of university professors are choosing to deliver tests in university testing centers. These stressful testing events are exacerbated by the added stress of sterile, windowless, and proctored testing centers (Sapp, 1993, Lohr, Pearson-Mims and Goodwin, 1996).

There is some evidence that environments dominated by vegetation tend to have lower levels of complexity and other arousal increasing properties than urban settings that lack nature (Wohlwill, 1976). Such theories suggest that environments containing prominent vegetation – in contrast to intense, perceptually jumbled urban settings – have positive, stress-reducing effects on people (Ulrich, 1979; Ulrich, 1984). As West states

(1986), "The increasing complexity of both technological tasks and the built environment is a source of many negative stress response patterns. In buildings, institutions, and communities, the nurturing properties of vegetation can ameliorate stress and provide maintenance for a healthy society." (p.5)

This study emphasizes the importance of student contact with nature and plants in built environments and helps bridge the literature gap about stressful academic environments in which we ask adult students to labor.

### *Research Questions*

This study examines the hypothesis that exposure to plants reduces human stress. This study will answer the following questions:

1. Can viewing plants be effective in fostering restoration from stress in college students? In a testing center environment?
2. Do college students perform better on subject matter tests in the presence of plants or without the presence of plants?
3. What are the physiological measures such as heart rate, blood pressure and body temperature of students in the presence of plants and not in the presence of plants during a stressful test event?

The Null hypothesis states that: There is no significant difference in student's Math 101 test scores in the presence and not in the presence of plants.

*Definition of Terms*

Allostatic State - Adaptation to an elevated state of chronic stress (Croker, 2000).

Biophilia - Innate, genetic, hereditary emotional attraction of humans to nature and other living organisms (Wilson, 1972).

Homeostasis - A state of equilibrium between different but interrelated functions in an organism (Sapolsky, 2000).

Natural Environment - ". . . The vast domain of organic and inorganic matter that is not a product of human activity or intervention. . ." (Wohlwill, 1983, p.7).
It deals with the landscape rather than the built environment.

Horticulture Therapy - "Horticulture Therapy is a process through which plants; gardening activities and the innate closeness we all feel toward nature are used as vehicles in professionally constructed programs of therapy and rehabilitation" (Davis, 1998, p3).

Perceived Stress Scale (PSS)- The PSS is a ten-item self-report instrument with a five point scale (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often). The PSS is designed to measure the degree to which situation one's life are appraised as stressful (Cohen, Karmarck and Mermelstein, 1983, p. 385, 394).

Plant- An organism that is stationary, makes food from the atmosphere and has no sense organs. (Webster School & Office Dictionary, 1990, p.544) The common medium used by those who practice therapeutic horticulture.

Stress - The process of responding psychologically, physiologically and often with behavior to a situation that is taxing or threatening to well being. (Evans and Cohen, 1987).

Testing Center - A building, room or section, specifically set aside for college students to take exams. Test centers are required to provide a distraction-free, secure testing environment with continuous candidate

surveillance. It must provide an enclosed, professional environment that is clean and comfortable; provide adequate lighting and ventilation, comfortable seating, privacy and adjustable computer monitors and keyboard stations. All personal belongings are to be stored in a secure, locked area that cannot be accessed by the students during testing. All activities are monitored by a site manager/administrator (Pearson Vue, 2005).

Therapeutic Horticulture - The passive, purposeful use of plants and plant related activities to promote health and wellness for an individual or group (Larsen, Hancheck, and Vollmar, 2005).

*Delimitations*

The Perceived Stress Scale test and physiological measures of stress; such as blood pressure, heart rate and body temperature will be administered to BYU-Idaho students enrolled in the summer of 2005 Math 101 classes.

### *Limitations*

The study may be limited by the honesty, accuracy and ability of undergraduate students. Students' perception of questions on the Perceived Stress Scale self test may be a limitation. Self rankings will utilize a Likert scale to measure how students feel at the time of a mathematics subject matter test being delivered in the BYU-Idaho testing center.

# CHAPTER II
# Review of Literature

## *Introduction*

Researchers routinely report that clients who interact with nature and plants recover from stress more quickly and feel more hopeful (Ulrich, 1984). Behavioral problems of youth diminish, self-esteem improves and stress diminishes when children have contact with nature (Waliczek, Bradley, Lineberger and Zajicek, 2000).

Some of the literature surveyed, dealing with supportive environments, includes health care facilities, educational settings, and the work place. A common environmental variable, in much of the related literature, deals with the psychological and physiological benefits of passively being around or viewing nature or plants. Relf (2000) found that, "Simply viewing plants measurably reduces stress." (p.1) Ulrich (1993) noted that a common recurring theme in the literature on environmental aesthetics is "The consistent tendency for North American and European groups to prefer natural scenes over built views." (p. 110) Anciently, healing places were often found in nature. Some examples that Cooper-Marcus and Barnes (1999) note are "healing spring[s], sacred grove[s] and special rock[s] or cave[s]" (p.1). According to Cooper-Marcus and Barnes, some of the earliest hospitals were infirmaries contained in monasteries that used prayer and herbs to heal.

In addition to the intuitive sense that addresses the importance of natural settings to human well-being, there is growing empirical research that supports both the passive appreciation of plants and the active participation with plants. This division can also be represented using the terminology of therapeutic horticulture for passive experiences with

plants and horticultural therapy (HT) for active interaction with plants, utilizing a client based approach for self improvement (Davis, 1998). Both approaches share the commonality of using plants to improve the human state, with the ultimate goal of improving health and well-being (Haller, 2004).

### *Importance of Nature*

The word nature is often reserved for areas that have been unaffected by human influence. Often these areas contain trees, water, and other vegetation. Many people appreciate contact with nature. As stated by Frumkin (2001), "Nature matters to people. Big trees and small trees, glistening water, chirping birds, budding bushes, colorful flowers – these are important ingredients in a good life." (p.234) That which is nearby for most individuals, most of the time, could hardly be described as lacking human influence. Yet as the Kaplan's (1989) suggest, vegetation is often present and qualified as nature even if it is at one's doorstep. "The first point to be kept in mind then," Olmstead (1865) insisted, "is the preservation and maintenance . . . of the natural scenery." The potential benefits of nearby nature can be garnered, whether, found in ones yard or in National Parks. The potential psychological benefits are the same.

The Kaplan's (1982) further suggest that human's affinity to nature has evolutionary roots, is learned behavior, and connects settings high in vegetation with intuitively and cognitively based preferences with restorative capabilities. Ulrich (1983) modifies the evolutionary theory by suggesting a psychoevolutionary perspective, which holds that a human's emotional response to nature is central to all thoughts, memory, meaning and behavior related to interaction with human environments. While Wilson

(1984) reports that humans have an innate genetic attraction to nature and other living things coining the term biophilia. Further validation of a human's deep emotional connection, to nature, regardless of whether it is learned behavior or genetic, or both (Kaplan and Kaplan, 1989), is indicated by a human's need to import bits of nature into built environments. As Wohlwill (1983) suggests "the importance attached to such signs of the natural world in our man-made environment itself testifies to the value ascribed to the domain of nature, possible as counter force to the domination of artifacts felt by the residents of our cities." (p. 10) Frumkin (2001), advances the notion that contact with nature is most advantageous when humans are exposed to nature as a preventative component of well-being by saying that ". . . we as a species find tranquility in certain natural environments – a soothing, restorative, and even healing sense. If so, contact with nature might be an important component of well-being." (p.234)

An important finding, as Ulrich (1983) states,

> Is the pattern of widespread agreement among individuals and groups in their aesthetic preferences for natural environments. This picture of agreement, coupled with the success in identifying highly efficacious predictors of preference, contradicts strongly the traditional notion that aesthetic response to environment is an inherently subjective phenomenon, impervious to empirical investigation. . . . (p. 119)

This study will add to the body of literature by investigating, empirically, some of the psychological benefits of passively viewing plants.

*The Stress Concept*

The stress reaction is the process of responding psychologically, physiologically and often with behavior to a situation that is taxing or threatening to our well-being (Evans and Cohen, 1987). However, it is important to note that all stress isn't bad. Positive stress (eustress) occurs when there is a moderate challenge. In these instances, the body "releases chemicals like adrenaline and norepinephrine, which actually heighten our perception, increase motivation, and strengthen our bodies – all conditions which enhance learning" (Jensen, 2000 p.229).

The negative form of stress (distress) occurs when the subject is threatened by physical or emotional danger, intimidation, embarrassment, or fear of rejection. Sapolsky (2000) found that the body responds to high or chronic stress by releasing stress hormones from the adrenal glands. While small amounts can feel good and be a motivation force, too much depresses the immune system, tenses muscles, and ultimately impairs learning. Although certain short-term stressful situations may improve human performance and cognitive functioning, this study considers stress to be a negative condition that should be mitigated over time to prevent negative effects on human health and well-being.

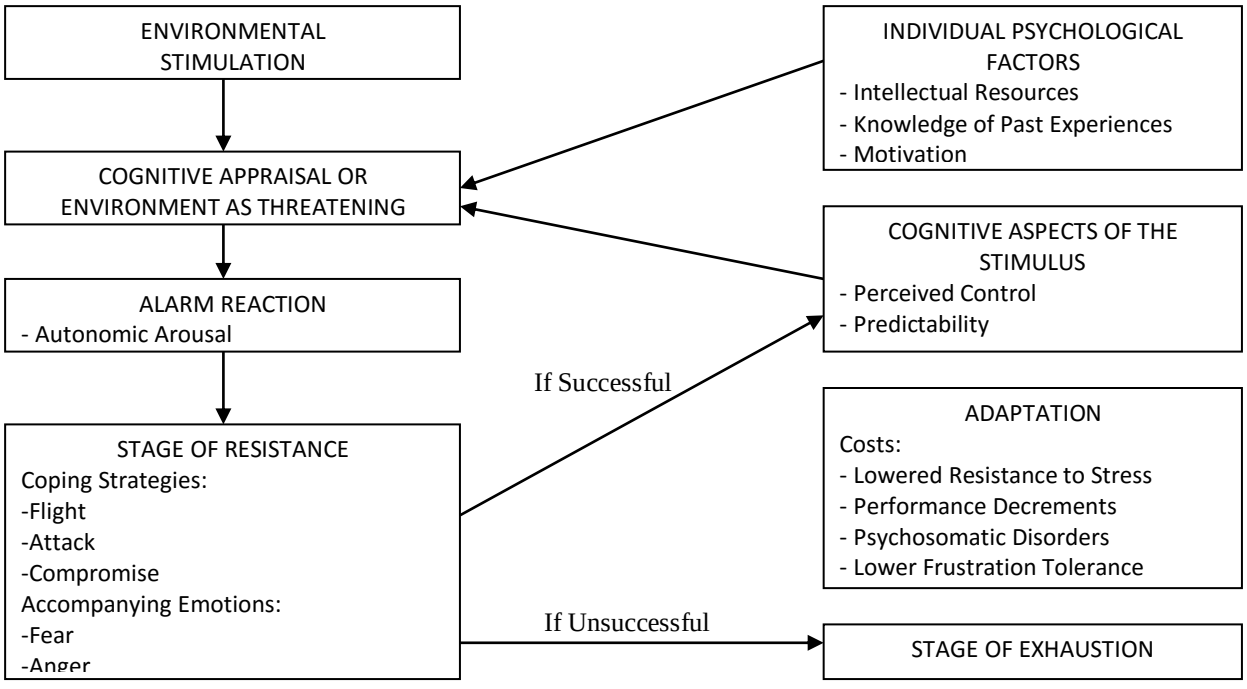
The brain's response to stress is a complex series of events. The following represents a layman's version of how the brain and body react to stress. In response to stress, Seyle (as cited in Mascott 2004), says that the brain activates the hypothalamic-pituitary-adrenal (HPA) system. The HPA system first triggers the production of steroid hormones. Next the pituitary gland, which is influenced by the hypothalamus, causes the adrenal cortex to release hormones into the bloodstream. One group of hormones, the

glucocorticoids, increases the amount of blood sugar in the body, while the body is concurrently trying to adapt to stress. Further Seyle suggests that by releasing more blood sugar, the body has more energy which facilitates increased blood circulation. The negative side of this transformation, however, is that these hormones reduce resistance to infection and reduce the body's ability to repair/change.

During a response to stress Seyle (as cited in Mascott 2004) notes that the brain releases neurotransmitters such as dopamine, norepinephrine, and epinephrine (also called adrenaline). The neurotransmitters activate the amygdala in the brain. The amygdala triggers an emotional response to the stressor, which can result in problems with short term memory, concentration, inhibition, and rational response.

The following figure aids in visualizing the bodies response to stress as it tries to obtain homeostasis or equilibrium.

Figure 1 *The Stress Model*




(Bell, Green, Fisher, and Baum, 2001)

Seyle's (as cited in Mascott 2004) general adaptation syndrome can be defined as "the total organism's non-specific response to stress." According to Seyle, the response occurs in three stages:

1 – Alarm Reaction – Pituitary – adrenocortical system produces hormones essential for fight or flight. The heart rate increases, blood sugar is elevated, pupils dilate, and digestion slows.

2 – Resistance or adaptive stage – acute symptoms diminish and the body begins to repair the effect of arousal.

3 – Exhaustion stage occurs when the body can no longer respond to the stress. As a result one or several diseases may occur.

Seyle says that during the exhaustion phase our bodies are more susceptive to disease because our body runs out of hormones to secrete. Cohen (1986), however, suggests that this rarely happens. Instead of running out of hormones, the body spends so many of its resources that other components collapse. The stress response, itself can become damaging.

Sapolsky (2000) defined a "stressor as anything that throws your body out of homeostatic balance – for example, an injury, an illness, subjection to great heat or cold. The stress-response, in turn, is your body's attempt to restore balance. This consists of the secretion of certain hormones, the inhibition of others…." (p.7)

"In an increasingly complex society, stress is a constant companion. It has a dramatic impact on us emotionally and physically (Sears, 1995 p.24). Maintaining homeostasis amidst daily stressors is difficult and efforts to reestablish that balance can eventually wear one down. If the stress response is repeatedly turned on it can eventually

become nearly as damaging as some stressors themselves. Cohen, Kessler and Underwood (1995) say that "Prolonged or repeated activation of these systems is thought to place persons at risk for the development of a range of both physical and psychiatric disorders." (p.8)

Both massive stressors and everyday stressors, such as taking an examination, have been linked with decreased immune function and, in the case of more extreme stressors, increase mortality (Antonosky, (1979). Herbert and Cohen (1994) suggest that when individuals experience stress, or make a stress appraisal, they usually experience negative emotions (e.g. anxiety, depression). These physiological changes that often manifest themselves behaviorally "increase the risk for disease and mortality." (p.325) Cohen (1996) has determined that people who are under stress are more likely to get the common cold. Others such as Antonovsky (1979) suggest a causative link between stressors and disease. Bell, Greene, Fisher and Baum (2001) support the long term negative effects of stress by stating that "…prolonged exposure to stress can lead to serious after affects, including mental disorders, performance decrements, and lowered resistance to stress." (p.134)

Stress negatively affects the immune system (Herbert & Cohen, 1994), circulatory system, energy storage, growth, and reproduction. ". . . A critical shift in medicine, according to Sapolsky (2000), has been the recognition that many of the damaging diseases of slow accumulation can be either caused or made far worse by stress." (p.3)

Research suggests that stress related diseases emerge because often, people activate, a physiological system that has evolved for responding to acute physical emergencies, but some turn it on for months, worrying about mortgages, exams,

relationships, and promotions. These small events may have a greater cumulative effect on psychological and physical health than major life events, such as the death of a relative (Mason, 1984). Sapolsky (2000) suggests that when we activate the stress response out of fear of something that turns out to be real, [or physical]; we congratulate ourselves that this cognitive skill allows us to mobilize our defenses early. And "when we get into a physiological uproar… over non-real psychological stresses that we can't resolve physically, we attach to that stress such labels as "… 'anxiety', 'neurosis', 'paranoia', or 'needless hostility'". (p.8)

Sapolsky (2000) has found that during extended periods of chronic stress, cortisol and related stress hormones cause nerve cells in certain parts of the brain to lose their dendritic branches and spines and eventually to die off completely. This can lead to poor memory, fuzzy thinking, and a lack of creativity. Stress destroys the ability to make neural connections. Exposure to chronic stress for long periods of time creates an allostatic state which fools the victim into believing their stress is non-existent when in reality stress levels have only decreased, leaving them vulnerable to the onset of stress related illnesses (Croker, 2000). Stress reduction, according to Cooper-Marcus and Barnes (1999) "is one of the most significant components of well-being for the individual with a chronic or terminal condition, when the quality of his or her life is of paramount concern." (p.3)

As Lee (1997) says, there is "research implicating stress in 60 percent to 90 percent of medical problems, companies cannot afford to ignore the huge health-care expense employee stress creates." (p.1) In a study Lee (1997) found "that workers experiencing high stress were over two times more likely to be absent more than five

times per year." (p.1) "The California Workers' Compensation Institute (CWCI) reports that the number of workers compensation claims for mental stress increased by almost 700 percent between 1979 and 1988" (Lee, 1997 p.1). "In Maine, stress-related claims have increased by 1,000 percent since 1985, according to Bureau of Labor Standards statistics" (Lee, 1997 p.1).

According to Rosch, (as cited by Schar,1994), stress is "taking a terrible toll on the nation's health and economy. It is a heavy contributor to heart disease, cancer, respiratory distress, lupus, and many other life-threatening illnesses. It is a key reason for our astronomic health care costs." Rosch (1994) continues by saying that "every week 12 million people take medication for stress-related symptoms and that it costs American business $150 billion each year in absenteeism, lost productivity, accidents, and medical insurance." (p.14)

Stress is recognized as a serious social and economic problem and a public health concern, because it's potential to negatively affect young people, including students, who are still in some of their most productive years. Being adversely affected by a high incidence of stress contributes to these persons being excluded from activities that contribute to economic growth and social well being. As reported by Chrysalis Performance Strategies, Inc., (2002), "Stress costs industry over $300 billion a year in the United States, over $16 billion a year in Canada, and as much as £7.3 billion in the United Kingdom." (p.1)

Wagner, Compas, and Howell (1988) explored the relationship between stress and mental health in first year college students. They developed a scale to measure the perceived importance, frequency, and desirability of recent life events. More weight was

given to events which occurred frequently and/or the student felt had an important impact. This scale measured the students' perceived and environmental stress. The students also completed a checklist consisting of fifty-seven psychological symptoms related to stress. The researchers concluded that there was a significant relationship between stress and psychological symptoms. Relf (1999) reviews "the final theory discussed by Ulrich and Parsons (1992) [which] maintains that people's responses to plants are a result of evolution; that is, since humans evolved in environments comprised primarily of plants, they have psychological and physiological responses to them." (p. 11)

This paper attempts to make a distinction between physiological and psychological theories of stress, however it is important to point out that both the "physiological and psychological stress reactions are interrelated, and do not occur alone" (Bell, Greene, Fisher and Baum, 2001. p.116).

### *Psychological Considerations*

A growing body of research on recreational experiences has suggested that leisure activities in nature settings with vegetation are important in helping people manage stress and meet other non-stress-related needs. Most of this research focused on benefits from experiences in wilderness environments, but a number of studies have measured the psychological effects of leisure experiences, locations such as urban parks, botanical gardens, hospitals, workplaces, yards, and common areas of housing developments. A consistent finding in wilderness studies have shown that psychological restoration, through stress reduction, is one of the most important verbally expressed, perceived benefits (Driver and Knopf, 1976; Knopf, 1987; Kuo and Sullivan, 2001). Similarly,

restoration from stress has emerged as a key perceived benefit in much of the research on urban parks and green spaces in residential areas (Ulrich and Addoms, 1981; R. Kaplan, 1983; Hayward and Weitzer, 1984; Talbot, Bradwell and Kaplan, R., 1987).

Separate from restoration gained by viewing vegetation and other nature, several factors contribute to stress recovery. Factors such as physical exercise, nutrition, age, and achieving a sense of control with respect to work pressures and other stressors through temporary escape (Driver and Knopf, 1976) or being away (Kaplan and Talbot, 1983). A significant contributor to stress recovery results from viewing vegetation and nature. This conclusion is supported by several park studies that have significant associations between reported restoration and questionnaire items relating to a park's appearance such as trees, grass, and open space (Ulrich and Addoms, 1981). Also, additional research identified restorative effects while controlling variables such as physical exercise and psychological escape. Hartig, Mang, and Evans (1987) produced stress in subjects with a demanding cognitive task. They then measured recovery produced by either (1) reading magazines or listening to music for 40 minutes, (2) walking in an urban area for 40 minutes, or (3) walking for an equivalent period in a nature area dominated by trees and other vegetation. They learned that individuals who had taken the nature walk had more positively toned feelings than subjects assigned to the other conditions. Tristan, Bright, Sutherland and Duguay, (2002) found that self-reported stress of college students was reduced after touring a greenhouse and garden. The authors also pointed out that the horticultural intervention (garden tour) "is successful in alleviating already stressed students, but it also helps them manage their stress before it becomes a problem." (p.85)

Francis, and Cooper-Marcus, (1992) investigated places which university students in California seek when feeling stressed and depressed. As the following tables suggest, a considerable majority of students identified outdoor natural settings that were rural or urban settings such as wooded parks and places next to water features, as places they prefer when stressed or depressed.

Table 1 *Types of Places Selected by University Students When Feeling Stressed*

| Places | Number | Percent |
|---|---|---|
| Natural settings | 62 | 40% |
| - With water | 34 | 22% |
| - Without water | 28 | 18% |
| Designed outdoor settings | 47 | 31% |
| - Campus, sport facility, yard, etc. | 29 | 19% |
| - Urban park | 18 | 12% |
| Enclosed spaces | 27 | 18% |
| - Own room, home, etc. | 25 | 17% |
| - Other | 2 | 1% |
| Urban and built settings (e.g., mall, movie theater, bar, store, church) | 18 | 12% |
| TOTALS | 154 | 100% |

(Francis and Cooper-Marcus1992)

Table 2 *Elements and qualities of places chosen by university students when feeling stress*

| Types of Elements or Qualities | Number of Mentions | Percent of Total Sample Who Mentioned |
|---|---|---|
| Natural elements | 106 | 69% |
| Sensory qualities | 97 | 63% |
| Evokes safety/comfort | 94 | 61% |
| Provides privacy/solitude | 79 | 51% |
| Viewpoint, expansive scale | 43 | 28% |
| Urban milieu | 42 | 27% |
| Opportunities for movement | 36 | 23% |
| Opportunities for exploration/challenge | 6 | 4% |

(Francis and Cooper-Marcus1992)

In a pivotal study that tested the restorative effects of merely viewing vegetation. Ulrich (1984) compared hospital records of matched pairs of gall bladder surgery patients who had window views of either a small stand of trees or a brick-building wall. Ulrich found, that in a stressful hospital environment, patients with a view of trees had a shorter post-operative hospital stay, required fewer potent pain drugs, and received fewer negative staff evaluations about their conditions than those with the wall view.

Cooper-Marcus, and Barnes (1995) summarize in Table 3, environmental qualities which help attain mood change in hospital patients.

Table 3 *Percent of respondents who named these qualities as helpful in attaining a mood change in four hospital garden settings*

| | Percent |
|---|---|
| Trees and Plants<br>flowers, colors, greenery, heritage trees, being in nature, seasonal changes | 69 |
| Features involving auditory, olfactory, or tactile sensations<br>birds/squirrels, wind/fresh air, water, quite, light/sun, shade, fragrances | 38 |
| Psychological or social aspects<br>peaceful, escape from work, openness/large, privacy/secret places, oasis, companionship, watching others, knowing it is here | 50 |
| Visual qualities relating to more than plant materials<br>attractive landscape design, views, variety of elements, textual contrast/quality, differing shapes/sizes | 26 |
| Practical Features<br>seating, well-maintained, accessibility, vending machines, smoking allowed, pathways | 17 |
| No answer or “don’t know”<br>(Number of respondents: 143) | 8 |

(Cooper-Marcus and Barnes, 1995)

Research on window views and windowless settings provide additional suggestions that visual contact with vegetation and nature can be preferred and restorative. Compared to settings with windows, windowless rooms tend to be disliked and can be stressful, especially in workplaces and health-care settings (Keep and Inman, 1980; Ruys, 1970). Heerwagen and Orians (1986) found that office workers with little or no visual access to the outside were more likely to decorate their work spaces with posters and other depictions of outdoor scenes than were workers with windows. Most outdoor pictures used by the windowless group displayed settings dominated by vegetation and other nature (Heerwagen, 1990). In interiors with windows, views having depth, vegetation, or other nature are preferred over low-depth and visually stark window views (Markus, 1967; Verderber, 1986).

Astronauts and cosmonauts provide more evidence of the important restorative effects of nature in stressful interior environments (Wise and Rosenberg, 1988). Wise and his associates interviewed a culturally diverse group of Western astronauts and Soviet cosmonauts, and asked for suggestions for interior décor options they would prefer. Responses indicate a strong, widely shared preference for more plants and other nature elements in stressful orbital environments. Respondents were nearly unanimous in asking for more natural and varied colors, plants, landscape pictures, and natural woods, regardless of their particular national origin. A human beings' love for nature and natural materials and forms, especially in high technology habitats, seems to extend national boundaries (Wise, McCohville, and Al-Sahhaf, 1990).

### *Physiological Considerations*

In addition to psychological manifestations, stress and restoration have important physiological dimensions. The physiological component is reflected in responses or levels of activity in numerous bodily systems, such as the cardiovascular. Data obtained by recording physiological responses are recognized to have scientific credibility as indicators of stress and restoration. Physiological methods can identify influences on well being that may be outside the awareness of individuals and hence may not be identified by verbal measures such as ratings or questionnaires.

Ulrich and Addoms (1981), studied brain electrical activity of unstressed individuals who viewed slide presentations of outdoor scenes. A major finding was that alpha wave activity was higher when subjects viewed nature settings dominated by vegetation as opposed to urban scenes lacking vegetation. Apart from indicating that nature and urban scenes had different effects on electrocortisol activity, the alpha wave results suggested that vegetation views are more responsible for a wakeful, relaxed state. In the same study, self-ratings data suggested that vegetation settings sustained attention/interest at higher levels than did urban scenes and produced more positive emotional states.

Other physiological measures have also been used to study stress reducing effects of visual experiences of nature. Ulrich and Simons (1986) conducted a series of physiological responses while stressed subjects' experienced a recovery period consisting of ten minute color/sound videotapes of either natural or urban outdoor environments. Results indicated that people recovered more quickly and completely from stress when exposed to natural settings, which included a park-like setting dominated by vegetation.

Recovery during nature exposures were indicated by lower blood pressure, muscle tension, and skin conductance. Nature settings also fostered more recovery from psychological stress, indicated by greater reductions in self-rated fear and anger, and much greater increases in positive feelings (Ulrich and Simmons, 1986). Physiological findings by Ulrich and Simmons (1986) indicated that nature settings produced significant recovery from stress in only 4-6 minutes. This rapid recovery suggests that comparatively brief visual contacts with vegetation may be important for many urban dwellers in fostering restoration for mild daily stressors such as commuting to work.

Physiological measures may also be used to investigate stress-reducing effects of nature scenes in health-care and workplace settings. Heerwagen and Orians (1986) studied stressed patients in the waiting room of a dental clinic. On some days, the researchers hung a large mural on a waiting room wall depicting a view of distant mountains, clustered trees, and open grassy areas. On other days, the wall was blank. Findings obtained from self-ratings of feelings suggested that patients felt calmer or less stressed on days when the scene with vegetation and other nature was on the wall. Likewise, heart-rate measurements also indicated that individuals were less stressed or tense when the nature scene was visible.

Relf (1999) reports “the administrative offices of the John Deere Corporation have been structured so that employees are no more than 45 feet from plant vegetation. Company leaders ‘report that creativity has been enhanced, productivity increased, and employees voluntarily have upgraded their standard of dress.” (p.11)

These physiological findings support the hypothesis that people may not have to be consciously aware of the presence of plants in homes, workplaces, or other settings for plants to have positive influences on emotional states and physiological indicators.

### *Psychophysiological Considerations*

A distinction has historically been made, including this paper, between the physiological and psychological effects of stress. This is in part due to the fact that physiological stress concerns the anatomic nervous systems reaction to harm or the threat of harm. Additionally, psychological stress focuses on a cognitive assessment of whether an individual has the necessary resources to meet a difficult challenge (Bell, Greene, Fisher and Baum 2001; Herbert and Cohen, 1994).

The term psychophysiological denotes the marrying of psychological and physiological methodology. According to Johnson and Anderson (1990) this term demonstrates the value of employing measures of multiple systems that regulate the endpoints for homeostatic systems.

"Though the potential for theoretically and practically useful information is great with these methods, their use can be expensive and many require specialized training" (Parsons, Ulrich, & Tassinary, 1994, p.369).

Johnson and Anderson (1990) believe that "One maximizing strategy is to evaluate the biological relevance of a physiological variable in relation to a psychological process under study." (p.224) This intersystem relationship will go far in demonstrating the empirical reliability of stress reducing mechanisms.

### *Math Anxiety*

A study population of Math 101 students is chosen in part because of a condition termed math anxiety. Mathematics anxiety has been defined as involving "feelings of tension and anxiety that interface with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic settings" (Richardson and Suinn, 1972 as cited by Suinn and Winston, 2003, p.167).

"Math anxiety is an extremely common phenomenon among college and university students today" (Krantz, 1999). Krantz continues by suggesting frequently observed physiological symptoms of those whom are negatively affected by math anxiety, they include; sweaty palms, nausea, heart palpitations, and experiences of paralysis of thought. Krantz claims that 85 percent of students who take his introductory mathematics classes claim to feel at least mild math anxiety, according to surveys (Krantz, 1999).

Brigham Young University basic mathematics requirement for most majors is College Algebra or Math 110. Those students taking a more remedial math course, such as Math 101, may fall into the category of those students who experience math anxiety, thereby increasing their potential stress, making them good candidates for a stress study.

### *Test Anxiety*

"Test anxiety is due to the brain's reduced ability to process information while under severe stress" (Texas State University Counseling Center, 2005, p.2). To students suffering from anxiety, this is of particular concern.

Although there are a myriad of classroom assessment techniques which measure performance, the traditional "test" conjures many emotions and is often accompanied by anxiety. Regardless of teachers goals and how clearly they are presented, students goals and activities are strongly influenced by tests or other activities which determine grades (McKeachie, Pintrich, Lin, and Smith, 1986). Test anxiety is a special case of general anxiety consisting of phenomenological, physiological, and behavioral responses related to fear of failure (Sieber as cited in Sapp, 1993).

Testing for a driver's license or standardized college admissions test causes some degree of anxiety. Many times this anxiety can inhibit performance. According to Payne (2003), test anxiety is described as "an uncontrollable feeling before, during, or after an examination or evaluation." The greater the significance, Payne says, of the test results or the greater the importance of the decisions to be made on the basis of the test results, the greater the test anxiety is. According to Payne test anxiety can be manifest in inhibited memory, upset stomach, profuse sweating, elevated blood pressure, and increased pulse. (pp. 286-327)

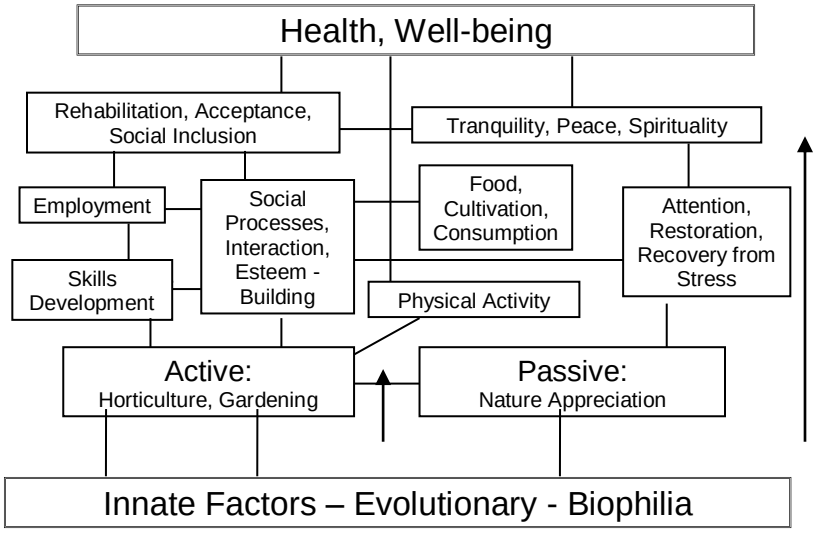
In a classic test anxiety and performance study performed in1908, Yerkes and Dodson, (as cited in Sapp, 1993) demonstrated that moderate levels of anxiety can lead to optimal performance on certain tasks; however, performance deteriorated when anxiety increased. Heightened levels of test anxiety improved performance on simple tasks; but served as a distraction when task complexity increased. In a phrase Yerkes and Dodson coined as "negative self evaluation," those being assessed routinely think the following: "I can't remember the answers and I am going to fail this exam." They also listed several

physiological sensations that one experiences when test anxiety manifests, such as: perspiration, abdominal pangs, muscle rigidity and nervousness (Sapp, 1993).

"A major source of information about stressors and various coping opportunities lies within the configuration of the physical environment." Stokols and Altman, (1987 p. 573). Also, according to Stokols and Altman, "Insufficient attention has been paid to qualities of physical environments that may be more likely to place adaptive demands on the organism [students]." (p.574)

The following figure illustrates both passive and active ways that some people interact with plants with the goal of improved health and well being in mind. It starts with an innate need for nature and results in improved health and well-being within the division of "active" and "passive" there are many plant based processes and activities which overlap, and are inter-related, and which provide rehabilitation, acceptance and inclusion on one side and tranquility, peace and spirituality on the other (Sempik, Aldredge & Becker, 2003).

*Figure 2* Flow Chart of Passive and Active Plant Interactions




(Sempik, J., Aldridge, J. & Becker, S., 2003)

*Active Participation with Plants*

Throughout time the connection between healing and nature was gradually replaced by an ever increasing technological approach. The notion that nature and plants played a role in healing was relegated to token decorations in sterile hospital hallways (Cooper-Marcus and Barnes, 1999; Warner, 1994). However, Relf (2000) "has documented that people benefit psychologically, physically, mentally, and socially through their involvement with plants." (p.1) A growing allied field of horticulture which deals "actively" with growing plants and their therapeutic potential is horticultural therapy. According to Davis (1998) horticultural therapy is:

> A process through which plants, gardening activities, and the innate closeness we all feel toward nature are used as vehicles in professionally conducted programs of therapy and rehabilitation. (p. 3)

There are three predominant types of horticultural therapy programs; vocational, therapeutic and social (Haller, 1998):

Vocational – models treatment objectives enabling clients to contribute to society through meaningful horticulture related work. This type of program often targets populations of at-risk youth or prison inmates.

Therapeutic – uses a medical model of HT interventions with an effort to retrain, gain strength or heal. Typical populations accessing the therapeutic model are persons with physical disabilities or accident victims.

Social – typically follows human wellness models, focusing on improving quality of life through interactions with plants. Those who typically benefit most from social intervention are elderly, children, and college students.

Horticultural Therapy is both a treatment modality and a profession (Haller, 2004). Often HT programs are one of many treatment modalities used in conjunction with occupational therapy, recreational therapy, nursing and social work. In horticultural therapy programming, plants are grown specifically for the restorative and rehabilitative effects they might have on the person growing them. The primary objective of the plant intervention is to heal the patient; producing plants and flowers is a secondary benefit (Lewis, 1993).

A study in Norway by Fjeld (2000), investigated whether indoor foliage plants used for decoration affected self reported human health and discomfort symptoms. The three categories of symptoms were neuropsychological, mucus membrane, and skin symptoms. The study found that the twelve measured symptoms were 23 percent during the period in which participants were exposed to plants in their offices. A significant reduction was obtained in neuropsychological symptom (fatigue, headache, dizziness, and concentration problems) and in mucous membrane symptoms (itchy eyes, irritated, running or stuffy nose, dry or hoarse throat, and cough) when plants were present. Plants can improve indoor air quality by increasing the relative humidity, decreasing temperature and carbon dioxide levels; reduce concentrations of volatile organic compounds such as formaldehyde, benzene and trichlorothane. Relative humidity can be increased by an average of 5 %, dust reduced by 20% and temperature moderated as much as 20% by using plants indoors (Lohr, Pearson-Mims 1996).

Similar studies have documented that simply viewing plants, in interior spaces, or outdoor spaces with vegetation can be stress-reducing and promote positive responses

(Pearson-Mims, Lohr, 2000; Honeyman, 1992; Tennesseen and Cimprich, 1995; Ulrich, 1981; Ulrich, Simons, Losito, Fiorito, Miles and Zelson, 1991).

The elderly population has long been a favorite of horticultural therapists to work with. Leos (1998) indicates the benefits that horticultural therapy might provide to elderly individuals. "Results include improvement in memory, time on task, attention span, range of motion, muscle strength and balance, fine and gross motor skills, and grip strength." (p. 81) These and other demonstrated changes evidence the behavioral (Hagedorn, 1991), cognitive (Pryor, 1994), physical (Gallagher and Mattson, 1986), and psychological (Buettner, Lundgren, et.al., 1996) benefits of horticultural therapy for the elderly.

"Horticulture has been identified as the number one leisure pursuit of older Americans and as a therapeutic activity which enhances physical and mental health." (Simson and Haller, 1997, p.125). There are an estimated 1.8 to 2.25 million persons providing care to aged family members (Smith and McCallion, 1997). For both the trained horticultural therapist and the non-trained family member providing elderly care, stress can manifest itself. Smith and McCallion state that some caregivers report an increase in back injuries, disrupted sleep, depression. Care-giving is also reported to affect job performance and career aspirations (Toseland, Smith, and McCallion, 1995). Whether plants are used as a therapeutic modality to alleviate stress by trained horticulturists or experienced passively by non-trained caregivers, both groups can benefit positively from plants in stress relief (Smith and McCallion, 1997).

When people and plants are brought together, there arises the potential for profound and compelling experiences. "There is a natural rhythm, a time and a season

for all things, and nothing can be forced out of its natural order and still survive" (Relf 1999 p.12). Humans offer utility, recognition, and awe to the natural world. In response, nature displays symbols and provides challenges urging humans toward their highest potential. This strong historical relationship creates fertile ground from which positive change can occur in the future. "Plants bring balance and harmony into our soul, behavior and thoughts and help us create a life worth living" (Relf, 1999 p.11).

### *Passive Appreciation of Plants*

Research in the environmental health field is providing a wealth of information about what is hazardous to human health. For example air pollution is linked to respiratory disease (American Thoracic Society, 1996). Long-term exposure to air pollution can be a serious hazard for people with lung disorders. Pollution also raises the risk of dying from those conditions, as well as coronary heart disease (McReynolds, 2002). Urban decay such as graffiti and dilapidated buildings contribute to an increase in crime and less safe inner city neighborhoods (Kuo and Sullivan, 2001). Plants benefit mankind psychologically by reducing stress (Ulrich and Simmons, 1986). Workers with a view of natural elements like flowers and trees are more productive (Zadik, 1994). Prison inmates are better citizens and exhibit less recidivism. (Rice and Remy, 1994) Lohr, Pearson-Mims, and Goodwin (1996) explored stress relief among students in a computer lab in the presence of plants and in the absence of plants; students were randomly assigned to the treatment. When plants were present students were less stressed and reported feeling more attentive than students that tested with no plants present. Additionally, in the presence of plants, students had lower blood pressure and

quicker reaction times on a computer task (12%). This study supports the notion that plants can evoke calming responses and enhance performance. In another study by these same authors; Pearson, Mims and Lohr (2000) looked at the interior plant environment literature and summarized several studies. One of the contributions they made was to point out some weaknesses in the early literature. Some of those criticisms are that the studies "relied on anecdotal evidence and self-reported evaluations." (p.10) Another criticism was "few of them utilized…double-blind" methodologies. (p.10) Despite these limitations there are many substantial claims which espouse plants to be an important component of interiorscapes, which will be noted throughout this study. Although it is important to know what environmental exposures negatively threaten human health it is also imperative to understand those environmental factors that enhance human health and well-being.

The medical community has led the way in assimilating research on what environmental variables contribute to healing in built hospitals settings. Some twenty variables, including nature views, were assimilated through a literature review. Some representative variables include room size, aroma, type of furnishings, lighting, color of the walls, etc. (Rubin, Owens and Golden, 1998).

There has also been much information on what environmental conditions such as room arrangement, room color, room temperature, etc. contributes to enriched educational environments (Weinstein, 1979, McGuffrey, 1982, Parkay and Hass, 2000, Sturt, 2004). One of these life enhancing environmental variables are the "passive" viewing of plants.

*Summary*

Mankind is literally and figuratively connected to plants for food, clothing, shelter and the very air we breathe. The benefits of plants extend beyond these foundational qualities as noted in this chapter. The combination of psychological and physiological effects may underlie beneficial health-related influences of plant views found in stressful real world settings such as hospitals, prisons, workplaces and university settings.

# CHAPTER III
# Methodology

## *Introduction*

This chapter describes the methodology that will be used to assess students' test performance in the presence and absence of live plants. Included in this chapter will be introduction, research method, population selection, data collection, significance of the study, human subjects and a summary. This information according to Gravetter and Wallnau (2002) along with the statistical procedures to be employed to summarize and simplify the data is needed in quantitative studies.

In an effort to document human health benefits of plant environments, research has demonstrated physiological evidence of the stress-reducing effects of plants in working and other environments. Doxon, Mattson, and Jurich (1987) recorded lower blood pressures and electro dermal responses of developmentally challenged adults working in a greenhouse compared to a training center. Additionally, Lohr, Pearson-Mims, and Goodwin (1996) reported lower systolic blood pressures when interior foliage plants were introduced into a windowless computer lab, compared to no plants present in the same lab.

## *Research Method*

"A common experimental design used to assess people's responses to plants is to expose people to different experimental treatments, for example, a setting with plants and the same setting without plants, while monitoring a quantitative response, such as skin temperature" (Shoemaker, Relf, Lohr 2000, p. 89). Following the lead of Shoemaker,

Relf, and Lohr, live plants will be placed into a basement level, windowless university testing center. Given the major role of plants in this experiment, care will be taken to select common indoor plants and maintain a consistently high level of plant health. No distracting colors or flowering plants will be used.

The experimental room, BYU-Idaho's student testing center, is 51 feet long, 51 feet wide and 8 feet high. Walls are an off white, painted cinderblock. The room has no windows and is illuminated with overhead fluorescent lights. The conditions in the room will average 73º F, 6% relative humidity and 700 foot candles at desk height during the experiment. The room will be divided by a temporary partition to facilitate the treatments (plants and no plants). The testing center seats number 220, with 18 inches between rows and 36 inches front to back. Each Math 101 student will be randomly assigned to the plant treatment group or non-plant control group in the university testing center. When seated in the testing center, each student will take their respective math 101 subject matter test. Upon completion, each student will take the perceived stress scale (PSS). The PSS test utilizes a Likert scale based on categorical rating scales from 0 to 4. This psychological assessment tool requires Math 101 students to choose which of a number of categories best reflect his or her perception of objects or stimuli present. The format of the test consists of ten open ended statements. The underlying premise of utilizing the PSS scale is as Cohen (1986) said, ". . . one's perception of the stress fullness of a situation is more important than the objective measure of the stressor level." (p.79) Cohen (1986) continues by suggesting that the PSS questions were written to address three concepts that are central to stress: lack of control, overload and unpredictability.

Students will then return their tests and answer sheets to the testing center personnel and proceed to an adjacent room where physiological measures will be taken. These include blood pressure, heart rate, and temperature. Nursing students trained on the proper use of a Dinamap vital signs machine, model number 5200 101A which records blood pressure, heart rate and temperature in approximately thirty seconds will aid in taking physiological measures.

The statistical design for the study will be a randomized complete block 2x2 factorial design. It is important to note that randomization, according to Cobb (1998), "… converts uplanned, systemic variability into planned chance like variability." (p.15) The experiment will have four treatment levels. The study will be conducted two different times; first summer term and second summer term. The following table helps visualize the experimental design.

Table 4 *Diagram of Randomized Complete Block Design*

| | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Beginning | T | C | C | T |
| End | C | T | C | T |

Score = Have Plants + Test Number + Block + Stress + BP + HR + T + Likert Scale

The four treatment combinations are 1) plants present / plants absent, 2) Plants absent / plants present, 3) Plants absent / plants absent and 4) Plants present / plants present. Students will be randomly assigned on paper to their respective treatments. Upon arriving in the testing center, testing center personnel will refer to the randomized print out of participants and assign them to a treatment. This design methodology will allow researchers to examine several important affects; such as the effect of plants. The

effect of the math test from beginning to end and the interaction of both plants and the math test, for example perhaps plants offer more stress relief during a more difficult math test.

Ott and Longnecker (2001), define a randomized complete block design as "an experimental design for comparing [treatments within blocks]. The blocks consist of homogeneous experimental units. Treatments are randomly assigned to experimental units within a block, with each treatment occurring several times in every block." (p.861) According to Ott and Longnecker there are certain advantages and disadvantage of randomized complete block design, they follow: (p.861)

Advantages

1. The design is useful for comparing *t* treatment means in the presence of a single extraneous source of variability.
2. The statistical analysis is simple.
3. The design is easy to construct.
4. It can be used to accommodate any number of treatments in any number of blocks.

Disadvantages

1. Because the experimental units within a block must be homogeneous, the design is best suited for a relatively small number of treatments.
2. This design controls one extraneous source of variability (due to blocks). Additional extraneous sources of variability tend to increase the error term, making it more difficult to detect treatment differences.

3. The effect of each treatment on the response must be approximately the same from block to block.

Montgomery (2001) summarizes the advantages of factorial designs by saying that "they are more efficient than one-factor-at-a time experiments. Furthermore, a factorial design is necessary when interactions may be present to avoid misleading conclusions. Finally, factorial designs allow the effects of a factor to be estimated at several levels of the other factors, yielding conclusions that are valid over a range of experimental conditions." (p.175)

### *Population Selection*

Undergraduate students enrolled in a BYU-Idaho Math 101 course will be the subjects of this study for the following reasons: 1) There are relatively large numbers of students who are required to take the course, which in turn, provides a good population size. There are two hundred thirty-seven students currently enrolled in Math 101 during summer 2005. 2) Math is perceived by many to be a difficult or stressful subject matter (Tobias, 1978). 3) Math 101 students' tests are all delivered in the University Testing Center. 4) There is much historical performance data of Math 101 students, which will provide a historical check and balance on study assertions.

### *Data Collection*

There will be two fundamental treatments in this experiment: plants present and plants absent. For the treatment with plants present, common low-light tolerant species of interior plants (see table 1) will be added around the periphery of the room and around

the testing centers sole central pillar. The following table exemplifies the type of plants used in a previous study.

Table 5 *Interior plants that will be added to the testing center*.

| *Species* | *Common name* | *Quantity* | *Height or length (m)* |
|---|---|---|---|
| Aglaonema sp. | Chinese evergreen | 5 | 50 |
| Chamaedorea seifrizii | Reed palm | 5 | 125 |
| Dracaena marginata | Red-edge dracaena | 5 | 225 |
| Dracaena deremensis "Janet Craig" | Janet Craig dracaena | 5 | 125 |
| Epipremnum aureum | Golden pothos | 7 | 75 |
| Homalomena siesmeyeriana | Arrowhead | 3 | 25 |
| Hoya sp. | Wax plant | 3 | 50 |
| Philodendron scandens | Heart-leaf philodendron | 3 | 100 |
| Sansevieria trifasciata | Snake plant | 7 | 75 |
| Scindapsus pictus 'Argyraeus' | Satin pothos | 5 | 50 |
| Syngonium podophyllum | Arrowhead vine | 7 | 25 |

(Lohr, Pearson-Mims, & Goodwin, 1996)

Floor plants, table plants, and hanging plants will be added, giving the appearance of a well-designed, but not lush, interiorscape. Plants will be placed so that plants will be present in the peripheral view of each student, but not interfere with students' test taking activities.

Physiological, psychological, and performance measurements will be assessed on approximately 237 college students enrolled in the summer 2005 Math 101 course. "The use of both psychological and physiological measures makes possible a deeper level of understanding and a wider range of inferences. Physiological responses can be used for psychological benefits" (Shoemaker, Relf, Lohr, 2000, p.89).

"Physiological methods can identify influences on well-being that may be outside the conscious awareness of individuals and hence may not be identified by verbal measures such as ratings or questionnaires" (Shoemaker, Relf, Lohr, 2000 p. 89; Ulrich

and Addoms 1981). "Physiological measurements are widely recognized to have scientific credibility as indicators of stress and restoration" (Shoemaker, Relf, Lohr, 2000, and Ulrich, Parsons, 1992). Physiological measurements in this study will be administered by nursing students trained on a Dinamap machine which measures blood pressure, heart rate, and temperature. This process takes approximately thirty seconds to complete all three measures.

Psychological measures will consist of a self-report; ten question Perceived Stress Scale (PSS). The PSS utilizes a 0-4 Likert scale (0 = Never, 4 = Very Often). This scale has been used successfully in student populations to measure the degree to which situations in one's life are appraised as stressful (Cohen, Kamarck, Mermelestein, 1983). "The PSS showed adequate reliability and, as predicted, was correlated with life event scores…" (Cohen, Karmarck, Mermelstein, 1983, p. 385). Cohen, Karmarck, and Mermelstein (1983) continue by suggesting, "…that the impact of 'objectively' stressful events is, to some degree, determined by one's perceptions of their stressfulness." (p. 385).

"The PSS can be used as an outcome variable, measuring people's experienced levels of stress as a function of objective stressful events, coping resources, personality factors, . . ." (Cohen, Karmarck, Mermelstein, 1983, p. 393).

Performance on a subject mathematics matter test, which some students perceive as stressful will be an additional measure of whether plants in the BYU-I testing center improve performance. Study variables and instruments are summarized in Table 6.

Table 6 *Variables and Instruments*

| Variables | Instruments |
|---|---|
| Psychological<br><br>Measures the degree to which situations in one's life are appraised as stressful. | PSS – Self Report, 10 item stress test, utilizes a 4 point Likert Scale. |
| Physiological<br><br>- Blood Pressure<br>- Heart Rate<br>- Body Temperature | Clinical Data generated by Dynamap machine, which measures blood pressure, heart rate, and body temperature. |
| Performance<br><br>Stressful Event | Mathematics subject matter test. |

## *Significance of Study*

While there have been studies involving students and plants in computer labs and garden settings, no studies have been done to date in what can be a stressful setting, such as a university testing center.

This is particularly applicable because a growing number of university professors are choosing to deliver tests in university testing centers while available. According to Sapp (1993) and Lohr, Pearson-Mims, and Goodwin (1996), these stressful testing events are exacerbated by the added stress of sterile, windowless, and proctored testing centers.

Many people intuitively feel that adding plants to interior environments improves student performance, yet there are few, studies examining this impact. This study using

commonly available interior plants placed in a university testing center will be beneficial by adding to the literature that suggests that plants may contribute to reduced stress and increased performance in college students.

### *Human Assurances*

This study has been approved by the University of Idaho Human Assurances Committee (pending) as well as the Human Subjects Review Committee of Brigham Young University-Idaho. Student participation will be confidential with the researcher. All data gathered will be maintained in a secure environment and shared only with statisticians. Consent to participate will be indicated by student participants signature and date on an informed consent form.

### *Summary*

This study is designed to examine the effect of plants to relieve students' real or perceived stress and as a result, improve performance. The comparison of test performance of Math 101 students who take a subject matter test (a stressful event) in a university testing center (a stressful place) in the presence and absence of plants will be analyzed to see whether students' respective math test scores improve in the presence of plants.

Controlled empirical studies with plants may help increase the credibility of horticulture related treatments and promote understanding of specific outcomes in student populations. Understanding the benefits of interior plants in stressful locations may help educational administrators provide environments which enhance learning. This may

ultimately lead to the permanent installation of green plants in stressful environments including university-testing centers.

*References*

American Thoracic Society (1996), Committee of the environmental and occupational health assembly. Health effects of air pollution. *American Journal Respiratory Critical Care Medicine 153*:3-50, 477-98.

Antonovsky, Aaron (1979). *Health: Stress and coping*. San Francisco, CA: Jossey-Bass.

Bell, P.A., Greene, T.C., Fisher, J.D., & Baum, A. (2001). *Environmental psychology*. Belmont, CA: Wadsworth Group/Thomson Learning.

Buettner, L.L., Lundgren, H., Lago, D., Farrell, P. & Smith, R. (1996). Therapeutic recreation as an intervention for persons with dementia and agitation: An efficacy study. *American Journal of Alzheimer's Disease, 1*(5), 4-12.

Chrysalis Performance Strategies, Inc (n.d.) *What stress costs: Approaching Change*, November 2002 –3, 3. Retrieved February 2, 2005 from http://www.teamchrysalis.com/AC/V3/AC33_What_Stress_Costs.htm

Cobb, G. W. (1998). *Introduction to design and analysis of experiments*. Emeryville, CA: Key College Publishing

Cohen, S. (1986). Cognitive processes as determinants of environmental stress. In I.G. Sarason & C.D. Spielberger (Eds.) *Stress and Anxiety: 10,* 65-81. Washington, D.C.: Hemisphere Publishing Corp

Cohen, S. (1996). Stress and Susceptibility to the Common Cold. In N.R.S. F. Hall, I. Altman & S.J. Blunmenthal (Eds.), *Mind-body Interactions and Disease*. Tampa, FL: Health Dateline Press.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A Global Measure of Perceived Stress. *Journal of Health and Social Behavior, 24*, 385-396.

Cohen, S., Kessler, R. C., & Underwood, G. L. (1995). Strategies for measuring stress in studies of psychiatric and physical disorder. In S. Cohen, R. C. Kessler, & L. Underwood Gordon (Eds.), *Measuring stress: A guide for health and social scientists*. New York: Oxford Press.

Cooper-Marcus, C. & Barnes, M. (1995). *Gardens in healthcare facilities: Uses, therapeutic benefits, and design recommendations.* Martinez, CA: Center for Health Care Design.

Cooper-Marcus, C., & Barnes, M. (1999). *Healing Gardens: Therapeutic benefits and design recommendations*. New York: John Wiley & Sons Inc.

Crewsell, J.W. (2002). *Research design, qualitative, quantitative, and mixed method approaches*. Thousand Oaks, CA: Sage Publications.

Croker, R. (2000). Idaho State University, *Learning Styles* Class Lecture.

Davis, S. (1998). *Horticulture as therapy principles and practices*. Binghamton, N Y: Haworth Press.

Doxon, E.L., Mattson, R.H., & Jurich, A.P. (1987). Human stress reduction through horticultural vocational training. *HortScience, 22*(4), 655-666.

Driver, B.L. & Knopf, R.C. (1976). Temporary escape: One product of sport fisheries management. *Fisheries, 1* (2), 24-29.

Dunnett, N., Qasim, M. (2000, January-March). Perceived benefits of human well-being of urban gardens. *HortTechnology*, 40-45.

Easterling, N. (2003). Upon reflection. *Journal of Therapeutic Horticulture, 14*, 36.

Evans, G.W., & Cohen, S. (1987). Environmental stress. In D. Stokols, & I. Altman (Eds.), Handbook of Environmental Psychology 571-610. New York: John Wiley & Sons Inc.

Fisher, M.B., Noble, J.L. (1960). *College education as personal development*. Englewood Cliffs, NJ: Prentice Hall Inc.

Fjeld, T. (2000, January-March). The effect of interior planting on health and discomfort among workers and school children. *HortTechnology*, 46-52.

Francis, C. & Cooper-Marcus, C. (1992). Restorative places: Environment and emotional well-being. In: *Proceedings of 24th Environmental Design Research Association Conference.* Boulder, CO: EDRA.

Frumkin, H. (2001). Beyond toxicity: Human health and the natural environment. *American Journal of Preventative Medicine, 20*, (3), 234-240.

Gallagher, M.J., & Mattson, R. H. (1986). Evaluation of arthritis using the horticulture hand capacities test. *Journal of Therapeutic Horticulture, 1*, 31-36.

Gerlach-Spriggs, N., Kaufman, R.E., & Warner, S.B. Jr. (1998). *Restorative gardens: The healing landscape*. New Haven, CT: Yale University Press.

Gravetter, F. J., & Wallnau, L. B. (2002). *Essentials of statistics for the behavioral sciences.* Pacific Grove, CA: Wadsworth Group.

Hagedorn, R. (1991). Horticulture as a prescriptive tool for behavioral change. *Professional Horticulture, 1*(5), 129-133.

Haller, R. (1998). Vocational, social and therapeutic programs in horticulture. In S.P. Simpson & M.C. Strauss (Eds.). *Horticulture as Therapy: Principles and Practice*. Binghamton, NY: The Food Products Press.

Haller, R. (2004) Horticultural therapy institute, horticultural therapy programming class lecture.

Hartig, T., Mang, M. & Evans, G. (1987). *Perspectives on wilderness: Testing the theory of restorative environments* [Paper presented at Fourth World Wilderness Congress]. Estes Park, CO.

Hayward, D.G., & Weitzer, W.H. (1984). The public's image of urban parks: Past amenity, past ambivalence, uncertain future. *Urban Ecology, n.8*, 243-268.

Heerwagen, J.H. (1990). The psychological aspects of windows and window design. In: R. I. Selby, K .H. Anthony, J. Choi, & B Orland (Eds.). *Proceedings of 21st Annual Conference of the Environmental Design Research Association*. Oklahoma City: EDRA, 269-280.

Heerwagen, J.H., & Orians, G. (1986). Adaptations to windowlessness: A study of the use of visual décor in windowed and windowless offices. *Environment and Behavior 18*(5), 623-639.

Herbert, T.B. & Cohen, S. (1994). Stress and illness. Encyclopedia of Human Behavior Volume 4. New York: Academic Press Inc.

Honeyman, M.K. (1992). Vegetation and stress: A comparison study of varying amounts of vegetation in countryside and urban scenes. In: D. Relf (Ed.). *The role of horticulture in human well-being and social development: a national symposium*, 143. Portland, OR: Timber Press

Jensen, E. (2000). *Brain-Based Learning*. San Diego, CA: The Brain Store

Johnson, A.K., Anderson, E.A. (1990). Stress and arousal. In: J. T. Cacioppo & L. G. Tassinary (Eds.). *Principles of Psychophysiology: Physical, social, and inferential elements*. New York: Cambridge University Press.

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

Kaplan, R. & Kaplan S. (1989). *The experience of nature: A psychological perspective*. New York: Cambridge University Press.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology15,* 169-182.

Kaplan, S and Kaplan R. (1982). *Cognition and environment: Functioning in an uncertain world*. New York: Praeger.

Kaplan, S., & Talbot, J.F., (1983). Psychological benefits of a wilderness experience. In: I. Altman and J.F. Wohlwill (Eds.), *Behavior and the natural environment*. New York: Plenum.

Keep, P, James, J., & Inman, M. (1980). Windows in the intensive therapy unit. *Anesthesia, 35*, 257-262.

Knopf, R. C. (1987). Human behavior, cognition and affect in the natural environment. In: D. Stokols & I. Altman, (Eds.). *Handbook of Environmental* Psychology (2 vols.), 783-825. New York: John Wiley & Sons, Inc.

Knowles, M.S., Holton, E.F., III, & Swanson, R.A. (1998). *The adult learner: The definitive classic in adult education and human resource development*. Woburn, MA: Butterworth-Heinemann.

Krantz, S.G. (1999). How to teach mathematics. *American Mathematical Society*. Providence, RI.

Kuo, F.E., & Sullivan, W.C. (2001). Green streets, not mean streets: Vegetation may cut crime in the inner city. *Human Environment Research Laboratory, 1*, 1. Urbana–Champaign: University of Illinois.

Larsen, J., Hancheck, A., & Vollmar, P. (2005). *Accessible gardening for therapeutic horticulture*. Minneapolis: University of Minnesota.

Lee, D. (1997). Employee stress: The true cost. *The John Liner Review, 11*, (3), pgs. 33-38.

Leos, J. G. (1998). A survey of Pennsylvania long-term care facilities: Challenges and incentives to the application of horticultural therapy in geriatrics. *Journal of Therapeutic Horticulture: Seeds of hope, Horticultural therapy at work, 9*, 81.

Lewis, C.A. (1996). *Green nature/human nature the meaning of plants in our lives*. Urbana-Champaign: University of Illinois.

Lohr, V.I., Pearson-Mimms, C.H. & Goodwin, G.K. (1996, June). Interior plants may improve worker productivity and reduce stress in windowless environment. *Journal of Environmental Horticulture, 14*(2): 97-100.

Lovins, A., (2005). *An introduction to biophilia and the built environment*. Snowmass, CO: Rocky Mountain Institute.

Markus, T. A. (1967). The function of windows: A reappraisal. *Building Science, 2,* 97-121.

Mascott, C. (2004). The therapeutic recreation stress management primer. State College, PA: Venture Publishing, Inc.

Mason, L.J. (1984). Stress reduction. In: E. Bauman, L. Piper, A. I. Brint, and A. Wright, (Eds.), *The Holistic Health Handbook*. Lexington, MA: Stephen Greene Press.

McGuffrey, C. (1982). Facilities. In: H. J. Walbert, (Ed.), *Improving Educational Standards and Productivity*. Berkeley, CA.

Mc Keachie, W.J., Pintrich, P., Lin, Y., & Smith, D. (1986). *Teaching and learning in the college classroom: A review of the research literature.* Ann Arbor: National Center for research to Improve Post-Secondary Teaching and Learning. University of Michigan.

McReynolds, D. (2002, March). Personal best. *Journal of the American Academy of Child and Adolescent Psychiatry, 41*. (3), 313-321.

Murphy, M.C., & Archer, J. (1996). Stressors on the college campus: A comparison of 1985 -1993. *Journal of College Students Development 37*, 1, 20-28.

Myer, I.A. (1981). *Assessing relationships between horticultural knowledge and mental well-being of female college students*. Master's thesis. Manhattan: Kansas State University.

Olmstead, F. (1865). The Yosemite Valley and the Mariposa Big Tree: A preliminary report. *"Prospect" Landscape Architecture 81*, No. 3 (March 1991): 136.

Ott, R. L. & Longnecker, M. (2001). *An introduction to statistical methods and data analysis* 5th ed. Pacific Grove, CA: Duxbury.

Parkay, F.W., Hass G. (2000). *Curriculum planning a contemporary approach*, 7th edition. Boston: Allyn and Bacon.

Parsons, R., Ulrich, R.S., & Tassinary, L.G. (1994). Experimental approaches to the study of people – plant relationships. *Plant Relationships: Setting Research Priorities*. Binghamton, NY: The Haworth Press.

Payne, D.A. (2003). Creating performance, product, and observational assessments. *Applied Educational Assessment* (2nd Edition, pp. 286-327). Belmont, CA: Wadsworth/Thomson Learning.

Pearson-Mims, C.H., & Lohr, V. (2000, January-March). Reported impacts of interior plantscaping in office environments in the United States. *HortTechnology,* 82-86.

Pearson Vue Testing. *Setting up the test center* (n.d.) Retrieved April 1, 2005, from http://www.vue.com/pvtc/facility_reqs.pdf

Pryor, G. (1994). Horticultural therapy: Working with our special populations. *Lebanon Co. Cooperative Extension Service*. (Seminar Publication.)

Relf, P.D. (1999). The *role of horticulture in human well-being and social development*. Portland, OR: Timber Press.

Relf, P.D. (2000, May). Southeast Regional master Gardener Conference. Retrieved February 26, 2005 from http://www.gactr.uga.edu/conferences/2000/may/14/gardener.phtml

Rice, J.S., & Remy, L.L. (1994). *Evaluating horticultural therapy: The ecological context of urban jail inmates*. Binghamton, NY: Haworth Press Inc.

Rubin, H. R., Owens, A., & Golden, G. (1998). *Status report: An investigation to determine whether the built environment affects patients' medical outcomes*. Martinez, CA: The Center for Design Health.

Ruys, T. (1970). *Windowless offices*. Master's thesis, College of Architecture. London: University of Unwig.

Sapolsky, R.M. (2000). *Why zebras don't get ulcers*. New York: W.H. Freeman and Company.

Sapp, M. (1993). *Test anxiety*. Lanham: University Press of America, Inc.

Schar, D. (1994). *Dump your stress in the compost pile*. Washington, DC: Elliot and Clark Publishing.

Sears, B. (1995). *The Zone: A dietary road map*. New York: Harpers Collins Publishers Inc.

Sempik, J., Aldridge, J. & Becker, S. (2003). *Social and therapeutic horticulture: Evidence and messages from research*. Loughbourgh University, Leicestershire, UK: Media Services Press.

Shoemaker, C.A., Relf, P.D., & Lohr, V.I. (2000, January-March). Social science methodologies for studying individuals' response in human issues in horticulture research. *HortTechnology*, p. 89.

Simson, S. & Haller, R. (1997). *Horticultural therapy education and older adults*. New York: Haworth Press, Inc.

Smith, D.J. & McCallion, P. (1997). Alleviating stress for family caregivers of frail elders using horticultural therapy. In: Suzanne E. Wells, MS (Ed.) *Horticultural Therapy and the Older Adult Population.* New York: Haworth Press, Inc.

Stokols, D. & Altman, I. (1987). *Handbook of environmental psychology*. New York: John Wiley & Sons.

Stoneham, J. (2002). *Interaction by design bringing people and plants together for health and well-being*. C. A. Shoemaker (Ed.). Ames: Iowa State Press.

Sturt, G., (2004). *Learning environment and classroom design*. Retrieved March 11, 2004, from www.garysturt.free-online.co.uk/classdes.htm

Sundstrom, E., Bushby, P.L., & Asmus, C.L. (1996). *Environmental psychology 1989-1994, Annual Review, 47*, 485-512.

Suinn, R.M.. & Winston, E.H. (2003). The mathematics anxiety rating scale, a brief version: Psychometric data. *Psychological Reports, 92,* 167-173.

Talbot, J. F., Bradwell, L. V., & Kaplan, R. (1987). The functions of urban nature: Uses and values of different types of urban nature settings. *Journal of Architectural and Planning Research, 4*, 47-63.

Tennesseen, C.M, & Cimprich, B.E (1995). Views to nature: Effects on attention. *Journal of Environmental Psychology, 15*(1), 77-85.

Texas State University Counseling Center, (2005). www.counseling.swt.edu/bro/stress

Tobias, S. (1978). *Over-coming math anxiety.* Boston: Houghton Mifflin Company.

Toseland, R., Smith, G.C., & McCallion, P. (1995). Supporting the "family" in family caregiving. In G. Smith, S.S., Tobin, B.A. Robertson-Tchabo, & P. Powers (Eds.), *Enabling aging families: Directions for practice and policy*. Newbury Park, CA: Sage.

Tristan, J., Bright, M.A., Sutherland, M. & Duguay, C.L. (2002). *Horticultural intervention as a stress management technique among University of Massachusetts/Amherst students*. Therapeutic Design Applications. Iowa Press.

Ulrich, R.S. (1979). Visual landscapes and psychological well-being. *Landscape Research. 4*(1):17-23. Manchester, England.

Ulrich, R.S. (1980). Benefits of passive experiences with plants. *The Longwood Program Seminars, 12,* 26-31. University of Delaware and Longwood Botanic Gardens.

Ulrich, R.S. (1983). Aesthetic and affective response to natural environment. In: I. Altman and J. F. Wohlwill (Eds.), *Human behavior and environment: Behavior and the natural environment, vol. 6*. New York: Plenum Press.

Ulrich, R.S. (1984, April). View through a window may influence recovery from surgery. *Science, 224* (4647): 420-421.

Ulrich, R.S. (1992, September-October). How Design impacts wellness. *Healthcare Forum Journal,* 20-25.

Ulrich, R.S. (1993). Biophilia, biophobia, and natural landscapes. In: S. Kellert and E. O. Wilson, (Eds.), *The Biophilia Hypothesis*. Washington, DC: Shearwater/Island Press, pp 74-137.

Ulrich, R.S. (1999). Effects of gardens on health outcomes: Theory and research. In: C. Cooper-Markus & M. Barnes, (Eds.), *Healing gardens: Therapeutic benefits and design recommendations.* New York: John Wiley & Sons.

Ulrich, R.S., & Addoms, D.L. (1981). Psychological and recreational benefits of a residential park. *Journal of Leisure Research, 13*, 43-65.

Ulrich, R.S., & Parsons, R. (1992). Influences of passive experiences with plants on individual well-being and health. In: D. Relf (ed.). *The role of horticulture in human well-being and social developmen*t. p. 93-105. Portland, OR: Timber Press.

Ulrich, R.S., & Simons, R.F. (1986, April). Recovery from stress during exposure to everyday outdoor environments. In: J. Wineman, R. Barnes, & C. Zimring (Eds.), *Proceedings of the Seventeenth Annual Conference of the Environmental Design Research Association*. Washington, D.C.

Ulrich, R.S., Simmons, R.F., Losito, B.D., Fiorito, E., Miles, M.A., & Zelson, M. (1991). *Stress recovery during exposure to natural and urban environments*. NY: Academic Press.

Verderber, S. (1986). Dimensions of person-window transactions in the hospital environment. *Environment and Behavior, 18*, 450-466.

Wagner, B.M., Compas, B.E., & Howell, D.C. (1988). Daily and major life events: A test of an integrative model of psychosocial stress. *American Journal of Community Psychology, 61*, 189-205.

Waliczek, T.M., Bradley, J.C., Lineberger, R.D., & Zajicek, J.M. (2000). Using a web-based survey to research the benefits of children gardening: *HortTechnology*. 71-76.

Warner, S.B. (1994). The periodic rediscoveries of restorative gardens: 1100 to the Present. In: Francis, M., Lindsey, P. and Rice, J. (Eds.), *The Healing Dimensions of People-Plant Relations*. University of California. Davis: Center for Design Research.

Webster (1990). *The pocket Webster school & office dictionary*. New York: The World Publishing Company

Weinstein, C. (1979). The physical environment of the school: A review of the research. *Review of Educational Research, 49* (4), 577610.

West, M.J. (1986). *Landscape views and stress response in the prison environment*. Master's thesis, p. 5. University of Washington.

Wilson, E.O. (1984). *Biophillia: the human bond with other species*. Cambridge: Harvard University Press.

Wilson, L.M. (1972). Intensive care delirium: The effect of outside deprivation in a windowless unit. *Archives of Internal Medicine, 130*, 225-226.

Wise, J. A., McCohville, K., & Al-Sahhaf, N. (1990, April). Managing cultural diversity in orbiting habitats. *Proceedings of Space '90*. Albuquerque, NM.

Wise, J. A., & Rosenberg, E. (1988).*The effects of interior treatments on performance stress in three types of mental tasks*. CIFR Technical Report number 002-02-01988. Grand Valley State University, Grand Rapids, MI.

Wohlwill, J.F. (1976). Environmental aesthetics: The environmental as a source of affect. In: I. Altman & J. Wohlwill (Eds.), *Human Behavior and Environment, 1,* 37-38.

Wohlwill, J.F. (1983). The concept of nature, A psychologists view. In: I. Altman and J. Wohlwill (Eds.) *Behavior and the natural environment: Advances in theory and research 6*. New York: Plenum.

Zadik, M.H. (1994), *Studying the corporate garden*. Binghamton, New York: Haworth Press Inc.

Zhan, L. (1992, July). Quality of life: conceptual and measurement issues. *Journal of Advanced Nursing, 17*, (7): 795-800.

Zitzow, D. (1984). The college adjustment rating scale. *Journal of College Students Personnel, 25*:160-164.