Relationship Between Nature Connectedness and Cortisol Levels in Horticultural Therapy



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Writers' Comment: The collaboration for Professor Arosteguy's Grant Proposal Project allowed us to create a research design synthesizing our various passions. Having both experienced the benefits of Nature-Based Therapies, Mussen is interested in further research into this discipline through studying animal behavior and human emotions, while Jones is interested in utilizing therapeutic horticulture by developing a small farm community. Additionally, Pillitiere's area of interest lies with the implications of Nature-Based Therapy as a horticultural and occupational therapy for survivors of human trafficking in developing countries. Blending these interests, our research design aims to contribute to research on horticultural therapy's intriguing and potentially sustainable treatment for human and global well-being in relation to climate change. Specifically, this study investigates the correlation between the influence of horticultural therapy on cortisol levels and how connected an individual feels to the natural world. As a mutually advantageous partnership between the Psychology and Agricultural Departments at UC Davis, we designed our study for the student farms at this university.

Instructor's Comment: Proposing an innovative research study is an important skill those pursuing professions in the field of psychology need to practice. As such, I design my Writing in Psychology class to lead up to this somewhat daunting task. Prior to writing the research proposal, students first write literature reviews in which they evaluate recent studies on a chosen topic and tell the story of the research for a specialist audience. Then for the research proposal,

students form groups of 3 based on similar topics they researched in their lit reviews. Together, they choose one of their topics and design a psychological research study to fix an inadequacy in the past research or expand the research in some meaningful way. Tina, Christopher, and Esther—though they all study different aspects of psychology—immediately gelled and worked enthusiastically to identify similarities in their interests/topics and brainstorm an approach to the proposed research plan that they could all contribute to. The group worked collaboratively to write a concise introduction that would provide a mixed audience of specialists and non-specialists with a sense of the previous research conducted on nature connectivity and horticultural therapy and design a study that would both contribute to existing research and prove feasible to conduct at UC Davis farms. In all, their proposal identifies a current, interesting topic in psychology that needs further research and their proposed plan demonstrates the innovative and smart thinking expected of future psychologists.

—Katie Arosteguy, University Writing Program

Abstract

College students report suffering from high rates of stress and stress symptoms, which may have long-term consequences for this population. While previous research has demonstrated that horticultural therapy may offer an intervention that decreases stress, we propose that there is a correlation between nature connectedness and the effectiveness of horticultural therapy on cortisol levels. We will recruit 100 UC Davis students to participate in a 10-week, two-hours per-session gardening program at the UC Davis Agricultural Department's student farm. Students will fill out a preliminary self-report survey that includes their subjective connectedness to nature and perceived stress levels. Then, they will be instructed on the procedures for saliva collection, 9 samples per participant. We will then analyze the bivariate relationships between variables, including: cortisol slope, average cortisol concentrations, levels of subjective nature conductivity, perceived stress, gender, socio-demographic characteristics, and religion. We anticipate that students

who report the greatest perceived nature connectivity will experience the greatest improvement in cortisol levels during the 10-week horticultural therapy program.

Introduction

Since Wilson's biophilia hypothesis (1984) first speculated that humans held an innate connection to other lifeforms due to their shared evolutionary history, researchers have been investigating whether spending time in nature could improve one's psychological well-being. Empirical data has since demonstrated that interacting with nature can not only improve an individual's well-being, but also their physical health, cognitive abilities, and social attachments (Keniger, Gaston, Irvine & Fuller, 2013).

While there is currently no consensus on the mental mechanism through which nature imparts these benefits, recent evidence has shown that the connection a person feels with the natural world can moderate their feelings of well-being. Researchers have discovered that elevated levels of nature connectivity (NC) reliably predict happiness in participants and that nature connectivity is distinct from other forms of connectivity, such as feeling connected to one's family or city (Zelenski & Nisbet, 2014). In a separate study, those with elevated NC not only reported greater psychological health but also indicated a stronger spiritual orientation (Kamitsis & Francis, 2013), suggesting that NC may convey well-being by bringing meaning and purpose to people's lives. NC has also been positively correlated with mindfulness, the act of focusing one's attention on what is happening in the moment, implying that attending to one's environment may be a necessary component of reaping the psychological benefits of nature (Howell, Dopko, Passmore & Buro, 2011).

Nature-Based Therapies (NBTs) are another channel through which nature has been shown to improve an individual's psychological state. NBTs include a diversity of treatments and interventions that are designed to use the natural environment to rebuild self-esteem, improve self-control, and assist those who suffer from a variety of psychological disorders (Cutcliffe & Travale, 2016; Ihlebaek, Ellingsen-Dalskau & Berget, 2014). One type of NBT, referred to as horticultural therapy, tasks the client with performing gardening activities as a means of lowering stress and improving their mental state. Sidenius et al. (2016)

explored the effects of gardening on a population of individuals who were unable to work due to a variety of stress-related symptoms. After working for 10 weeks in a university therapy garden, these individuals acquired increased feelings of safety and freedom, developed greater courage and self-awareness, and improved their ability to act in accordance with their physical and mental abilities.

In addition to helping those with psychological disorders, contact with nature has been shown to improve physiological health measures such as blood pressure, heart rate, and muscle tension (Ulrich et al., 1991). To look for an additional biomarker of how nature could reduce stress in individuals, Roe et al. (2013) explored whether increased exposure to nature in disadvantaged communities was associated with lower levels of the stress hormone cortisol. Their findings showed that individuals who lived in neighborhoods with more "green space" (such as parks or greenbelts) had lower levels of perceived stress as well as a steeper decline in their cortisol secretion throughout the day. These results provided much-needed quantitative data to the literature on the effects of NBTs, many of which rely solely upon qualitative findings that are lacking in external validity.

This proposed study will expand upon the findings of Roe et al. by using cortisol measurements to explore how nature connectedness can modulate the effects of horticultural therapy on a high-stress population of college students. While many college students accept living with stress as part of their higher education, its effects may be causing more harm than they realize. In a recent survey of 95,000 college students, 32% stated that stress had negatively impacted their academic performance while 55% acknowledged they had experienced higher-than-average stress within the past 12 months (American College Health Association, 2016). Another survey found that 45% of students who sought mental health counseling on college campuses named stress as one of their primary motivators for seeking treatment (Winerman, 2017). Whereas minor stressors may be an unavoidable consequence of the academic lifestyle, students who live with chronic stress throughout their college education may be conditioning themselves to live an unhealthy lifestyle that will persist well beyond their graduation. To combat the proliferation of these stress-related disorders in college students, as well as the population at large, it is imperative that more research be conducted into alternative means of stress reduction, such as those utilized in NBTs.

This study will provide therapy garden space to students at the University of California, Davis over a 10-week period to determine if levels of cortisol and perceived stress will decrease after spending time in nature. As seen in previous studies, it is anticipated that cortisol levels and perceived stress will be lower at the end of the procedure for most participants. Additionally, it is anticipated that pre-study NC levels will serve to moderate the effects of the horticultural therapy, with those who are higher in NC seeing the greatest reduction in cortisol and stress and those who are lower in NC experiencing a lesser decline.

Description of Planned Research

100 college students at the University of California, Davis will be randomly selected to participate in this research. The students will participate in a 10-week program, 4 hours per week (2 hours on Wednesdays and 2 hours on Fridays), participating in horticultural activities. Their cortisol levels will be tested from 9 saliva samples taken on the 1st, 5th, and 10th Wednesdays of the study. Participants will be sent prompts via text messages to take their own saliva samples 3, 6, and 9 hours after waking and will be instructed to collect and freeze each sample. The first saliva sample will establish a baseline of cortisol levels, the second will evaluate changes in cortisol mid-way through the study, and the third will measure the overall change in cortisol levels throughout the course of the program. Participants will also be instructed to bring their log and 3 samples to their following horticultural session during the 1st, 5th, and 10th (final) week. Additionally, a Nature Connectedness Scale and a Perceived Stress Scale Survey will be administered at the beginning and end of the study.

Participants

Because of the diverse nature of the UC Davis population, we anticipate that our 100 (each 18-26 years old) full-time undergraduate students will reflect both rural and urban backgrounds with varying levels of nature connectedness. The program will be advertised as a Horticultural Stress Management Program (Figure 1) in student centers throughout campus. Students will understand that the program is for the purpose of testing stress reduction through horticultural therapy, but they will also receive several incentives, including free take-home produce

and notation on their academic transcripts for 40 internship hours of horticultural training and experience. Students will also be notified that they will learn to care, tend, and harvest produce through the program, 4 hours per week on Wednesdays and Fridays, from 4 to 6 in the afternoon.

Materials

The study will be conducted at the Market Garden, a 7-acre farm at UC Davis that produces small-scale, organic crops of vegetables. Each participant will be provided with gardening gloves, a hand trowel (1 each), and wheelbarrows, hoes, and rakes (approximately 25) as needed, by the Agricultural Department at the UC Davis. Student interns at the farm will provide the necessary instruction for harvesting produce, sowing seeds, maintaining and transplanting plants in the field, weed management, pest control, and irrigation of crops (Internships and Volunteer Positions, n.d.).

Materials will also include 200 Connectedness to Nature Scale (CNS) surveys (100 administered at the beginning of the study and 100 administered at the end). This self-report survey, used by Mayer and Frantz (2004), consists of 14 Likert-scale questions (1= strongly disagree and 5=strongly agree). The higher the scores, the greater the subjective connectedness to nature. A sample question is: "I often feel a sense of oneness with the natural world around me" (Mayer & Frantz, 2004).

Similarly, 200 Perceived Stress Scale Surveys (PSS), will be administered in the same manner as the CNS surveys. The PSS, according to Roe et al. (2013), "comprises 10 items measured on a 5-point response from 'never' to 'very often.'" The results of this self-report survey give an assessment of the stress levels in the previous month. For example: "In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?"

Demographic questionnaires will be administered at the beginning of the study as well, with Self Report Evaluations at the end of the study (200 total). Throughout the study, cortisol collection, and testing kits (900 samples) will be used, with samples freezed and evaluated at the Healthy Emotions, Relationships & Development (HERD) Lab at the University of California, Davis.

Procedural Timeline

Date of Procedure	*Procedure*
April 3, 2019	Self-Report Surveys; Saliva Samples Taken; 2 Hours Horticultural Work
April 5, 2019	2 Hours Horticultural Work; Deliver Saliva Samples
April 10, 2019	2 Hours Horticultural Work
April 12, 2019	2 Hours Horticultural Work
April 17, 2019	2 Hours Horticultural Work
April 19, 2019	2 Hours Horticultural Work
April 24, 2019	2 Hours Horticultural Work
April 26, 2019	2 Hours Horticultural Work
May 1, 2019	Saliva Samples Taken; 2 Hours Horticultural Work (5 Weeks)
May 3, 2019	2 Hours Horticultural Work; Deliver Saliva Samples
May 8, 2019	2 Hours Horticultural Work
May 10, 2019	2 Hours Horticultural Work
May 15, 2019	2 Hours Horticultural Work
May 17, 2019	2 Hours Horticultural Work
May 22, 2019	2 Hours Horticultural Work
May 24, 2019	2 Hours Horticultural Work
May 29, 2019	2 Hours Horticultural Work
May 31, 2019	2 Hours Horticultural Work
June 5, 2019	Self-Report Surveys, Self-Report Evaluation; Saliva Samples Taken; 2 Hours Horticultural Work
June 7, 2019	2 Hours Horticultural Work; Deliver Saliva Samples
June 5, 2019	Evaluation and Publication

Results

We will analyze the bivariate relationships between variables and perform multiple linear regressions to examine the main effects and interaction effects in relationship with the primary outcome variables. The primary outcome variable include CNS scores, cortisol slopes (Figure 2), and average cortisol concentrations for weeks 1, 5, and 10. The non-primary variable includes PSS scores, gender (Figure 3), and socio-demographic characteristics (i.e., SES, rural vs. urban residences, and religiosity) which may underlie or moderate perceived connectedness to nature and/or cortisol levels (e.g., a relationship between religion and nature connectivity).

Discussion

In general, we anticipate that students who report the greatest perceived nature connectivity will also have the lowest cortisol levels and greatest improvement in cortisol levels over the 10-week program. These results would suggest that highly stressed college students and the general public could benefit from therapeutic horticulture by cultivating their connection with the natural environment to improve unhealthy cortisol levels, increasing their overall physical and psychological well-being. In addition, if our findings support our predictions, then they suggest that objective cortisol measures add to the validity of one's subjective experience as reported on the CNS. Thus, expensive and labor-intensive cortisol testing may be unnecessary in future research. However, we recommend that this study be replicated at other colleges to establish its reliability and improve student well-being, while comparing perceived stress scores between colleges. Furthermore, as reported in previous studies, we anticipate gender differences in cortisol levels (Roe et al., 2013). While we have made no predictions about the relationship between primary and non-primary variables, compelling findings may guide the trajectory of future research.

If cortisol levels improve during the 10-week program, but do not correlate with nature connectivity, this might suggest that gardening is beneficial for stress management regardless of one's perceived connectedness to nature. As before, we recommend that the study be replicated at other colleges. However, rather than nature connectivity, researchers could explore and expand upon one of the other compelling

findings.

On the other hand, if cortisol levels do not improve during the 10-week program, then student stress levels may be too high to benefit from a structured gardening program or horticultural therapy may be an ineffective approach for stress management. In this situation, we would recommend a similar study be conducted in a different "green" environment with activities that are less structured (e.g., time spent walking in an arboretum).

Budget Justification

Budget for Research Proposal	*Cost (in U.S. dollars)*
Salaries, Essential Personnel	
Principal Investigators	25,000
Researcher(s)	10,000
Field (Horticulture) Technicians	5,000
Professional and Technical Services (lab contract)	25,000
Supplies and Materials	
Cortisol, Passive Drool Collection System & Salivary Assay Kits (quote for 900 samples)	6,865
Printing (flyers & questionnaires)	120
Gardening Supplies (provided)	0
Total Project Costs	**$71,985**

The budget for this study totals $71,985. The proposed budget includes: the cost for essential personnel needed to conduct and manage the horticultural stress management program; contracted lab technicians to analysis cortisol samples; as well as, expenditures for print materials, passive drool collection, and salivary assay kits for 900 samples from Salimetrics. While the salaries make up the majority of the budget, many costs have been reduced by utilizing available resources (space and gardening supplies) at UC Davis that are within close proximity. The study will be conducted during the spring quarter and will contribute

to the existing horticultural setting as well as provide evidence that college students and the general public could benefit by participating in therapeutic horticulture to reduce stress and improve cortisol levels.

Personnel

Christopher Mussen

Christopher Mussen earned his AA in psychology at Sacramento City College and has completed the course requirements for a BA in psychology at the University of California, Davis. Upon graduation, he plans to pursue a Master's degree in animal behavior and explore human emotions by investigating the commonality they share with nonhuman animal species. As an individual who has experienced the rejuvenating qualities of spending time in nature firsthand, he is personally invested in understanding the mechanism through which Nature-Based Therapies may impart benefits to others.

Tina Jones

Tina Jones earned her BA in psychology at the University of California, Davis and her studies include sustainable living and an emphasis in environmental science. Her research with aquaponics suggested that the natural environment may offer therapeutic benefits for an overly active nervous system. As a business owner and project manager she intends to apply this research in the development of a small community farm where local mental health professionals will utilize therapeutic horticulture and educators can teach organic and sustainable farming practices.

Esther Pillitiere

Esther Pillitiere earned her AA in psychology at the College of Alameda, and is currently well on her way to achieving a BA in psychology at the University of California, Davis. Her future goals include earning a Master's in marriage and family therapy, and working with sexual assault and human trafficking survivors in mental and emotional recovery. Horticultural therapy may be one way to providing cost-effective mental relief for trauma survivors, by reducing cortisol levels and providing sex trafficking survivors with experience in humane agricultural work.

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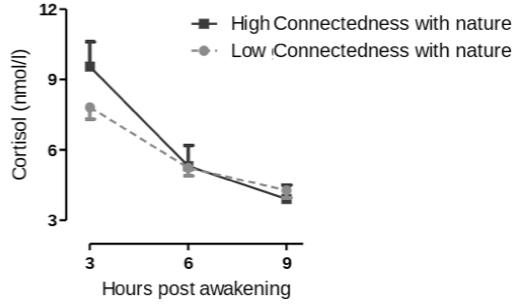
Appendix

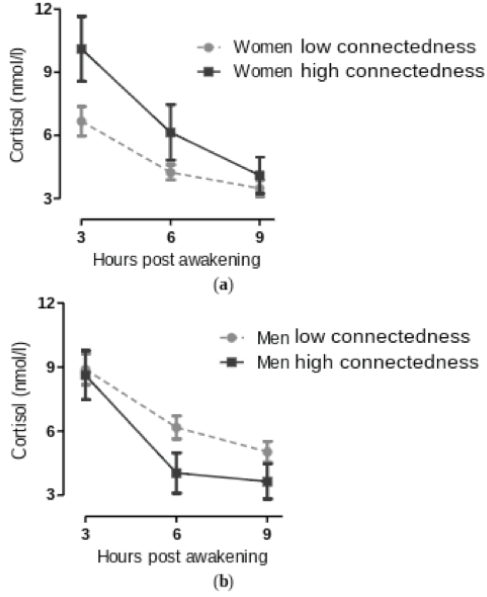
Figure 1. Recruitment Flyer.

Figure 2. Difference in cortisol slope between participants with high versus low connectedness with nature.



Source: Roe, et al. 2013 (Image edited to reflect our proposal).

Figure 3. (a) Differences in mean cortisol slope in women with low versus high connectedness with nature. (b) Differences in mean cortisol slope in men with low versus high connectedness with nature.



Source: Roe, et al. 2013 (Image edited to reflect our proposal).