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Cultivating Healthy Trajectories: An Experimental Study of Community Gardening,
Personality, and Health Behaviors

A Dissertation submitted in partial satisfaction
of the requirements for the degree of

Doctor of Philosophy

in

Psychology

by

Dietlinde Paula Heilmayr

June 2017

Dissertation Committee:

Dr. Howard S. Friedman, Chairperson
Dr. Will L. Dunlop
Dr. Megan L. Robbins
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2017

The Dissertation of Dietlinde Paula Heilmayr is approved:

Committee Chairperson

University of California, Riverside

Acknowledgements

Successful gardening requires hope, patience, and hard work. A garden that has not been treated with diligence, thoughtful care, and the occasional uprooting and turning of soil will yield a sad harvest, indeed. The longer I plowed through my dissertation, the more I realized that it is not *my* dissertation; it belongs to those who have helped me grow as a scientist, nurtured me as a human, and cultivated me into a mindful scholar, educator, and citizen. Thank you for having hope, showing me patience, and giving me the occasional (metaphorical) uprooting. I wouldn't be here without any of you.

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beyond the numbers?), and for that I will always be grateful. Megan, I have always admired your perceptive questions, and your feedback and advice about research directions are always both helpful and insightful. Kate, I'm not sure that I have ever met someone who is quite so consistently generous with their time, and who is also so successful both personally and professionally. In response to the many favors I have asked of you, you never made me feel as if I was intruding upon your time; I am certain many other students feel similarly—your feedback and advice has lifted us all to greater heights. Kate and Megan, I am grateful to have both of you as strong female role models in academia—for that, I cannot thank you enough.

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Dedication

To my father, who energized my love of science, and my mother, who revealed to me the value of gardening in the six short years we spent together.

ABSTRACT OF THE DISSERTATION

Cultivating Healthy Trajectories: An Experimental Study of Community Gardening,
Personality, and Health Behaviors

by

Dietlinde Paula Heilmayr

Doctor of Philosophy, Graduate Program in Psychology
University of California, Riverside, June 2017
Dr. Howard S. Friedman, Chairperson

Modern populations face high levels of mental health challenges, chronic diseases, and premature death due to preventable conditions. Advances in theory and methods suggest that optimal solutions to these problems will be multifaceted, targeting multiple behaviors and ways of thinking simultaneously. One promising, widely-used approach addressing modern health problems at multiple levels involves community gardens. Utilized in the United States since the 1890s, community gardens are thought to promote community cohesion, mental wellness, and physical health. Do these programs work? If so, what is it about community gardening that promotes thriving? This project addressed these questions using a controlled experimental design, with extensive valid assessment. Participants were randomly assigned to one of five health interventions: community gardening, physical activity, social film club, exposure to nature, or growing a living thing. Each comparison group was designed to rule out or isolate an element of community gardening that may be a cause of observed correlations with good health. After completing a pretest and attending a workshop, participants engaged in their health

behavior two hours a week for four weeks. They then completed a posttest. Participants also completed a subset of measures during the intervention period and three weeks after the conclusion of the intervention. Results showed that, regardless of experimental condition, participants improved in emotional well-being, conscientiousness, social relationships, environmental identity, and self-reported health from pre- to posttest. Though the omnibus ANOVA suggested differential group change in environmental identity (such that the garden and nature groups increased compared with other groups), follow-up analyses did not reach statistical significance. There were no changes in sleepiness, physical activity, or produce consumption. Though results were equivocal, this study is the first true experiment attempting to tease apart the causal mechanisms of community gardening in relation to health and wellness. Thus, this dissertation provides a framework—with measures and models—for researchers studying the effects of community gardening and similar broad health interventions. Rigorous research on whether and why community gardening promotes health is still in its budding stages, and continued research attention is warranted considering the potential implications for individual and community health.

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A critical question in modern society, where largely preventable chronic diseases are the leading causes of premature death, is how to promote human wellness (CDC, 2015). Changing the population prevalence of incapacitating and deadly diseases—mainly cardiovascular disease, cancer, diabetes, and lung disease—is most effective with an interdisciplinary approach that not only promotes healthy habits by shifting individual ways of thinking, feeling, and behaving, but also changes aspects of both the built and the social environment (Kern & Friedman, 2011; Stokols, 1992; Suls & Rothman, 2004). One example of such a multifaceted health intervention is gardening. Gardens are widely used in health initiatives as a way to modify the built environment to shift individual and community level patterns, but when and why gardens accomplish their goals has never been fully investigated. (Blair, 2009; Draper & Freedman, 2010; Ozer, 2007; Subramaniam, 2002; Tidball & Krasny, 2014)

Gardens have been planted throughout much of US history to serve core agendas that ultimately relate back to health promotion (Lawson, 2005). Modern gardening programs in the US originated with school-based gardens in the late 19th century, which sought to teach children civic-mindedness. For example, youth learned good work habits and humanitarianism by tending to the land and contributing to their communities. From this movement grew gardening campaigns that addressed food shortages during the first World War, and that engaged and empowered women and children in the war effort. More recently, we have seen an increasing number of community gardens that promote neighborhood aesthetics and community bonding and cohesion. Today, gardens are not only being sown in a growing number of schools, but are also cropping up among prisons

and hospitals across the country (Lawson, 2005; Pudup, 2008). In fact, over a quarter of elementary schools nationwide now have a school garden (Turner, Sandoval, & Chaloupka, 2014). The doctrines of modern gardens are frequently evocative of those from a century ago. For example, current horticulture programs for at-risk youth (e.g. From the Ground Up, Los Angeles) are reminiscent of a 1911 project that sought to help “backward or defective boys” (Lawson, 2005, p. 8). Ultimately, the focus of all of these programs is to improve both mental and physical health as a means to decrease or delay chronic diseases, disability, and risky behaviors, and to enhance the productivity and unity of citizens.

The terms *urban garden* or *urban agriculture* are widely used to characterize many different types of horticulturally based structured programs, including community gardens, school gardens, therapy gardens, and more. Though the term “urban” may elicit thoughts of the city, “urban” in the context of gardening is meant to distinguish it from rural agriculture, as it includes gardening programs in the suburbs and at the edges of the city (Lawson, 2005). In fact, “urban” gardening programs have recently extended into rural settings to provide gardening experiences to individuals living in low-density but non-farm areas (Lawson, 2005).

That gardening programs have been used for over a century to address a variety of societal ailments begs the question of how effective they are in fulfilling their purpose. Though most programs—school gardens especially—present a plethora of participant testimonials, empirical research on *whether, when, and why* gardening programs are effective is still in the nascent stages of scientific investigation. This dissertation

addresses these critical questions. To orient the reader towards these questions, what follows is a brief review of the gardening research to date, and a theoretical exploration of why gardening might be a key means to encourage healthy thoughts and behavioral patterns.

Literature Review

The research on gardening and health to date can be categorized into five general domains: diet, education, environmental stewardship, social competence, and well-being. First, with regard to diet, gardening has led to increased vegetable intake (Langellotto & Gupta, 2012). Relatedly and importantly, gardeners have a lower average body mass index (BMI) than non-gardeners (Zick, Smith, Kowaleski-Jones, Uno, & Merrill, 2013)—perhaps because of the combination of a healthy diet and physical activity that gardening reportedly promotes (D’Abundo & Carden, 2008; van den Berg, van Winsum-Westra, de Vries, & van Dillen, 2010). Second, with regard to education and cognitive development, school gardens show promise for engaging students in academics (Bowker & Tearle, 2007; Graham & Zidenberg-Cherr, 2005; Somerset, Ball, Flett, & Geissman, 2005), and improving test scores, especially in science-based subjects (Dirks & Orvis, 2005; Klemmer, Waliczek, & Zajicek, 2005; Mabie & Baker, 1996). For example, by teaching biology, math, or even history using hands-on examples in the garden—a setting where students can move and interact—teachers may encourage deeper learning than in a traditional classroom. Third, many school garden programs have a specific focus on the environment, which fosters environmental concern among students, as well as ethical and political interest in protecting the earth that goes beyond encouraging interest in science

(Mayer-Smith, Bartosh, & Peterat, 2007; Skelly & Zajicek, 1998). Fourth, social benefits of community gardens have been documented: gardens facilitate social capital (Alaimo, Reischl, & Ober Allen, 2010; Kingsley & Townsend, 2006), collective efficacy (Teig et al., 2009), and social support (Armstrong, 2000; Firth, Maye, & Pearson, 2011; Wakefield, Yeudall, Taron, Reynolds, & Skinner, 2007). For example, gardeners describe community gardens as a non-threatening place to connect across cultures, feel a part of a community, and exchange assistance with others. In other words, gardens can strengthen social fabric. Lastly, gardens may enhance individual psychological well-being. (Dunnett & Qasim, 2000; van den Berg & Custers, 2011; Webber, Hinds, & Camic, 2015). Gardeners report that gardens are a pleasant environment that promote relaxation, creativity, and restoration (Dunnett & Qasim, 2000), and score higher in eudaimonic well-being and quality of life than non-gardeners (Shiue, 2015; Webber et al., 2015).

Despite the beneficial effects reported in many studies, and the general lack of harmful effects, there are significant weaknesses with the gardening research to date. First, most of the studies lack random assignment, thus undermining confidence that observed effects are due to gardening rather than preexisting differences, varying situations, or other confounds. Second, many researchers fail to take measures at baseline, and only compare posttests across conditions. This approach limits the precision of assessment and introduces the possibility of selection artifacts. Third, typically only the immediate effects of gardening are measured, with few researchers considering how gardening may cause more long-lasting, fundamental shifts that might change a person's lifestyle and thus have a more meaningful impact on health and wellness. In short, there

is an important need for true experiments of gardening (with random assignment), with comprehensive measurement, and that test lasting effects.

Perhaps the most complex and challenging flaw in the extant literature on gardening is the lack of adequate comparison (control) groups. Utilizing rigorous comparison groups is key to understanding the effects of gardening. That is, studies of interventions can only inform us how effective the intervention is *compared with* another intervention. Many studies focused on dietary impacts of school gardens have properly used nutrition education as a control group, but there is a severe lack of adequate comparison groups in studies of effects beyond school gardens and diet. Importantly, including proper control groups is critical to understanding causal pathways—what it is about gardening that might drive the beneficial effects. Are the effects due to being active? Being outdoors? Growing something? Such understanding is necessary both for refining the psychology of health promotion and for designing the most effective future interventions.

Using path-analysis, Litt, Schmiege, Hale, Buchenau, & Sancar (2015) considered the mechanisms of gardening improving self-reported health through neighborhood experience. In their model, gardening status (either community gardener or home gardener) directly predicted fruit and vegetable consumption. Further, gardening status predicted ratings of neighborhood aesthetics and social involvement, both of which indirectly predicted self-reported health via collective efficacy. This study illustrates relevant conceptual and analytical tools that can be used when thinking about how gardening affects health. But gardening may also predict health outcomes more directly,

and it is still unclear why gardening may be beneficial for individuals, independent of their neighborhood experience. In this dissertation, I explore the relationship between gardening and positive health outcomes by using theoretically-relevant and rigorously-designed comparison groups. In developing appropriate comparison groups, I first developed a theoretical framework of ways in which gardening may be beneficial.

Theoretical Framework for the Effects of Gardening

Physical Activity

There are many theory-based reasons why community gardening may be healthy. First, gardening requires physical activity, a well-established predictor of health and well-being (Pedersen & Saltin, 2006; Penedo & Dahn, 2005; Warburton, Nicol, & Bredin, 2006). Regular physical activity is not only associated with reduced health risk (e.g., heart, cancer, non-communicable diseases) for healthy individuals (Lee et al., 2012; Lee, Paffenbarger, & Hsieh, 1990; Paffenbarger, Wing & Hyde, 1978), but is also beneficial for individuals suffering from chronic disease, including but not limited to Type 2 diabetes, osteoarthritis, depression, asthma, and hypertension (Pedersen & Saltin, 2006). Physical activity has also been linked with enhanced mood, quality of life, and reduced depression (Daley et al., 2015; Ekkekakis, 2015; Rejeski & Mihalko, 2001; Stathopoulou, Powers, Berry, Smits, & Otto, 2006). Perhaps most indicative of the benefits of physical activity is its influence on all-cause mortality (Lan, Chang, & Tai, 2006; Lissner, Bengtsson, Bjorkelund, & Wedel, 1996; Paffenbarger et al., 1993; Paffenbarger, Hyde, Wing, & Hsieh, 1986; Samitz, Egger, & Zwahlen, 2011; Wolinsky et al., 1995).

Despite the abundance of evidence linking physical activity with better mental and physical health outcomes, many Americans fail to meet federal guidelines for physical activity (i.e. 20 to 30 minutes of moderate activity most days of the week; CDC, 1999; Pate et al., 1995). This raises the question of how to engage individuals in a healthy amount of physical activity. Gardening has been found to be an effective way to meet the governmental guidelines for moderate to vigorous activity (Park, Shoemaker, & Haub, 2008). By raking, digging, weeding, and pruning, gardening can be a form of strength and endurance training. These activities can be adjusted based on fitness or ability—for example, strong and healthy individuals can mend plots with effortful digging and turning of soil, while disabled gardeners can sit in a chair while pulling weeds from a raised garden bed. Thus, one pathway from gardening to health may be through the physical activity that gardening requires.

Exposure to Nature

Not only do gardens provide an opportunity for exercise—a health promoting activity in and of itself—but activity in nature has been shown to have benefits above and beyond exercise in synthetic environments like gyms (Bowler, Buyung-Ali, Knight, & Pullin, 2010). Specifically, a review of the literature suggests that exercising in nature compared with synthetic environments is associated with higher levels of energy, and lower levels of anxiety, anger, fatigue, and sadness (Bowler et al., 2010). Thus, another pathway from gardening to healthy outcomes may be through exposure to nature.

A growing body of evidence supports the idea that exposure to natural environments is beneficial to health and well-being, though the definition of “natural

environments” varies from study to study, and involves both objective referents (e.g. flora and fauna) as well as subjective perception (e.g., a city dweller’s perception of what constitutes a natural environment may differ from that of person who lives in a rural setting; Hartig, Mitchell, Vries, & Frumkin, 2014). Still, there is a general consensus that nature experiences, broadly construed as “the subjective experience of nature as such,” (Hartig et al., 2014, p. 209) benefits human functioning.

Some researchers have linked nature experiences to physiological restoration. For example, nature experiences can reduce stress levels and blood pressure (Hartig, Evans, Jamner, Davis, & Gärling, 2003; Pretty, Peacock, Sellens, & Griffin, 2005), and can also act as a stress buffer, such that nearby nature moderates the effects of stressful life events (Wells & Evans, 2003). Evidence that gardening helps individuals return to homeostasis after a stressful experience comes from one of the only experimental gardening studies to date. After a stressful activity, experienced gardeners assigned to garden for half an hour had lower levels of cortisol and higher levels of positive mood than gardeners assigned to read indoors for the same amount of time (van den Berg, van Winsum-Westra, de Vries, & van Dillen, 2010). Though this suggests that gardening is more effective than reading in reducing stress in gardeners, the effect can be attributed to a number of variables, including exposure to nature, but also physical activity or working to produce a living thing. The present study will begin to tease these variables apart with the use of several comparison groups.

The attention-restoration hypothesis (Kaplan & Kaplan, 1989), suggests that nature restores attentional capacities because it allows individuals to disengage from

pressures and distractions of life; it is related to Milgram's concept of stimulus overload, whereby humans become exhausted from urban life, and require relief from the constant stimulation (1970). Kaplan and Kaplan suggest that we have two types of attention: directed attention, which is effortful and susceptible to fatigue, and involuntary attention, which requires no effort and is resistant to fatigue (1989). Directed attention is critical for executive functioning and self-regulation (Kaplan & Berman, 2010). Because nature meets the requirements of a restorative environment (Kaplan, 1995), one way that depleted directed attention can be restored is through exposure to nature (Hartig, Mang, & Evans, 1991). To this end, there is evidence that impulsivity sometimes stems from mental fatigue, in which case nature may restore self-discipline by replenishing directed attention capacities (Taylor, Kuo, & Sullivan, 2002). Thus, gardening may replenish a person's ability to self-regulate by providing natural surroundings in which to restore directed, focused attention.

There is some evidence that the impacts of green space accrue over the lifespan to ultimately influence mortality risk. In a study of green space, health, mortality, and morbidity, people with more green space had lower all-cause mortality rates (Mitchell & Popham, 2008). Further, the smallest difference in mortality rates between socioeconomic status (SES) groupings was among the highest access to green space group, and the largest discrepancy among SES groups in mortality rates was for the groups with the least access to green space (Mitchell & Popham, 2008). In other words, greater green space decreased the mortality rate difference across SES groups. Though

the mechanisms have not been fully explored, this is burgeoning evidence that exposure to natural environments influences objective health outcomes.

Social Support

Community gardens may also influence health through social mechanisms. First, let us consider social support, defined as the experience or perception that one is valued and cared for by others, and the extent to which one feels a part of a social network of mutual assistance (Taylor, 2007). The effect of having social ties on morbidity and mortality is similar in size to the effect of smoking, blood pressure, obesity, and physical activity (Holt-Lunstad, Smith, & Layton, 2010; House, Landis, Karl, & Umberson, 1988). Social support is generally classified as either structural or functional: the former represents supportive interactions and the degree of integration in a social network, and the latter represents a person's perceptions that they have support available; a recent meta-analysis suggests that both influence all-cause mortality (Holt-Lunstad et al., 2010).

Community gardening may contribute to both structural and functional social support. Previous research suggests that gardens foster friendship building (Teig et al., 2009) and also have a strong community building capacity (Firth et al., 2011). Thus, community gardeners may not only gain friendships through gardening (structural support), but may also gain a sense of living in a supportive community where they can rely on people nearby (functional support). Having a strong community is also associated with engagement with other neighborhood issues. For example, community gardens have been shown to facilitate neighborhood improvements, such as food distribution, cleanups, or sidewalk building (Armstrong, 2000; Blair, Giesecke, & Sherman, 1991). Thus, it may

be that urban agriculture influences health by facilitating community improvements that provide community members with access to resources that reduce burden, and that provide a sense of perceived support and belonging.

Additionally, social support is related to good health behaviors and ongoing maintenance of healthy habits; social isolation, on the other hand, is tied to unhealthy responses to stress, such as drinking and drug use (Taylor, 2007). Having a social network, especially a social network of healthy individuals who may foster healthy subjective norms, may explain part of the relationship between gardening and health. If this is the case, the benefits of community gardening should (1) be similar to the benefits of partaking in a different social group, and (2) have a greater health promoting effect compared with gardening individually. Indeed, a previous study has found that community gardeners are more likely than home gardeners to eat five daily servings of fruit and vegetables—an effect that may be partially explained by social mechanisms (Litt et al., 2011).

Importantly, community and school gardens may promote a diverse range of social relationships, also known as social integration. By working together on common goals, people from different backgrounds may come to empathize with one another, and enjoy the diversity (Sherif, 1958). Some gardens make this their main focus: they provide contact between different generations (Krasny & Tidball, 2009; Mayer-Smith et al., 2007) and cultures (Lautenschlager & Smith, 2007). Indeed, experimental research suggests that gardens foster a sense of closeness with dissimilar others (Hoffman, Morales Knight, & Wallach, 2007). Because social integration promotes positive affect,

self-worth, purpose, and identity, which are associated with healthy physiological responses (Cohen, 2004), it may be that the relationship between gardening and health is through nurturing relationships that may otherwise have not existed.

Growing a Living Thing

Perhaps it is something about nurturing a living thing that promotes health in gardeners. Because of the direct connection between a gardener's efforts and observed results, gardening may instill a sense of responsibility, achievement, and purpose. The act of growing a plant is the least researched pathway from gardening to health, but evidence, which is mostly qualitative and from horticultural therapy programs (i.e., programs that engage individuals in therapist-led, plant-based activities to achieve therapeutic treatment goals; AHTA.org), suggests that the process of growing a plant can benefit mental functioning. In the words of a college student who participated in a study on gardening, "Just watching a plant grow; I mean, it just makes you feel good, especially when it turns out well" (Mecham & Joiner, 2012, p. 236).

One non-profit organization, Common Ground Relief, is based on the notion that gardens foster a sense of self-sufficiency in a post-disaster context (Common Ground Relief, 2009; Okvat & Zautra, 2013). By providing survivors of disasters (e.g. Hurricane Katrina) with a means to contribute to the restoration of their community, the founders of this non-profit argue that gardening bolsters victims' resilience. Similarly, older individuals, who are often limited in cognitive or physical functioning, may find a sense of personal mastery through gardening, and take interest in the continuous opportunities to learn (Infantino, 2004; Milligan, Gatrell, & Bingley, 2004). In other words, the

positive engagement with an activity that produces tangible results may buffer stressful life events or processes such as aging.

In addition to providing a sense of purpose or self-sufficiency, growing plants may contribute to meaning-making processes. That is, gardening may teach individuals about the cycles of nature, which may ultimately help gardeners cope with challenging circumstances. In one study of gardening and mindfulness with a small group of elderly individuals, researchers found evidence of participants taking refuge in the idea that life goes through cycles the same way that the garden does; by doing so, some participants reported greater coping ability, and a more positive outlook (Okvat, 2011). These positive, hopeful feelings may ultimately translate into action. That is, the combination of meaning-making and producing observable outcomes in the garden may instill individuals with the sense of self-efficacy needed to make beneficial changes to their lifestyle.

By having slow results from effortful, planned behavior, gardeners may learn to be more aware of their environment and to respond to changes deliberately rather than hastily reacting. When time to harvest comes, gardeners may feel a sense of accomplishment and satisfaction, reinforcing the productive gardening behaviors and possibly underlining them in other parts of the person's life. Though there is little rigorous research on the possibility that growing a plant may shift psychosocial functioning, qualitative evidence and theory suggest that the process of growing plants may be one pathway between gardening and healthy outcomes.

Cultivating a Healthy Pathway

The possible mechanisms tying community gardening to health may also work in synchrony to produce health benefits beyond any one independent mechanism. Indeed, some research suggests that healthy behaviors and patterns cluster together (de Vries, van 't Riet, et al., 2008) such that adopting one healthy behavior may produce a domino effect. Especially relevant to the present study is the positive association between physical activity and healthy diet (de Vries, Kremers, Smeets, & Reubsaet, 2008; Johnson, Nichols, Sallis, Calfas, & Hovell, 1998; Kremers, De Bruijn, Schaalma, & Brug, 2004). If gardening enhances both physical activity and healthy eating, other healthy behaviors may follow. For example, gardeners may adopt a better sleep schedule or become more likely to adhere to a medical treatment. Identifying as a gardener and with healthy gardener peers may shift subjective norms and expectations for healthy behavior. Thus, health behavior changes are not necessarily a direct outcome of gardening, but may also be a part of a more general shift toward a healthier lifestyle. This pattern—a pattern of conscientious living—may in turn be more enduring and impactful.

Sowing Conscientiousness

Gardening may change everyday habits that are predictive of long life. Gardening requires many productive behaviors related to conscientiousness—organization, planning, impulse control, competence, and persistence. It may be that practicing these behaviors in the garden helps reinforce them in everyday life, ultimately manifesting in individual trait-level changes. Though personality traits are characterized by some level of stability (McCrae & Costa, 2008), there is mounting evidence that personality

undergoes developmental changes throughout the life course (Caspi & Roberts, 2001; Magidson, Roberts, Collado-Rodriguez, & Lejuez, 2014; Roberts, Walton, & Viechtbauer, 2006; R W Robins, Fraley, Roberts, & Trzesniewski, 2001), and is also amenable to intervention (Jackson, Hill, Payne, Roberts, & Stine-Morrow, 2012; Krasner et al., 2009; Magidson et al., 2014; Piedmont, 2001).

Regarding deliberate change, targeting behaviors that underlie personality traits can give way to new habits, shifting patterns of behavior over time. Ultimately, these new patterns can translate into lasting trait-level change (Roberts & Mroczek, 2008). For example, medical students who underwent mindfulness training exhibited changes in conscientiousness, agreeableness, neuroticism, and empathy (Krasner et al., 2009). In another early study of personality change, social skills training for substance abusers resulted in changes to agreeableness, conscientiousness, and neuroticism (Piedmont, 2001). Finally, natural increases in job investment results in a boost to conscientiousness (Hudson & Roberts, 2016), suggesting that life experiences and shifts in values and behaviors have the potential to create more fundamental, personality-based changes.

Conscientiousness is most directly predictive of health through health behaviors—conscientious people are more likely to engage in health protective behaviors (e.g., physical activity, wearing a seatbelt) and to avoid health risky behaviors (e.g., excessive alcohol use, risky sex; Bogg & Roberts, 2004). Being diligent and reliable also predicts higher education and career attainment, subsequently protecting health both through selection into healthy environments (e.g., challenging and rewarding workplace) and the avoidance unhealthy ones (Kern, Friedman, Martin, Reynolds, & Luong, 2009;

Moffitt et al., 2011; Roberts, Caspi, & Moffitt, 2003). Finally, conscientious people also tend to have more stable, higher quality relationships (Asendorpf & Wilpers, 1998; Larson & Holman, 1994; Lodi-Smith & Roberts, 2007; Robins, Caspi, & Moffitt, 2002), which are relevant for good health (House et al., 1988; see previous section on social support). Considered collectively, these patterns reinforce conscientiousness and set individuals onto a healthy life pathway toward a longer life (Friedman et al., 1993; Iwasa et al., 2008; Kern & Friedman, 2008; Wilson, Mendes de Leon, Bienias, Evans, & Bennett, 2004). In turn, targeting conscientiousness in health promotion efforts directs the focus away from traditional approaches that place emphasis on step-by-step methods to changing single, isolated health behaviors (e.g., eating more vegetables, increasing physical activity, etc.). That conscientious people tend to have healthier *lifestyles* compared with their less conscientious counterparts suggests that increasing conscientiousness may make individuals more likely to engage in a constellation of healthier behaviors, as well as seek out healthier environments and have healthier relationships. In theory, such an intervention will result in more powerful, cost-effective effects on health than more narrow interventions. In my dissertation, I test whether a structured, ongoing activity that requires conscientious behaviors (i.e., community gardening) results in trait-level changes to conscientiousness.

Crossroads of Sustainability and Health Psychology

The study of gardening provides a unique opportunity to consider the intersection of sustainability and health psychology. These two fields are intimately linked: environmental problems (e.g., ozone depletion, climate change) have serious

consequences for human health, while in turn, human health behaviors affect the environment (e.g., meat consumption, commuting methods). Thus, acting sustainably can promote human health, and behaving healthfully can benefit the environment. Despite these parallels, the confluence of human and environmental health in psychological science is rare (Nisbet & Gick, 2008). The study of gardening bridges sustainability and health psychology, as gardening has the potential to enhance both environmental stewardship (Aguilar, Waliczek, & Zajicek, 2008; Skelly & Zajicek, 1998; Travaline & Hunold, 2010) as well as health behaviors and well-being (Blair, 2009; Langellotto & Gupta, 2012; Ozer, 2007; Robinson-O'Brien, Story, & Heim, 2009; Wang & MacMillan, 2013).

At the forefront in the exploration of the psychology of gardening and environmental responsibility is whether gardening changes attitudes toward the natural environment. This question has not been rigorously addressed, and the findings are mixed. For example, elementary school children who participated in a gardening program, compared with children in a control group, were found to have more positive attitudes toward the environment (Skelly & Zajicek, 1998). However, a similar study resulted in no difference (Aguilar et al., 2008). Notably, though, many participants in the latter study reported engaging in informal gardening activities outside of school regardless of group assignment—a plausible reason for the lack of difference between experimental groups in environmental attitudes. Indeed, analyses that compared students who had experience gardening with students who did not revealed that the former had higher scores on environmental attitudes (Aguilar et al., 2008). In general, more positive

nature experiences in childhood (not only gardening specifically) predict positive environmental attitudes and responsible environmental behavior in adulthood (Gifford & Nilsson, 2014; Wells & Lekies, 2006). Indeed, environmentalists report that childhood experiences in nature, as well as role models and education, served as formative life experiences for their environmentally oriented life paths (Chawla, 1999). Gardens not only provide opportunities to engage with nature beginning at a young age, but also frequently offer exposure to environmentally-minded role models and opportunities for environmental education.

But does changing attitudes about the natural environment translate into eco-conscious behavior? Whether an individual engages in environmental stewardship at any one occasion is the result of many factors (e.g., incentives, barriers, demographics, knowledge, and more), but attitudes about nature do play a significant role (Klößner, 2013; Stern, 2000). For example, affinity with nature predicts simple conservation behaviors (Kals, Schumacher, & Montada, 1999), and connectedness to nature (i.e., the extent to which an individual feels that he or she is part of nature; Schultz, 2001) is positively related to environmentally responsible behavior (Mayer & Frantz, 2004). The broader concept of environmental identity, which incorporates not only identity and emotional association with nature, but also an endorsement of policies that protect natural environments, correlates positively with a variety of pro-environmental behaviors such as turning off lights (Clayton, 2003). As a whole, this body of research suggests that attitudes do predict behavior in some contexts, but a full causal model has yet to be proposed. And while there is good evidence for being able to change individuals'

environmental behaviors, for example, via social influence (Abrahamse & Steg, 2013; Goldstein, Cialdini, & Griskevicius, 2008; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007), the question of whether we can manipulate attitudes about nature and subsequently shift environmental behavior to a more foundational level—therefore making it longer lasting and more broad-reaching—remains to be determined. This dissertation will begin to explore the first part of this question—whether and how environmental attitudes can be changed.

Purpose of the Present Study

Before beginning the present study, I conducted an extensive literature review that examined all of the published studies on gardening and health and well-being. As sketched above, many encouraging correlations emerged. I then conducted my own pilot experimental study. In this pilot study, I randomly assigned participants to a nutrition education condition, or to a community gardening condition. Over the course of four weeks, participants completed a pre-intervention questionnaire, participated in a two-hour intervention, and completed a post-intervention questionnaire. We found evidence for positive change in the gardening condition compared with the nutrition education control in self-reported health, willingness and self-efficacy to eat healthy foods, and decreased neuroticism in women.

This work has confirmed that gardening can be closely associated with key health-relevant ways of thinking, feeling, and behaving, but that there are empirical shortcomings in understanding why. Thus, the focal aim of this current dissertation study is to distill what it is about gardening that might be driving salubrious effects.

Method

Design Overview

College students were randomly assigned to one of five health intervention groups. In addition to a community gardening group, each of four groups was developed based on one aspect of community gardening that theory suggests might be driving beneficial effects. By examining differential outcomes, I can tease apart which components of gardening influence specific health and well-being outcomes. Because of the random assignment experimental design, I can be confident that differential outcomes are due to the intervention.

Exploring fully when, where, and why gardening may be health protective will likely entail a full career of research. I focus here on a subset of especially theoretically-relevant mediators between gardening and health. Specifically, my literature review suggests the most promising pathways are:

(1) physical activity: these participants were assigned to a *moderate, indoor exercise* group;

(2) exposure to nature: these participants were assigned to *solitary, outdoor nature exposure* group;

(3) being a part of a community: these participants were assigned to a *social film club*;

(4) growing and sustaining a living thing: these participants were assigned to an *indoor container gardening* group.

I designed comparison groups based these theoretically-plausible mechanisms, and each comparison group is meant to rule out (or qualify) a specific mechanism of the effects of community gardening (Davidson & Kaszniak, 2015). By using rigorously designed and controlled comparison groups, the present study will begin to provide insight into which components of community gardening are fundamental to its beneficial effects and are especially promising for promoting health and well-being.

Participants

A total of 138 eligible undergraduate and graduate students at the University of California, Riverside were recruited for participation in this study. The demographic breakdown for the full sample is 37.7% Hispanic, 31.2% Asian American, 13.8% White, 6.5% Black, and 10.8% other. The majority of participants were undergraduate students (94.9%), and female (68.8%), with a mean age of 20.6 ($SD = 3.30$). Due to the longitudinal and time-intensive nature of this study, some participants did not complete the full study. Pre and post data were collected for 110 participants (71.8% female; 93.6% undergraduate), who had a mean age of 20.6 ($SD = 3.32$). See Results section under “Baseline differences” for a comparison of participants who completed pre and post measures versus those who did not.

Recruitment and Compensation

Participants were recruited using flyers, promotional emails, communication with campus clubs, and via the Psychology Subject Pool during winter and spring quarters, 2016. The study was advertised as a health study that would teach participants science-based methods of health improvement. Recruiting participants who were interested in

health promotion parallels the reality of conducting a community health intervention, in that participants who have no interest in becoming healthier are unlikely to partake in a real-world health intervention.

Participants earned drawing entries for completing parts of the study—up to eight drawing entries total—and recruitment advertisements included potential prizes that participants could win. If all possible drawing entries were earned, participants earned two bonus entries for a total of ten entries. Prizes included health relevant items that undergraduates might find appealing: heart rate monitors, body composition scales, healthy college cookbooks, healthy snack boxes, sports headphones, Camelbak bottles, Blender bottles, activity and sleep trackers, hydration backpacks, yoga kits, lunchboxes, portable speakers, vegetable slicers, and gift certificates to Lululemon, Goodwin’s Organics, and Juice it Up. Prizes were distributed upon the completion of data collection.

Participants who were recruited using the Psychology Subject Pool received two Subject Pool credits for completion of the entire study in addition to drawing entries as noted above. If participants only completed a portion of the study, they received one Subject Pool credit.

Eligibility

To be eligible for the study, participants were asked for verbal confirmation that they could “partake in activities such as walking, gardening, watching films, eating fresh food, communing with nature, dancing, and playing video games.” They were also required to have three hours of availability per week for the duration of five weeks.

Study Timeline

After recruitment, participants were scheduled to come to the lab to complete baseline measures. Upon arrival, participants were randomly assigned to a condition, screened for eligibility, and provided consent forms. After consenting, participants completed baseline (Time 1) measures that took approximately 25-35 minutes to complete. Thereafter, participants scheduled attendance at a workshop to take place during the next two weeks that was designed to orient participants toward their assigned health behavior. At this point, participants also scheduled an appointment to complete posttest (Time 3) measures in the lab. All orientation workshops were conducted during a one-week timeframe. Following the week of the workshops, all participants began their assigned health behavior, and engaged in their assigned behavior for two hours a week for four weeks. During week two of the four weeks, participants completed abbreviated online measures (Time 2). Participants then returned to the lab to complete posttest measures (Time 3) one or two weeks after the final intervention week. Three weeks thereafter, participants completed abbreviated online follow-up (Time 4) measures. Prizes were distributed in the months following data collection completion. See Appendix A for a visual timeline of the study.

Experimental Conditions

Participants were randomly assigned to one of five experimental conditions: community gardening ($n = 21$), moderate indoor exercise ($n = 21$), exposure to nature ($n = 23$), a social film club ($n = 22$), and indoor container gardening ($n = 23$). (N s reported here are participants who completed both pre- and posttests. There was no differential

drop out by group; see “Baseline differences” in Results section for more detail.) To introduce participants to their assigned activities, all participants attended a workshop after completing baseline measures and before beginning the four-week health intervention period (scripts and resources for the workshops can be found in Appendix B). Regardless of group, all participants were asked to spend two hours a week for four weeks engaging in their assigned health behavior. They were also asked not to exceed three hours of their assigned activity per week. Participants who worked at the community garden could take home harvested produce. Thus, to minimize the possible confounding effect of availability of produce in fruit and vegetable intake, participants in all other conditions were provided with fruits and vegetables that they could take home or eat immediately (either at the workshop or during film screenings, depending on group). All the experimental conditions are described in more detail below.

Community gardening. Participants assigned to the community gardening condition were required to log two hours of community gardening a week at the UCR community garden. During the workshop, participants received a handout about the community garden (Appendix C), and the experimenter walked the participants to the UCR community garden and gave participants a brief tour. Activities at the community garden varied, but included activities such as weeding, planting, harvesting, watering, and turning compost. Participants could harvest and take home produce grown in the garden. This experimental condition will henceforth be referred to as the **Garden** group.

Moderate indoor exercise. Participants in the exercise group (**physical activity**) were required to exercise for a total of two hours a week. At the workshop participants

received instructions about and resources for at-home physical activity, as well as a bag of produce to “promote a healthy lifestyle.” Resources provided (Appendix D) included a handout of web-based videos for at-home fitness exercises, as well as two web-based printouts of guided exercises. Participants were also told that their exercise must be conducted independently (this minimized any possible confounding effects of social contact). Suggested physical activities were moderate-to-vigorous in nature in an effort to match the exertion required for gardening (NIH; Park, Lee, Lee, Son, & Shoemaker, 2013; Park, Lee, Son, & Shoemaker, 2012). This experimental condition will henceforth be referred to as the **Activity** group.

Exposure to nature. Participants assigned to spend time in nature (**nature exposure**) were required to sit quietly in nature for a total of two hours a week. At the workshop, participants learned what they may do while spending time in nature, and were walked to example on-campus locations where could spend their two weekly hours. Based on research that suggests simply being exposed to nature promotes health (Grinde & Patil, 2009; Mitchell & Popham, 2007; Tennessen & Cimprich, 1995; Ulrich, 1984) participants were allowed to read, listen to music, or engage in other sedentary, solitary activities while they were in nature. That is, I did not believe that these every day behaviors would interfere with the effect of spending time in nature. Cell phone use was allowed, with the exception of social media, texting, and phone calls. This restriction was to limit social activity from being introduced as a confounding variable. At the workshop, participants also received a handout (Appendix E), and a bag of produce to “promote a

healthy lifestyle.” This experimental condition will henceforth be referred to as the **Nature** group.

Social film club. Participants assigned to the film club (**being part of a community**) were required to attend weekly short film screenings and discussions, as outlined in the handout they received (Appendix F). Six screenings were scheduled each week to accommodate schedules. Between two and eight participants attended each screening, along with two research assistants who helped facilitate discussions. After viewing a film, participants discussed the film for approximately thirty minutes. Healthy snacks (fruits and vegetables) were served at each screening. For a list of films and discussion questions, see Appendix F. This experimental condition will henceforth be referred to as the **Film** group.

Indoor container gardening. Participants assigned to the indoor container gardening group (**growing a living thing**) were required to care for plants in their own home. Participants attended a workshop during which they planted a basil seedling and radish seeds in pots they took home. The workshop covered the basics of plant care, and participants were sent home with a handout on how to care for their plant (Appendix G). Participants took home from the workshop two small plant containers with their planted seeds and seedling, and a bag of produce to “promote a healthy lifestyle.” This experimental condition will henceforth be referred to as the **Plant** group.

Manipulation Check

Each participant was required to provide evidence—email or text a date-stamped photo at the completion of each activity—to document that they engaged in their weekly

behavior as scheduled. Participants were provided a phone number and an email address to which they could send their photo, and were instructed to send the photo by the end of the day on which they completed their behavior. All participants who failed to submit at least one photo by Thursday of each week were contacted and encouraged to participate in their assigned activity. If a photo was still not uploaded by Saturday, participants were contacted again to confirm that they did not engage in their assigned behavior that week, and to encourage participation in the coming week. Whether participants participated in their behavior (i.e., sent a weekly date-stamped photograph) was documented throughout the study.

Because participants in the social film club met in the lab weekly to watch and discuss a short film, the experimenter confirmed that they attended (yes or no). To minimize unintended differences between groups due to the manipulation check, participants in the social film club were also asked to send in a weekly photo of something that reminded them of that week's movie.

Measures

Measures were taken at four time points. A pretest (Week 0; Time 1 measures) assessed the baseline for each group, and was used to identify any preexisting differences among groups. Participants also completed abbreviated measures halfway through the intervention (Week 3; Time 2 measures), full posttest measures after the intervention (Week 6; Time 3 measures), and abbreviated measures one month after the intervention (Week 9; Time 4 measures). Measures in Weeks 0 and 6 were completed in the lab on a desktop computer, and abbreviated measures at Weeks 3 and 9 were emailed to

participants to complete in their own time and at the location of their choosing during the week. All measures were distributed and completed using Qualtrics, an online survey platform tool.

I measured health relevant variables, broadly construed. Consistent with the World Health Organization's definition of health (1948), and the recommendations of Friedman and Kern (2014), I included physical, mental, and social components in my assessment of health. Specifically, I assessed four broad domains to capture overall health and well-being: (1) physical health and health behaviors; (2) subjective well-being; (3) social relationships; and (4) productivity and persistence. All variables were measured using self-report. To minimize participant burden, cognitive ability, though it is one of the outcomes Friedman and Kern (2014) suggest is important to overall health, was not assessed in this study. Environmental identity was also assessed using self-report. The specific scales used to assess the broad categories outlined above are described below.

Due to the large quantity of questions, two optional break times were built into the Qualtrics surveys. Participants were reminded that thoughtful responses are required for the research, and that participants should take a short break if needed. Additionally, to identify careless or non-attentive responders, two instructed items (e.g., "To ensure that participants read the questions, please select 'Very Satisfied' on the scale;" Oppenheimer, Meyvis, & Davidenko, 2009) were inserted into the questionnaire.

Physical health. Self-reported physical health was measured using the 4-item Global Physical Health component of the 10-item Global Health Short Form (PROMIS; Hays, Bjorner, Revicki, Spritzer, & Cella, 2009) at Time 1 ($\alpha = 0.56$) and Time 3 ($\alpha =$

0.62). Participants also completed the 4-item Fatigue Short Form 4a (PROMIS; Garcia et al., 2007) at Time 1 ($\alpha = 0.89$) and Time 3 ($\alpha = 0.88$). Items 3 (“In general, how would you rate your physical health?”) and 6 (“To what extent are you able to carry out your everyday physical activities such as walking, climbing stairs, carrying groceries, or moving a chair?”) from the Global Health Short form, and items 3 (“In the past 7 days, how run-down did you feel on average?”) and 4 (“In the past 7 days, how fatigued were you on average?”) of the Fatigue Short Form 4a were also asked at Time 2 and 4. To assess Body Mass Index (BMI), participants were asked for their height and weight at Time 1 and Time 3.

Subjective well-being. Participants completed the 10-item Perceived Stress Scale Stress (Cohen, Kamarck & Mermelstein, 1983) at Time 1 ($\alpha = 0.75$) and Time 3 ($\alpha = 0.79$); the 4-item subjective happiness scale (Lyubomirsky & Lepper, 1999) at Time 1 ($\alpha = 0.89$), Time 2 ($\alpha = 0.89$), Time 3 ($\alpha = 0.89$), and Time 4 ($\alpha = 0.88$); a 10-item self-efficacy scale from the NIH Toolbox (NIH TB; Gershon et al., 2013) at Time 1 ($\alpha = 0.90$), Time 2 ($\alpha = 0.89$), Time 3 ($\alpha = 0.92$), and Time 4 ($\alpha = 0.93$); and the 20-item Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) at Time 1 (positive $\alpha = 0.89$; negative $\alpha = 0.87$), Time 2 (positive $\alpha = 0.89$; negative $\alpha = 0.84$), Time 3 (positive $\alpha = 0.91$; negative $\alpha = 0.87$), and Time 4 (positive $\alpha = 0.91$; negative $\alpha = 0.87$). Mental health was also measured using the 4-item Global Mental Health component of the 10-item Global Health Short Form (PROMIS; Hays, Bjorner, Revicki,

Spritzer, & Cella, 2009) at Time 1 ($\alpha = 0.70$), Time 2 ($\alpha = 0.79$), Time 3 ($\alpha = 0.78$), and Time 4 ($\alpha = 0.85$).

Social relationships. Participants completed a 6-item measure of companionship (PROMIS; Hahn et al., 2014) at Time 1 ($\alpha = 0.91$), Time 2 ($\alpha = 0.93$), Time 3 ($\alpha = 0.93$), and Time 4 ($\alpha = 0.95$); a 6-item measure of social isolation (PROMIS; Hahn et al., 2014) at Time 1 ($\alpha = 0.92$) and Time 3 ($\alpha = 0.90$); and a measure of social integration (Crittenden, Pressman, Janicki-Deverts, & Smith, 2014; Thoits, 1983). The social integration scale is a sum of the number of roles a person holds (e.g., volunteer, sibling, etc.) out of ten possible roles, thus making alpha unsuitable for this scale. The average number of roles a participant held at Time 1 was 4.36 ($SD = 1.60$); at Time 3, the average was 4.33 ($SD = 1.63$).

Conscientiousness and individual differences. Participants completed a 10-item trait self-control inventory (adapted from Tangney, Baumeister, & Boone, 2004) at Time 1 ($\alpha = 0.82$) and Time 3 ($\alpha = 0.82$); and a 14-item Resilience Scale (Wagnild & Young, 2009) at Time 1 ($\alpha = 0.91$) and Time 3 ($\alpha = 0.90$). To measure the Big Five personality traits, participants completed the 44-item Big Five (personality) Inventory (BFI; Benet-Martinez & John, 1998; John, Donahue, & Kentle, 1991; John, Naumann, & Soto, 2008) at Time 1 (openness $\alpha = 0.72$; extraversion $\alpha = 0.84$; conscientiousness $\alpha = 0.80$; agreeableness $\alpha = 0.74$; neuroticism $\alpha = 0.83$) and Time 3 (openness $\alpha = 0.78$; extraversion $\alpha = 0.84$; conscientiousness $\alpha = 0.78$; agreeableness $\alpha = 0.72$; neuroticism α

= 0.84). Six facets of conscientiousness were also measured using the 60-item Chernyshenko Conscientiousness Scale (Hill & Roberts, 2012) at Time 1 (orderliness $\alpha = 0.89$; virtue $\alpha = 0.76$; traditionalism $\alpha = 0.66$; control $\alpha = 0.78$; responsibility $\alpha = 0.60$; and industriousness $\alpha = 0.79$) and Time 3 (orderliness $\alpha = 0.87$; virtue $\alpha = 0.74$; traditionalism $\alpha = 0.65$; control $\alpha = 0.78$; responsibility $\alpha = 0.67$; and industriousness $\alpha = 0.83$).

Health behaviors. Participants completed selections of a Food Frequency Questionnaire (NCI, 2012). Specifically, they completed items that measured dietary intake of fruits and vegetables at Time 1 and Time 3. Physical activity was measured using the single-item Stanford Leisure-Time Activity Categorical Item (L-Cat; Kiernan et al., 2013) at all four time points. To assess sleep, participants completed the 8-item Epworth Sleepiness Scale (Murray, 1991) at Time 1 ($\alpha = 0.74$), Time 2 ($\alpha = 0.66$), Time 3 ($\alpha = 0.77$), and Time 4 ($\alpha = 0.78$). At Time 1, participants answered whether they had ever smoked tobacco daily in the past; at Time 1 and 3, participants indicated their current tobacco use (Global Adult Tobacco Survey Collaborative Group, 2011). Finally, participants were asked whether they ever drank alcohol; if they indicated yes, they completed seven items about alcohol consumption from the Alcohol Use Short Form (PROMIS; Pilkonis et al., 2013) at Time 1 ($\alpha = 0.97$) and Time 3 ($\alpha = 0.97$).

Environmental measures. Participants completed a 24-item environmental identity scale (Clayton, 2003) at Time 1 ($\alpha = 0.92$) and Time 3 ($\alpha = 0.94$), and a single item Connectedness to Nature Scale (Mayer & Frantz, 2004) at all four time points.

Participants also completed the 12-item Inclusion of Nature in Self Scale (Schultz, 2001), which measures egoistic, altruistic, and biospheric environmental concerns. Participants completed this scale at Time 1 (biospheric $\alpha = 0.90$; egoistic $\alpha = 0.83$; altruistic $\alpha = 0.86$) and Time 3 (biospheric $\alpha = 0.87$; egoistic $\alpha = 0.92$; altruistic $\alpha = 0.85$).

Qualitative measures. Participants were also asked a series of qualitative questions at Time 3. Specifically, participants answered: What was this experience like for you? What was a high point of this experience? What was a low point of this experience? Has this experience changed you in any way? At Time 4, participants were again asked whether the experience had changed them, and to rate the degree to which they adhered to their assigned health intervention from 0-100.

Hypotheses

Because community gardening involves components of each of the other comparison groups, I predicted that participants assigned to the community garden would increase in measures of physical health and health behaviors, subjective well-being, social relations, measures related to conscientiousness, and environmental identity above and beyond the comparison groups. That is, I expected the community gardening group to better fit a theory of positive change for all outcomes compared with the four comparison groups.

Further, I expected that specific comparison groups would fit a theory of positive change for specific outcomes better than the other comparison groups. In particular, I predicted that the exercise group would show the greatest increases in physical health and health behaviors compared with the other comparison groups. It is well established that

exercise is health-promoting, which I expected to see this reflected in health assessments. Further, studies suggest that health behaviors often occur in clusters (de Bruijn, Kremers, van Mechelen, & Brug, 2005; de Vries et al., 2008), thus, I predicted that individuals who begin to exercise may also start eating better, and may even quit smoking and drinking to excess.

I predicted that the nature exposure group would show the greatest increases in environmental identity compared with the other comparison groups. Because participants were asked to focus on the environment and their surroundings, participants may have come to appreciate their natural surroundings and identify with them. This, in turn, may have increased well-being, but I believed increases in environmental identity would be observed first.

I expected the film club to show the greatest increases on measures of social relations. Because this group was a social club that encouraged discussion and that met regularly, I predicted that it would serve to bolster individuals' feelings of integration and community.

Lastly, I predicted that the indoor gardening group would show the greatest increases in well-being and productivity compared with the physical activity, social, and nature exposure groups. Helping a plant grow may have made participants feel good, and may have made them aware of the work that is involved in growth. That is, caring for the plant may have fostered a need to take care of oneself, and thus spurred an individual to become more organized and prudent. Though I predicted that indoor gardening would produce the greatest benefits to subjective well-being, both exercise and spending time in

nature are consistently linked with well-being (Maller, Townsend, Pryor, Brown, & St Leger, 2006; Penedo & Dahn, 2005). Thus, I carefully explored the differential outcomes.

Results

Forming Composites: Five Broad Domains

Due to the wide range of overlapping variables measured, composites were formed to increase reliability of the variables of interest, and to reduce the total number of statistical analyses, thus lessening the likelihood of Type I errors. All baseline scales, with the exception of self-reported health behaviors and with the addition of two items from the Global Health Short Form that are not included in the physical or mental health subscales, were utilized in this variable reduction. Initial groupings of composite scores were based upon a priori plans to measure five broad domains; theory-based face validity of scales; and inter-scale zero-order correlations. A factor analysis yielded a check of the initial groupings, and suggested minor restructuring of composites. The five-factor solution to the factor analysis accounted for 55.89% of the variance of measured variables. Finally, reliability analyses (reported below) confirmed acceptable reliability of the resulting composite scales.

Self-reported health behaviors, including fruit consumption, vegetable consumption, sleepiness, alcohol consumption, and physical activity were not included in the data reduction. These behaviors or direct correlates of behavior (e.g., sleepiness) are distinct from self-reported functioning, and it is important to understand how each one discreetly changes over time. See Table 1 for correlations among composites and health behaviors.

Table 1

Correlations Among Composites and Health Behaviors

Composite/Variable	1	2	3	4	5	6	7
Emotional well-being (1)	--						
Conscientiousness (2)	0.53**	--					
Social relationships (3)	0.63**	0.32**	--				
Environmental identity (4)	0.16	0.23*	0.17	--			
Self-reported health (5)	0.56**	0.45**	0.46**	0.02	--		
Sleepiness (6)	-0.47**	-0.43**	-0.18	-0.10	-0.37**	--	
Physical activity (7)	0.14	0.18	0.16	0.04	0.37**	0.01	--
Produce consumption (8)	0.13	0.25*	0.14	0.18	0.38**	0.06	0.25**

Note. Correlations are composites or scales at baseline, using scores only from participants who also completed Time 3 (posttest) measures.

*Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed).

Composite 1: Emotional well-being.

Seven scales were combined to create the emotional well-being composite (α Time 1 = 0.96; α Time 3 = 0.96): perceived stress (reverse-scored), subjective happiness, self-efficacy, negative affect (reverse-scored), neuroticism (reverse-scored) from the BFI, global mental health, and isolation (reverse-scored). Agreeableness also loaded highly onto this factor, but because it is theoretically distinct from emotional well-being, it was excluded from the composite.

Composite 2: Conscientiousness and persistence.

Nine scales were combined to create a conscientiousness and persistence composite (α Time 1 = 0.94; α Time 3 = 0.95): all six subscales of the Chernyshenko Conscientiousness Scale (order, industriousness, responsibility, traditionalism, control, and virtue), conscientiousness from the BFI, resiliency, and self-control.

Composite 3: Social relationships.

Four scales and one item were combined to create a composite of social relationships (α Time 1 = 0.88; α Time 3 = 0.91): companionship, extraversion, roles, positive affect, and item nine from the Global Health Short Form (“In general, please rate how well you carry out your usual social activities and roles.”)

Composite 4: Environmental identity.

Four scales and a single-item scale were combined to create an environmental identity composite (α Time 1 = 0.93; α Time 3 = 0.94): subscales of the nature identity scale (biospheric, altruistic, and egospheric environmental concern), the environmental identity scale, and the single-item connectedness to nature scale. Openness also loaded highly onto this factor, but because it is theoretically distinct from environmental identity, it was excluded from the composite.

Composite 5: Self-reported health.

Two scales and one item were combined to create a self-reported health composite (α Time 1 = 0.84; α Time 3 = 0.87): fatigue (reverse-scored), global physical health, and item one from the Global Health Short Form (“In general, would you say your health is...”)

Combining scales.

To enhance interpretability, all scales on which higher scores indicate worse functioning (e.g., perceived stress, negative affect) were reverse scored. The proportion of maximum scaling (POMS) method was used to bring variables with different response scales to the same metric (Moeller, 2015). By subtracting the minimum possible score from the observed score, dividing the result by the maximum possible score minus the minimum possible score, and multiplying the final result by 100, all variables are put on a common 0-100 scale. To create composite scores, a mean score was calculated using the POMS scores from each item or scale to be used in the composite. This resulted in each composite having a possible range of 0-100, with higher scores reflecting better functioning in that domain.

Summary of Measures Used in Analyses

In addition to the five composites (emotional well-being, conscientiousness and persistence, social relationships, environmental identity, and self-reported health), sleepiness and physical activity were also considered. Fruit and vegetable consumption were averaged for a total produce consumption score. Alcohol consumption and tobacco use were not considered in analyses due to low variability of both in this college population. Only seven participants (6.4%) reported smoking, and of the of the 58 (52.7%) participants who reported drinking alcohol in the past month, most used alcohol responsibly (mean alcohol use = 0.81 on a 0-5 scale). Thus, to lower the probability of a Type I error, neither tobacco use nor alcohol use were subjected to a significance test. Means and standard deviations of all variables (collapsed across groups) at all time points

can be found in Table 2. Table 3 shows means and standard deviations of the health behavior variables and the composites used in significance testing organized by experimental groups.

Table 2

Means and Standard Deviations at Each Time Point Across Groups

Measure	Possible Range	Time 1 <i>M (SD)</i>	Time 2 <i>M (SD)</i>	Time 3 <i>M (SD)</i>	Time 4 <i>M (SD)</i>
Physical health	4-20	12.96 (2.76)	--	14.07 (3.07)	--
Mental health	4-20	13.21 (2.61)	13.49 (2.80)	13.96 (3.04)	14.62 (2.98)
Fatigue	4-20	10.38 (3.37)	--	9.61 (3.36)	--
Physical Activity	1-6	3.02 (1.46)	2.91 (1.26)	3.09 (1.29)	2.67 (1.41)
Stress	0-56	26.00 (6.37)	--	24.23 (6.67)	--
Happiness	1-7	4.78 (1.35)	4.90 (1.33)	5.05 (1.27)	5.16 (1.19)
Self-efficacy	1-5	3.69 (0.60)	3.82 (0.55)	3.89 (0.58)	3.96 (0.60)
Positive affect	10-50	33.01 (7.56)	34.08 (7.10)	34.01 (7.68)	35.42 (8.01)
Negative affect	10-50	22.60 (8.04)	20.89 (6.58)	21.30 (7.03)	18.78 (6.51)
Companionship	1-5	3.94 (0.88)	3.92 (0.88)	4.05 (0.81)	4.02 (0.82)
Isolation	1-5	2.48 (0.93)	--	2.19 (0.79)	--
Roles	0-10	4.32 (1.46)	--	4.33 (1.63)	--
Self-control	1-5	3.24 (0.70)	--	3.38 (0.69)	--
Order ^a	1-4	3.00 (0.63)	--	3.02 (0.58)	--
Virtue ^a	1-4	2.80 (0.52)	--	2.82 (0.47)	--
Traditionalism ^a	1-4	2.68 (0.37)	--	2.70 (0.37)	--
Self-control ^a	1-4	2.90 (0.47)	--	2.91 (0.47)	--
Responsibility ^a	1-4	3.21 (0.39)	--	3.23 (0.38)	--
Industriousness ^a	1-4	3.10 (0.45)	--	3.12 (0.46)	--
Resilience	14-98	75.85 (13.51)	--	79.54 (10.87)	--
Extraversion ^b	1-5	3.13 (0.82)	--	3.19 (0.79)	--
Agreeableness ^b	1-5	3.96 (0.57)	--	4.01 (0.54)	--
Conscientiousness ^b	1-5	3.61 (0.64)	--	3.62 (0.59)	--
Neuroticism ^b	1-5	2.96 (0.78)	--	2.78 (0.78)	--
Openness ^b	1-5	3.61 (0.56)	--	3.57 (0.59)	--
Produce consumption	0-10	4.80 (1.73)	--	4.93 (1.62)	--
Sleepiness	0-24	9.34 (4.44)	8.70 (3.81)	8.86 (4.36)	7.15 (4.29)
Alcohol consumption	0-5	0.81 (0.89)	--	0.81 (0.96)	--
Environmental Identity Scale	24-110	77.8 (15.66)	--	79.81 (17.86)	--
Connectedness to nature	1-7	4.35 (1.38)	4.25 (1.64)	4.72 (1.34)	4.19 (1.60)
Biospheric environmental concern	1-7	6.14 (0.81)	--	6.09 (0.85)	--
Egoistic environmental concern	1-7	6.03 (0.89)	--	6.05 (1.06)	--
Altruistic environmental concern	1-7	6.23 (0.93)	--	6.34 (0.78)	--

Note. Means and standard deviations are derived using scores from participants who completed at least Time 1 and Time 3.

^aSubscale of the Chernyshenko Conscientiousness Scale. ^bFrom the Big Five Inventory.

Table 3

Time 1 and Time 3 Scores for Composites and Health Behavior Measures by Group

Composite/Scale	Range	Time 1 <i>M (SD)</i>	Time 3 <i>M (SD)</i>
Emotional well-being	0-100		
<i>Garden</i>		61.17 (12.78)	65.42 (14.81)
<i>Physical activity</i>		61.94 (18.48)	66.60 (15.46)
<i>Nature</i>		58.79 (15.00)	66.11 (13.26)
<i>Film</i>		58.79 (14.03)	63.60 (15.51)
<i>Plant growing</i>		63.07 (13.81)	67.10 (14.39)
Conscientiousness	0-100		
<i>Garden</i>		62.63 (9.80)	64.07 (11.43)
<i>Physical activity</i>		67.67 (11.49)	70.04 (9.48)
<i>Nature</i>		65.34 (11.33)	67.77 (12.07)
<i>Film</i>		65.75 (8.97)	65.87 (10.38)
<i>Plant growing</i>		63.70 (9.59)	63.68 (9.98)
Social relationships	0-100		
<i>Garden</i>		59.89 (9.16)	62.26 (10.78)
<i>Physical activity</i>		57.61 (11.11)	63.52 (11.89)
<i>Nature</i>		55.80 (15.20)	59.33 (14.06)
<i>Film</i>		56.02 (14.03)	59.34 (16.61)
<i>Plant growing</i>		58.62 (11.77)	60.70 (11.43)
Environmental identity	0-100		
<i>Garden</i>		73.15 (13.26)	78.52 (12.84)
<i>Physical activity</i>		74.54 (12.35)	74.14 (13.92)
<i>Nature</i>		72.59 (12.51)	77.81 (13.20)
<i>Film</i>		78.38 (10.11)	76.48 (13.03)
<i>Plant growing</i>		76.42 (10.45)	77.95 (10.39)
Self-reported health	0-100		
<i>Garden</i>		59.62 (13.89)	63.19 (18.80)
<i>Physical activity</i>		57.44 (13.15)	63.89 (17.64)
<i>Nature</i>		52.81 (19.05)	61.86 (17.91)
<i>Film</i>		53.60 (18.13)	60.98 (17.13)
<i>Plant growing</i>		61.50 (15.56)	64.04 (16.20)
Sleepiness	0-24		
<i>Garden</i>		9.10 (4.38)	9.24 (4.10)
<i>Physical activity</i>		8.95 (4.64)	7.71 (4.92)
<i>Nature</i>		8.13 (4.66)	8.78 (5.46)
<i>Film</i>		10.77 (4.21)	9.27 (3.12)
<i>Plant growing</i>		9.73 (4.22)	9.26 (4.02)
Physical activity	1-6		
<i>Garden</i>		2.81 (1.50)	2.76 (1.18)
<i>Physical activity</i>		3.24 (1.64)	3.10 (1.22)
<i>Nature</i>		2.78 (1.31)	3.09 (1.24)
<i>Film</i>		3.14 (1.36)	3.05 (1.17)
<i>Plant growing</i>		3.13 (1.58)	3.43 (1.59)
Produce Consumption	0-10		
<i>Garden</i>		4.14 (1.30)	4.64 (1.47)
<i>Physical activity</i>		4.76 (1.59)	4.76 (1.45)
<i>Nature</i>		4.39 (2.29)	4.87 (1.74)
<i>Film</i>		5.27 (1.60)	5.36 (1.79)
<i>Plant growing</i>		5.37 (1.46)	5.00 (1.66)

Baseline Differences

A series of one-way ANOVAs were conducted to assess differences at Time 1. First, differences between conditions were examined using all available baseline data. There was a statistically significant difference for total produce consumption at Time 1, $F(4,137) = 2.52, p = 0.045$. A Tukey HSD test revealed that the Plant Growing condition ($M = 5.48$) was significantly different (higher) than the other groups (average $M = 4.46$) in produce consumption. Pearson's chi square tests to assess whether there were group differences in tobacco use (yes/no), gender, student status, or ethnicity were all non-significant. Importantly, there was also no difference between groups in attrition: eight participants dropped from the Gardening condition, five from the Nature condition, five from the film condition, four from the Plant Growing condition, and six from the Activity condition, $\chi^2(4) = 1.67, p = 0.80$.

Next, independent-samples t-tests were conducted to compare baseline differences between participants who did and did not complete Time 3 (post) measures. The test for equal variances not assumed was used when Levene's Test for Equality of Variances was statistically significant. Participants who provided only partial data (did not report Time 3 data) reported lower scores on social relationships, $t(136) = 2.00, p = 0.05$, and higher alcohol consumption, $t(34.79) = 2.18, p = 0.04$ at Time 1. There were trending differences for environmental identity, $t(34.54) = 1.85, p = 0.07$, and produce consumption, $t(136) = 1.83, p = 0.07$, with participants who reported partial data scoring marginally lower on both. Pearson's chi square tests suggest that participants who completed the study varied in ethnicity from those who provided only partial data, $\chi^2(5) =$

12.65, $p = 0.03$. The odds of dropping out prior to Time 3 based on ethnicity were: 0.36 for those who identified as White; 0.50 for those who identified as Black; 0.13 for those who identified as Hispanic; 0.23 for those who identified as Asian-American; and 0.44 for those who identified as “Other.” Of the two Pacific Islanders in the study, both dropped out. When the Pearson’s chi square was conducted with the two Pacific Islanders identified as “other,” differences in drop out based on ethnicity became non-significant, $\chi^2(5) = 7.51, p = 0.11$. Participants who completed Time 3 measures did not vary from participants who did not complete Time 3 measures in tobacco use, gender, or student status.

Effects of Intervention: Comparing Group Change from Time 1 to Time 3: 2x5

ANOVAs

To compare how groups changed from Time 1 (pretest) to Time 3 (posttest), 2 (Time) x 5 (Group) mixed ANOVAs were used. See Table 3 for a summary of descriptive statistics, and Table 4 for a summary of significance tests.

Table 4

2 (Time) x 5 (Group) ANOVA Results

Composite/Scale	<i>df</i>	<i>F</i>	<i>p</i> -value	η^2_p
Emotional well-being				
<i>Effect of time</i>	(1,105)	28.00	<0.001**	0.21
<i>Time x Condition</i>	(4,105)	0.41	0.80	0.02
Conscientiousness/productivity				
<i>Effect of time</i>	(1,105)	4.82	0.03*	0.04
<i>Time x Condition</i>	(4,105)	0.85	0.50	0.03
Social relationships				
<i>Effect of time</i>	(1,105)	13.57	<0.001**	0.11
<i>Time x Condition</i>	(4,105)	0.51	0.73	0.02
Environmental identity				
<i>Effect of time</i>	(1,105)	4.94	0.03*	0.04
<i>Time x Condition</i>	(4,105)	2.72	0.03*	0.09
Self-reported health				
<i>Effect of time</i>	(1,105)	14.61	<0.001**	0.12
<i>Time x Condition</i>	(4,105)	0.65	0.63	0.02
Sleepiness				
<i>Effect of time</i>	(1,105)	1.87	0.17	0.02
<i>Time x Condition</i>	(4,105)	1.32	0.27	0.05
Physical activity				
<i>Effect of time</i>	(1,105)	0.21	0.65	0.00
<i>Time x Condition</i>	(4,105)	0.49	0.74	0.02
Produce consumption				
<i>Effect of time</i>	(1,105)	0.71	0.40	0.01
<i>Time x Condition</i>	(4,105)	0.97	0.43	0.04

* $p < 0.05$. ** $p < 0.01$.

Emotional well-being: 2x5 ANOVA.

There was an effect of time, such that regardless of group, participants increased on emotional well-being from pre- to posttest, $F(1,105) = 28.00$, $p < 0.001$, $\eta^2_p = 0.21$.

However, groups did not change differentially over time, $F(4,105) = 0.41$, $p = 0.80$, $\eta^2_p = 0.02$. See Figure 1 for mean emotional well-being scores for each group at Time 1 and Time 3.

Conscientiousness and persistence: 2x5 ANOVA.

There was a significant effect of time on conscientiousness, $F(1,105) = 4.82, p = 0.03, \eta^2_p = 0.04$, such that participants, regardless of experimental condition, increased on the composite measure of conscientiousness and persistence. There was no interaction effect of group and time, $F(4,105) = 0.85, p = 0.50, \eta^2_p = 0.03$. See Figure 2 for mean conscientiousness scores for each group at Time 1 and Time 3.

Social relationships: 2x5 ANOVA.

There was a significant effect of time, such that participants increased on measures of social relationships over time, regardless of group, $F(1,105) = 13.57, p < 0.001, \eta^2_p = 0.11$. Change over time did not vary by group, $F(4,105) = 0.51, p = 0.73, \eta^2_p = 0.02$.¹ See Figure 3 for mean social relationships scores for each group at Time 1 and Time 3.

Environmental identity: 2x5 ANOVA.

Overall, participants increased in environmental identity from Time 1 to Time 3, $F(1,105) = 4.94, p = 0.03, \eta^2_p = 0.04$. There was, however, a significant interaction, such that groups changed differentially over time, $F(4,105) = 2.72, p = 0.03, \eta^2_p = 0.09$.² That is, as shown in Figure 4, the garden and nature groups increased while the others did not.

¹ Neither the interaction effect nor the effect of time changed when outliers (one at Time 1 and three at Time 3) were dropped from the analysis.

² The effect of time did not change when outliers (two at Time 1 and two at Time 3; one outlier at each time point was the same participant) were dropped, $F(1,103) = 6.30, p = 0.01, \eta^2_p = 0.06$. The interaction effect became non-significant when outliers were dropped, $F(4,103) = 2.34, p = 0.06, \eta^2_p = 0.08$. Importantly, the participants who were outliers were assigned to the Physical and Film conditions and had low scores, suggesting that the change in effect had to do with higher Time 1 scores and Time 3 scores in these groups (thus resulting in a less dramatic decrease compared with the Nature and Garden groups).

To see if group differences could be teased apart, Tukey HSD tests were conducted. None of the Tukey HSD tests were statistically significant. The difference between the garden condition and film condition was trending ($p = 0.08$), as was the difference between the nature exposure condition and the film condition ($p = 0.08$). Figure 4 shows that the Garden group and Nature group increased in environmental identity, the Plant Growing group increased slightly, and the Film and Physical activity groups decreased slightly. Although these were not reliable group differences, they are conceptually sensible and heuristic.

Self-reported health: 2x5 ANOVA.

There was a significant effect of time, such that, as a whole, participants increased in self-reported health over time, $F(1,105) = 14.61, p < 0.001, \eta^2_p = 0.12$. Change over time did not vary by group, $F(4,105) = 0.65, p = 0.63, \eta^2_p = 0.02$.³ See Figure 5 for mean self-reported health scores for each group at Time 1 and Time 3.

Sleepiness: 2x5 ANOVA.

There was no significant effect of time on sleepiness, $F(1,105) = 1.87, p = 0.17, \eta^2_p = 0.02$. There was also no significant group by time interaction, $F(4,105) = 1.32, p = 0.27, \eta^2_p = 0.05$. See Figure 6 for mean sleepiness scores for each group at Time 1 and Time 3.

³ Neither the interaction effect nor the effect of time changed when an outlier (at Time 3) was dropped from the analysis.

Physical activity: 2x5 ANOVA.

There was no significant change in physical activity over time, $F(1,105) = 0.21, p = 0.65, \eta^2_p = 0.00$. There was also no significant interaction between time and group, $F(4,105) = 0.49, p = 0.74, \eta^2_p = 0.02$. See Figure 7 for mean physical activity scores for each group at Time 1 and Time 3.

Produce consumption: 2x5 ANOVA.

There was no significant effect of time on produce (fruit and vegetable) consumption, $F(1,105) = 0.71, p = 0.40, \eta^2_p = 0.01$. There was also no significant group by time interaction, $F(4,105) = 0.97, p = 0.43, \eta^2_p = 0.04$. See Figure 8 for mean produce consumption scores for each group at Time 1 and Time 3.

Summary of 2x5 ANOVAs.

Regardless of condition, participants increased in emotional well-being, conscientiousness, social relationships, environmental identity, and self-reported health during the study. There was no statistically significant change over time in sleepiness, physical activity, or produce consumption.

The 2x5 ANOVA suggested that there was differential change by group for environmental identity. Means suggest that the Garden and Nature Exposure groups experienced the greatest increase, the Plant Growing group experienced a moderate increase, and the Film and Physical Activity groups experienced a slight decrease. Post hoc Tukey tests revealed that the patterns of change over time by group were not statistically significantly different from one another, though the difference between the Garden and Film, and between the Nature and Film groups were trending significance.

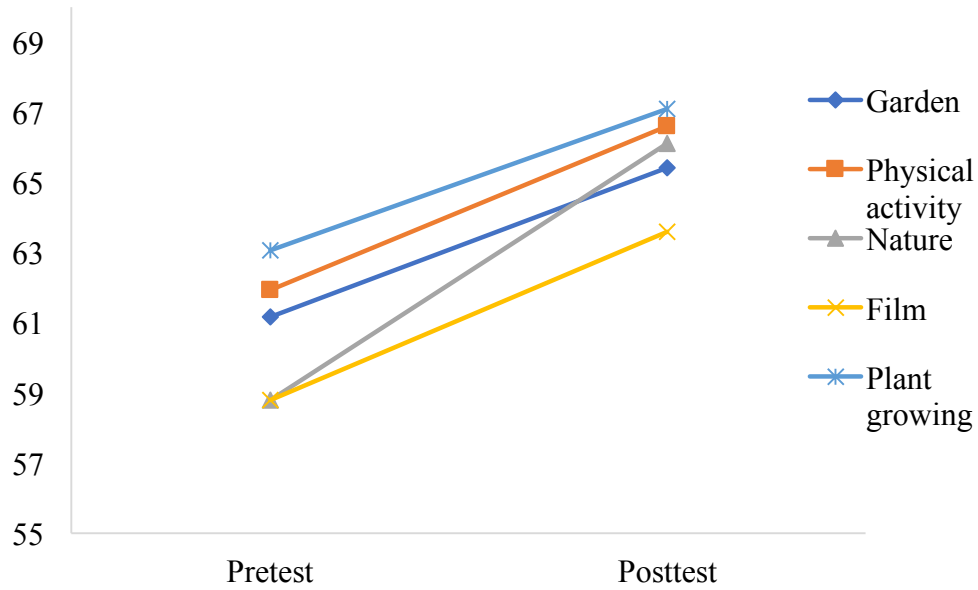


Figure 1. Emotional well-being (composite) at Time 1 (pretest) and Time 3 (posttest) by experimental group.

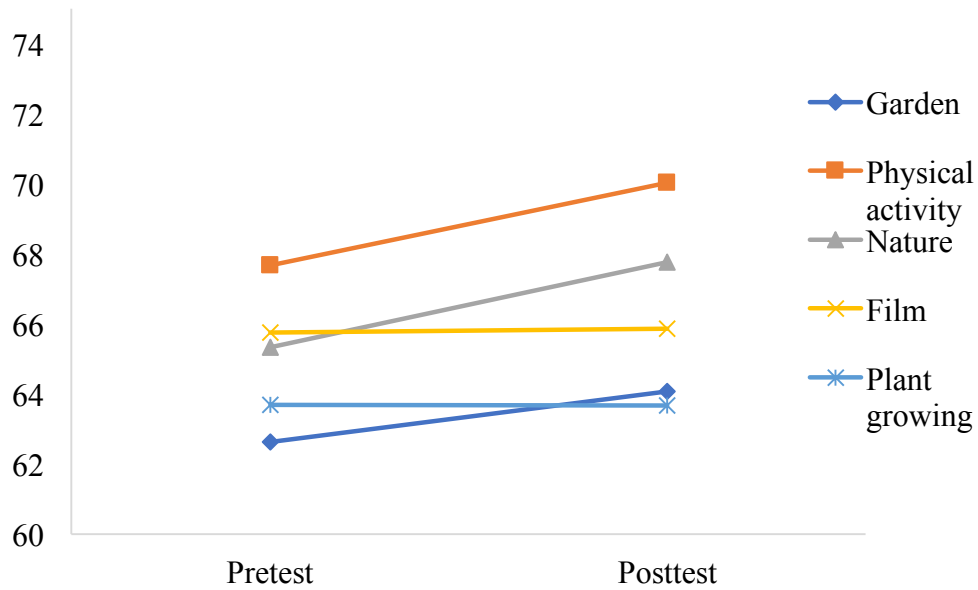


Figure 2. Conscientiousness (composite) at Time 1 (pretest) and Time 3 (posttest) by experimental group.

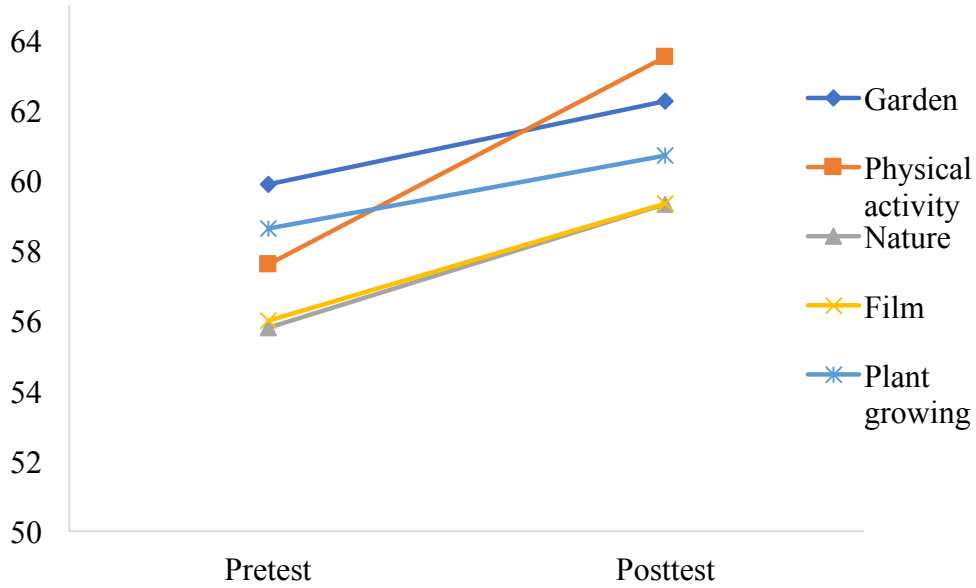


Figure 3. Social relationships (composite) at Time 1 (pretest) and Time 3 (posttest) by experimental group.

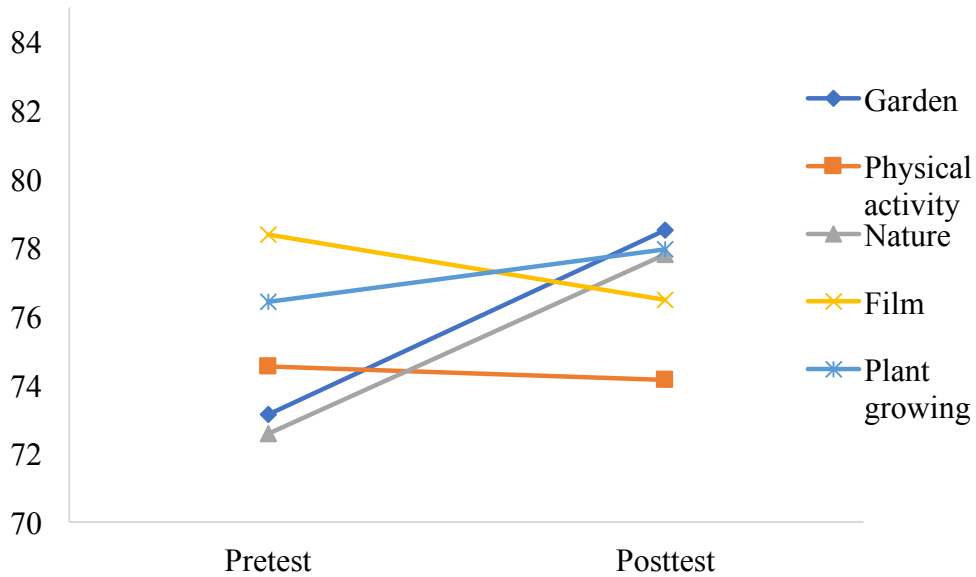


Figure 4. Environmental identity (composite) at Time 1 (pretest) and Time 3 (posttest) by experimental group.

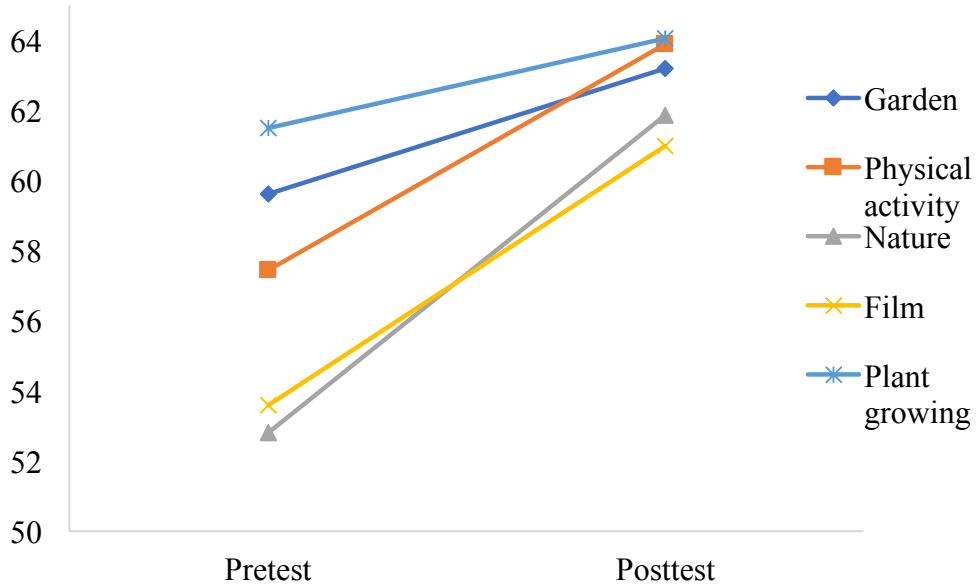


Figure 5. Self-reported health (composite) at Time 1 (pretest) and Time 3 (posttest) by experimental group.

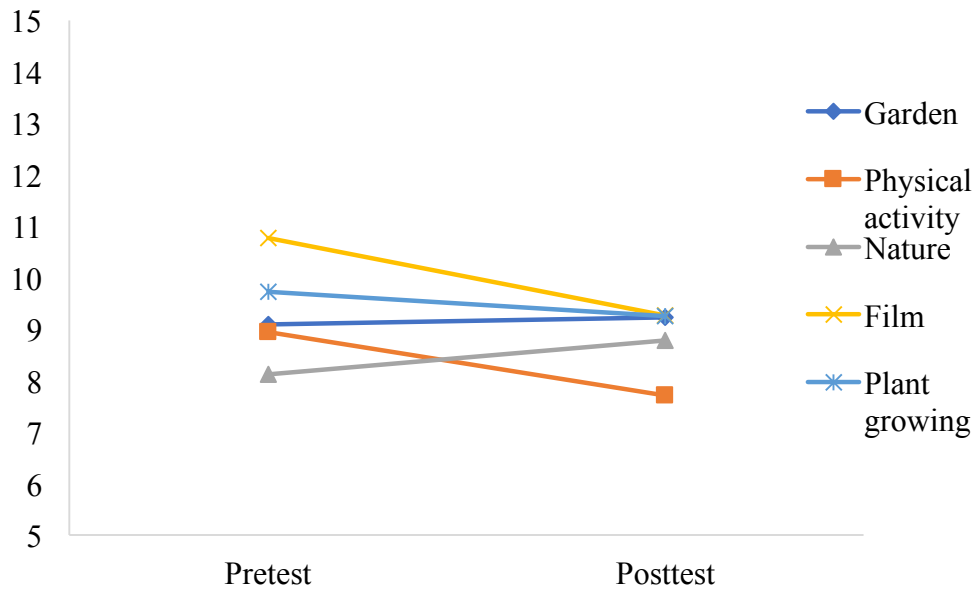


Figure 6. Sleepiness at Time 1 (pretest) and Time 3 (posttest) by experimental group.

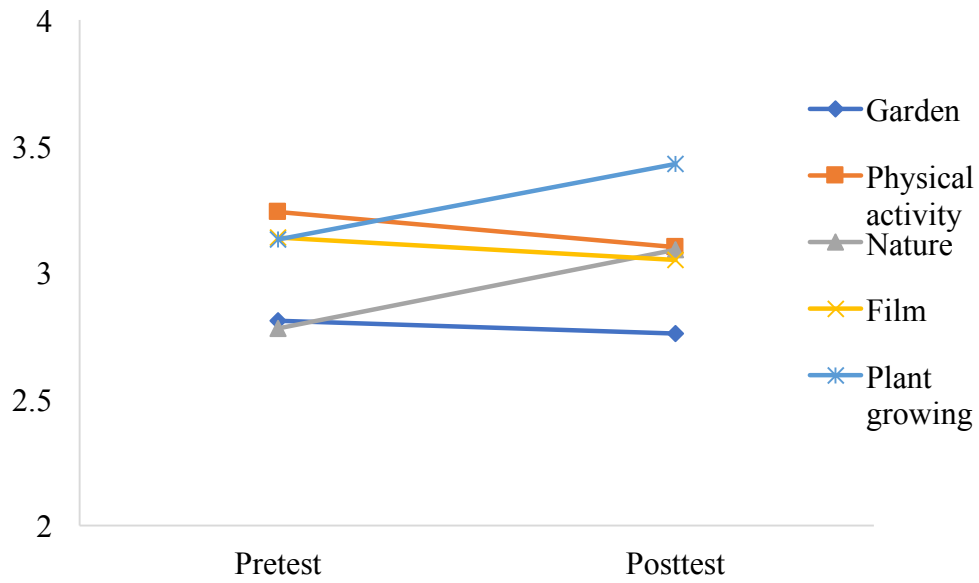


Figure 7. Physical activity at Time 1 (pretest) and Time 3 (posttest) by experimental group.

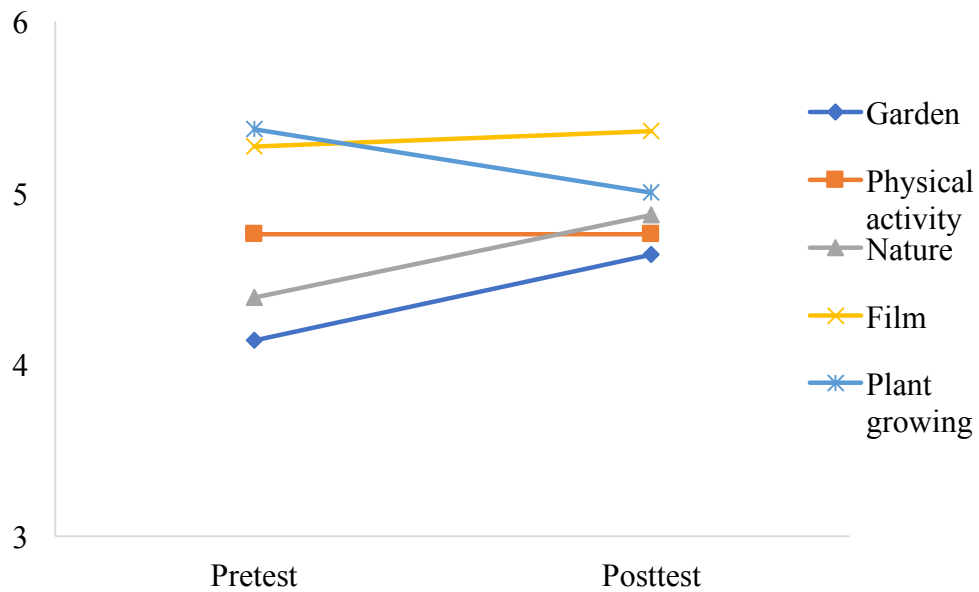


Figure 8. Produce consumption at Time 1 (pretest) and Time 3 (posttest) by experimental group.

Comparing Group Change from Time 1 to Time 3: Contrasts

To further examine the omnibus ANOVAs, I conducted planned contrasts following steps outlined by Rosenthal, Rosnow, and Rubin (2000) and Furr and Rosenthal, (2003). That is, one-sample *t*-tests were conducted using *L* scores to test whether the data fit a specific hypothesis. An *L* score is calculated by multiplying each individual's score (e.g., Time 1 score and Time 3 score) by the respective assigned lambda weights that reflect a specific prediction. I predicted a positive, linear increase (assigned lambda weights: -1, 1) from Time 1 to Time 3. Thus, to calculate *L* scores I multiplied Time 1 and Time 3 scores for each individual by -1 and 1, and summed the two products. The *L* score reflects the degree to which a participant exhibits the expected pattern of results.

I then calculated *r* scores to understand how well the data as a whole fit the predicted trend, as well as how well each group fit the hypothesized trend (Table 5). An *r* score is the correlation between an individual's data and the lambda weights. Similar to *L* scores, *r* scores signify the degree to which the data fit a theory, though *r* scores are more sensitive to the agreement in the patterning of scores as opposed to the absolute value of scores. Individual *r* scores were averaged by group and also as a full sample to identify the degree to which each group and the full sample fit the theorized pattern of change.

I then tested three sets of contrasts for how well each group fit the hypothesized positive, linear trend. The first contrast (theorized a priori) tested whether the garden group fit the hypothesized (positive, linear) trend better than all of the comparison groups (4, -1, -1, -1, -1). The second contrast (theorized a priori) tested whether the garden group

and a specific hypothesized comparison group fit the hypothesized trend better than the other comparison groups (1.5, 1.5, -1, -1, -1). The third prediction was developed after considering the data; lambda weights were assigned to groups based on L scores and r scores and varied depending on the variable of interest. Because the third set of contrasts was not theorized a priori, alpha levels were adjusted using the Bonferroni procedure. Six of the eight variables were tested in the third set of contrasts (for two of the variables, the assigned lambda weights would have been identical to the first or second set of contrasts). Thus, the adjusted alpha level for the third set of contrasts based on a family of six statistical tests was $\alpha = 0.008$. All reported p -levels for contrasts reported below are one-tailed unless otherwise specified. A summary of contrast tests reported below can be found in Table 6.

Table 5

Average Group r Scores for Positive Change Pre- to Posttest Theory

Measure/Composite	Garden	Physical activity	Nature	Film	Plant growing	All groups
Emotional well-being	0.71	0.33	0.48	0.27	0.48	0.45
Conscientiousness	0.05	0.24	0.22	-0.18	0.00	0.06
Environmental identity	0.52	0.05	0.48	0.00	0.30	0.27
Social relationships	0.52	0.71	0.22	0.36	0.09	0.37
Self-reported health	-0.05	0.52	0.13	0.14	0.00	0.15
Sleepiness ^a	-0.19	0.43	-0.09	0.23	0.00	0.07
Physical activity	0.10	0.05	0.17	-0.09	0.17	0.08
Produce consumption	0.29	0.29	0.22	0.14	-0.13	0.15

Note. r scores are the correlation between lambda weights and a participant's raw scores. Lambda weights used to test positive change from pre- to posttest were -1 and 1.

^aSleepiness r scores are calculated using a negative change (-1,1) theory, such that better fitting r scores indicate decreasing sleepiness over time.

Table 6

Results For $t_{contrast}$, Testing Group Differences in Positive, Linear Change Theory Fit from Time 1 to Time 3 (-1, 1 Lambda Weights)

Composite/Scale	Lambda weights used (Garden, Nature, Film, Plant, Physical Activity)	$t(105)$	p -value	$r_{contrast}$
Emotional well-being				
<i>Contrast 1</i>	4, -1, -1, -1, -1	-0.40	0.69 [†]	0.04
<i>Contrast 2</i>	1.5, -1, -1, 1.5, -1	-0.76	0.45 [†]	0.07
<i>Contrast 3^a</i>	1, 1, -1.5, 1, -1.5	0.24	0.40	0.02
Conscientiousness/productivity				
<i>Contrast 1</i>	4, -1, -1, -1, -1	0.15	0.44	0.01
<i>Contrast 2</i>	1.5, -1, -1, 1.5, -1	-0.79	0.43 [†]	0.08
<i>Contrast 3</i>	1, 1, -1.5, -1.5, 1	1.73	0.04	0.17
Social relationships				
<i>Contrast 1</i>	4, -1, -1, -1, -1	-0.31	0.76 [†]	0.03
<i>Contrast 2</i>	1.5, -1, 1.5, -1, -1	-0.17	0.86 [†]	0.02
<i>Contrast 3</i>	-1, -1, -1, -1, 4	0.71	0.24	0.07
Environmental identity				
<i>Contrast 1</i>	4, -1, -1, -1, -1	1.09	0.14	0.10
<i>Contrast 2</i>	1.5, 1.5, -1, -1, -1	1.07	0.14	0.10
<i>Contrast 3</i>	--	--	--	--
Self-reported health				
<i>Contrast 1</i>	4, -1, -1, -1, -1	-0.23	0.82 [†]	0.02
<i>Contrast 2</i>	1.5, -1, -1, -1, 1.5	-0.08	0.94 [†]	0.01
<i>Contrast 3</i>	-1.5, 1, 1, -1.5, 1	0.29	0.39	0.03
Sleepiness^b				
<i>Contrast 1</i>	4, -1, -1, -1, -1	-1.87	0.06 [†]	0.18
<i>Contrast 2</i>	1.5, -1, -1, -1, 1.5	0.19	0.42	0.02
<i>Contrast 3</i>	-1, -1, -1, 1.5, 1.5	2.64	0.005**	0.25
Physical activity				
<i>Contrast 1</i>	4, -1, -1, -1, -1	-3.89	0.002** [†]	0.36
<i>Contrast 2</i>	1.5, -1, -1, -1, 1.5	-5.53	<0.001** [†]	0.47
<i>Contrast 3</i>	-1, 1.5, -1, 1.5, -1	8.22	<0.001**	0.62
Produce consumption				
<i>Contrast 1</i>	4, -1, -1, -1, -1	1.35	0.09	0.13
<i>Contrast 2</i>	1.5, -1, -1, -1, 1.5	0.48	0.32	0.05
<i>Contrast 3</i>	--	--	--	--

Note. All $t_{contrasts}$ are one-tailed.

[†]Two-tailed tests.

^aBecause Contrast 3 weights were developed post hoc, alpha levels are adjusted using the Bonferroni method. For Contrast 3, $\alpha = 0.008$. ^bThe contrast for sleepiness tested for fit with a linear, decreasing trend (-1, 1), such that better fit indicates decreasing sleepiness over time.

* $p < 0.05$. ** $p < 0.01$.

Emotional well-being: Contrasts.

Across all groups, the average r score was 0.45. The Garden (0.71), Plant (0.48), Nature (0.48), Activity (0.33), and Film (0.27) groups all fit the hypothesized positive time trend.

There was no evidence for the first hypothesis, that the Garden group would better fit the positive linear trend compared with the other groups, $t(105) = -0.40$, $p = 0.69$ (two-tailed), $r_{\text{contrast}} = 0.04$.

For emotional well-being, I hypothesized that the Plant group would better fit the hypothesized trend compared with the other comparison groups. The t-contrast did not support this hypothesis, $t(105) = -0.76$, $p = 0.45$ (two-tailed), $r_{\text{contrast}} = 0.07$.

Using the r scores as a guide, I assigned the following weights for the third contrast: Garden (1), Nature (1), Film (-1.5), Plant (1), Activity (-1.5). The t-contrast did not support this hypothesis, $t(105) = 0.24$, $p = 0.40$, $r_{\text{contrast}} = 0.02$.

Conscientiousness: Contrasts.

Across all groups, the average r score was 0.06. The Activity (0.24), Garden (0.05), and Nature (0.22), groups fit the hypothesized pattern, but the Film (-0.19) and Plant (0.00) groups did not.

There was no support for the first hypothesis, that the Garden group would better fit the positive, linear trend compared with the other groups $t(105) = 0.15$, $p = 0.44$, $r_{\text{contrast}} = 0.01$.

For conscientiousness, I hypothesized that the Plant group would better fit the hypothesized trend compared with the other comparison groups. There was no support for this hypothesis, $t(105) = -0.79$, $p = 0.43$ (two-tailed), $r_{\text{contrast}} = 0.08$.

Using the r scores as a guide, I assigned the following weights for the third contrast: Garden (1), Nature (1), Film (-1.5), Plant (-1.5), Activity (1). There was no support for this hypothesis at the adjusted alpha level of 0.008, $t(105) = 1.73$, $p = 0.04$, $r_{\text{contrast}} = 0.17$.

Social relationships: Contrasts.

Across all groups, the average r score for social relationships was 0.37. All groups positively fit the theorized trend, with the Physical Activity group having the strongest correlation (0.71), followed by the Garden group (0.52), the Film group (0.36), the Nature group (0.22), and the Plant group (0.09).

There was no support for the first hypothesis, that the Garden group would better fit the positive, linear trend compared with the other groups, $t(105) = -0.31$, $p = 0.76$ (two-tailed), $r_{\text{contrast}} = 0.03$.

For social relationships, I hypothesized that the Film group would better fit the hypothesized trend compared with the other comparison groups. There was no support for this theory, $t(105) = -0.17$, $p = 0.86$ (two-tailed), $r_{\text{contrast}} = 0.02$.

Using the r scores as a guide, I assigned the following weights for the third contrast: Garden (-1), Nature (-1), Film (-1), Plant (-1), Activity (4). The significance test did not support this trend, $t(105) = 0.71$, $p = 0.24$, $r_{\text{contrast}} = 0.07$.

Environmental identity: Contrasts.

Across all groups, the average r score for environmental identity was 0.27. The Garden (0.52), Nature (0.48), Plant (0.30), and Activity (0.05) conditions fit the hypothesized trend. The Film group did not fit the theory of positive, linear change (0.00).

There was trending support for the first hypothesis, that the Garden group would better fit the positive, linear trend compared with the other groups $t(105) = 1.09, p = 0.14, r_{\text{contrast}} = 0.10$.

For environmental identity, I hypothesized that the Nature group would better fit the hypothesized trend compared with the other comparison groups. There was trending support for this theory, $t(105) = 1.07, p = 0.14, r_{\text{contrast}} = 0.10$.

I did not test a third contrast for environmental identity; using the r scores as a guide, the two predictions already tested seem to be the best fitting theories.

Self-reported health: Contrasts.

Across all groups, the average r score for self-reported health was 0.15. The Physical Activity (0.52), Film (0.14), and Nature (0.13), groups all fit the theorized trend. Neither the Plant (0.00) nor the Garden (-0.05) conditions fit the theorized trend.

There was no support for the first hypothesis, that the Garden group would better fit the positive, linear trend compared with the other groups, $t(105) = -0.23, p = 0.82$ (two-tailed), $r_{\text{contrast}} = 0.02$.

For self-reported health, I hypothesized that the Physical Activity group would better fit the hypothesized trend compared with the other comparison groups. There was no support for this theory, $t(105) = -0.08$, $p = 0.94$ (two-tailed), $r_{\text{contrast}} = 0.01$.

Using the r scores as a guide, I assigned the following weights for the third contrast: Garden (-1.5), Nature (1), Film (1), Plant (-1.5), Activity (1). The significance test did not support this trend, $t(105) = 0.29$, $p = 0.39$, $r_{\text{contrast}} = 0.03$.

Sleepiness: Contrasts.

Because lower sleepiness is better, 1 and -1 (instead of -1 and 1) were used as the pre/post lambda weights. Therefore, the r scores reported here indicate how well groups fit the theory of *decreasing* sleepiness over time, and the contrasts test whether groups differ in whether they fit the prediction of decreasing (as opposed to increasing) sleepiness over time.

Across all groups, the average r score for sleepiness was 0.07. The Activity (0.43) and Film (0.23) groups fit the hypothesized trend. The Garden (-0.19), Nature (-0.09), and Plant (0.00) groups did not.

There was trending support in the opposite than predicted direction for the first hypothesis, that the Garden group would better fit the negative, linear trend compared with the other groups, $t(105) = -1.87$, $p = 0.06$ (two-tailed), $r_{\text{contrast}} = 0.18$.

For sleepiness, I hypothesized that the Physical Activity group would better fit the hypothesized trend compared with the other comparison groups. There was no support for this hypothesis, $t(105) = 0.19$, $p = 0.42$, $r_{\text{contrast}} = 0.02$.

Using the r scores as a guide, I assigned the following weights for the third contrast: Garden (-1), Nature (-1), Film (-1), Plant (1.5), Activity (1.5). There was support for this trend, $t(105) = 2.64, p = 0.005, r_{\text{contrast}} = 0.25$.

Physical activity: Contrasts.

Across all groups, the average r score for physical activity was 0.08. The Nature (0.17), Plant (0.17), Garden (0.10), and Activity (0.05) groups all fit the hypothesized positive, linear trend. The Film condition did not fit the hypothesized trend (-0.09).

There was support in the opposite than predicted direction for the first hypothesis, that the Garden group would better fit the positive linear trend compared with other groups, $t(105) = -3.89, p = 0.002$ (two-tailed), $r_{\text{contrast}} = 0.36$.

For physical activity, I hypothesized that the Physical Activity group would better fit the hypothesized trend compared with the other comparison groups. There was support in the opposite than predicted direction for this theory, $t(105) = -5.53, p < 0.0001$ (two-tailed), $r_{\text{contrast}} = 0.47$.

Using the r scores as a guide, I assigned the following weights for the third contrast: Garden (-1), Nature (1.5), Film (-1), Plant (1.5), Activity (-1). There was support for this trend, $t(105) = 8.22, p < 0.0001, r_{\text{contrast}} = 0.62$.

Produce consumption: Contrasts.

Across all groups, the average r score for produce consumption was 0.15. The Garden (0.29), Activity (0.29), Nature (0.22), and Film (0.14) groups all fit the hypothesized trend. The Plant condition did not fit the theorized trend (-0.13).

There was trending support for the first hypothesis, that the Garden group would better fit the positive linear trend compared with other groups, $t(105) = 1.35, p = 0.09$. $r_{\text{contrast}} = 0.13$.

For produce consumption, I hypothesized that the Physical Activity group would better fit the hypothesized trend compared with the other comparison groups. There was no support for this theory, $t(105) = 0.48, p = 0.32, r_{\text{contrast}} = 0.05$.

I did not test a third contrast for produce consumption; using the r scores as a guide, the two theories tested seemed to be the best fitting theories.

Summary of contrasts for two time points.

There was differential group fit of the positive, linear change theory for sleepiness and for physical activity. For sleepiness, the theory that the Garden group best fit the theory of decreasing sleepiness over time was trending significance in the opposite direction than predicted. The post-hoc theory that the Plant Growing and Physical Activity groups would best fit a theory of decreasing sleepiness over time was statistically significant in the predicted direction.

For physical activity, the prediction that the Garden group best fit the theory of increasing physical activity over time was statistically significant in the opposite than predicted direction. The prediction that the Garden and Physical Activity groups would best fit the theorized time trend were also statistically significant in the opposite than predicted direction. The post-hoc theory that the Plant Growing and Nature Exposure groups would best fit the time trend theory was statistically significant. No other tested interaction contrasts were statistically significant.

Comparing Group Change Across Four Time Points

As previously noted, in addition to Pretest (Time 1) and Posttest (Time 3), there were assessments midway through the intervention (Time 2) and three weeks after intervention completion (Time 4). That is, subset of variables was measured at four time points, allowing a deeper understanding of how experimental groups changed over time. Nine variables were measured at all four time points (Time 1: Pretest, Time 2: Mid-Intervention, Time 3: Posttest, and Time 4: Follow-up): mental health using the Global Health Short Form, subjective happiness, self-efficacy, negative affect, positive affect, companionship, sleepiness, physical activity using the LCAT, and connectedness to nature. Two individual items from the Global Health Short Form were also measured at all four time points: “In general, how would you rate your physical health?” (item 3); and “To what extent are you able to carry out your everyday physical activities such as walking, climbing stairs, carrying groceries, or moving a chair?” (item 6). Finally, two individual items from the Fatigue Short Form were measured at all four time points: “In the past 7 days, how run-down did you feel on average? (item 3); and, “In the past 7 days, how fatigued were you on average?” (item 4).

Description of participant subsample.

A total of 78 participants completed full measures at all four time points. The demographic breakdown for the subsample is 42.3% Hispanic, 32.1% Asian American, 14.1% White, 3.8% Black, and 7.7% other. The majority of participants who completed all four time points were undergraduate students (91%), and female (71.8%), with a mean age of 20.96 ($SD = 3.78$).

Compared with participants who did not complete all four time points, participants who completed all four time points scored higher on the Conscientiousness Composite at Time 1, $t(136) = -2.44, p = 0.02$. There was no differential drop out by experimental group, student status, ethnicity, or gender.

Forming composites.

Due to the wide range of related variables measured, composites were formed analogously to what was done in the pretest/posttest analyses reported above. All baseline scales that were measured at all four time points, with the exception of physical activity and sleepiness, were entered into a factor analysis. Upon reviewing the unrestricted, promax rotated solution, two variables were considered to be theoretically distinct from the two clear composites that emerged, and were removed from the factor analysis and analyzed separately: the Connectedness to Nature scale and the Companionship scale (PROMIS adult Companionship). After removing these variables from the factor analysis and restricting the factor analysis to a two-item solution, the new composites accounted for 54.76% of the variance. Reliability analyses (reported below) confirmed acceptable reliability of the resulting composite scales. See Table 7 for correlations among composites and individually analyzed variables.

Table 7

Correlations Among Composites and Variables Measured at Four Time Points

Composite/Variable	1	2	3	4	5
Mental Health Composite (1)	--				
Physical Health Composite (2)	0.51**	--			
Companionship (3)	0.24*	0.17	--		
Physical Activity (4)	0.24*	0.39**	-0.09	--	
Sleepiness (5)	-0.43**	-0.38**	0.04	-0.07	--
Connectedness to Nature (6)	0.05	-0.12	-0.20	0.26*	-0.23*

Note. Correlations are composites or scales of baseline, using scores only from participants who completed all four time points.

†Two-tailed *p* value.

p* < 0.05 (one-tailed). *p* < 0.01 (one-tailed).

Composite 1: Mental health.

Five scales were combined to create the mental health composite (alpha range for different time points = 0.93–0.95): subjective happiness, self-efficacy, negative affect (reverse-scored), positive affect, and global mental health. Two items about fatigue were also loaded highly onto this factor, but were instead used in the physical health composite to correspond more closely with the composites developed for Pretest/Posttest analyses.

Composite 2: Physical health.

Five items were combined to create the physical health composite (alpha range for different time points = 0.74–0.82): Items 1, 3, and 9 from the Global Health Short Form, and items 3 and 4 from the Fatigue Short Form (reverse-scored).

Combining scales.

Again, to enhance interpretability, all scales and items on which higher scores indicate worse functioning (e.g., fatigue, negative affect) were reverse scored. The proportion of maximum scaling (POMS) method was used to bring variables with

different response scales to the same metric (Moeller, 2015), putting all variables on a common 0-100 scale. After a POMS score was calculated for each scale or item to be used in a composite score, an average was calculated. This resulted in each composite having a possible range of 0-100, with higher scores reflecting better functioning in that domain.

Individual scales analyzed.

In addition to the mental health and physical health composites, changes in companionship, physical activity, sleepiness, and connectedness to nature across the four time points were analyzed. No other variables were measured at all four time points.

Comparing group change across four time points: Analytical approach.

To assess how groups changed over the four time points, I employed a combination of omnibus mixed model ANOVAs, contrasts, one-way ANOVAs, and post hoc analyses. First I conducted 4 (time) x 5 (group) ANOVAs to provide an overall sense of whether groups changed over time, and whether changes varied by experimental group. Post-hoc contrast analyses were used to understand where the differences lie.

Focused contrast analyses were then used to further tease apart the omnibus 4x5 ANOVAs. Before seeing the data, I theorized three possible patterns of change across the time points and assigned lambda weights based on those theories: positive, linear change (-3, -1, 1, 3); positive, linear change that regresses at follow-up (-1, 0, 1, 0); and delayed positive change that regresses at follow-up (-1, -1, 2, 0). *L* scores for all measures for each of the theories were calculated using the methods previously described. Because I had no theory about how groups would differentially change over the four time points, I

conducted a one-way ANOVA on L scores to uncover whether there were group differences in time trends. A non-significant one-way ANOVA signifies that there were no between group differences in how well (or poorly) the groups fit the specific time trend. A significant one-way ANOVA signifies that there were statistically significant between group differences in how well (or poorly) the groups fit the specific time trend.

If the one-way ANOVA was not statistically significant, I conducted a t_{contrast} to test how well the data fit the specific theory of change, regardless of condition (as the one-way ANOVA signified that there were no between group differences). Because the theories were not orthogonal (i.e., predictions were related) it is possible for multiple theories to fit the data.

Comparing group change across four time points: 4x5 ANOVAs.

Means and standard deviations for each time point for each variable or composite analyzed in a 4x5 ANOVA can be seen in Table 8. Omnibus 4x5 tests are reported below and in Table 9. When Mauchly's sphericity test was significant (a problem of unequal variances in repeated-measures ANOVAs), the Greenhouse-Geisser adjustment to degrees of freedom was used.

Table 8

Means and Standard Deviations for Composites and Variables Measured at Four Time Points

Measure	Range	Time 1 <i>M (SD)</i>	Time 2 <i>M (SD)</i>	<i>M</i>	Time 3 <i>M (SD)</i>	Time 4 <i>M (SD)</i>
Mental health composite	0-100	56.41 (12.66)	58.14 (13.51)		60.66 (13.60)	62.36 (12.62)
Physical health composite	0-100	57.95 (15.11)	58.72 (15.55)		65.19 (16.82)	65.32 (16.58)
Companionship	1-5	3.90 (0.90)	3.89 (0.92)		4.08 (0.82)	4.01 (0.83)
Physical activity	1-6	3.01 (1.42)	2.95 (1.30)		3.13 (1.26)	2.74 (1.40)
Sleepiness	0-24	8.56 (4.23)	8.31 (3.66)		8.15 (4.27)	6.99 (4.26)
Connectedness to nature	1-7	4.32 (1.34)	4.18 (1.68)		4.74 (1.35)	4.14 (1.58)

Note. Means and standard deviations are derived using scores from participants who completed measured at all four time points.

Table 9

4 (Time) x 5 (Group) ANOVA Results

Composite/Scale	<i>df</i>	<i>F</i>	<i>p</i> -value	η^2_p
Mental health composite				
<i>Effect of time</i>	3,219	13.92	<0.001**	0.16
<i>Time x Condition</i>	12,219	1.09	0.37	0.06
Physical health composite				
<i>Effect of time</i>	3,219	10.79	<0.001**	0.13
<i>Time x Condition</i>	12,219	0.88	0.57	0.05
Companionship				
<i>Effect of time</i>	2.63,191.79	3.73	0.01*	0.05
<i>Time x Condition</i>	10.51,191.79	0.98	0.46	0.05
Physical activity				
<i>Effect of time</i>	3,219	2.18	0.09	0.03
<i>Time x Condition</i>	12,219	1.12	0.34	0.06
Sleepiness				
<i>Effect of time</i>	2.53, 184.54	6.65	0.001**	0.08
<i>Time x Condition</i>	10.11,184.54	0.95	0.49	0.05
Connectedness to nature				
<i>Effect of time</i>	2.55, 186.39	6.26	0.001**	0.08
<i>Time x Condition</i>	10.21, 186.39	1.42	0.17	0.07

p* < 0.05. *p* < 0.01.

Mental health: 4x5 ANOVA.

There was a significant effect of time on mental health, $F(3,219) = 13.92, p < 0.001, \eta^2_p = 0.16$, such that there was a significant increase in mental health between at least two time points, see Figure 9. Follow-up contrast analyses suggest the difference lies between Time 2 and Time 3, such that participants, regardless of group, increased in mental health from Time 2 to Time 3, $F(1,73) = 5.51, p = 0.02, \eta^2_p = 0.07$. There was a trending increase from Time 3 to Time 4 as well, $F(1,73) = 3.90, p = 0.05, \eta^2_p = 0.05$. There was no significant interaction between time and group, $F(12,219) = 1.09, p = 0.37, \eta^2_p = 0.06$.

Physical health: 4x5 ANOVA.

There was a significant effect of time on physical health, $F(3,219) = 10.79, p < 0.001, \eta^2_p = 0.13$, such that there was a significant increase in physical health between at least two time points, see Figure 10. Follow-up contrast analyses suggest that, regardless of group, participants increased in physical health from Time 2 to Time 3, $F(1,73) = 18.81, p < 0.001, \eta^2_p = 0.20$. There was no significant interaction between time and group, $F(12,219) = 0.88, p = 0.57, \eta^2_p = 0.05$.

Companionship: 4x5 ANOVA.

There was a significant effect of time on companionship, $F(2.63,191.79) = 3.73, p = 0.01, \eta^2_p = 0.05$, such that there was a significant increase in companionship between at least two time points, see Figure 11. Follow-up contrast analyses suggest the difference lies between Time 2 and Time 3, such that participants, regardless of group, increased in companionship from Time 2 to Time 3, $F(1,73) = 11.90, p = 0.001, \eta^2_p = 0.14$. There

was no significant interaction between time and group, $F(10.51,191.79) = 0.98$, $p = 0.46$, $\eta^2_p = 0.05$.

Physical activity: 4x5 ANOVA.

There was no significant effect of time on physical activity, $F(3,219) = 2.18$, $p = 0.09$, $\eta^2_p = 0.03$, see Figure 12. There was also no significant interaction between time and group, $F(12,219) = 1.12$, $p = 0.34$, $\eta^2_p = 0.06$.

Sleepiness: 4x5 ANOVA.

There was a significant effect of time on sleepiness, $F(2.53,184.54) = 6.65$, $p = 0.001$, $\eta^2_p = 0.08$, such that there was a decrease in sleepiness between at least two time points, see Figure 13. Follow-up contrast analyses suggest the difference lies between Time 3 and Time 4, such that participants, regardless of group, decreased in sleepiness from Time 3 to Time 4, $F(1,73) = 11.26$, $p = 0.001$, $\eta^2_p = 0.13$. There was no significant interaction between time and group, $F(10.11,184.54) = 0.95$, $p = 0.49$, $\eta^2_p = 0.05$.

Connectedness to nature: 4x5 ANOVA.

There was a significant effect of time on connectedness to nature, $F(2.55,186.39) = 6.26$, $p = 0.001$, $\eta^2_p = 0.08$, such that there was a change in connectedness to nature between at least two time points, see Figure 14. Follow-up contrast analyses suggest that participants, regardless of group, increased in connectedness to nature between Time 2 and Time 3 $F(1,73) = 17.82$, $p < 0.001$, $\eta^2_p = 0.20$, and decreased between Time 3 and Time 4, $F(1,73) = 23.70$, $p < 0.001$, $\eta^2_p = 0.24$. There was no significant interaction between group and time, $F(10.21,186.39) = 1.42$, $p = 0.17$, $\eta^2_p = 0.07$.

Summary of 4x5 ANOVAs.

Regardless of condition, participants reported a statistically significant change between at least two time points for mental health, physical health, companionship, sleepiness, and connectedness to nature. Participants increased in mental health from Time 2 to Time 3; increased in physical health from Time 2 to Time 3; increased in companionship from Time 2 to Time 3; decreased in sleepiness from Time 3 to Time 4; and increased in connectedness to nature from Time 2 to Time 3, and decreased from Time 3 to Time 4. There was no effect of time on physical activity, nor were there any group by time interaction effects for any of the composites or variables tested.

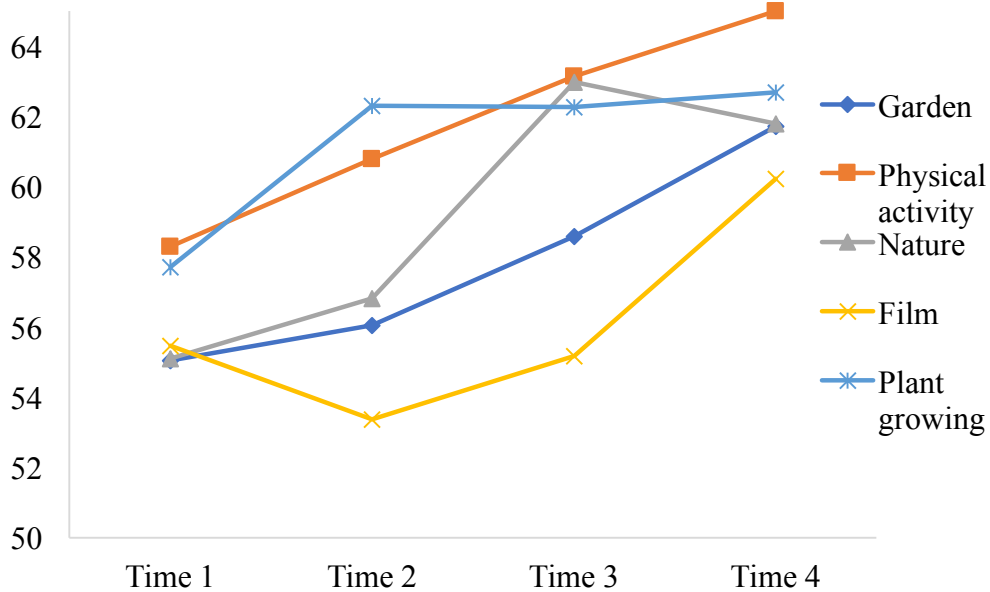


Figure 9. Mental health (composite) scores by experimental group at all four time points.

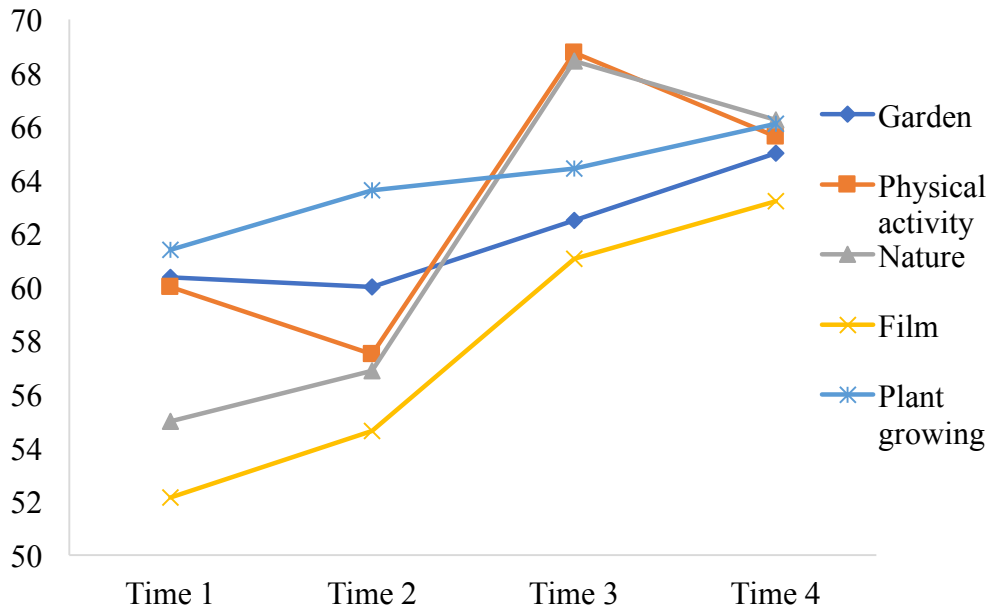


Figure 10. Physical health (composite) scores by experimental group at all four time points.

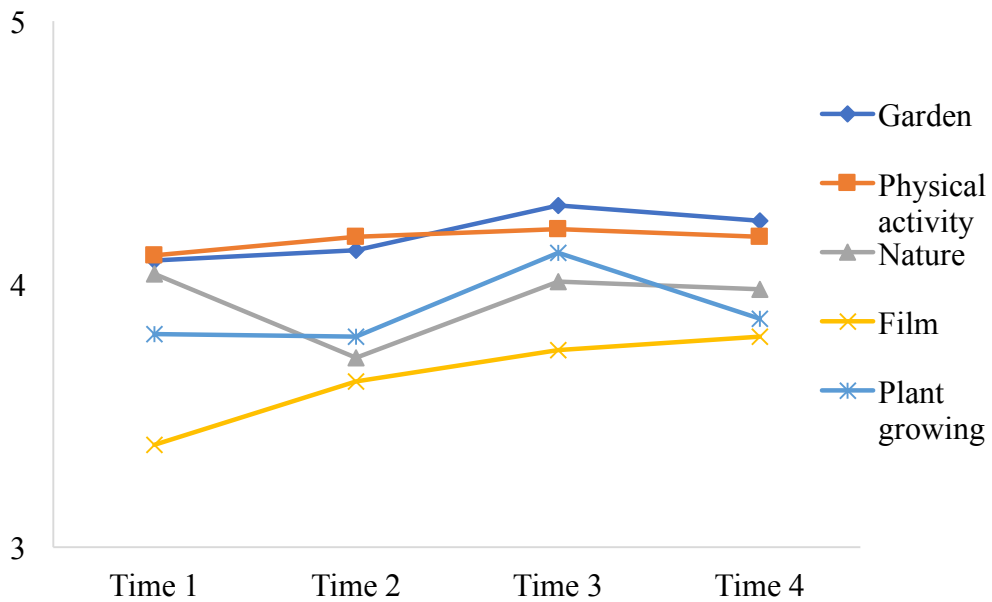


Figure 11. Companionship scores by experimental group at all four time points.

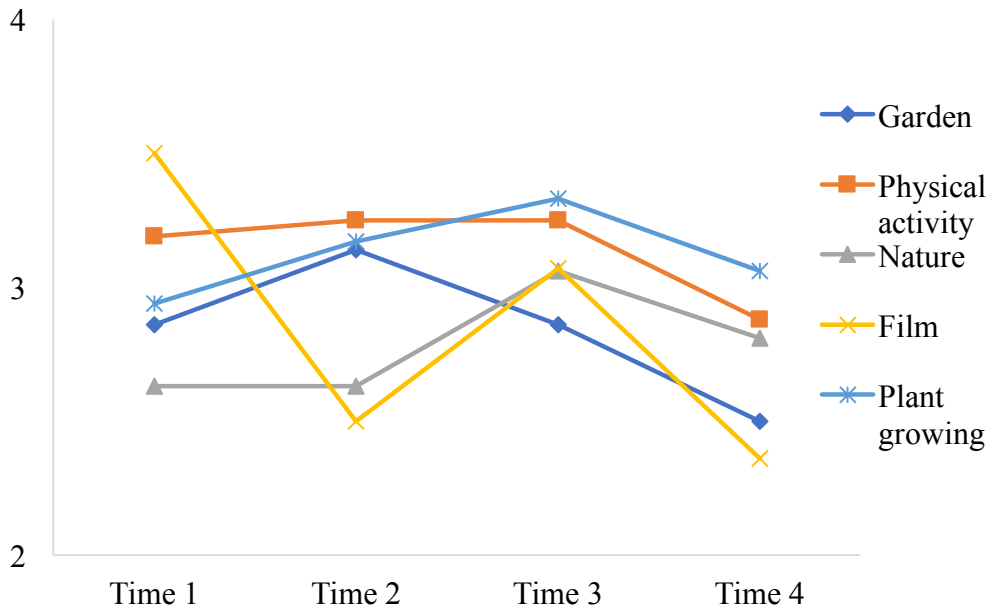


Figure 12. Physical activity scores by experimental group at all four time points.

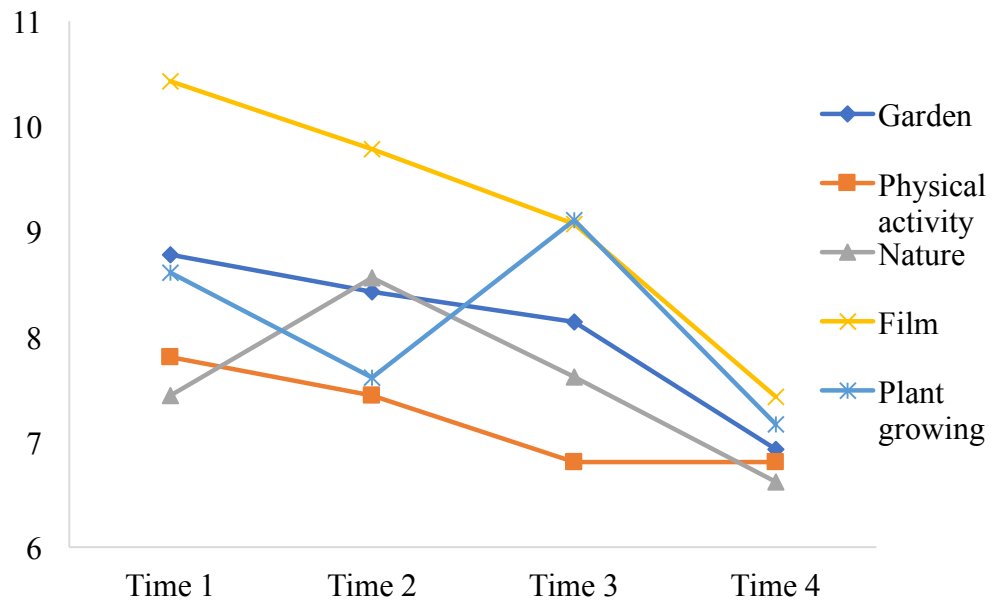


Figure 13. Sleepiness scores by experimental group at all four time points.

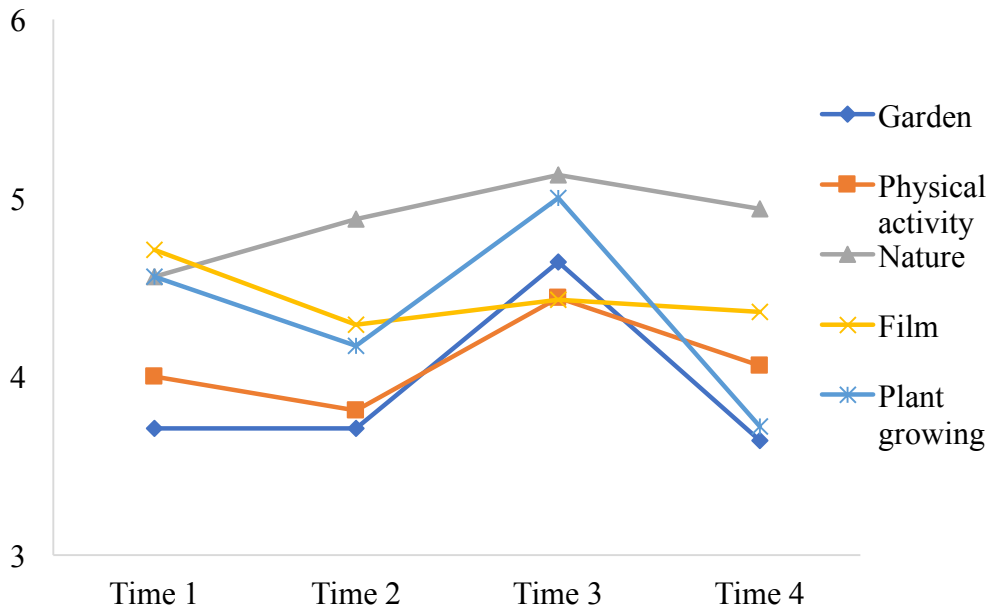


Figure 14. Connectedness to nature scores by experimental group at all four time points.

Comparing group change across four time points: Contrasts.

Three theories of change were assessed by assigning lambda weights that reflect the theories. I tested a positive, linear change trend (-3, -1, 1, 3); a positive, linear change trend that regresses at follow-up (-1, 0, 1, 0); and a delayed positive change trend that regresses at follow-up (-1, -1, 2, 0). L scores were calculated by multiplying each score by the appropriate lambda weight, and summing the result. One-way ANOVAs were then calculated using the L scores to assess whether there were group differences in theory fit. If there were no statistically significant differences between groups in theory fit, a t_{contrast} was employed to test how well the data (regardless of experimental group) fit the specific theory of change. Again, because the predictions were related (not orthogonal) it is

possible for multiple theories to fit the data. Because all contrasts considered were theorized a priori, no adjustments to the alpha level were made. Contrast results can be found in Table 10, and average r scores (the average of correlations between an individual's scores and a theory as reflected by lambda weights) broken down by group and outcome is reflected in Table 11.

Table 10

Contrasts on Composites and Variables at Four Time Points

Composite/Scale	Lambda weights used (Time 1, Time 2, Time3, Time 4)	$t(77)$	p -value	r_{contrast}
Mental health composite				
<i>Contrast 1</i>	-3, -1, 1, 3	5.91	<0.001**	0.56
<i>Contrast 2</i>	-1, 0, 1, 0	3.99	<0.001**	0.41
<i>Contrast 3</i>	-1, -1, 2, 0	3.48	<0.001**	0.37
Physical health composite				
<i>Contrast 1</i>	-3, -1, 1, 3	4.65	<0.001**	0.47
<i>Contrast 2</i>	-1, 0, 1, 0	4.10	<0.001**	0.42
<i>Contrast 3</i>	-1, -1, 2, 0	4.72	<0.001**	0.47
Companionship				
<i>Contrast 1</i>	-3, -1, 1, 3	2.13	0.02*	0.24
<i>Contrast 2</i>	-1, 0, 1, 0	2.88	0.002**	0.31
<i>Contrast 3</i>	-1, -1, 2, 0	4.08	<0.001**	0.42
Physical activity				
<i>Contrast 1</i>	-3, -1, 1, 3	-1.08	0.28 [†]	0.12
<i>Contrast 2</i>	-1, 0, 1, 0	0.71	0.24	0.08
<i>Contrast 3</i>	-1, -1, 2, 0	1.13	0.13	0.13
Sleepiness				
<i>Contrast 1</i>	3, 1, -1, -3	3.16	0.001**	0.34
<i>Contrast 2</i>	1, 0, -1, 0	1.05	0.15	0.12
<i>Contrast 3</i>	1, 1, -2, 0	0.82	0.21	0.09
Connectedness to nature				
<i>Contrast 1</i>	-3, -1, 1, 3	0.05	0.48	0.005
<i>Contrast 2</i>	-1, 0, 1, 0	2.82	0.003**	0.31
<i>Contrast 3</i>	-1, -1, 2, 0	4.50	<0.001**	0.46

Note. All $t_{\text{contrasts}}$ are one-tailed.

[†]Two-tailed test.

* $p < 0.05$. ** $p < 0.01$.

Table 11

Average r Scores by Group and Outcome For Three Time Trend Theories

Variable/Composite	Garden	Physical	Nature	Film	Plant growing	All groups
Mental health composite						
<i>Theory 1^a</i>	0.54	0.45	0.50	0.21	0.28	0.40
<i>Theory 2^b</i>	0.27	0.26	0.39	-0.03	0.24	0.24
<i>Theory 3^c</i>	0.27	0.24	0.36	0.07	0.17	0.23
Physical health composite						
<i>Theory 1</i>	0.15	0.67	0.35	0.36	0.14	0.26
<i>Theory 2</i>	0.03	0.36	0.34	0.23	0.14	0.22
<i>Theory 3</i>	0.09	0.51	0.34	0.27	0.08	0.26
Companionship						
<i>Theory 1</i>	0.39	0.06	0.02	0.30	0.17	0.18
<i>Theory 2</i>	0.40	0.13	-0.03	0.24	0.23	0.19
<i>Theory 3</i>	0.44	0.16	0.12	0.19	0.23	0.24
Physical activity						
<i>Theory 1</i>	-0.06	0.06	0.15	-0.30	0.07	-0.01
<i>Theory 2</i>	0.09	0.10	0.14	-0.18	0.06	0.07
<i>Theory 3</i>	0.02	0.08	0.17	0.01	0.12	0.10
Sleepiness^d						
<i>Theory 1</i>	0.24	0.30	0.22	0.43	0.08	0.24
<i>Theory 2</i>	0.04	0.26	0.01	0.11	-0.11	0.05
<i>Theory 3</i>	0.02	0.29	0.12	0.09	-0.15	0.06
Connectedness to nature						
<i>Theory 1</i>	0.08	0.13	0.12	-0.08	-0.14	0.02
<i>Theory 2</i>	0.46	0.22	0.14	-0.12	0.23	0.19
<i>Theory 3</i>	0.50	0.26	0.11	-0.04	0.32	0.24

^aTheory 1 = positive, linear change trend (-3, -1, 1, 3). ^bTheory 2 = positive, linear change trend that regresses at follow-up (-1, 0, 1, 0). ^cTheory 3 = delayed positive change trend that regresses at follow-up (-1, -1, 2, 0). ^dTheories tested for sleepiness were reversed to test for decreasing sleepiness across time.

Contrast 1: Positive, linear change.

One-way ANOVAs on the L scores reflecting a positive, linear change trend that regresses at follow-up (-1, 0, 1, 0), showed there were no statistically significant differences in how the experimental groups fit the theory of change for any of the composites or variables, $0.25 < p > 0.81$.

Many variables did fit the theory of positive, linear change. Table 10 shows that mental health, $t(77) = 5.91, p < 0.001, r = 0.56$; physical health, $t(77) = 4.65, p < 0.001, r = 0.47$; companionship, $t(77) = 2.13, p = 0.02, r = 0.24$; and sleepiness (reverse-scored), $t(77) = 3.16, p = 0.001, r = 0.34$ fit the theory. Physical activity, $t(77) = -1.08, p = 0.28$ (two-tailed), $r = 0.12$ and connectedness to nature $t(77) = 0.05, p = 0.48, r = 0.005$ did not fit the theory.

Contrast 2: Positive, linear change that regresses at follow-up.

One-way ANOVAs on the L scores reflecting a positive, linear change trend that regresses at follow-up (-1, 0, 1, 0), showed there were no statistically significant differences in how the experimental groups fit the theory of change for any of the composites or variables, $0.18 < p > 0.52$.

As can be seen in Table 10, mental health, $t(77) = 3.99, p < 0.001, r = 0.41$; physical health, $t(77) = 4.10, p < 0.001, r = 0.42$; companionship, $t(77) = 2.88, p = 0.002, r = 0.31$; and connectedness to nature, $t(77) = 2.82, p = 0.003, r = 0.31$ fit the hypothesized trend. Sleepiness (reverse-scored), $t(77) = 1.05, p = 0.15, r = 0.12$; and physical activity, $t(77) = 0.71, p = 0.24, r = 0.08$, did not fit the theorized trend.

Contrast 3: Delayed positive change that regresses at follow-up.

One-way ANOVAs on the L scores reflecting a delayed positive change trend that regresses at follow-up (-1, -1, 2, 0), showed that there were no statistically significant differences in how the experimental groups fit the theory of change for any of the composites or variables, $0.07 < p > 0.61$.

The variables that fit the theorized trend, as can be seen in Table 10, were mental health $t(77) = 3.48, p < 0.001, r = 0.37$; physical health $t(77) = 4.72, p < 0.001, r = 0.47$; companionship $t(77) = 4.08, p < 0.001, r = 0.42$; and connectedness to nature $t(77) = 4.50, p < 0.001, r = 0.46$. Physical activity $t(77) = 1.13, p = 0.13, r = 0.13$, nor sleepiness (reverse-scored), $t(77) = 0.82, p = 0.21, r = 0.09$, fit the theorized trend.

Summary of contrasts for four time points.

There were no group differences in theory fit. Regardless of experimental group, there was a statistically significant fit with Theory 1 (positive, linear change), Theory 2 (positive, linear change that regresses at follow-up), and Theory 3 (delayed positive change that regresses at follow-up) for mental health, physical health, and companionship. Theory 1 (reversed) fit sleepiness, and Theory 2 and 3 fit connectedness to nature. None of the time trend theories fit physical activity.

Discussion

Gardens are widely used health initiatives that modify the built environment to shift individual and community level patterns, but when and why gardens accomplish health goals has never been fully investigated. In this study, I employed a randomized experimental design to test whether community gardening, compared with theory-derived

comparison groups, changes health-relevant outcomes. I found that all participants, regardless of experimental condition, improved in emotional well-being, conscientiousness, social relationships, environmental identity, and self-reported health from pretest to posttest. That all participants improved, regardless of experimental group, could be due to participants' completing assessments on a similar timeline, an external factor affecting the entire cohort, participation in a study of this sort, or each experimental manipulation being effective in improving health-relevant outcomes. Indeed, all these possibilities are conceivable. Given that most participants were undergraduates at the same university, it would make sense for individuals to change in a similar manner over the duration of a quarter due to common experiences. Participants may have been more stressed as they adjusted to new classes and a new schedule at the beginning of the quarter (when the pretest was completed) and may have subsequently reported lower emotional well-being, organization, self-control (conscientiousness), social involvement, and physical health. Towards the end of the quarter, participants may have successfully adjusted to the workload and schedule, and may have been excited and optimistic about the approach of summer vacation.

It may also be that all the experimental conditions had a salubrious effect to some degree. Indeed, all conditions were created based on the premise that they are health-promoting and might be the reason for the positive effects of community gardening found in past work. In other words, I did not uncover specific effects of the elements of community gardening, thus highlighting the need for more rigorous evaluation of

community interventions. Still, the present experimental design should also be employed with a larger sample size and a longer follow-up before any such conclusions are drawn.

In regard to the observed increase in emotional well-being specifically, a past study conducted at the same university found that participants in a no-treatment control group decreased in subjective well-being over the duration of a quarter (Lyubomirsky, Sheldon, & Schkade, 2005). That is, the increase in the present study is the opposite of the trend observed over the duration of a quarter in another study. Of course, these studies cannot be used as direct comparisons, and any interpretations warrant caution. However, that students sometimes decrease in subjective well-being lends additional merit and direction for following up on the present findings. Researchers developing future studies might consider including an “empty control group,” that is, an experimental group that is not assigned to an activity but simply takes the pretest and posttest. Though such a design is not always recommended due to placebo effects and demand characteristics, given the results of the present study, it may prove to be useful in future research.

Results that arose from the four time point measures largely support the observed trends from Time 1 to Time 3. That is, across the four time points, participants improved in self-reported mental health, physical health, companionship, sleepiness, and connectedness to nature. With the exception of sleepiness, these improvements all occurred from Time 2 to Time 3 (with connectedness to nature decreasing again from Time 3 to Time 4). This makes sense, as the time between Time 2 and Time 3 was the longest stretch of active participation in the intervention. That participants showed

increases during the longest stretch of the intervention hints at some support for the idea that all experimental manipulations were effective to some degree, but Time 3 measures also coincided with the approach of summer, thus making this argument tenuous.⁴

Exploring the Results: Environmental Identity

The differential change by experimental group for environmental identity is of note. Though post hoc tests and contrasts suggest that the differential change may have been due in part to between group variation at pretest, the direction of change for groups fits with theory and with study predictions. The greatest mean increase on environmental identity from pre- to posttest was observed in the Garden and Nature Exposure groups. These groups were assigned to spend time outdoors in nature during the weeks-long intervention. On the contrary, slight mean decreases were observed for the (indoor) Film and (indoor) Physical Activity groups. (The Plant Growing group was in between, with a slight increase.) Though these results need to be interpreted cautiously due to the non-significant post hoc tests, it may be that any outdoor activity changes identification with the natural environment. That is, both active (gardening) and passive (nature exposure) engagement with nature may begin to shift environmental identity. These findings fit with past research that shows that general positive experiences in nature predict a stronger environmental identity (Chawla, 1999; Gifford & Nilsson, 2014; Wells & Lekies, 2006).

⁴ Sleepiness showed a slightly different pattern, and decreased from Time 3 to Time 4. Given that participants were college students, and given that Time 4 was during summer vacation, it may be that the decrease in sleepiness from Time 3 to Time 4 had to do more with the increased free time and less to do with the intervention.

As Americans flock to urban centers and away from more rural settings, it is important to find effective methods of increasing individuals' appreciation for nature. There is some evidence that environmental identity is linked with environmental stewardship (Mayer & Frantz, 2004), and so interventions that target environmental identity could have implications for environmental protection, an urgent area of research given the current political clashes over environmental science and given the rapidly changing global climate. Based on the findings in the present study, it may be that spending time in nature each week may be enough to boost environmental identity. However, as evidenced by the decrease in environmental identity from Time 3 (posttest) to Time 4 (follow-up), these gains may not last long past the intervention. Future research that seeks to increase environmental stewardship via environmental identity might focus on developing interventions with low participant burden—ideally an activity that an individual can easily engage in on a weekly basis—to prevent individuals from giving up on the activity and ultimately returning to baseline levels of environmental identity. Before committing to interventions that increase environmental stewardship via environmental identity, though, it is critical to further investigate the magnitude of the relationship between the two variables, and to identify potential mediators and moderators.

Qualitative Responses: What Can We Learn from Participant Experiences?

Participants provided qualitative responses to five questions: (1) “What was this experience like for you?” (asked at Time 3); (2) “What was the low point of this experience?” (asked at Time 3); (3) “What was the high point of this experience?” (asked

at Time 3); (4) “Has this experience changed you in any way?” (asked at Time 3 and Time 4); and “Have you continued with your health behavior?” (asked at Time 4). In general, participants reported the study as a positive experience, regardless of experimental group. Each group had one or two participants who reported a fairly neutral or a negative experience (e.g., “it was an interesting experience;” “the study felt like a waste of time”), but overall, participants reflected positively on their experiences. One theme of the qualitative responses was that finding time to participate in the study was stressful or difficult (“It was time consuming”), but worth it in the end (“but I enjoyed [the study]”). In the Nature, Garden, and Plant Growing groups, participants reported feeling rewarded with relaxation and stress reduction: “Being in nature for two hours really helped me keep my spirits up, helped with depression and anxiety;” being in the garden “refreshes me when I have lots of school work. When I go to the garden, I feel relaxed;” “I had to constantly check up on [my plant] and make sure that it did not die [...] but taking care of [the plant] was a fun and calming experience.” Film participants reported “learn[ing] a lot of different things from different people” and being able to “go out of my comfort zone and make friends with different types of people,” while Activity participants thought “It felt good to set goals for myself and actually accomplish them. I began to believe in myself more.”

Thus, though participants in all groups reported struggling to complete their weekly activities, participants in all groups also reported benefits to mental, physical, and/or social health. (See Table 12 for example quotes; quotes were selected based on face value of reflecting a specific benefit.) Much health advice found online or in popular

media outlets recommends that individuals should relax, unwind, and “treat yourself.” Though an occasional massage or beach vacation may be rejuvenating, research suggests that a life of relaxation and disengagement from challenge may do more harm than good (Friedman & Kern, 2014). Despite popular advice, challenge can be beneficial, especially when an individual feels supported and capable of overcoming challenges (McEwen, 2000; Friedman & Kern, 2014). Though participants reported feeling challenged by the time commitment required for the study, they were given tools and resources to succeed (e.g., map to nature-based places; guides for exercises), and were committing to something that they found meaningful (i.e., their own health). The study may have provided participants, regardless of experimental group, a sense of motivation and support to achieve a goal, ultimately resulting in the observed increases to self-reported emotional well-being, health, and social relationships. That is, the qualitative responses lend support to the notion that health interventions might be more likely to promote health and thriving if they shift away from focusing on positive emotions directly (hedonic well-being), and instead focus on supporting individuals to become (and stay) engaged in ongoing, structured activities. Perhaps pursuing health and wellness (an intrinsic goal), and being mindful and aware of the health intervention and its purpose, promoted eudaimonic well-being (Ryan, Huta, & Deci, 2008). In other words, the intervention may have shifted individuals’ focus away from seeking out positive emotions, and toward one of living the “good life” by seeking out health, vitality, and meaning. Such a shift may encourage a cycle of positive emotions, physical health, and meaningful social relationships.

Table 12

Example Qualitative Reports of Time Management Challenges, and of Improved Mental, Physical, and Social Health by Group.

Group	Time Challenge	Mental Health	Physical Health	Social Health
Garden	“It was hard to take time away from daily life as a college student to actually garden and do stuff in nature.”	“Going to the garden was really nice and peaceful. Definitely a different experience and it was a breath of fresh air and no stress.”	“My experience was positive. I felt like I was kept accountable to live out a healthy life.”	“It was fun to meet new people and engage in an on-hands activity as a group.”
	“I think [the low point] was figuring out the fact that it's hard to make time for something I value, such as nature.”	“To me, this experience is like a break for me. It refreshes me when I have lots of school work. When I go to the garden, I feel relaxed.”	“I am more aware of my activity levels, and of the need to make being active a priority if I want to actually accomplish it, i.e., I have to make time to go on a walk rather than try to fit it in when I feel like it.”	“I enjoyed this experience because I was able to socialize with other people while working in a garden that allowed me to experience what it is like to work/grow in a garden.”
Nature	“This was a positive experience that made me realize how important it is to go outdoors. Taking time to go outdoors did allow me to unplug from all the stresses in my life, but sometimes it was difficult finding time do so. I had to manage my time effectively in order to make time for outdoors.”	“Being in nature for 2 hours really helped me keep my spirits up, helped with depression and anxiety”	“This was a great experience to kickstart (sic) a healthier lifestyle.”	--
	“Sometimes busy school work and important exams got in the way of me trying to go outdoors and enjoy the nature. However, taking a few hour break from studying was definitely worthwhile.”	“It was a very good experience sitting quietly by myself for at least 2 hours. It felt very relaxed. Everything is peaceful”	“...I am starting to take daily/near daily walks in the botanical gardens.”	

Film	<p>“It was time consuming but I enjoyed the social interactions with others.”</p> <p>“[the low point was] the last two weeks when schoolwork and studying were piling up and I had to spend 2 hours attending film meetings.</p>	<p>“This experience helped me take a step back from my busy routine of school and work and focus a little more on my well-being.”</p> <p>“[The high point was] having two hours a week to get away from school and getting to relax and watch a movie. And after film club I was always in a good mood.”</p>	<p>“I am eating more healthy food at home and interacting with everyone”</p> <p>“The high point of this experience was being able to reach higher health goals.”</p>	<p>“although some of the movies were a little strange I liked coming here and just having a conversation with the wother (sic) girls who were here. We did not become friends or anything but it was just nice that we would speak about random subject matters.”</p> <p>“It was a very interesting experience for me because I was able to go out of my comfort zone and make friends with different types of people.”</p>
Plant	<p>“a little stressful, I would go about my day and think "did I water my plants?"”</p> <p>“[...]It was another thing to worry about but totally doable.”</p>	<p>“I became more aware of my daily routine and how certain aspects of my life can have a profound effect on my well being in general.”</p> <p>“Taking care of the plants made me feel like I have a responsibility and it made me calm and enjoyed doing so.”</p>	<p>“It has made me more aware of the time I spend in the outdoors and conscious of my time spent active.”</p> <p>“I was more motivated to go to the gym, eat healthier, and tried to have a more balanced life style.”</p>	--
Activity	<p>“This was kind of challenging because I found that it is really difficult to get everything done and get some exercise in[...]”</p> <p>“[The study] helped motivate me as I felt swarmed with all the other responsibilities that I have. I felt that I had more control of my schedule when I had to think about planning some exercise into my schedule.”</p>	<p>“This experience for me was great. I loved the fact that they made me get out my room and be active. Being active helped me reflect on life and release stress.”</p> <p>“I really enjoyed being able to be active, even for short periods of time. I felt better about myself doing this.”</p>	<p>“It was interesting and challenging to be open minded and try new health activities that I was not used to. It also made me feel better and that I too can live a healthier lifestyle if I really set my mind to it.”</p> <p>“I feel a lot better about myself in general, physically and mentally.”</p>	--

Qualitative responses from the study are also helpful to understanding promising interventions that seek to boost productivity, self-control, and reliability (i.e., conscientiousness). As mentioned, participants reported difficulty in finding time to engage in their assigned behavior, but pointed to the study as giving them the support and motivation necessary to manage time effectively. For example, one participant wrote that the study “helped motivate me as I felt swarmed with all the other responsibilities that I have. I felt that I had more control over my schedule when I had to think about planning some exercise into my schedule.” Another wrote that the study “was a new experience in that I now had to make going to the garden a priority, which meant I had to manage my time better and keep track of my schedule.”

In one dissertation in which the researchers sought to increase conscientiousness in college students, the researcher focused on goal setting, overcoming obstacles, and time management—that is, they targeted conscientiousness directly (Della Porta, 2013). However, the qualitative responses in the present study, paired with the finding that participants increased in conscientiousness over time, allows for speculation that perhaps an effective way to promote conscientiousness is to engage individuals in meaningful and challenging experiences that require conscientiousness (or facets thereof) for success. Because participants felt committed to the study and wanted to improve their own health, they may have adopted more conscientious behaviors (e.g., better time management and organization) to ensure that they could complete two hours of their weekly health behavior. Nonetheless, few differences emerged across experimental conditions, and so caution is warranted.

Past evidence shows that the personality traits that predict work outcomes (e.g., conscientiousness and career attainment) are also the traits that change in relation to those work experiences (Roberts et al., 2003). That is, the process becoming involved in meaningful work—something that requires organization, reliability, and time management—predicts increases in conscientiousness. It may be that an increase in conscientiousness in participants in the present study was observed for similar reasons: a degree of conscientiousness was required for success in the study, thus participants flexed their “conscientiousness muscles” to complete the study, and ultimately experienced gains in the trait. Again, these implications need to be interpreted carefully, as it is unclear whether participants changed over time due to the time in the quarter (for example), or due to experiences in the study. Nevertheless, future researchers focused on enhancing self-control, reliability, or other conscientiousness-related characteristics might consider targeting the trait indirectly via meaningful involvement in ongoing, authority-supported activities.

Future Studies

Perhaps the most exciting and important implication of the present study is that it provides a framework for how to use rigorous scientific methodology, including random assignment, validated measures, and pre and post measures, to study community gardening. As noted, community gardens are common in a large and growing number of schools, and are also cropping up among prisons, hospitals, and urban sites across the country. Now that the groundwork has been laid for valid evaluation studies, it is possible

to move ahead with this line of research while also addressing some of the limitations of the present study.

A clear next step that stems from the present study would be to add more participants, an “empty” control group, and use longer timeframe. Such a study would address the largest limitations of the present study, and may provide some clarification for the present study’s mixed results. Such a study might also address more nuanced limitations of the present study, for example, the use of self-reported data for all measures. Objective measures of health, use of daily diaries, observer reports, and momentary time sampling would all improve and expand upon the present study’s data collection methods.

Another important study would be to further explore the relationships between environmental identity and pro-environmental behavior. This may be an important first step to developing an intervention that seeks to promote sustainable acts via increased environmental identity. This dissertation found evidence for nature exposure and community gardening increasing environmental identity, but how a change in environmental identity in turn affects environmental stewardship remains to be determined. In this line of research, it would first be important to understand the degree to which environmental identity relates to pro-environmental behaviors, and how this relationship is moderated by demographics and personality traits. Do different types of what the present study considered under the umbrella of “environmental identity” predict different types of pro-environmental behavior? For example, perhaps connectedness to nature predicts donations to wilderness conservation nonprofits, while a more cognitive

awareness of the importance of a healthy environment to human health and to future generations is more likely to predict day-to-day energy conservation (e.g., reducing trash production or beef consumption). Studies exploring such questions would add a meaningful piece to the body of environmental and sustainability psychology literature, and would have clear implications for real-world application.

After clarifying the links among environmental identity and pro-environmental behaviors, experimental designs could further inform the potentialities for interventions. For example, stemming from the present study, researchers could begin to tease apart the differences between active nature experiences (e.g., community gardening, bird watching) versus passive nature experiences (e.g., nature exposure, viewing nature scenes). The present study found that both active (community gardening) and passive (nature exposure) interaction with nature seemed to increase environmental identity. This finding could be explored with more depth by comparing different types of active and passive nature experiences, and how they differentially relate to various components of environmental identity. For application and real-world relevance, the ultimate question would be how such experiences predict pro-environmental behaviors. In conducting such studies, it would be particularly interesting and compelling to measure behavior using home-monitoring or smart phone applications. For example, changes in water usage, recycling behaviors, donations, or commuting habits could all be measured in real time.

Finally, due to the mixed results of the present study, it could be informative to take a step back and seek to further understand the types of people who garden. In-depth interviews with different types of gardeners (e.g., community garden leaders, urban

garden activists, home gardeners, etc.) might provide a more nuanced insight into what it is about gardening that promotes health, and the types of people different kinds of gardening activities draw in. These interviews might be contrasted with interviews conducted with different types of hobbyists (e.g., crafters, surfers, book clubbers) to provide further insight into the unique offerings of gardening. Relatedly, conducting an ethnography (detailed qualitative study) of an ambitious, gardening-based program would be informative to the development of future gardening programs and gardening-based research. One example of such a program is the Earthaven Ecovillage in Asheville, North Carolina, a self-governed and self-sustaining ecovillage built on 329 acres. The goals of Earthaven include developing and supporting a local economy, practicing fair and effective self-governance, using collective labor to provide infrastructure for the community, and developing and using ecologically sound technologies for essential systems such as energy and water use (Earthaven.org). There are many other sustainable communities that vary in specific goals and missions, but in general, such communities tend to focus on environmental and economic sustainability, social equality, and collective governance. Developing a complete understanding of how such communities and the individuals who make them up function, what draws individuals to such an experience, and whether and how the experience promotes thriving might further our understanding of why and how garden-based programs may improve social, mental, and physical functioning.

Limitations

Although this is the first detailed, randomized biopsychosocial study of community gardening, a number of limitations should be noted to inform future research. First, the study had 80% power to detect small interaction effects (i.e., η^2_p of 0.014), and benefitted from a repeated-measures design in which individuals served as their own controls. However, a larger sample in future work will increase the validity and reliability of the results, allowing detection of more subtle interaction effects. Second, the participants were college students. Collaborations with elementary schools or well-established gardening programs in the future would help to make results more generalizable, and also make higher-powered studies more attainable. Third, the study was conducted in a limited timeframe. A four-week health intervention is unlikely to shift lifestyles in a major way, and thus may have only minimal effects on health and health-relevant variables. A longer study, in which the health behavior becomes a habit that is well-integrated into an individual's life is likely to produce more reliable and more valid effects. Especially when comparing interventions that are all thought to promote health, as was done in the present study, such long-term studies are critical as differences may be small, nuanced, and develop over time.

Another limitation of this project arises from relying on participants to complete their health behavior on their own time every week. Though participants did have a degree of oversight due to the requirement of sending date-stamped photographs, whether participants truly spent two hours engaging in their assigned behavior every week that they sent a photograph cannot be validated. Presumably, if a participant walks to the

garden or begins an exercise routine, they will spend at least some time engaging in the behavior as opposed to taking a picture and leaving immediately, but the procedures used in the present study do not allow for any claims of certainty. One relatively simple solution to this limitation that would only add a minor degree of participant burden would be to have participants send a time- and date-stamped photograph both at the beginning and at the end of their engagement in the behavior, or to use a GPS tracking device. Though a GPS tracking device could not verify that an individual is exercising at home, it could confirm that a participant is at a community garden. Such validation could also be used as a measurement tool by informing researchers of the specific types of nature environments participants are seeking out and spending time in. This could add rich insight into how different types of nature experiences promote health. For example, how does going to the mountains for a hike differ from a walk in a local park in terms of tangible health-relevant outcomes and correlates? Mapping where, when, and how individuals experience nature and cataloguing differential changes in health-relevant outcomes would be a worthwhile endeavor. Opportunities for such research are becoming increasingly feasible with the growth of Big Data (e.g., Facebook).

Although this study used a significant number of carefully chosen, well-validated measures, and assessed several different aspects of thriving, all measures were self-reported. It is well established that self-reported health and well-being is distinct from objective health (Friedman & Kern, 2014), and that self-reported measures of how one feels and functions is not necessarily a direct correlate for behaviors and objective functioning and outcomes (Vazire & Mehl, 2008). Still, perceptions of how one is feeling

and functioning is a useful and important baseline for future studies, and provides necessary insight and direction for moving forward. Future studies might consider using daily diaries to track health behaviors, direct observation of behavior instead of self-report (e.g., providing options of different foods and recording what and how much is eaten), or tracking devices, as previously noted.

Closing Remarks

The leading causes of morbidity and premature mortality in the United States are due to reasons that can, to some degree, be prevented or delayed with healthy lifestyles. Optimal ways in which to promote such lifestyles will certainly function through multiple pathways, on multiple levels, and stem from a diversity of scientific fields. Though the solutions to decreasing preventable diseases and improving mental health will be multifaceted and complex, there are programs and interventions in use today that properly target and ease some of the problems facing America. Community gardening is one activity that may begin to shift individuals and communities towards a healthier life.

As our societal burdens develop and change, so too must our interventions that address them. It is only with rigorous research that we can develop targeted, effective interventions that address the tribulations of communities most in need. For example, with a growing number of refugees across the globe, some community leaders, including in the U.S., are turning to gardens to nourish refugees socially, mentally, and physically (Okvat & Zautra, 2013; Tidball & Krasny, 2014). But what components of community gardening are crucial for such interventions to be effective? With whom are they effective? Can we broaden such programs to alleviate underlying civil tensions to begin

with, or in places where refugees are relocated? There is a diversity of valiant efforts to help communities and individuals via gardening in existence today (Blair, 2009; Cammack, Waliczek, & Zajicek, 2002; Spees, Joseph, Darragh, Lyons, & Wolf, 2015; Wang & MacMillan, 2013), but a clear and thorough understanding of how such programs function and help communities is yet to be uncovered.

In a letter to a friend, Thomas Jefferson wrote that “Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country and wedded to its liberty and interests by the most lasting bonds” (letter to J. Jay, August, 23, 1785). Is this true of modern day gardeners? If so, investing in community gardening infrastructure and research is of utter importance to the health and well-being of individuals and communities today.

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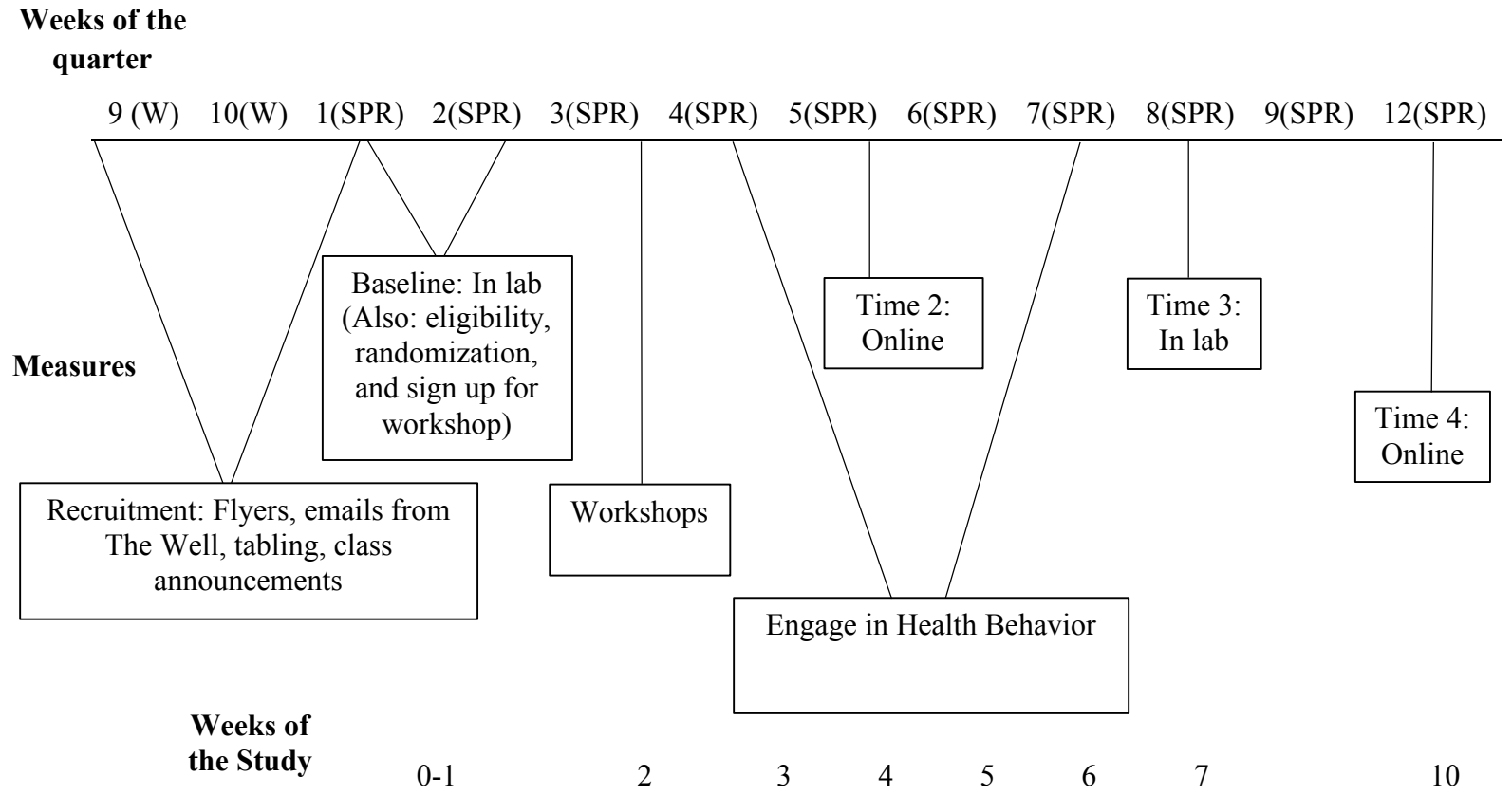
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Appendix A: Timeline



Appendix B: Week 1 Workshops

All participants attended a workshop unique to their group. Workshops were conducted over the course of one week and each workshop was offered at least four times to accommodate participant schedules. Participants signed up for a specific workshop for their group after they completed Time 1 measures. All participants were sent a reminder email and text the day prior to their workshop. The four weeks of engaging in the health behaviors begins the week after the workshop.

At each workshop, the compensation for study participation was explained. Participants were told “Partaking in this study will involve completing four questionnaires, and engaging in and sending confirmation of your health behavior every week. Completing these requirements will earn you entries into drawings. You will earn 1 entry into a drawing for prizes for every questionnaire you complete (up to four entries). Furthermore, you will earn 1 entry into the drawing for every week you complete your behavior (also up to four entries). If, by the end of the study, you have completed all parts (i.e. you have eight drawing entries), you will earn two bonus entries.

If you wish to receive Subject Pool credits, you will earn one subject pool credit if you complete any portion of the study, and you will earn two units if you complete the entire study.”

Community Gardening

Participants arrived at 3136 of the Psychology building at their scheduled workshop time. After all scheduled participants arrived, participants were read the following script:

“Thank you for coming today and for signing up as a participant in this research. The purpose of the study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by participating in community gardening. Thus, all of you will garden at the UCR community garden for two hours every week for the next four weeks. This will entail walking to the on-campus community garden near parking lot 30, and carrying out various gardening activities, such as weeding, harvesting, planting, or watering. The hours of the community garden are 3–7 PM on weekdays, and you may come and go as your schedule allows. A garden facilitator will be there to guide your efforts. You are required to garden for 2 hours a week for 4 weeks, but you may complete your two hours all in one day, or broken up over the course of the week. Are there any questions so far? We will now walk over to the community garden together. You will meet the coordinator of the garden, and receive a tour of the garden.”

Participants and the experimenter then walked to the community garden, where the PI gave a brief tour of the garden. This entailed telling participants what is currently growing, showing them the fruit orchard, explaining plans for a future greenhouse, and showing and explaining the watering and compost systems the garden uses. Participants were then reminded (1) of the times the garden is open for them to come work, and (2) that they needed to take a time-stamped photo every time they went to the garden.

Indoor Gardening

Participants arrived at 3136 of the Psychology building. After all scheduled participants arrived, participants were read the following script:

“Thank you for coming today and for signing up as a participant in this research. The purpose of the study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by helping another living thing, such as plants, to grow. Thus, all of you will plant some seeds and seedlings today that you will care for over the next four weeks. This will entail making sure your plants receive adequate sunlight and water. Today, you will receive two pots. In one, you will plant radish seeds, and in the other you will plant basil seedlings.”

Participants then planted seeds and seedlings based on the following instructions, which the PI carried out as an example as she gave instructions. To help with references to inches, rulers were provided. “First, fill one pot about three-quarters of the way full with soil. In one pot, scatter approximately 10 radish seeds over the soil. Then, cover all seeds with approximately one-quarter inch of soil. Water lightly.

“Next, we will plant basil. Fill your pots a little past three-quarters of the way full. Now, dig a hole in the pot that is deep and wide enough for your basil seedling. Pick up your seedling, and tear off the cardboard covering around the bottom of the plant. Then place the seedling in the hole. Cover so that no roots are showing—the top of the soil from the seedling should be slightly below the soil line.”

After all participants finished planting, instructions for how to care for radishes and basil were provided. Participants were asked if they have any remaining questions, and were reminded to take a weekly photo of their plants which should be sent to the PI. Before participants were dismissed, they received a bag of produce to “encourage a healthy lifestyle.”

Nature Exposure

Participants arrived at 3136 of the Psychology building. After all scheduled participants arrived, participants were read the following script:

“Thank you for coming today and for signing up as a participant in this research. The purpose of the study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by spending time in natural environments. Thus, every week for the next four weeks you will spend at least two hours in nature. Your two weekly hours in nature may be spent reading, listening to music, listening to audiobooks or podcasts, on your phone, or simply sitting and observing. We ask that you do not use email, text messaging, or voice calling during your two hours, unless an emergency arises. We also ask that you spend this time alone and sitting still. You can choose to stay on campus, or go to another natural setting, be it a backyard with lots of greenery, a favorite park, or elsewhere. Are there any questions?”

“We will now go on a short tour highlighting some places on campus you may choose to spend time during your intervention.” Before leaving for the tour, participants received a bag of produce to “encourage a healthy lifestyle.”

Participants were then walked to the botanic gardens, “picnic hill,” a shaded walkway with benches between the health center and Aberdeen, and a tree-covered area near the Science Library.

Film Club

Participants arrived at 3136 of the Psychology building. After all scheduled participants arrived, participants were read the following script:

“Thank you for coming today and for signing up as a participant in this research. The purpose of the study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by engaging with a social group on a regular basis. Thus, we will be meeting on a weekly basis over the course of four weeks to watch short films and discuss them. Every week, you will attend one film screening, and participate in a 20-30 minute discussion of the film with your peers. Snacks will be provided. We ask that you please attend the same time every week. Please contact the PI if a conflict arises. Today, we’ll watch and discuss a short film.” All movies were rated PG-13 or lower or not rated, and ran 100 minutes or less, leaving at least half-an-hour for discussion. Below are the movies participants viewed each week, and a short summary from IMDB (<http://www.imdb.com>).

- Workshop Film: Day and Night (Pixar short); 6 minutes; G
 - The personification of daytime and nighttime learn to get along.
- Week 1: Fantastic Mr. Fox; 87 minutes, PG
 - An urbane fox cannot resist returning to his farm raiding ways and then must help his community survive the farmers' retaliation.
- Week 2: Beasts of the Southern Wild; 93 minutes, PG-13
 - Faced with both her hot-tempered father's fading health and melting ice-caps that flood her ramshackle bayou community and unleash ancient aurochs, six-year-old Hushpuppy must learn the ways of courage and love.
- Week 3: Midnight in Paris; 93 minutes; PG-13

- While on a trip to Paris with his fiancée's family, a nostalgic screenwriter finds himself mysteriously going back to the 1920s everyday at midnight.
- Week 4: Mary and Max; 92 minutes, Not Rated
 - A tale of friendship between two unlikely pen pals: Mary, a lonely, eight-year-old girl living in the suburbs of Melbourne, and Max, a forty-four-year old, severely obese man living in New York.

Movies were chosen based on appropriateness, running time, and potential to foster discussion among college students. Discussion were facilitated using the following questions, which varied based on the movie. (Questions derived from <http://www.teachwithmovies.org/standard-questions.htm>)

- Did you learn anything from this movie? If you did, what was it?
- What is the message of this movie? Do you agree or disagree with it?
- Was there something you didn't understand about the film? What was that?
- What did you like best about the movie? Why?
- What did you like least about the film? Why?
- Who was your favorite character in the movie? Why?
- Who was your least favorite character in the film? Why?
- What part of the story told by the movie was the most powerful? Why?
- If you had a chance to ask a character in this movie a question, what would it be?
- Describe one thing that was universal that you learned from the film.
- What motivates the major characters? Are their motivations or wants explained outright or revealed over time?

- What comment is the author trying to make about the culture of the characters in this story?

Physical Activity

Participants arrived at 3136 of the Psychology building. After all scheduled participants arrived, participants were read the following script:

“Thank you for coming today and for signing up as a participant in this research. The purpose of the study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by being physically active. Thus, you will be given tools and resources that help you lead an active lifestyle. In this study, you will be asked to engage in two hours of moderate physical activity each week for four weeks. Moderate means that you should be breathing heavy, but should still be able to carry on a conversation. This activity should be at-home. That is, exercise at a gym, fitness classes, or outdoor activity does not count. We encourage you to explore the resources we provided, and find videos that you like best. Please take a time-stamped photo of yourself after you finish the activity, along with the link to the video that you watched. We also ask that you be careful in your exercise routine, and modify exercises as you see fit. If at any point during your workout you begin to feel dizzy or have physical discomfort, you should stop immediately. If you incur any injuries, please contact the researcher via email or phone.”

Participants were then asked if they had any questions. Before they were dismissed, they were given a bag of produce to “encourage a healthy lifestyle.”

Appendix C: Handout for Community Gardening Group

The purpose of the Healthy Activities Make Healthy Students Study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by participating in community gardening. Thus, you will garden at the UCR community garden for two hours every week for the next four weeks. This will entail walking to the on-campus community garden near parking lot 30, and carrying out various gardening activities.

The hours of the community garden are 2-7 PM on weekdays, and you may come and go as your schedule allows. When you arrive, please check in with a garden facilitator, who will be there to guide your efforts. You are required to garden for 2 hours a week for 4 weeks, but you may complete your two hours all in one day, or broken up over the course of the week. You are encouraged to bring a bag to take home produce that you harvested.

Weather restrictions: Please note that if the high temperature outside is 94 degrees Fahrenheit or above (according to weather.com), the garden will not open until 4:00 PM that day. If it is actively raining, the garden will not be open.

Please send a weekly time-stamped photo of yourself at the UCR garden to the researcher along with your unique ID number. You may email the photo to XYZ@gmail.com, or text it to the researcher at (XXX)-XXX-XXXX. To earn an entry into the drawing, you must send your photo by Sunday each week.

Appendix D: Handout for Physical Activity Group

The purpose of the Healthy Activities Make Healthy Students study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by being physically active. Thus, you will be given tools and resources that help you lead an active lifestyle. For the next four weeks, you will be asked to engage in two hours of individual, indoor, moderate physical activity.

Below you will find a list of online resources to help guide you in your physical activity. We encourage you to explore the resources we provide, and find videos and routines that you like best—you are not limited to the resources we provide. If you already exercise regularly, we ask that you add 2 hours of indoor, individual physical activity to your routine each week. Please be careful in your exercise routine, and modify exercises as you see fit. If at any point during your workout you begin to feel dizzy or have physical discomfort, you should stop immediately. If you incur any injuries, please contact the researcher via email or phone.

Email: XYZ@ucr.edu; Phone: (XXX)-XXX-XXXX

Videos

- Low Impact Cardio Workout for Beginners - Beginner Cardio & Toning Workout Routine - <https://www.youtube.com/watch?v=bSZj19AUU5I>
- 15-Minute Core Workout to Transform Your Body - <https://www.youtube.com/watch?v=xRMnGxfEZaI>
- 15-Minute Boxing Workout You Can Do At Home -

<https://www.youtube.com/watch?v=pWLEkO0MIXs>

- The Ultimate 30-Minute Cardio Pilates Workout! -
<https://www.youtube.com/watch?v=LrB4CjpC-F8>
- 20 minute High Intensity Interval Training
<https://www.youtube.com/watch?v=cZnsLVArIt8>
- Back To School Bootcamp Mobile Workout -
<https://www.youtube.com/watch?v=yjI9YyH-ugw>
- Burn to the Beat Dance Intervals: Hip Hop Cardio Dance Workout -
<https://www.youtube.com/watch?v=ND9viRzgPSg>
- BeFiT Transform: 15 Min Full Body Pump Workout -
<https://www.youtube.com/watch?v=2MFhQcmiBPA>
- Slim Down Cardio Burn Workout -
<https://www.youtube.com/watch?v=OwVqStjPYQ0>

Resources

- Nine free resources for workouts at home: <http://www.thesimpledollar.com/nine-free-resources-for-inexpensive-home-exercise/>
- Fitness Blender: Husband and wife duo provide resources for at home workouts
<https://www.fitnessblender.com/videos>
- Free yoga instruction videos: <http://www.myfreeyoga.com/>
- Feel free to explore the internet and find something that you like and works for you!

****Please send a weekly time-stamped photo of yourself at the UCR garden to the researcher along with your unique ID number. You may email the photo to XYZ@gmail.com, or text it to the researcher at (XXX)-XXX-XXXX. To earn an entry into the drawing, you must send your photo by Sunday each week.****

Appendix E: Handout For Nature Exposure Group

The purpose of the Healthy Activities Make Healthy Students Study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by spending time in natural environments. Thus, every week for the next four weeks you will spend at least two hours in nature. You may complete your two hours all in one day, or broken up over the course of the week. Your two weekly hours in nature may be spent reading, listening to music, listening to audiobooks or podcasts, or simply sitting and observing. We ask that you do not use email, text messaging, or voice calling during your two hours, unless an emergency arises. We also ask that you spend this time alone and sitting still. You can choose to stay on campus, or go to another natural setting, be it a backyard with lots of greenery, a favorite park, or elsewhere.

Attached you will find a campus map of areas (circled) that are ideal for spending time in nature. You are not limited to these areas, but please spend your two weekly hours somewhere with minimal mechanical noise, that is uncrowded, and where you have lots of nature to look at and listen to.

****Please send a weekly time-stamped photo of yourself at the UCR garden to the researcher along with your unique ID number. You may email the photo to XYZ@gmail.com, or text it to the researcher at (XXX)-XXX-XXXX. To earn an entry into the drawing, you must send your photo by Sunday each week.****

Appendix F: Handout for Film Group

The purpose of the Healthy Activities Make Healthy Students Study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by engaging with a social group on a regular basis. Thus, we will be meeting on a weekly basis over the course of four weeks to watch and discuss short films. Every week, you will attend one film screening, and participate in a 30 minute discussion of the film with your peers. We ask that you please attend the same time every week. Please contact the principal investigator if a conflict arises. You can do so via email to XYZ@gmail.com, or by phone at XXX-XXX-XXXX.

You have signed up to attend film screenings:

on _____ from _____.
(day) (time)

Film screenings will take place in room 3136 of the Psychology building in Weeks 5-8 of the quarter.

Please send a weekly time-stamped photo of yourself at the UCR garden to the researcher along with your unique ID number. You may email the photo to XYZ@gmail.com, or text it to the researcher at (XXX)-XXX-XXXX. To earn an entry into the drawing, you must send your photo by Sunday each week.

Appendix G: Handout for Indoor Gardening Group

The purpose of the Healthy Activities Make Healthy Students Study is to assess the effectiveness of health interventions. One means of encouraging growth and thriving is by helping another living thing, such as a plant, to grow. Thus, for the next four weeks, you will take care of indoor, edible plants.

Below, you will find instructions for care of your plants. Please follow the instructions to help your plant thrive. Remember to take a time-stamped photo once a week and send it to the researcher.

Radishes

- Let soil dry between watering, but do not leave dry for more than a day or two. (Water approximately ½ cup every 3-4 days when there is plentiful sunshine.)
- Allow 6 or more hours of direct sunlight a day.
- After plants have grown to about 1 inch in height, thin plants to about 2 inches.
- Radishes should be ready for harvest in about 4-5 weeks. Store harvest radishes in a plastic bag in the refrigerator

Basil

- Keep basil well watered, but allow soil to dry between watering. (Water approximately ½ cup sections every 3-4 days when there is plentiful sunshine.)
- Basil likes as much sun as possible.
- Pinch off the center shoot of the basil after it has grown for several weeks to force side growth and to prevent early flowering.

- Harvest leaves as the plant starts to bud. Be sure to pinch off flower buds to keep the plant productive.

****Please send a weekly time-stamped photo of yourself at the UCR garden to the researcher along with your unique ID number. You may email the photo to XYZ@gmail.com, or text it to the researcher at (XXX)-XXX-XXXX. To earn an entry into the drawing, you must send your photo by Sunday each week.****