

Towards well-being: what are the effects of the
sensory garden on 'apparently well' people and
could it be a viable self-help tool for staff and
students on campus?

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ATTESTATION OF AUTHORSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgement is made.

Name Gayle Souter-Brown

Date 25th February 2020

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ETHICS APPROVAL

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AWARDS, PUBLICATIONS AND CONFERENCE PRESENTATIONS FROM THIS PHD THESIS

International Sport and Culture Awards 2018, Copenhagen, *Joint runner up*, design for healthy, active lifestyles 'MOVEment Spaces'

Peer-reviewed Journal Publications

Chapter 2 of this thesis represents an individual paper that was submitted to a peer-reviewed Journal and accepted for publication.

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Activity and Nutrition Aotearoa conference, Wellington, November 2017.

Preliminary findings were reported in:

The Listener magazine, *It's only natural*, pp 34 – 35 April 27 – May 3, 2019,

Stuff, online news report, Felicity Reid, *University's sensory garden improves health and combats stress*, May 2018,

New Zealand Gardener magazine, *Should doctors prescribe gardening?* pp 24 – 29, January 2018,

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AUT, online video, January 2018.

ABSTRACT

In New Zealand, chronic stress impacts staff and student well-being, productivity, relationships and behaviour. Stress recovery and attention restoration theories assert a need for nature connection. Internationally, many mental health treatment programmes are now nature-based. The Swedish University of Agricultural Sciences Alnarp, developed an evidence-based rehabilitation garden on campus as part of a horticulture therapy programme to treat people referred for burnout and depression. In UK, South Africa and Australia, hospitals and other health-related facilities use sensory gardens, which include texture, colour and fragrance, to promote well-being. While such sensory and therapeutic settings effectively reduce stress, they require the expense of a trained professional to facilitate the experience. Referencing sensory and therapeutic gardens, this research sought to understand whether salutogenic design of an unfacilitated place for nature connection is an effective stress-reducing health promotion tool for 'apparently well' people in a workplace setting.

The multidisciplinary investigation incorporated health, landscape design and ecology to compare a biodiverse, wildlife-attracting sensory garden (SG) with ubiquitous urban open space (Awataha Plaza (AP)), at a University campus in Auckland, New Zealand. The mixed methods research comprised two studies. A randomised controlled trial (Study 1) enriched by qualitative data tested effects of environmental design on salivary cortisol and indicators of well-being. 'Apparently well' (n = 179) 18-65-year-old staff and students were randomised into two intervention groups, SG (n=60) or AP (n=60), and a control. Participants had a monitored 'appointment with nature' for 30 minutes once weekly for four weeks. The control group participated in data collection only. Study 2 tested the sustainability of the garden as a self-care tool. All participants could access the SG for 30 minutes once weekly for four weeks. Participants were tested pre and post intervention and monitored in the field. SPSS was used to analyse laboratory and survey data and generate generalised linear models. Themes were induced through Thematic Analysis.

Study 1 showed positive effects of time spent in the SG and trends towards negative effects of the AP. Significant differences were observed in the Garden group post intervention in cortisol -16.1% (95% CI: -32.0%, 0.2%; p = 0.04), well-being 6.9% (95% CI: 2.7%, 11.1%) and productivity 2.8% (95% CI: 0.1%, 5.5%, p < 0.05). Similarly, participants perceived improved

social connection, improved cognitive function, felt more in control, ate more healthily and exercised more in their leisure time. In Study 2, participants previously assigned to the garden group in Study 1 showed significantly higher voluntary attendance rates (90%) than participants originally assigned to the Plaza (84%) or Control (83%) groups ($P < 0.05$).

This study suggests that ecological health is linked with human well-being. Spending time in a salutogenically-designed environment protects against stress and promotes well-being in a way that simply being outdoors or taking time out in a planted plaza does not. Participants valued the accessibility of the self-care environment. A positive effect was seen regardless of age, sex and culture. The university provided an effective setting for health promotion, with the sensory garden supporting staff and students towards well-being.

Chapter 1 INTRODUCTION

The environment is under pressure as never before; so too is human health and well-being (Cook, Howarth, & Wheeler, 2019; Schäffler & Swilling, 2013). Stress is a feature of 21st century lifestyles (Weiten, Dunn, & Hammer, 2015). The effects of prolonged (chronic) stress impact workplace well-being, manifested through reductions in productivity and social connection, and increasing rates of lifestyle-related disease (Noblet & LaMontagne, 2006). Health promotion is considered necessary to combat the social and economic cost of stressed workers (Bousquet et al., 2011). As a potential intervention to reduce chronic stress, salutogenesis is a medical methodology that focusses on factors to promote and support human health and well-being, rather than on causes of disease (Mittelmark & Bauer, 2017). A salutogenic landscape design approach acknowledges and incorporates contact with nature as a health promotion intervention. Nature connection is known to be an effective option for 'upstream' health promotion, to provide a protective and therapeutic 'ambulance at the top of the cliff' (Maller, Townsend, Pryor, Brown, & St Leger, 2006). Less well understood is the effect of places for nature contact in the workplace. A well-designed sensory garden can provide a nature connection point to reduce stress and boost health and well-being (Souter-Brown, 2015). Auckland University of Technology, as a large-scale employer, was utilised as a workplace where this research was conducted. This thesis utilised design research to explore the effect of a sensory garden, as a self-help tool to boost well-being.

1.1 BACKGROUND

Health, including both mental well-being and physical health, is impacted by a range of social, economic, environmental, physiological and psychological factors (Allen, Balfour, Bell, & Marmot, 2014). The current paradigm, a deficit-based approach, has medicalised health to focus on causes of disease (Crisp, 2020). Causes of health inverts all medical training but offers a new way of thinking, to unlock the potential of people and place (Crisp, 2020). Place is important, with up to 70% of health created in the community (Mason, 2020). Chronic stressors in the community, workplace, home or school may detrimentally affect mental or physical health (Fisher & Baum, 2010). Intuitively, people have understood that time in nature is restorative since ancient times (Cooper Marcus & Barnes, 1999). More recently, research interest in measuring the restorative potential of nature has grown. Roger Ulrich measured

the response to a green view (Ulrich, 1984), which spawned research on the response to a nature connection away from the stressful situation, through visits to natural environments such as parks and forests, or outdoor activity programmes such as gardening or therapeutic horticulture (For example see (Morita et al., 2007; Schnell, Harel, & Mishori, 2019; Shanahan et al., 2016; Soga, Gaston, & Yamaura, 2016; Stigsdotter, Corazon, Sidenius, Refshauge, & Grahn, 2017; C Ward Thompson, Aspinall, Roe, Robertson, & Miller, 2016; Wood et al., 2018)). This thesis posits that to reduce chronic stress and hence enhance health and well-being, sensory-rich nature connection points, as low-cost high-impact environments, could effectively be 'designed in' to settings through attention to ecological well-being.

1.1.1 What is well-being?

This study considers well-being from a health promotion perspective. The World Health Organization (WHO) (2014, 2019a) emphasise well-being as mental health where "every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community." This is integrated with the Organization for Economic Cooperation and Development (OECD) (2015, 2019) framework that includes material conditions, quality of life and sustainability. Well-being is also captured by the United Nations Sustainable Development Goal #3 'good health and well-being' (United Nations, 2020). The aggregated 'good mental states' are combined into a sense of psychological well-being, expressed as human flourishing. Well-being thus connotes happiness, contentment, productivity and prosperity, as well as the absence of negative determinants in the life of an individual or a community (World Health Organization, 2019a).

1.1.2 What is salutogenesis?

Health promotion is at the heart of salutogenesis. In his book, 'Health, stress and coping', Antonovsky (1979) sets out his conception of elements necessary to maximise health. The sense of coherence inherent within the salutogenic model is instrumental in managing stress and hence promoting an individual's ability to cope with life experiences (Mittelmark & Bauer, 2017). A salutogenic approach has been embraced by a range of disciplines, from public health to urban planning, landscape design to mental health (M. Eriksson & Lindström, 2008; Souter-Brown, 2017; Stoltz & Schaffer, 2018; von Lindern, Lymeus, & Hartig, 2016). This study

contends that environmental design can offer measurable stress reduction, through the employment of a coherent landscape that activates and integrates the senses.

1.1.3 Why is it of interest?

Attention on well-being as a health promotion tool is now encapsulated within all policy in New Zealand /Aotearoa (Treasury, 2019). The United Nations 17 Sustainable Development Goals (SDG) challenge governments to act to save the planet and to achieve sustainable, inclusive human development (Kosinska & Tiliouine, 2019). To achieve these human development goals, the WHO states that self-care can be an effective part of national health systems (World Health Organization, 2019b). However, the essence of environmental and social supports known to enhance self-care and affect well-being can achieve more than SDG3, Good Health and Well-Being (Souter-Brown, 2019). SDG13, Climate Action and SDG15, Life on Land can also be impacted.

The environment where people live, learn, work and play affects how they feel, their sense of well-being (Hartig, 1993 ; Ulrich, 1984; Van den Berg, Hartig, & Staats, 2007; Velarde, Fry, & Tveit, 2007; Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003). Perceived well-being is linked with future health outcomes (Largo-Wight, Chen, Dodd, & Weiler, 2011; Twohig-Bennett & Jones, 2018; Ulrich, 1999), mental health (Bratman et al., 2019), productivity (Johnson, Robertson, & Cooper, 2017) and social outcomes (Anderson, Ruggeri, Steemers, & Huppert, 2017). Potential future health impacts centre on the four most common non-communicable diseases (NCD)s: cardiovascular diseases, cancers, chronic respiratory disease and type 2 diabetes (Ministry of Health, 2018) and include the lifestyle related conditions: depression and obesity (Blas & Kurup, 2010). To combat potential negative outcomes, the environment can be designed and used as a prescription to improve health and well-being (Cox, Shanahan, Hudson, Fuller, & Gaston, 2018; Lowe, Boulange, & Giles-Corti, 2014). However, in rapidly-growing urban centres direct experience of nature can become rarer and the converse of poor health and well-being outcomes also true (Cox, Hudson, Shanahan, Fuller, & Gaston, 2017).

Urbanisation

The rapid increase in urbanisation, with associated environmental degradation, has given rise to sick cities (Hancock, 2011; Lowe et al., 2014; Souter-Brown, 2018). At 86%, New Zealand has had one of the highest rates of urbanisation in the OECD for some time (Statistics New Zealand, 2006). Compared to Europe, the area of publicly accessible greenspace available for nature connection in New Zealand's towns and cities is low (the highest in Europe of 68% is in Oslo, compared with the highest in New Zealand of 13% in New Plymouth (World Cities Culture Forum, 2018)). On average, in New Zealand urban parkland averages 7.3% of land area within towns and cities (range 3.5 -11.4%) (Clarkson, Wehi, & Brabyn, 2007). This compares with northern European cities that average 30% green space. Pressures of urbanisation have led to productive land cleared for housing, residential plots becoming smaller and parks and playgrounds built over. Rapid urbanisation is possibly linked to New Zealand also having one of the highest rates of depression in the OECD (Brazier, 2017). Within the WHO, programmes recognise connections between deteriorating ecological health and impact on human health and well-being (World Health Organization Europe, 2016).

Across the developed world, young and old spend less time outside than previous generations (Louv, 2012). The predominantly paved, noisy, busy, greyness of towns and cities offers little to attract people outdoors. Similarly, there may be internal or external influences exerting pressure to work indoors or stay close to a digital screen. Although overwhelming evidence links positive outcomes for health and well-being with the stress-reducing properties of the environment, a opportunities for nature connection are increasingly difficult to find.

Non-communicable disease

As well-being is linked with nature connection, experience of nature is linked with health outcomes. The WHO's recent global preventable burden of non-communicable diseases (NCDs) study expected mortality, morbidity and disability attributed to major NCDs (cardiovascular diseases, cancers, respiratory diseases, and diabetes) to reach 73% of all deaths and 60% of the global burden of disease by 2020 (Benziger, Roth, & Moran, 2016). In New Zealand, at 89%, the death rate for NCDs is already considerably higher (Ministry of Health, 2018).

Such preventable, lifestyle-related disease is considered a 'burden' because of the profound social and financial impact on the individual, their community, and the wider economy (Benziger et al., 2016; Bloom et al., 2011; Ustün, 1999; World Health Organization, 2017a). Findings from the 1996 global burden of disease study "reinforce[d] the importance of treating depressive disorders as a public-health priority and of implementing cost-effective interventions to reduce their ubiquitous burden" (Ferrari et al., 2013, p. 10). The WHO (2017a) reported that depression is the largest cause of disability worldwide. These statistics, when considered in conjunction with the broad health literature, are fundamental in establishing the need for examination of places for nature connection as a health promotion tool in urban settings.

'Apparently-well' People

People without obvious diagnoses have been coined the 'apparently well'. These people are identified as able to participate in typical daily activities and interactions. Health care and health design focus on morbidity, mortality and disability. But what of the people who are not 'in the system'? Growing economic pressures on society mean it is important to support the 'apparently well' to function at their peak (Sears, Shi, Coberley, & Pope, 2013).

Workplace well-being

In the workplace, maintaining and promoting well-being is important to success (Johnson et al., 2017; Miller, 2016; Organization for Economic Cooperation and Development, 2015). The Southern Cross Health Society, in conjunction with Business New Zealand, conducted a study reported in the Institute of Director's magazine (2017) that found New Zealand's low productivity was related to stress as it impacted workplace well-being. Although stress is recognised as a problem in New Zealand, as internationally, the incidence continues to rise at unsustainable rates, affecting the economy. While stress can be a positive influence, for example when it triggers a 'fight or flight response' when exposed to danger, prolonged stress is related to multiple health conditions (Benziger et al., 2016). Stress is one of the strongest risk factors for depression (Bogdan & Pizzagalli, 2006), and is associated with NCDs such as diabetes (Wellen & Hotamisligil, 2005), heart disease (Cooper & Marshall, 1976) and cancer (Reuter, Gupta, Chaturvedi, & Aggarwal, 2010). The World Economic Forum stated as early as 2011 that internationally, government health programmes cannot sustain the increasing

numbers of those affected by chronic stress (Bloom et al., 2011). In New Zealand, low productivity and poor mental health put particular pressure on the tax base, the ‘apparently well’ who are currently working, and the next generation who will be soon (Nolan, Pomeroy, & Zheng, 2019).

1.1.4 How can well-being be impacted?

Well-being is a complex, multi factorial blend of elements related to health, work, home, family and fun. When life is going well, those elements are in balance (Organization for Economic Cooperation and Development, 2013). Historically, social, emotional, spiritual and physical elements of well-being were provided free-of-charge by nature. Today, instead, care workers, pharmaceuticals, food additives and gym equipment providers offer a synthesis of what was once provided through direct experience (Biglan, Flay, Embry, & Sandler, 2012). When the environment where people live, work, learn and play is unhealthy or experience of nature is inaccessible, well-being can be impacted.

Nature disconnection, a cultural shift

A cultural shift reflects changes in beliefs, behaviours and outcomes (Kambil, 2019). As a backdrop to a growing disconnection from nature, over the last 30 years two significant cultural events have occurred:

The first event featured changed beliefs around family structures as the pace of urbanisation increased. Extended families living in close-knit rural communities moved to the relative isolation of the nuclear unit in the city. The effect of this can be dissected into three parts: *Firstly*, the costs of suburban/city living required long work hours, long commutes, reduced leisure time and created increased stress, posited as influencing depression rates (Banerjee, 2012). *Secondly*, the advent of the digital age has seen people connect with media devices and disconnect from nature (Louv, 2012). *Thirdly*, the rise of the self-esteem movement saw a fundamental shift from the outcomes approach (raising a child / student to be resilient, responsible and resourceful) to valuing personhood (e.g. raising a student to be aware of their rights, which in turn gave rise to the “me” generation) (Lythcott-Haims, 2015).

The second event changed behaviours. When both parents entered the workforce in record numbers, they struggled to find time to allow for children to play freely outdoors (Louv, 2005).

At the same time, the 1980s rise of televised crime against children brought a fear of strangers (Altheide & Michalowski, 1999). Combined with lack of time and a competitive workplace, parents began scheduling play. Day care for younger children then morphed into tutoring and other organised after-school activities for older children (Louv, 2005). As a result, students entering university today may have had little time to connect with nature during a structured, focussed childhood (Louv, 2010).

At the same time as the cultural shift away from experience of nature was occurring, a change was observed in young adults' health and well-being outcomes. In the UK, teenage rates of depression and anxiety increased by 70% since the mid-1980s, particularly in the past 25 years (YoungMinds, 2016). A similar picture is seen in NZ where youth suicide, anxiety disorders, eating disorders, behaviour problems and obesity increased as social skills, problem solving and personal resilience deteriorated (Disley, 1997; Lewis, 2019). Research by architects, eco-psychologists, foresters and economists hinted at a potential 3-way link between cultural changes, access to nature and health and well-being (Konijnendijk, 2008; Ulrich et al., 1991; Velarde et al., 2007). Their studies showed stress reduction, attention restoration and general health improvements follow exposure to a green (nature) view.

Stress

Stress can be positive. All life forms have evolved mechanisms to manage it and indeed some people consciously seek the biological response as when skiing, riding on roller coasters or watching horror films. However, this study is focussed on negative stress. Prolonged elevated stress levels are linked with a variety of negative outcomes, through conditions such as depression and anxiety (Friedrich, 2017) and non-communicable diseases (NCD)s such as some cancers, heart disease, type 2 diabetes (Benziger et al., 2016).

Reported levels of stress in the community have risen while natural environments have diminished and rates of urbanisation have increased (Beil & Hanes, 2013). Many towns and cities have lost both places to experience nature and the associated sense of wildness, for example wildflowers, long grass, unmanaged environments, and places of quiet serenity (Beil & Hanes, 2013). Urban health and well-being has been impacted as the quality and availability of green space has reduced (Nieuwenhuijsen, Khreis, Triguero-Mas, Gascon, & Dadvand, 2017). In response, programmes to activate optimal health, using many modalities, are now

mainstream (Brandling & House, 2009; Fjorback, Arendt, Ørnbøl, Fink, & Walach, 2011; Patel, Schofield, Kolt, & Keogh, 2011; von Lindern et al., 2016). Nature-based interventions offer peoples of all cultural backgrounds an opportunity to rest, reflect and restore (Bratman, Daily, Levy, & Gross, 2015; Grahn, van den Bosch, & Ward Thompson, 2017; Mangone, Capaldi, van Allen, & Luscuere, 2017; Selhub & Logan, 2012).

Exposure to urban greenspace for an experience of nature

Leveraging the evidence and to meet the growing need for stress-reducing interventions, biologist E.O Wilson's biophilia hypothesis, and the general notion that nature is good for well-being, has become a popular instrument in fashioning functional urban design (Geoffrey, Reeve, Desha, Hargreaves, & Hargroves, 2015; Joye, 2007; Ryan, Browning, Clancy, Andrews, & Kallianpurkar, 2014). Wilson believed that an innate love of living things is a necessary part of being human (Wilson, 1984). Kaplan's Attention Restoration Theory (ART) and Ulrich et al Stress Restoration Theory (SRT) took the biophilia hypothesis further and posited that time spent in nature is protective; it promotes and enhances health and well-being (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Ulrich, 1981, 1999; Ulrich, Kellert, & Wilson, 1993).

Contact with nature is recognised as useful in prevention of mental health and lifestyle-related physical health conditions (Canadian Mental Health Association, 2016; Maller et al., 2006; Waitemata Primary Health Organisation, 2016; World Health Organization Europe, 2016). However, urban greenspace is generally designed and managed to provide a 'green' view, but with little attention to the wonder and wildness of flowers, fragrance and wildlife representative of ecological health (Ignatieva, Meurk and Stewart, 2008).

Studies have also shown that exposure to natural environments enhances the ability to recover from stress, illness and injury, and provides a wide range of social, psychological, and physiological benefits (Corazon, Nyed, Sidenius, Poulsen, & Stigsdotter, 2018; Ewert & Chang, 2018; Hunter, Gillespie, & Chen, 2019; Largo-Wight et al., 2011; McAllister, Bhullar, & Schutte, 2017; Selhub & Logan, 2012; Wang, Rodiek, Wu, Chen, & Li, 2016). "Interventions to increase or improve urban green space can deliver positive health, social and environmental outcomes for all population groups... There are very few, if any, other public health interventions that can achieve all of this (World Health Organization, 2017b, p. 5)". A connection with nature has been found to be a vital, albeit often unconscious, component of well-being. The

challenge has been, what sort of nature contact is needed and how is it designed and managed in practice? Does nature contact include a sense of the wild and wilderness, through connection with varied forms of wildlife, and / or organically managed freely growing plants, or is a formally structured and managed environment sufficient to promote health and well-being?

Urban greenspace was introduced to Western towns and cities through urban planning to aid public health in the late 1800s. Greenspace offered a space where people could pause, switch off from the everyday 'noise' of the city and connect with nature. Maintenance was manual, weed and pest controls were chemical-free, and labour was cheap. Healthy soils supporting a biodiverse mix of large trees, flowers and water features were included in design and management plans. Over time, as labour became expensive and budgets reduced, flowers and water were often removed from plans, large trees replaced with smaller, lower-growing varieties, soil paved over, or land sold. In addition, with the advent of inorganic weed and pest control, chemicals were added, to plants, soil and water. Once the health-giving properties of urban greenspace were degraded, the varied parks and gardens initially designed to promote public health no longer had the same effect.

Sensory garden

Sensory gardens are wellness gardens, designated as places for urban nature connection. They have the potential to help mitigate many of the health issues surrounding chronic stress (Keniger, Gaston, Irvine, & Fuller, 2013; Shanahan, Fuller, Bush, Lin, & Gaston, 2015), with verifiable links between exposure to nature and health and well-being benefits (Hough, 2014; Keniger et al., 2013; Shanahan, Fuller, et al., 2015). Although, traditionally, they have been designed for adults and children with sensory impairment, (Cooper Marcus & Barnes, 1999; Detweiler et al., 2012; Hussein, 2010b), sensory gardens can be enjoyed actively or passively, by people with and without diagnoses, able-bodied and less-able alike.

Since ancient times, restorative landscapes have been a feature of human settlement. Intentionally richly planted, they offered four key features: serenity, contact with nature, space and a sense of refuge (Figure 1-1). The essence of a sensory garden is recognised in Buddhist monastic gardens, Islamic paradise gardens and Christian monastic gardens. Each offered an enclosed sanctuary from the world outside, appropriate to the culture and in

response to the wider landscape (Buijs, Elands, & Langers, 2009). Traditionally they were divided into four balanced quadrants. The harmonious form was used to create a sense of order and peace, required for healthy, creative thinking.



Figure 1-1 An ancient sensory garden, from Pompeii, with surrounding cloister providing refuge. A central area allowed walking and relaxation, with water feature and fragrant and edible plants

In New Zealand, indigenous Māori beliefs of well-being encompass five interconnected aspects; namely, mind, body, spirit, family and land (Mark & Lyons, 2010). Indigenous models of health, such as Te Whare Tapa Whā (Ministry of Health, 2017b) show the importance of connection between people of the land (tangata whenua) and the land itself (whenua). Likewise the health and well-being benefits of people and land connection are captured within Te Pae Mahutonga model: Mauriora (cultural identity) stemming from Waiora (physical environment), with Toiora (healthy lifestyles) flowing to Te Oranga (participation in society) are shown as key to Māori health promotion (Ministry of Health, 2017a). Humans and nature are intrinsically linked (Whitt, Roberts, Norman, & Grieves, 2008). As such, 'sensory gardens' did not exist as the land was not somewhere to 'visit' but an essential part of well-being (Mark & Lyons, 2010). Traditionally, well-being, thinking oneself well, came from a connection with nature, in nature as an extension of oneself, as an essential part of being (Mark & Lyons, 2010). With New Zealanders of all cultural backgrounds largely disconnected

from the land, with concomitant deterioration in indicators of well-being, sensitively located sensory gardens may offer an opportunity to reintroduce nature, serenity and a sense of refuge.

Contemporary sensory gardens are wellness gardens, designed for passive enjoyment. Unlike therapeutic and healing gardens, sensory gardens are specifically designed to stimulate and engage several senses (at least four of the five if not more, such as proprioception). Any tension between the terms sensory, healing and therapeutic gardens is perhaps explained through a recognition that any garden can offer sensory delight. In the same way, any garden can be 'therapeutic', and a community garden can be healing. However, therapeutic gardens tend to be associated with healthcare settings and designed to achieve a specific outcome, which often involves a programme of activities. Sensory gardens, as enclosed, nature-rich, wildlife-attracting and hence naturally sensory-rich places, offer unprogrammed innate sensory delight. Historically, sensory gardens were designed in settings principally for the sight impaired. More recently, designers and health commissioners have seen their potential to reduce stress in general health-related settings. However, a sensory garden has always sought to promote wellness, regardless of any presence or absence of diagnosis (Burton, 2014). Over the past 20 years, the evidence base for sensory gardens has grown, from applications in children's hospitals and special needs schools, to residential dementia care units (Hussein, 2010b; Uwajeh, Onosahwo, & Mukaddes, 2019; Whitehouse et al., 2001). The sensory garden makes elements of nature and the surrounding landscape accessible (Ellis, 2011).

1.1.5 What sort of design might best provide relief from stress, promote well-being and enhance productivity?

Despite an established link between green space and health (World Health Organization, 2017b), little is known outside of a healthcare setting of the effect of specific environmental design typologies on well-being. Disconnection from nature and the self may have contributed to a reliance on technology and facilitated (supplied by a trained professional) health-related interventions. Demand increasingly outstrips supply of doctors, nurses and psychologists, and many people cannot afford the cost of care or do not want the stigma of asking for help (World Health Organization, 2019b). Sensory gardens, as nature-rich green

spaces, are known to reduce stress and promote well-being in healthcare settings. Could they also benefit 'apparently well' people?

As a therapeutic tool, sensory gardens are principally used to relieve stress, anxiety and depression. Hospitals, aged care homes, mental health care facilities, special needs schools and settings for young and old living with sensory impairment use sensory gardens within their treatment programmes (Gonzalez & Kirkevold, 2014, 2015; Grahn, Pálsdóttir, Ottosson, & Jonsdotti, 2017; Grahn, van den Bosch, et al., 2017; Hussein, 2010b; Whitehouse et al., 2001). Building from the scientific evidence base and design practice experience, a sensory garden could provide a setting to enhance well-being for people without obvious diagnoses, the 'apparently well'. Despite existing evidence supporting the need for nature connection for health and well-being, on university campuses stress levels are rising (Lawton, 2019; Watts & Robertson, 2011) and ecological values are degraded through a proliferation of built structures, or at-best maintained (McFarland, Waliczek, & Zajicek, 2008). A solution is not readily apparent. However, by shifting the question from what is wrong to what works well, this study aimed to find a solution to a multi-factorial problem by research through design.

Evidence base

Supporting this thesis is a growing body of evidence that suggests that nature generally, and living and working environments in particular, have a profound effect on human health and well-being (Dadvand et al., 2015; H. Frumkin, 2008; Soga, Gaston, & Yamaura, 2016; Ulrich, 1984). To promote health and well-being, what is currently missing from the literature is how the designer can best facilitate nature contact within the urban setting.

Physical space, or the environment in which people live, work, learn and play, is recognised as a potential accelerant towards well-being (Bogdan & Pizzagalli, 2006; Corazon et al., 2018; Fischer & Boer, 2011). In educational as in workplace settings, an individual's well-being impacts outcomes. To enhance outcomes, measurable improvements in well-being may be able to be 'designed-in' (Learning Through Landscapes, 2003). With the downstream burden of stress on NCDs rising at unsustainable levels, and a mandate for well-being prioritised through the New Zealand Budget (Treasury, 2019), a new design focus on well-being is needed. Leveraging sensory gardens as a recognised place for nature connection (Bernez et

al., 2018; Ellis, 2011; Gonzalez & Kirkevold, 2014; Grahn, Pálsdóttir, et al., 2017), this research investigated the ability of a sensory garden to promote wellness on campus.

1.1.6 Settings-based health promotion

Against a background of urbanisation, with concurrent diminished opportunities for nature connection and rising stress, settings have a role to play in tackling and preventing stress (Kosinska & Tiliouine, 2019). Twenty years ago, the WHO suggested that universities could develop into model health-promoting settings (Tsouros, Dowding, Thompson, & Dooris, 1998). However, New Zealand universities, like 'sick cities' and universities overseas, still struggle with mental health issues (Benedictus, 2014; Lawton, 2019; Lewis, 2019). While on-campus well-being programmes exist, stress among students (Lawton, 2019) and staff burnout is increasingly common (Watts & Robertson, 2011). At Auckland University of Technology (AUT), while gym classes, mindfulness classes, yoga and counselling are available, prior to development of the sensory garden, all options required a trained facilitator, the free options focussed on treatment and prevention options were supplied as paid services. The university as the hoped-for model health promotion setting has not happened, potentially for two reasons. Firstly, university managers have not formally recognised a link between well-being and academic output. Secondly, mental health initiatives do not acknowledge links between ecological health and human well-being. This study aimed to explore the second link, between ecological and human health, to aid understanding of the first.

1.2 PROBLEM DEFINITION

While much work has been done in the area of connecting health with environmental design, there is still a disconnection between empirical knowledge, perception and belief. Although diverse settings have, increasingly, heard of the benefits of landscape interventions to enhance staff, patient, student or residents' wellbeing and request sensory gardens by name, such client knowledge is far from mainstream. Similarly, on the design side, research and practice utilising nature to achieve health goals is uncommon (Abraha et al., 2017).

Although experience of nature is considered vital for well-being (Bell, Westley, Lovell, & Wheeler, 2017), Western society has increasingly disconnected, at a time when, arguably, it most needs to be connected to the environment (Louv, 2005, 2012). In New Zealand, the

statistics show well-being is under stress, with depression and low productivity negative features within national health data (Ministry of Health, 2018). At the same time, the urban environment, including air quality, acoustics, tree cover, water bodies and city beaches, is increasingly degraded. Universities provide a useful model to study as they are large-scale employers and attract tens of thousands of students. Recent media reports that student stress and suicide are increasing in New Zealand (Lewis, 2019) support wider international concerns over staff and student stress (Oseyomon, 2015; Watts & Robertson, 2011). While New Zealand's health and safety legislation requires organisations to protect workers from harm and foster and support well-being (F. Barton, 2019), there is little data to show how to improve well-being through a health-promoting nature connection in the workplace.

1.2.1 Rising stress on campus

With stress levels rising on campus (Lawton, 2019), a well-being-promoting intervention that is inexpensive to develop and maintain, does not require a trained facilitator and can affect more than one person at a time, is needed. In an urban setting, it can be difficult to find spaces and places to connect with nature. Cities are noted for paved plazas, which may or may not include areas of trees, grass or shrubs. Plazas are considered desirable as the paving is hard-wearing, they can be traversed by mobility assistance devices, require minimal maintenance, can be hosed clean or vacuumed by mechanical sweepers (Hargrove & Dillon, 2009). "A well-designed plaza or terrace not only reduces upkeep costs, it also attracts tenants, increases property value, and enhances outdoor space" (Hargrove & Dillon, 2009, p. 1). In contrast, sensory gardens generally feature accessible yet soft, porous, surfacings, such as grass, bark, shell, non-mortared pavers, sand and gravel (Hussein, 2010a). Trees and flowers are planted in abundance, with an emphasis on colour, fragrance, texture, seasonal interest and wildlife attraction. Sensory gardens offer an urban setting in which to connect with nature, with potential to boost positive mental health (Ellis, 2011).

1.3 RESEARCH QUESTION

What is the effect of a sensory garden on 'apparently well' people and could it be a sustainable self-care tool for staff and students on campus?

1.3.1 Design research

The study's design research connected and integrated knowledge from the arts and sciences to explore a suitable design approach to promote well-being. The research recognises diverse foundations for the established evidence. To effectively take well-being into account within spatial planning requires an acknowledgment of nature's restorative and healing powers. Being outdoors and active gardening heightens feelings of tranquillity, spirituality and peace (K. Kaplan, 1995,2002). Using integrated systems thinking and working across a multi-disciplinary evidence-base, design challenges can be approached from a coordinated 'joined-up thinking' perspective.

1.4 THESIS RATIONALE

Why sensory gardens for 'apparently well' people in the workplace?

Lifestyle medicine practitioner Garry Egger stated that "We have spent our time and resources on noble efforts to resuscitate the canary while paying no mind to cleaning out the mine shaft" (Selhub & Logan, 2012, p. 213). For too long, design research and practice has focused on 'resuscitating the canary'.

This thesis contends that New Zealand's workplaces are the 'mineshaft' that need attention. The 'canary' is the status quo design paradigm. With the shrinking tax base of an ageing society it is important to explore ways to keep 'apparently well' people feeling well and prevent them from becoming ill. Urban green space can have a considerable effect on health, well-being and productivity related outcomes (Aavik et al., 2017; Carrus et al., 2015; Donovan, Gatzolis, Longley, & Douwes, 2018; Ely & Pitman, 2012; Schnell et al., 2019; Sonntag-Öström et al., 2015; Southon, Jorgensen, Dunnett, Hoyle, & Evans, 2018). However, New Zealand's unique biota and cultural heritage have created urban landscape design and management practices that favour a restricted plant palette. Such limited biodiversity in places for contact with nature affects psycho-social and physiological perceptions of and response to the space. Although potentially challenging to established practice, with rapid biodiversity loss and issues around climate change looming it was timely to apply a new lens to the case for biodiverse sensory gardens in the workplace.

In Sweden, the Swedish Agricultural University at Alnarp developed a sensory-rich therapeutic garden on campus, designed to treat patients suffering from burnout (Stigsdotter & Grahn, 2003). The fully-facilitated, caregiver-assisted, treatment intervention is effective (Adevi & Lieberg, 2012). This thesis was motivated to discover whether nature connection, through an un-facilitated sensory garden intervention, could be used to promote positive mental health.

1.4.1 Aims and Originality

The overarching purpose of this research was twofold: firstly, to produce new knowledge to help university staff and students mitigate the stress of academic life to enhance well-being and productivity. Secondly, to generate knowledge for people who administer, develop and maintain the university campus, to determine whether a sensory garden could be a sustainable self-care tool to aid staff and student well-being on campus. Using the university as a workplace setting, this study applied a multidisciplinary lens to joined-up design thinking as a coordinated distribution of knowledge to consider the context in which the design sits (Corburn, 2004; Lowe et al., 2014).

Aims

1. To develop a sensory garden as a salutogenic environmental design intervention on Auckland University of Technology (AUT) North Shore campus
2. To determine the effect of regular exposure to a sensory garden on staff and students' stress levels, well-being and productivity
3. To determine whether use of the sensory gardens offers a sustainable self-care approach for maintaining mental health and productivity of staff and students at AUT
4. To explore environmental design preferences to enhance mental health and productivity in a tertiary education setting

Originality

This study was the first to take sensory gardens out of the facilitated, health-related setting into evidence-based design for well-being in the community. It was also the first in New Zealand to design and develop a specially designed 'living laboratory', an evidence-based

sensory garden designed to address multi-sectoral knowledge gaps. The innovative multi-disciplinary health research through design approach allowed comparative environmental designs to be assessed through a randomised controlled trial (RCT).

Design research generally emphasises user response, by way of ‘post occupancy evaluations’ (Perkins and Will, 2013). This design research was novel in that it first established baseline data within a broad range of physiological and psycho-social measures. Environmental design interventions are usually conducted in summer (Laursen, Danielsen, & Rosenberg, 2014). This study was unique in that the RCT was conducted during winter, included both staff and students as study participants, and was the first to directly compare the effect of a plaza with a sensory garden.

Significance of the research

While other studies have examined links between greenspace and stress, and some have measured the effect of nature experience on cortisol, no randomised controlled trials or mixed methods studies of campus greenspace have been found. Further, this research was the first to take the results of the RCT and then test the practicality of the intervention in real life as a self-care tool. Few field experiments have used sufficiently large samples to elicit statistically significant findings. This study’s data were enriched by trained Research Assistant and participant observations throughout the two Studies. As such this research offers more detail than previous studies.

No other research has been found that synthesises design, health and urban ecology from a design perspective. In doing so, this study aimed to make a distinct contribution to collective efforts to build the cumulative evidence base for effective ways to boost well-being.

1.4.2 Choice of participants

The study covers ‘apparently well’ staff and students. People aged between 18 and 35 years, engaged in study or work within the university, were initially recruited to the study. Originally it was thought that over 35-year olds would have better coping strategies, and so may bias the results (Waitemata Primary Health Organisation, 2016). However, it became apparent that to be representative, to determine any effect on the workplace community, the upper age limit needed to be extended. Although there is no official retirement age, the national

pension age of 65 years was chosen as the upper age limit, to include students and staff as broadly indicative of a New Zealand workplace. Ethics Committee approval was sought, and once granted, the upper age range was extended to 65 years. Research participants were recruited from AUT North campus through posters on the shuttle bus and around the campus, through internal and external university websites, through social media and by word of mouth.

Although North campus houses the Faculty of Health and Environmental Sciences (FHES) and the School of Education, participants came solely from within the FHES Schools of Clinical Sciences, Interprofessional Health Studies, Public Health and Psychosocial Studies, Sport and Recreation. School of Education staff and students were made aware of the project but chose not to participate.

Note: all names used in this document have been changed to protect the privacy of individuals.

Delimiters

As a response to the medicalisation of health, the study tested the viability of the intervention as a self-care tool. In leveraging salutogenesis to design for well-being, the study limits its scope to 'apparently well' people in the university as a workplace setting. As such it does not cover dementia, clinical depression, or deprivation. They have been studied elsewhere.

1.4.3 Choice of measures

Measures chosen are explored in depth in Chapter 4. They are introduced here to explain how they aided the research.

To build the evidence base for design to promote health and well-being, it was important for the study to use rigorous tools. A randomised controlled trial (RCT) is considered best practice in health research, as it reduces bias by measuring effect of an intervention against a control (Hariton & Locascio, 2018). In this case the RCT used two designed intervention sites, one new and one existing, and the control, studying causal relationships between interventions and outcomes to deepen understanding of the effect of environment across a range of outcomes.

To determine whether a sensory garden could be effective to promote health and well-being in 'apparently well' people, outcomes of interest were: salivary cortisol, perceived stress, perceived well-being. Salivary cortisol levels are a useful biomarker that offer an ecologically meaningful measure of chronic stress: diurnal cortisol patterns reflect everyday circadian rhythms of health and longer term effects of stressors in the social and physical environment (L. Li, Power, Kelly, Kirschbaum, & Hertzman, 2007). To understand whether people who were predisposed to nature were likely to show positive effect, nature relatedness was included as an outcome measure. To determine whether any positive effect may influence workplace outcomes, a measure of perceived work output was included. These quantitative measures were supplemented by qualitative data. To appreciate the potential subtleties of a sensory garden experience, it was important for participants to tell their story. They were given opportunities to do this through diaries, a comments section in the survey questionnaire, through one on one interviews, focus groups and through direct conversations with trained Research Assistants and the researcher. Measures were designed to fill knowledge gaps.

1.4.4 Choice of design

To ensure a robust design, as this research sought to evaluate a tool used in healthcare settings out in the community, it was appropriate to acknowledge both the rigour of quantitative measures within the objectivity of a randomised controlled trial (RCT), and the value of qualitative enquiry. This research therefore chose a mixed methods approach. Mixed methods, while recognising the importance of the primary outcome, cortisol, gave meaningful voice to the experience of the study participants.

The intervention was designed to test what type of urban space or place is needed to ensure health and well-being. Shanahan et al., found that humans need a minimum of thirty minutes once a week outdoors in nature for health and well-being (Shanahan, Fuller, et al., 2015). Leveraging the established 'dose' duration of the Shanahan study, the RCT in Study 1 aimed to test whether different types of urban nature experience had different effects. The three groups, a control and two contrasting intervention groups, were chosen to explore what was needed to enhance workplace well-being (Table 1-1).

Table 1-1 Choice of research design

Group	Question	Study 1	Study 2
Control	Are normal day-to-day lifestyles enough to manage stress?	Monitored pre and post the four-week intervention period of 'doing nothing', being the normal daily life of simply being outside, walking the dog, moving from carpark to office, participating in organised sport.	To test the sensory garden's efficacy as a self-care treatment option
Awataha Plaza	Is spending 30-minutes outside to restore in a plaza effective to manage stress? Is it important to timetable 30 minutes once a week outdoors?	Monitored during, pre and post prescribed 30 minutes once per week, using an appointment system, in a ubiquitous urban space, being a predominately (>60%) paved plaza on campus, with fixed seats under trees and in the open, and boundary plantings of trees and shrubs	Participants from all previous groups could freely access the garden, Tuesday-Saturday, 8:30 am – 3:30 pm Attendance was monitored as participants were invited to spend 30 minutes once a week in the sensory garden
Sensory garden	Is being in a biodiverse sensory garden, which offers places for refuge, and an ability to modify the environment more effective at reducing stress?	Monitored during, pre and post prescribed 30 minutes once per week, using an appointment system, in the biodiverse sensory garden, with mature trees, water, edible and fragrant plants, abundant birds, water feature and flexible moveable seating	

The prescribed intervention in Study 1 was designed to test whether it was important to timetable 30 minutes once a week to rest outdoors, and if yes, whether stopping and resting outdoors in the sensory-rich species-rich environment of the sensory garden would make a difference (see Chapter 6).

Study 2 was designed to test the sensory garden's efficacy as a self-care option, with open access to all participants. The previous RCT groups allocated for Study 1 were referred to in Study 2, particularly where differences were seen in relation to attendance and well-being (see Chapter 7).

The mixed methods design aimed to bridge a language and evidence gap between built and natural environment practitioners (urban planners, architects and landscape architects / designers) and health commissioners.

A randomised controlled trial was conducted to ascertain whether there is a causal relationship between exposure to an ecologically rich natural environment, the sensory garden known as the Scholars' Garden and outcome variables (Table 1-2).

Table 1-2 Outcome measures used, why, how and when

Measure	Description	Validated Scale	Timepoints
Cortisol	Salivary cortisol as physiological stress	Salivary cortisol is sampled and analysed to detect levels, measured in nmols (Laudat et al., 1988)	To establish baseline data and follow-up any changes, all outcomes were measured at 4 time points: pre and post Study 1, and pre and post Study 2
Well-being	Perceived well-being as psycho-social measure	Flourishing Scale (Diener et al., 2010) is an 8 point scale	
Productivity	Perceived work output	Modified WHO Health and Work Performance Questionnaire (HPQ) (Ron Kessler et al., 2004), is a 15 point scale	
Perceived stress	Perceived happiness / contentment	Scale of positive and Negative Effect (SPANE) (Diener et al., 2010) is a 12 point scale	
Nature relatedness	Do people with a greater or lesser affinity for nature show difference in effect from being in contact with nature?	NR21 is a 21 point scale (Nisbet, Zelenski, & Murphy, 2011)	
Physical activity	Is positive behaviour change related to time outdoors in nature?	Visits to greenspace is a Likert scale over 3 categories	

1.4.5 Choice of analysis

The study used mixed methods to account for the range of subjective and objective effects observed and measured. SPSS software (for details, see Chapter 4) was used to generate generalised linear models to investigate dependent variables that deviated from a normal distribution. Thematic analysis was used to explore the qualitative data.

1.4.6 Definitions

Given the multi-disciplinary nature of this thesis, to avoid confusion and ensure consistency, the principle terms used are defined.

Biodiversity describes the number and variety of species found within a setting or region and the variability among those organisms. Changes in biodiversity alter ecosystem processes, which has important consequences for the effect humans derive from ecosystems (Chapin III et al., 2000).

Biophilia is used here as Wilson described: “the innately emotional affiliation of human beings to other living organisms” (Wilson, 1993, p.31).

Designer is used here interchangeably with architect. The term is taken to mean an individual working within a design practice, whether as landscape architect, landscape designer, interior architect, architect or other design professional.

Flourishing means to live within an optimal range of human functioning, one that connotes goodness, generativity, growth, and resilience (Fredrickson & Losada, 2005, p. 678). It has been linked with a host of benefits for the individual and society, including fewer workdays lost and the lowest incidence of chronic physical conditions. This definition builds on path-breaking work that measures mental health in positive terms rather than by the absence of mental illness (Keyes, 2002).

Ecosystem is used in this thesis as the network of natural biological systems which operate within a setting. Healthy ecosystems prompt nature connection.

Experience is used in this thesis to imply physically being in a space, seeing, touching, feeling, hearing, tasting.

Greenspace is defined here as a publicly accessible outdoor area planted in grass and/or trees. Different disciplines use the term loosely to describe ‘green space’ or ‘greenspace’ as parks, parkland, undeveloped land, open land or forest. The term is generally used in relation to an urban setting. The quality of the space is determined by factors such as biodiversity, perceived safety and walkability (L. Taylor & Hochuli, 2017).

Healing garden is a space designed intentionally to promote health among a certain group of patients. The garden may provide relief from the psychological distress of a disease, without altering its outcome (Burton, 2014).

Nature is defined here as all living things (plants, insects, birds, animals).

Nature connection is used within the study to describe an opportunity to experience nature and natural elements. Weather is included as experienced by viewing clouds, feeling the wind or rain, feeling warm sun directly on the skin or cool shade while under a tree.

Natural elements are those elements that have been produced without any intervention by humans. The ancient Greek philosopher Empedocles (c. 490–c. 430 BC) described them as earth, fire, wind and water. In Buddhism the four main elements are not viewed as substances, but as categories of sensory experience. Given this study's emphasis on the effect of natural sensory stimuli, it is appropriate to include weather as a fifth natural element, as a manifestation of air and water.

Place is used in this study to connote spaces known to people. Space and place are often used interchangeably. Plato's student, Aristotle's (384–322 BC), concept of place is as space which has become known to the people who give it meaning (Casey, 1997).

Plaza is a place that is predominantly (>60%) paved (Cooper Marcus & Wischemann, 1990), designed for mass public use as a transit point or place to pause. Historically, the plaza served as town centre.

Restorative environments provide measurable physical and/or psychological benefit to human health (Bratman et al., 2015). Restorative landscapes include views of hills, water, grassland or forest, to offer broad measurable benefit.

Salutogenesis comes from the Latin '*salus*' (health) and the Greek '*genesis*' (origin). By seeking the origins of health, ways to promote health and well-being rather than treat illness, salutogenesis, through a 'salutogenic' design approach, invokes design to function as an effective public health promotion tool (Antonovsky, 1996). Salutogenesis is a medical approach but balances Engel's biopsychosocial standard medical model (Engel, 1977) of pathogenic healthcare.

Sensory stimuli are elements that register within the body as inputs. Sight, sound, taste, touch and smell are the five main senses experienced by an individual and stimulated by the surrounding environment. Stimuli can be natural, digital or otherwise manufactured. While natural stimuli can be restorative, manufactured stimuli can burden an individual. When overwhelmed, a body may shut off further stimuli. Sensory deprivation describes life depleted of experience of one's surroundings.

Sensory gardens activate all the senses. Combining contemplation and restoration within a self-contained area, they concentrate a wide range of natural sensory experiences. Species-rich, sensory garden are places where one can walk barefoot, run one's hands through the soft planting, listen to birds calling and the wind in the trees, watch the play of light over different surfaces. Equally, they offer places retreat, out of view of others. A sensory garden invites exploration, whether playing, tasting plants or talking to others when previously one may not have. Components are balanced to provide sensory stimulation within a place of refuge (Hussein, 2010a).

Space is an area which allows movement. Creswell and Tuan describe space as the opposite of place, which they consider to require pause (T. Creswell, 2009 ; Tuan, 1977). Greenspace is open space planted with grass and perhaps trees, which allows for movement. A plaza is predominately-paved open space that likewise allows for movement.

Therapeutic garden or therapy garden is used in a healthcare environment as a setting for a therapy programme designed to have a specific and measurable outcome on the course of a disease (Burton, 2014).

Workplace well-being is an aggregation of well-being as defined by the WHO and OECD. Future well-being is also captured as the natural, human, social and economic capital available to sustain well-being over time. Workplace well-being includes "objective aspects" such as are observable by a third party. The aggregated indicators are captured within the Flourishing Scale (Diener et al., 2010), which measures people's self-rated success in key areas of life such as relationships and having a sense of purpose.

1.5 THESIS ORGANISATION

This thesis consists of eight chapters divided into four sections (Figure 1-1). The first section contextualises the research. A scoping literature review situates the study in its broad context of design for well-being. A systematic literature review then frames research on the effect of sensory gardens to understand where gaps in application may lie. The second section defines the experiment and describes creation of the 'laboratory'. A methodology/methods chapter outlines the theoretical basis for the research process and Chapter 5 is a case study analysis, which examines the sensory-garden-as-laboratory's design and implementation. In the third section, Chapters 6 and 7 report results from the two Studies, with qualitative and quantitative data analysis and findings included in each chapter. The concluding section draws together the various theoretical and empirical strands to offer a practical discussion of significant findings.

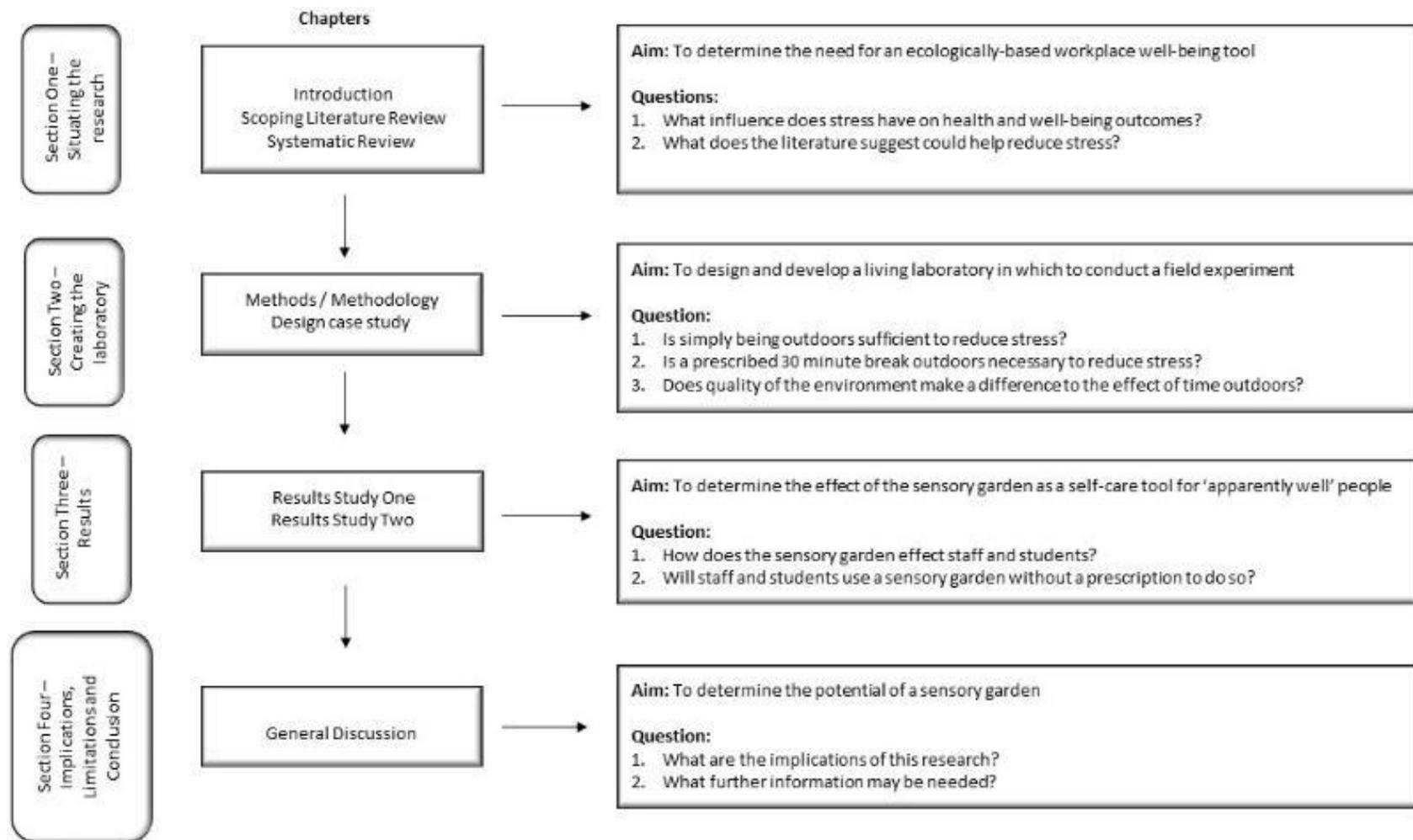


Figure 1-2 Thesis organisation, with chapter progression, aim and questions

1.6 SITUATING MYSELF IN THE RESEARCH

A researcher needs to recognise his or her position and have a solid understanding of self. I am a middle child; my siblings are both medically trained, with one a surgeon and the other in general practice. In contrast, my academic background comprised a geography degree, which emphasised environmental sciences at a time when the discipline did not quite exist. Interested in architecture, the environment and health economics from an early age, landscape, design and health promotion became the focus of my design practice.

I have been fortunate to work internationally across health, education, housing and eco-tourism. With children in schools and their families at home, with socially isolated migrants and older people, with executives wanting to de-stress their lives, dementia residents in care homes, a common theme ran through each of the client groups. Although each had need of some formal health provision, they also needed something quite simple. All of them had disconnected from nature to a greater or lesser degree and all lived, worked, played or went to school in non-supportive environments. Once the need was identified, the design response centred on how best to provide the necessary nature-rich environment for their situation.

Intensive personal research, extensive professional development, and invitations to present to the World Health Organization (2014), Global Challenges Summit (2018) and National Health Service (2019), supported and enriched my practice as a salutogenic landscape and urban designer. I include these biographical details to offer openness as to what may influence, directly, indirectly, or unconsciously, my ideas, readings, interpretations and reactions. Rigorous mixed methods research, a systematic literature review, and themes checked by my research supervisors mitigated any biases.

Chapter 2 THE THEORETICAL BASIS OF WELL-BEING AS A MOTIVATION FOR DESIGN

A scoping literature review serves to clarify concepts (Munn et al., 2018) and as presented here provides a broad background to this study. While the scoping review systematically searched the literature, it did not seek to answer a question but offers an epistemological lens to make the case for an integrated, multi-disciplinary approach to design for health and well-being. In contrast, the following chapter's systematic literature review is structured according to health research protocols (Moher, Liberati, Tetzlaff, & Altman, 2009) to answer the question "What is the effect of the sensory garden on psycho-social and physiological health?" In this chapter, theoretical evidence to support the theories behind development of the Scholars' Garden is presented. Spatial impacts of biophilic design and theories of Attention Restoration and Stress Recovery are investigated. The mainstream treatment for stress and depression, Cognitive Behaviour Therapy, is explored and the review extended to health promotion through a salutogenic design approach. Well-being as a design focus across urban settings is assessed and found to offer potential as a health promoting tool. The review was published in 2017, after Study 1 data collection but prior to completion of Study 2 and data analysis.

This chapter comprises the following paper published in *Journal of BioUrbanism December 2017, Vol15, Issue 1-2 (see Appendix I)*

2.1 INTRODUCTION

One could exemplify salutogenic design by confronting two city streets: one street has leafy trees and places to sit, while the other does not. Generally speaking, the first street is likely to attract more passers-by because of the peaceful feeling that it produces, and compared to the second street, to become a preferred location for businesses and shops.

Rapid urbanization requires a new design culture to offset and mitigate the impacts of change. Negative impacts on society, the environment, and economy have been greatest in places where change has happened most rapidly, where the triple bottom line has been crossed (Elkington, 2004). While contemporary design evolved with political and economic influence,

inclusion of elements effecting environmental and social outcomes can aid public health and well-being.

A search for urban design assessment models from the past 30 years shows little progress towards a new urban design approach that interfaces equity, culture, politics, and the environment. Standard healthcare still treats people when they are ill. Standard architecture still treats people as if they are well (Souter-Brown, 2015). At the same time, so-called lifestyle-related non-communicable diseases such as stress, depression, obesity, and some cancers now kill more people than the old communicable diseases such as measles, cholera, and malaria. In large part, this is due to improvements in sanitation and food safety, vaccines, antibiotics, and nutrition. However, the early success of medicine and early urban planning has created a problem. It has led people to put their faith in the notion that medical science would succeed in overcoming the remaining obstacles (Schlipköter, 2010). At the turn of the 20th century, health practitioners worked closely with urban planners (Kent & Thompson, 2012). As health improved and the war years intervened, the focus of urbanism moved away from health towards facilitating rapid economic recovery. Kent and Thompson noted that "despite closely linked origins, the contemporary professions of public health and urban planning largely operate within the neoliberal framework of academic, political, and policy silos(Kent & Thompson, 2012).

2.2 BEYOND SILO THINKING: THE CASE FOR AN INTEGRATED, MULTI-DISCIPLINARY APPROACH

Existing assessment models are based on outdated scientific patterns that analyse cities and their features as separated and disconnected pieces. But cities are complex systems, whose infrastructural, economic, and social components are strongly interrelated, and it is therefore impossible to understand them separately. The result is an ineffective policy, often leading to unfortunate and sometimes disastrous unintended consequences (Bettencourt & West, 2010).

We now know that health and well-being are intrinsically linked with sociological and environmental factors, the so-called "social determinants of disease" (Diener et al., 2010; Harter, Schmidt, & Keyes, 2003). Gary Cohen, a pioneer in the environmental health movement for over 30 years, believes that healthy environments are like a vaccine against illness. The environment where we live, work, learn, and play affects us. Likewise, it can offset

stress and reduced well-being resulting from urban migration and densification. Co-benefits of design for well-being allows for co-designing services and settings, addressing socio-environmental factors through design interventions, and leads to better health outcomes faster (Cohen, 2016). Well-being crosses theory and practice as a valuable epistemic foundation for design. Standard design practice no longer matches the multi-disciplinary theories that intersect well-being, requiring a focused, new design approach to mitigate the impact of urbanization. Urbanism that explores only the interaction of inhabitants with the built environment misses the natural environment in which a city is set.

Philosophically, design enquiry relies on doubt. This paper will critically review the literature to define well-being as a sound principle of design, to remove doubt, and to create a design paradigm in which designers are prepared to act.

As urban planning has successfully addressed public health in the past, we look there to find inspiration for the well-being of the future. In 1902, the father of modern town planning, Sir Ebenezer Howard, wrote in his book *Garden Cities of Tomorrow*, "in these days of strong party feeling and keenly contested social and religious issues it might be thought difficult to find a single question having a vital bearing on national life and well-being on which all persons... can agree. It is deeply to be deplored that people should continue to stream into the already overcrowded cities" (Howard, 1902, pp. 2-3)

Howard's "deplorable" migration to overcrowded cities has continued, with a backdrop of growing health challenges. Thirty years ago the emergent concept of lifestyle and the rise of lifestyle-related disease were noted by Coreil and colleagues (Coreil, Levin, & Jaco, 1985). Since then, researchers from multiple disciplines have recognized the need to formally link nature with urban studies but each have tended to come with a monofocal, reductionist lens. In 1984, the biophilia hypothesis was promulgated by Edward O. Wilson as a way of explaining humans' innate attraction to living things (Wilson, 1984). Ten years later, medical sociologist Aaron Antonovsky developed the concept of salutogenesis, an approach that focuses on factors that support human health and well-being rather than on factors that cause disease (pathogenesis) (Antonovsky, 1996). Although evidence of the health impacts of environmental design were growing, at that stage biophilia and salutogenesis were not linked. In 2003, ecologists led by Alberti proposed an integrated framework to test hypotheses of the

evolution on human-dominated ecosystems from interaction between humans and ecological processes. They observed that both the natural and social sciences have adopted complex systems theory to study emergent phenomena. They further stated that "while human and ecological processes are studied as separate phenomena decision making will remain fragmented" (Alberti et al., 2003, p. 1169).

At the same time, while ecologists were connecting humans and ecological processes, eco-psychology was growing as a new discipline. Kaplan and Kaplan were among the first to document the health benefits of a green view in post-operative patients (R. Kaplan & Kaplan, 1989). Soon after, Ulrich noted the stress-reducing effect of plants through experiments with unthreatening natural environments. He successfully predicted that nature-rich environments will have a reducing or restorative influence, whereas many urban environments will hamper recuperation (Ulrich et al., 1991). The resultant stress recovery and attention restoration theories developed as a response to the growing awareness of the potential health benefits of nature.

While ecology and psychology have been the major sources of literature on the impact of design, disciplines as diverse as forestry, real estate, workplace productivity, and accountancy have studied linkages with improved well-being on their area of interest. In 2008, the analytic hierarchy process was developed to determine the most sustainable design proposal for an area undergoing urban renewal (Lee & Chan, 2008). This process does not address lifestyle and well-being per se, but by looking beyond economic factors to include environmental sustainability in the design process, it rather addresses health and well-being by default.

Environmental degradation, inequality, stress, and depression add their weight to struggling infrastructure data. While urbanism attends to the interaction of inhabitants with the built environment, it misses the natural environment in which the city is set (Northridge, Sclar, & Biswas, 2003). While design has moved towards the politics of fashion and material convenience, the incidence of lifestyle-related disease has reached unsustainable levels (Chan & Bloomberg, 2016). Multi-disciplinary research now unequivocally shows what has been long suspected: nature reduces stress and improves well-being (Harter et al., 2003; R. Kaplan, 1995; Maller et al., 2006; Stigsdotter, 2005; Tenggart Ivarsson & Grahn, 2012). Sensory gardens, by their biophilic, salutogenic, attention-restoring, and stress-reducing

nature, offer an opportunity to provide a therapeutic dose of nature where people live, work, learn, and play (Gonzalez & Kirkevold, 2014; Hussein, 2010a, 2010b; Söderback, Söderström, & Schäländer, 2004). The broad general perspective aims to join the dots to break down the silos. While as individuals we may intuitively know that connecting with nature is good for us, the discipline of design still views the natural environment with ambivalence. However, as the marketplace shifts to demand more for money, one way to add value to the design process is through understanding well-being as motivation for a new paradigm.

2.3 SPATIAL IMPACTS OF BIOPHILIC DESIGN

As urbanization has sped up, the environment has suffered increasing degradation and the incidence of lifestyle-related diseases. This led to pockets of interest devoted to the intersection between health and well-being on one side and urban ecology, architecture, socio-economic, and academic/work outcomes on the other. To date, researchers have used a relatively narrow, discipline-defined lens to examine potential linkages. The theories of personality of socio-psychologist Eric Fromm first raised the term "biophilia", our love for living things, as a potential cue for many innate behaviors (Fromm, 1964). The ecologist Edward O. Wilson took the idea further, to propose the biophilia hypothesis. In his book *Biophilia*, he stated that "our natural affinity for life—biophilia—is the very essence of our humanity and binds us to all other living things" (Wilson, 1984). This approach asserts that humans have an innate connection with nature that assists in making the urban environment more effective with supportive, human abodes. In an urban context, opportunities to connect with nature can be problematic. For the purposes of this study we offer "landscape", "gardens", and "environmental design" as a means to facilitate the necessary nature connection within an urban setting (Souter-Brown, 2015). Biophilic design is thus articulated by the design profession as the relationships between nature, human biology, and the built environment (Browning, Ryan, & Clancy, 2014).

Edward O. Wilson's work brought together scholars from diverse fields. From this assemblage of intellectuals emerged the book *The Biophilia Hypothesis* (Kellert & Wilson, 1993). In 2006, academia, industry, government, finance, and civil sectors came together at a conference in Rhode Island, USA to further discuss the biophilia hypothesis. This prompted a search for potentially alternative "green" or nature-based therapies. As disease rates have grown, health

commissioners, sociologists, and health economists have looked to nature for facing the growing burden of lifestyle-related disease (Figueras & McKee, 2012). For all the work of academia, it took a journalist, Richard Louv, to note the condition and coin the term "nature deficit disorder" in his book *Last Child in the Woods* (Louv, 2005). Louv's work documents the impact of contemporary Western lifestyles against the amount of time children and adults spend outdoors. With the rise of technology has come a disconnection from nature. A study of 12,000 parents with children aged 5-12 years in 10 countries found that almost a third of children play outside for just 30 minutes or less a day. One in two children spend less than one hour outside per day, in contrast to prisoners who are guaranteed two hours in the open air every day (Packham, 2016). At the same time, mainstream media, as purveyors of the public see, create headlines that sell. Recently we have been told that trees are dangerous and must be carefully managed near children (Murphy, 2016). Trees have also been accused of adding pollution (Vidal, 2016). In some parts of certain cities, there are up to three generations with no lived experience of a tree (Wing-Long, 2012). While quick to point out that this is not a medical diagnosis per se, Louv suggests that nature deficit disorder is real and has far-reaching effects on child and adult health and well-being. Wilson's biophilia hypothesis explains why, subconsciously or consciously, we seek out leafy oases in the city. In his address to Santa Fe College students, Louv states that "the future will belong to the nature-smart—those individuals, families, businesses and political leaders who develop a deeper understanding of the transformative power of the natural world, and who balance the virtual with the real. The more high-tech we become, the more nature we need" (Louv, 2012, p. 4).

As a backdrop to a growing disconnection from nature, in the last 30 years two significant cultural events have occurred. Firstly, there has been increasing urban migration with the costs of city living requiring long work hours, reduced leisure time, and increased stress. With the advent of the digital age people have connected to devices and disconnected from nature (Louv, 2012). As mothers entered the workforce in record numbers, they struggled to find time to allow children to play outdoors. When parents began scheduling play, daycare for younger children morphed into organized after-school activities for older children (Lythcott-Haims, 2015). In 1983, the U.S. education policy statement, *A Nation at Risk*, told parents that their children needed to work harder to be competitive. Further, U.S. federal policies like *Race to the Top* "fomented an achievement culture, putting additional stress on students"

(Lythcott-Haims, 2015). This pressure to succeed has extended into tertiary education. As a result, students entering university may have had little time to connect with nature through their programmed, focused childhood.

Secondly, at the same time as the cultural shift, a change was observed in young adult health and well-being statistics. In the UK, teenage rates of depression and anxiety increased by 70% since the mid-1980s, particularly in the past 25 years (YoungMinds, 2016). A similar picture emerges in New Zealand where youth suicide, anxiety disorders, eating disorders, behavior problems, and obesity increased as social skills, problem solving, and personal resilience deteriorated (Disley, 1997). Research by architects, eco-psychologists, foresters, and economists hinted at a potential three-way link between cultural changes, access to nature, and child health and well-being (Hägerhäll et al., 2010; Ulrich et al., 1991). Their studies show that stress reduction, attention restoration, and general health improvements were seen to follow exposure to a green (nature) view.

In acknowledgement of this, public money has been lavished on parks and playgrounds as part of health promotion programs (Blanck et al., 2012). However, while research showing the health benefits of nature grows, fashion in architecture has become hard-edged. This has added to urban stress levels as we disconnect from nature (Söderlund & Newman, 2015). The book *Landscape and Urban Design for Health and Well-Being* showed that although some parks display an awareness of the need for nature connection, most new parks and playgrounds still show little awareness of their health promotion potential (Souter-Brown, 2015). While much work has been done in the area of connecting health with environmental design, there is still a disconnection between empirical knowledge, perception, and belief.

2.4 ATTENTION RESTORATION AND STRESS RECOVERY THEORY

Positive mental health focuses on well-being rather than the negatively connotated conditions such as depression, anxiety, and autism spectrum disorders (Keyes, Dhingra, & Simoes, 2010). Stress reduction is key to positive mental health (Wilkinson & Marmot, 2003). In the 1970s early eco- psychologists Greenway and Shapiro began to explore links between green views and health. Eco- psychology (or environmental psychology) explores the emotional bond between human beings and the environment out of which we evolve. Roger Ulrich's seminal study on the effect of a green view on patient recovery times established the

basis for use of nature for health outcomes (Ulrich, 1984). Steven and Rachel Kaplan took the exploration further with their attention restoration theory about restorative environments. Their book, *The Experience of Nature*, brought a health-promoting focus to psychology and ecology (R. Kaplan & Kaplan, 1989). "Eco-psychologists are drawing upon the ecological sciences to re-examine the human psyche as an integral part of the web of nature" (L. Brown, 1995). Maller's study, *Healthy Nature Healthy People: Contact with Nature as an Upstream Health Promotion Intervention*, shifted design thinking to focus on active lifestyles (Maller et al., 2006). Cycle ways and walkability were shown as necessary for healthy cities. Maas and colleagues' 2006 study, *Green Space, Urbanity, and Health: How Strong is the Relation?* took attention restoration and stress recovery further into the realm of health promotion (J. Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). Green space was found to be strongly associated with stress recovery. However, for all the work of eco- psychologists and epidemiologists to "set the scene" for nature-based treatments, traditional views continue to influence health service delivery.

2.5 COGNITIVE BEHAVIOR THERAPY

Cognitive Behavior Therapy is considered the most cost-effective treatment choice for mild-moderate stress and depression (Churchill et al., 2002). However, the clinical effectiveness of such a standard treatment was reviewed and it was found that "although there is support for the effectiveness of cognitive behaviour therapy, the finding that the reviewed randomized controlled trials had limited effectiveness within routine clinical practice demonstrates that the evidence is not conclusive" (Coull & Morris, 2011, p. 2239). Given such inconclusiveness and the growing evidence of the efficacy of green or nature-based interventions (World Health Organization Europe, 2016), this paper challenges standard design practice to propose a translational nature-rich space. When cost effectiveness and cost efficiencies are important, as they are across housing, business parks, the university estate, and elsewhere, evidence-based design is the research method of choice (H. Frumkin, 2003).

Mindfulness is increasingly used as a stress reduction intervention (Shapiro, Astin, Bishop, & Cordova, 2005). Mindfulness Based Stress Reduction and Mindfulness Based Cognitive Therapy were reviewed by Fjorback and colleagues with mixed results. Mindfulness Based Stress Reduction is recommended as a useful method for improving mental health and

reducing symptoms of stress, anxiety, and depression. However, results are generalizable only to individuals who have the interest and ability to participate in such a program (Fjorback et al., 2011). A meta-analysis of nature-environment studies by Bowler and colleagues found "testing for direct health benefits of nature is problematic given the variety of aspects of a natural environment and way in which they might impact on health" (Bowler, Buyung-Ali, Knight, & Pullin, 2010).

The more urbanization increases and our cities grow, the more design-based health promotion and prevention tools are critical. However, perhaps due to research problems in knowing what to study, design theory and practice have been slow to adapt. Steel louvres are still attached to buildings for shade instead of planting adjacent street trees. For example, the theory behind crime prevention through environmental design has promoted vandal-proof steel and concrete street furniture and "landscapes" to become commonplace across urban settings. Hard, square-edged material are used instead of softer, rounded, more sustainable and salutogenic timber. The environment is thus perceived (by users and viewers) as aggressive. Contemporary design paradigms, whereby form has prevailed over function, have negatively influenced the current health statistics (Souter-Brown, 2015). Therapeutic landscapes and humanist concepts such as sense of place and symbolic landscapes are under-recognized. Contemporary design archetypes do not offer a particular solution but rather the underlying system of ideas causes a range of solutions to be "normal" (Williams, 2002).

2.6 SALUTOGENESIS AS A DESIGN APPROACH

An alternative to traditional healthcare, the "salutogenic model" as a theory to guide health promotion, was first mooted by Aaron Antonovsky (Antonovsky, 1996). Traditional healthcare waits until one is ill and then treats the person back to health. Salutogenesis undertakes a better and less expensive path from preventing disease to address the social determinants of health (Mittelmark & Bull, 2013) within the community. The Landscape Institute states that "throughout history landscape architecture can be linked to the need to create places that were beneficial for people's health and well-being" (Landscape Institute, 2015). Mental health is closely linked to physical health (Canadian Mental Health Association, 2016). If we focus on physical health alone, then we miss a key driver for the overall well-being. Architecture recognizes the potential health impacts of design (Sadler et al., 2011), and ecologists

concerned with the environmental implications of a population disconnected from nature are looking to the growing demand for human well-being to provide environmental benefits (European Centre for Environment & Human Health, 2017). Nature connections, whether through forest walking or urban landscape design interventions, have been shown to reduce stress (Capaldi, Passmore, Nisbet, Zelenski, & Dopko, 2015). Stress is a primary prompt for mental and physical illness. Hence, a salutogenic design approach could be a powerful tool for health and well-being.

Young people with special or additional educational needs have been found to respond positively to nature-based design interventions (Stigsdotter et al., 2011). Likewise, a variety of lifestyle-related non-communicable diseases such as obesity, type 2 diabetes, cardiac and upper respiratory tract disease, depression, anxiety, and dementia can be effectively managed and prevented at a community level (Maller et al., 2006). A salutogenic approach to healthcare utilizes factors that support human health and well-being as a cost-effective, preventative tool (Bengt & Lindström & Monica Eriksson, 2005).

The literature has identified the eco-psychological basis for green, nature-based interventions (Grahn & Stigsdotter, 2010), and opportunities for community-based improved health outcomes (Roe et al., 2013). The World Health Organization's Healthy Settings movement came out of the World Health Organization strategy of Health for All in 1980. The approach was more clearly laid out in the 1986 Ottawa Charter for Health Promotion (World Health Organization, 1986). The successes of settings-based approaches have been validated through internal and external evaluation and experience (Bloch et al., 2014). Optimal spatial forms (the settings that make users feel good) derived from the environmental design formula to promote and enhance well-being. They are innovative and take a multi-disciplinary approach to health promotion and prevention (Carmichael, Barton, Gray, Lease, & Pilkington, 2012). Biophilic architecture and green buildings are two examples of this innovative approach. However, knowledge about the interplay of cultural structures on design typology or the potential for nature-based interventions in a place is insufficient. We know culture and ethnic background impacts appreciation and use of an environment, but do they impact the efficacy of gardens as a treatment for stress? In 2013, landscape architect Catharine Ward Thompson researched the stress levels in deprived urban communities and the effect of community-based greenspace to pedestrian exposure (Roe et al., 2013). Ward Thomson

found that regular exposure to street trees decreased stress cortisol levels across the sample population. Roadside trees are also thought to decrease driver stress levels. Speed was reduced in tree-lined streets in Baltimore, and in Toronto accident rates were up to 20% lower in tree-lined streets (Battaglia, 2010).

To add weight to the case for environmental design interventions as a social good, in 2011 Lynn Ilon investigated whether education equality can trickle down to economic growth. Her study found a strong correlation between education and economic growth in Korea. The national UK schools survey looked at the effects of introducing nature and social connection points. Social and educational effects were noticed with decreases in absenteeism, bullying, vandalism, and increases in attendance, attention in class, aspiration, and outcomes. Home-school partnerships were also enhanced with parents more involved in their community (Learning Through Landscapes, 2003). So, by extension, can environmental interventions enhance economic growth? Think tanks such as Terrapin Bright Green agree with Ilon's conclusion that "education's power to bring about social change, to stabilise or destabilise communities, and to increase global competitiveness places it firmly within the purview of national policy as well as market forces" (Ilon, 2011). He thus suggests that environmental design can be important as a social good (Terrapin Bright Green, 2012).

Stress on campus was examined in a study in Nigeria. The research, which interestingly was reported in an accountancy journal, looked to the need for students to perform at their peak in order to promote overall national development. As in the Korean study, education is seen as an important medium that facilitates improvement of leadership qualities and turns out excellent future managers and professionals in different fields (Oseyomon, 2015). The authors observed that undergraduate students at the University of Benin were moderately stressed and that an inverse relationship exists between perceived stress levels and academic performance. The study recommended the university to develop stress-coping techniques to lift academic/work performance, but did not suggest how to go about it. More recent research has addressed possible environmental design interventions for stress reduction. The impact of landscape views on stress and mental fatigue reduction has been studied by Li and Sullivan. They found positive correlations between attention levels and green views from classrooms, and that attention restoration and stress recovery are two distinct processes (D. Li & Sullivan, 2016).

2.7 WELL-BEING AS A DESIGN FOCUS: INTRODUCING SENSORY GARDENS

A defined "dose" of nature, within a controlled, specialist-facilitated, social, and therapeutic horticulture program can reduce stress and depression (Hartig et al., 2011). Hartig tested the restorative environments theory through a meta-analysis to prove its efficacy (Hartig, 1993). Dose responses for both intensity and duration show large benefits from short engagements in green exercise and diminishing but positive returns (J. Barton & Pretty, 2010). Every green environment improved both self-esteem and mood; the presence of water generated greater effect. As such, they found that the environment provides an important health service (J. Barton & Pretty, 2010). As new urban areas are developed, whether town centers, housing, universities, or business parks, one should consider the opportunity for stress reduction through environmental design. Well-being can be "designed-in".

Shanahan and colleagues investigated human response to natural parks in Brisbane, Australia. They sought to determine the required "dose" of nature for human health and well-being. In summary they found that,

“people who made long visits to green spaces had lower rates of depression and high blood pressure, and those who visited more frequently had greater social cohesion. Higher levels of physical activity were linked to both duration and frequency of green space visits. A dose-response analysis for depression and high blood pressure suggest that visits to outdoor green spaces of 30 minutes or more during the course of a week could reduce the population prevalence of these illnesses by up to 7% and 9% respectively”.
(Shanahan et al., 2016, p. 4)

Researchers at the Universities of Alnarp, Sweden and Copenhagen, Denmark, have created therapeutic sensory gardens to support psycho-social teaching programs with local primary health objectives. The University of Alnarp created them on campus. The University of Copenhagen's Gronska therapeutic garden is situated in a private green area. Like Alnarp, the Gronska garden is zoned according to the eight characters—or fundamental elements—of garden spaces, where Social and Therapeutic Horticulture and the "Alnarp Method" are the therapeutic tools (University of Copenhagen, n.d). Therapeutic horticulture is the process of using plants and gardens to improve physical and mental health, as well as communication and thinking skills. The Alnarp method was developed as a result of research into the fundamental building blocks of healing gardens (Grahn, 1991; Grahn, Stigsdotter, & Berggren-

Bärring, 2005; Hedfors & Grahn, 1998; Stigsdotter & Grahn, 2002). The Alnarp gardens have been used for 13 years to treat adults with depression and anxiety, and multiple studies have shown their efficacy in treating stress related disorders (Adevi & Lieberg, 2012). The eight fundamental design elements are: 1) serenity; 2) wild; 3) rich in species; 4) space; 5) common; 6) the pleasure garden; 7) festive, and 8) culture. These design elements can be combined within a zone or separated, but must be included for optimal effect (Grahn et al., 2005).

The Alnarp method allows people to progress at their own pace from one gradated garden zone to another, depending on need and mood. The zones progress from a passive reflective space through a garden designed to facilitate moderate physical exercise to a physically active tending, growing, edible, and ornamental plant space, to a space designed for social engagement. The sensory gardens provide key opportunities for:

- Improving mental health through a sense of purpose and achievement.
- Learning how to structure the weekday, to focus on the present moment, and to allow breaks and rest in order to avoid new relapse from stress and burnout.
- Bettering physical health through exercise, and learning how to use or strengthen muscles to improve mobility.
- Connecting with others by reducing feelings of isolation or exclusion.
- Acquiring new skills to improve the chances of finding employment.
- Simply feeling better for being outside, in touch with nature, and in the "great outdoors". (University of Copenhagen, n.d.).

The attention restoration theory and stress recovery from green space literature (R. Kaplan & Kaplan, 1989; Ulrich et al., 1991) suggests that a modified, non-specialist-facilitated form of Alnarp's sensory garden may be a viable self-help tool to manage stress. A future study will build on the existing literature to fuse an understanding of the role of urban ecology, objectified through nature connection, in creating and sustaining health and well-being as it influences academic or work achievements. It will test whether experience in a non-facilitated sensory garden is effective at reducing stress and improving work output in a New Zealand setting. Although based on the highly structured, managed experience of the Alnarp method, if the study shows the modified Alnarp sensory gardens to be effective at impacting stress, it may be possible to provide sensory gardens in diverse settings where people can self-heal. In

addition to the university, social housing developments, care homes, schools, and workplaces could benefit from a self-help health promotion design tool. If proven, the value of such a tool would be in its accessibility and relative low capital and operational maintenance cost. It would enable architects and facilities managers to promote their developments as the "healthy option".

How we look after the well-being of students and faculty within the institution of a university setting has parallels with care homes. Kane identifies the value of "quality-of-life domains—namely security, comfort, meaningful activity, relationships, enjoyment, dignity, autonomy, privacy, individuality, spiritual well-being, and functional competence" (Kane, 2001, p. 293). The author adds: "these kinds of quality-of-life outcomes are minimized in current quality assessment and given credence only after health and safety outcomes are considered" (Ibidem). Similarly, environments for younger students, especially pre-schoolers, are often designed around perceived safety and practicality. An emphasis on indoor environments and rubber-matted, hose down-able outdoor spaces, rather than around the health and well-being of the users, has impacted child health statistics (Souter-Brown, 2015). As a result of a largely sedentary life indoors, many children today have weaker bones, poor muscular coordination (although their thumbs and index fingers may be well developed), rickets, and such a low life expectancy that today's children are expected to live five years less than their parents (National Institutes of Health, 2005).

Focus on prevention presents opportunities and challenges. In 2016, Japanese and British ecologists recognized the ongoing loss of human interactions with nature, the so-called "extinction of experience", as one of the major obstacles to addressing global environmental challenges (Soga, Gaston, Yamaura, Kurisu, & Hanaki, 2016). Their study of schoolchildren found that affective attitudes (individuals' emotional feelings) toward and willingness to conserve biodiversity are positively associated with the frequency of both direct and vicarious experiences of nature. In the Japanese study, path analysis showed that these experiences on children's willingness to conserve biodiversity were mediated by their affective attitudes. Children who frequently experience nature are likely to develop greater emotional affinity to and support for protecting biodiversity. If sensory gardens connect people with nature, these will likely develop greater emotional affinity to and support for protecting biodiversity and become advocates for nature-based health and education initiatives.

2.8 COULD SENSORY GARDENS BE AN EFFECTIVE AID TO WELL-BEING?

Sensory gardens are accessible, species-rich environments within urban settings. They are designed to address specific social, emotional, cognitive, spiritual, and physical health needs of adults and children (Souter-Brown, 2015). The health-giving benefits of urban green space and nature are generally well defined. In an urban setting, where opportunities for nature connections are often managed, confined, and access-controlled, sensory gardens provide an ecologically-balanced environment where sensory inputs are planned in terms of access, comfort, acoustics, color, scent, sights, and sounds. Sensory gardens can bring a health-giving "dose" of nature.

The landscape architect Hazreena Hussein found that sensory gardens are effective as a tool to enhance the educational development and social interaction of children with special needs (Hussein, 2010b). In 2014, another landscape architect, Rita Berto, asked how attention restoration works and what is the role of nature in coping with psycho-physiological stress. She conducted a comprehensive literature review on restorativeness. Ecological restoration, through the development of sensory gardens or other nature-rich environments, were found to enhance and restore attention (Berto, 2014). As community stress levels grow and as urbanization increases pace, the incidence of adults and children suffering stress and diminished attention is growing. The World Health Organization has stated that the rising burden of non-communicable, lifestyle-related disease is unsustainable. The evidence is unequivocal. Sensory gardens afford opportunities to connect socially and with nature, which has been seen to promote well-being and community resilience (World Health Organization, 2016).

Lifestyle-related stress, depression, and physical inactivity are global challenges that require local solutions. On a local level, city mayors are well positioned to play a preventive role through the provision of green space for rest and recreation, clean air, and locally grown food (Chan & Bloomberg, 2016). Concomitantly, despite the growing body of literature showing causal relationships between health, well-being, education, and design (architecture) or nature, and between stress, environment, and lifestyle-related disease (British Association for Counselling & Psychotherapy, 2016), nature-based interventions are not routinely used as a prevention and health promotion tool.

2.9 MOTIVATION FOR DESIGN

Designers have an increased opportunity and responsibility to work collaboratively within multi-disciplinary teams. What are the designer's motivations? Do they live in art or science, or in the liminal space in between? Do designers desire to be known for an iconic piece of art, or to be part of a movement towards the science-art amalgam of beautiful forms that enhance functional well-being? Architect and educator Jonathan Hill believes that a subject creating, occupying, and even destroying a space moves spatial design beyond a subject that occupies an object (Hill, 2001). Green buildings are likely to become more popular with clients as corporations work to enhance both their image and human capital (Eichholtz, Kok, & Quigley, 2016). Green infrastructure has to become the norm if design is to tackle the dual challenges of public health and climate change. The spaces in between the buildings as well as the buildings themselves must be considered in their totality.

Placemaking has been supplanted by placekeeping. Places for both social and natural connections are required.

2.10 CONCLUSIONS AND FUTURE DIRECTIONS

Design for well-being is a departure from the mainstream. A salutogenic approach to well-being asks design's focus on forms to be redirected toward function. For human well-being, we need functioning, healthy, urban ecologies. Sensory gardens, from their species-rich serenity spaces, opportunities for culture, pleasure, and festivity, and view of wildlife-attracting water, sunlight, and shade, attract people. Urban street trees bring low-dose sensory delight, while sensory gardens can bring high-dose nature experience to users.

Well-being has been defined as more than the absence of disease. For people already disconnected from nature, when faced with increasing societal and perhaps personal stress, it might seem easy to maintain the concrete-and-steel urbanism. However, this is not true, and disconnected designers and their clients need to be awakened to the potential of design for well-being.

Design has been shown to be efficacious as a support for a sense of well-being. Reflecting on the epistemology of design and the blend of practice and theory helps us understand both the theoretical basis for well-being as design motivation and the very practical nature of such

an approach. The evidence presented shows design to be ready and able to play its part in public health and well-being. The past 50 years have seen a design emphasis on cities as centers of commerce. Cities of the future will judge their environments by how well people function. Functional urbanism requires a reinjection of nature. Our well-being depends on it.

Chapter 3 SYSTEMATIC LITERATURE REVIEW

The broad scoping literature review in Chapter 2 clarified the links between green space and health to provide the context for this thesis. Well-being was established as a motivation for general green space design. This systematic review both acknowledges the medicalisation of health and accepts that the scoping review did not examine gaps in the literature around the effects of sensory gardens. As such this chapter deepens the enquiry to provide a systematic review of the effect of sensory gardens on indicators of well-being. Given the established effect of green space on health and well-being, a sensory garden may benefit a broad range of users by offering a carefully designed suite of biodiverse sensory inputs. This systematic review aimed to explore the effect of sensory gardens on psycho-social and physiological health. This focussed review, of sensory gardens at the nexus of salutogenically designed urban environments, gave meaning to the broad approach taken in Chapter 2. The search strategy is set out in a mind map (Appendix K). Search methods followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Liberati et al., 2009b) to answer the question “What is the effect of the sensory garden on psycho-social and physiological health?”

3.1 RATIONALE

Historically, sensory gardens have been used since ancient times. The Hellenistic Greek and Roman cloistered courtyard gardens, Hortus conclusus (enclosed garden) and Hortus medicus (medicinal herb garden) are examples of early sensory or ‘wellness’ gardens. By the Middle Ages, monasteries and hospitals adopted the practice of using gardens as curative places. More recently, evidence that the environment may affect health and well-being outcomes continues to accumulate. However, the challenge is to harness that knowledge and implement it. Systematic literature reviews are fundamental to decision making in evidence-based medicine. Similarly, evidence-based design (EBD) will be greatly aided by a rigorous understanding of the effect of a sensory garden.

The past 20 years have seen a steep increase in publications on the subject of health-promoting environments. Evidence based design (EBD) aims to influence health outcomes. Academic journals across diverse disciplines, from Alzheimer’s Disease to Clinical Nursing,

Death Studies to Urban Forestry and Urban Greening, feature articles on sensory gardens. This breadth of interest shows application of nature and greenspace developing as research studies examine experience. However, while sensory gardens are becoming more widely accepted as an actionable response to increased chronic stress, their use appears limited to health-related settings.

The purpose of this systematic review was to examine the effect of a sensory garden on psychosocial and physiological health in qualitative and quantitative studies across different settings, populations and ages and to establish where gaps in application may lie.

3.2 METHODS

3.2.1 Data sources

Searched electronic databases included Scopus (Elsevier), and combined EBSCOhost MEDLINE, CINAHL Complete and GreenFILE, from January 2001-December 2019, using specific search terms using Boolean/Phrase. Databases were selected to best represent source material in health, allied health and design. A hand search of reference lists was also undertaken.

An initial search was conducted on 'sensory gardens'. Search results were checked against citation reference searches of previous review articles. From this, a list of keywords was created, which included terms relating to sensory gardens (Table 3-1). The definition of a 'sensory garden' was extended to include therapeutic gardens and healing gardens.

Table 3-1 Sensory garden effect Boolean search terms used, where * indicates alternate endings accepted

Terms used		
Sensory garden*	Effect*	Benefit
Healing garden	Impact	Advantage
Therapeutic garden*	Consequence	

For this review 'effect' was defined as an impact, consequence, benefit or advantage. Other terms used in the literature such as 'greenspace' and 'nature' were considered too broad for the purposes of this systematic review but were included in the scoping literature review in Chapter 2. The PRISMA protocol was used as an evidence-based guide to the systematic

review (Moher et al., 2009). Using search terms within the Boolean phrase above, Scopus was searched. In EBSCO host, three data bases were selected: GreenFILE, MEDLINE, and CINAHL Complete Databases were combined in one search.

3.2.2 Inclusion criteria

All types of studies (e.g. RCT, exploratory) with participants of all ages and primary outcome measures that related to psychosocial or physiological health that examined the effect of a sensory, healing and/or therapeutic gardens were included. Results were limited to full text, peer reviewed original articles and publication date of January 2001 – December 2019. Criteria included English language, publication type (e.g. academic journal), document type (e.g. article) studies used human participants, abstract availability, no related words, no equivalent subjects.

3.2.3 Exclusion criteria

Not appropriate to discipline (e.g. dentistry, computer science, climate change, environmental impact analysis, emissions, energy), duplicates, commentaries and editorials, studies based on effect of horticulture therapy.

3.3 SEARCH STRATEGY

For this review, 'effect' was defined as an impact, consequence, benefit or advantage. 'Greenspace' and 'nature' were considered too broad for the purposes of this systematic review but were included in the scoping literature review in Chapter 2. References on sensory gardens, therapeutic gardens and healing gardens were also hand searched. Terms were discussed with two independent researchers (EH and DS). Search terms used:

"sensory garden*" OR "therapeutic garden" OR "healing garden" AND "effect* OR impact OR consequences" AND "benefits OR advantages"

3.4 STUDY SELECTION

From the initial search results, 55 records were identified via web search and a further 12 records were identified via hand search. An additional 31 records were hand-picked from narrative reviews identified via the hand search (Figure 3-1). Titles were reviewed, abstracts and full manuscripts read as necessary to determine selection. All steps were discussed,

replicated and confirmed by EH who evaluated all titles and independently assessed abstracts and full texts of eligible studies. Articles went to full review as agreed by the GSB and EH. Disagreements were reconciled by discussion.

3.4.1 Selection Criteria

Must describe effect of sensory or therapeutic garden on psycho-social and physiological health

3.4.2 De-selection criteria

Studies that focussed on the effect of a therapeutic programme rather than the environment, focussed on general greenspace rather than specifically on sensory garden, did not include a sensory garden, were in a foreign language or did not provide full text.

De-duplication: Results were collated and recorded. Using EndNote, the “Find Duplicates” button under the “References” menu was used, which found 21 duplicate records in the EndNote library that were removed.

Records (n = 39) were excluded for not meeting the inclusion criteria listed in 3.2.2.

The search and selection strategy is shown in Figure 3-1.

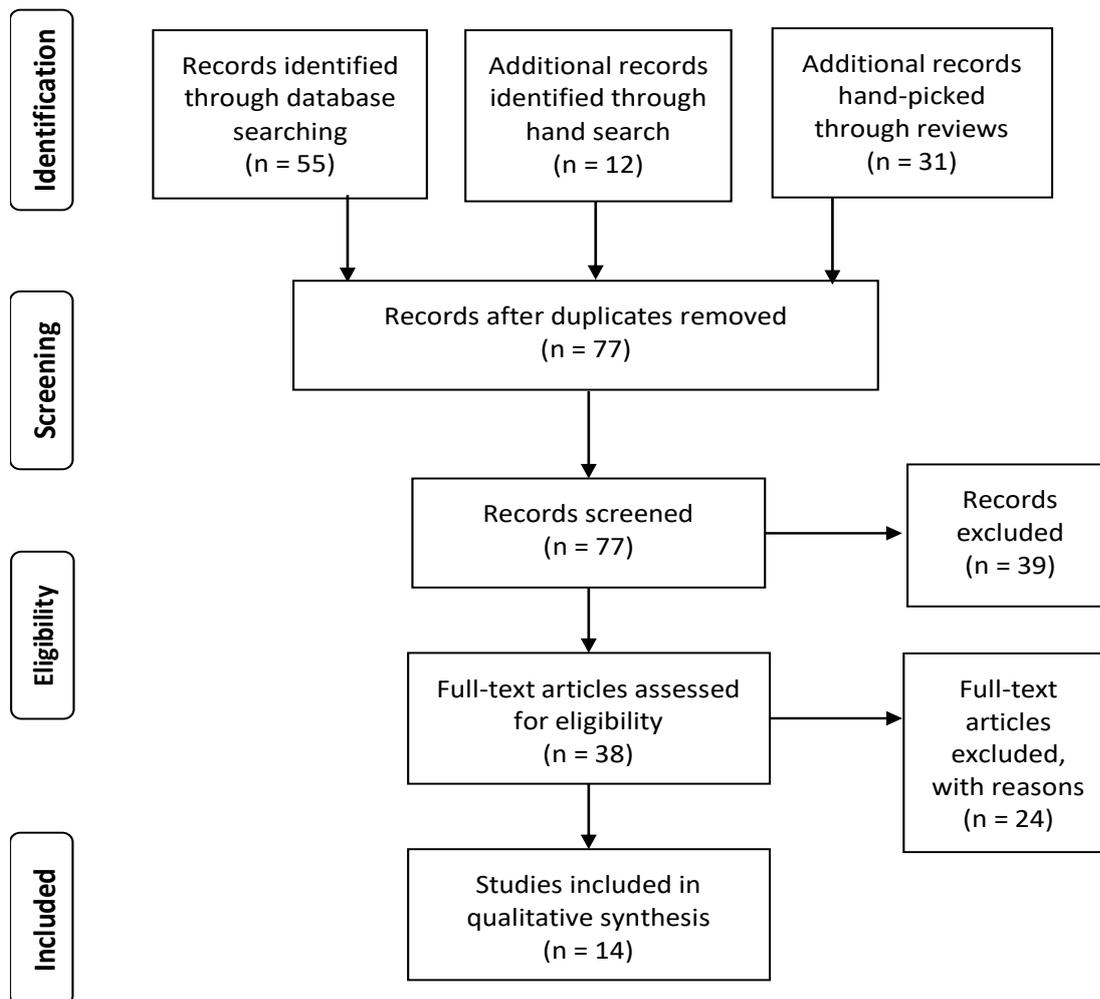


Figure 3-1 PRISMA flow diagram, from Moher et al, (Moher et al., 2009)

Full text articles (n = 38) were selected and assessed for eligibility against the inclusion and exclusion criteria in 3.4.1 and 3.4.2. After screening, the following 24 articles were excluded:

1. Deaton (2015) assessed a Chicago art installation as a healing garden but does not identify the healing garden as an agent in the effect of the installation.
2. The Horowitz (2012) narrative account of the role of therapeutic gardens in health care did not include their effect on physiological or psycho-social effects.
3. The study 'Nursing homes: Engaging patients and staff in healing garden design through focus group interviews' (Senes, Fumagalli, Crippa, & Bolchini, 2012) was about the effectiveness of a participatory design process to develop a healing garden, rather than the effect of the garden per se.

4. Pasha (2013)– focussed on the effect of design elements within a garden, not the physiological or psycho-social effects.
5. Suchocka, Kosiacka-Beck, Myszk, and Niewiarowska (2019) focussed on effect of therapy, not of effect of garden,.
6. Paraskevopoulou et al. (2018) did not examine the effect of the garden per se.
7. The narrative review by Detweiler et al. (2012) did not discuss the physiological or psycho-social effects.
8. The study by Weerasuriya, Henderson-Wilson, and Townsend (2018) examined barriers to access in a sensory garden, but not the effect of the space.
9. Abraha et al. (2017) conducted a systematic review of non pharmacological interventions, but did not include the effect of sensory gardens in their results.
10. The study by Memari, Pazhouhanfar, and Nourtaghani (2017) examined the effect of general nature contact in a healthcare setting, but not the effect of a sensory garden.
11. Davis (2011) conducted a post occupancy evaluation of a hospital sensory garden, but did not include its effect.
12. Borgen and Guldahl (2011) described the benefits of a sensory garden in Oslo Botanic gardens, but not the physiological or psycho-social effects
13. The Milligan et al study did not include the effect of a sensory garden (Milligan, Gatrell, & Bingley, 2004).
14. Naderi did not include the physiological or psycho-social effects (Naderi & Shin, 2008).
15. The Scartazza study did not include the effect of a sensory garden (Scartazza et al., 2020).
16. Adevi and Lieberg examined the effectiveness of a therapeutic programme from a caregiver perspective, not the physiological or psycho-social effects of the garden (Adevi & Lieberg, 2012).
17. Lehman et al examined the effect of a therapeutic programme, not the garden, (Lehmann, Detweiler, & Detweiler, 2018).
18. Marsh examined the effect of a therapeutic programme, not the garden (Marsh, Spring, Viera, & Bowen, 2014).
19. Pachana did not discuss the physiological or psycho-social effects (Pachana, McWha, & Arathoon, 2003).

20. Eriksson examined the effect of a therapeutic programme, not the garden (T. Eriksson, Westerberg, & Jonsson, 2011).
21. Artman did not include the effect of a sensory garden, so was excluded (Artmann et al., 2017).
22. Infantino examined the effect of a therapeutic programme, not the garden (Infantino, 2004).
23. The study by Heath did not discuss the physiological or psycho-social effects, (Heath, 2004).
24. The Adevi et al study examined the effect of a programme conducted within a garden, rather than the effect of the garden per se (Adevi, Uvnäs-Moberg, & Grahn, 2018).

3.5 DATA EXTRACTION

A data extraction form was developed based on the 'Cochrane checklist of items to consider in data collection' (Higgins & Green, 2008).

The candidate selected the studies based on the inclusion criteria in 3.4.1 and sent findings to EH for review. Once study selection was confirmed, the candidate extracted the data (Table 3.2) and sent it back to EH for review. EH conducted a detailed review of the abstracted data on 20% of the articles. Disagreements were resolved by discussion until a consensus was reached. Data was extracted and summarised to provide an overview of the effect of sensory gardens seen in the 14 articles included for review (Table 3-2).

Table 3.2 summarises data extracted from records identified through the database search, hand search and four hand-picked articles. The source of the handpicked articles (designated * or **) is noted in a footnote to the table.

Table 3-2 Summary of data extracted from included records

Lead author, year, location	Study aim	Study design	Participant characteristics (n) and age	Setting	Outcomes measured	Assessment tool or dataset	Results
Edwards, 2013, Australia (Edwards, McDonnell, & Merl, 2013)	To determine quality of life changes after time in therapeutic garden	Cohort study	Dementia in-patients	Therapeutic garden at Magnolia House	Quality of Life	The Dementia Quality of Life Instrument (DEMQOL and DEMQOLProxy), The Cornell Scale for Depression in Dementia (SCDD) and the Cohen-Mansfield Agitation Inventory (CMAI)	QoL > 10%. p = 0.00068 Depression rates < 10%. p=0.01994 Mean agitation scores <50% p = 0.00002. GP does not need to visit so often
Ellis, Dr (MD), 2011, South Africa (Ellis, 2011)	To describe the development and use of a sensory garden in clinical practice	Case study	One hospital, one sensory garden	Psychiatric Hospital in Pietermaritzburg Dementia connection, testing	Nostalgic memory	'Bright Eyes' therapy	Enhanced mood and responsiveness
Gonzalez, 2015, Norway (Gonzalez & Kirkevold, 2015)	Improve clinical use of sensory gardens and outdoor environments	Cross-sectional e-mail survey	N = 488 nursing home leaders	Norwegian nursing homes	Clinical impressions of leaders and staff regarding benefits of sensory gardens to the residents	Web-based questionnaire	SGs facilitated taking residents outdoors, offered convenient topics for communication and facilitated social privacy for relatives.

Lead author, year, location	Study aim	Study design	Participant characteristics (n) and age	Setting	Outcomes measured	Assessment tool or dataset	Results
Grahn, 2017, Sweden (Grahn, Pálsdóttir, et al., 2017)	Determine effect of length of a nature-based rehabilitation programme on return to work one year after the onset of the programme?	Prospective, quasi experimental study	N = 106 patients 45.7 years old with long-term reactions to severe stress and/or depression	Alnarp Rehabilitation Garden, Sweden	Return to work, occupational competence	Mantel–Haenszel Chi-Square test	Longer period of rehabilitation was beneficial. 68% of participants returned to work within 12 months of intervention.
Hernandez, 2007, USA (Hernandez, 2007)	To examine effect of sensory garden on quality of life of residents	Case study analysis	Unspecified number of staff and families at two dementia units	Residential dementia unit	Quality of life, mood, interest	Thematic analysis of interviews	Improved mood, enhanced observational skills, reduced stress.
Hussein, 2010, UK (Hussein, 2010b)	Summarise findings of two case studies of sensory gardens in UK,	Observational case study	Unspecified number of School aged children	Special needs schools	User behaviour, development and social interaction of children with special needs and carer staff	Photo essay	Positive behaviour, improved acquisition of social, cognitive and problem-solving skills, engaged staff.
Mitchell, 2019, USA (Mitchell & Van Puymbroeck, 2019)	To decrease signs and symptoms of depression and anxiety, and increase acclimation to Long Term Care	Case study	N = One 76-year-old female patient with dementia	A long-term care facility in USA	Symptoms of depression and anxiety, acclimation to Long Term Care	Recreation therapy, coping skill education and leisure planning with evidence-based therapeutic gardening techniques	Continuation of existing medication, but no new therapies added.

Lead author, year, location	Study aim	Study design	Participant characteristics (n) and age	Setting	Outcomes measured	Assessment tool or dataset	Results
Reeve, 2017, Australia * (Reeve, Nieberler-Walker, & Desha, 2017)	To evaluate visitor experience of four sensory garden	Review of 4-weeks of visitor book comments	Child-aged patients, parents, family members, staff	Children's Hospital Brisbane, Australia	Perceived benefits	Thematic analysis	Feeling of being 'away', of restorativeness of gardens
Tenngart, 2012, Sweden (Tenngart Ivarsson & Grahn, 2012)	To deepen the knowledge on environment-behaviour relations needed when designing therapeutic gardens	Environment-behaviour study	N=17 adult patients undergoing a treatment programme for stress-related diseases in a healing garden	Alnarp Rehabilitation Garden, Sweden	How patients use and interact with the therapeutic setting by looking at their pattern of movements over a 7-month period	Participatory observation by the researcher	Increase in walking
Uwajeh, 2019, North Cyprus, Turkey (Uwajeh et al., 2019)	To document the role of gardens in healthcare environments and their impact on wellness to optimise the clinical outcomes in patients with Alzheimer's disease	Narrative review	91 studies evaluated from Web of Science, PubMed, ProQuest Central, MEDLINE, Scopus and Google Scholar, reviewed	online	Positive health implications of therapeutic gardens on Alzheimer's Disease	Scientific evaluation of the role of gardens as a therapeutic intervention	Strong evidence of broad benefits of use of therapeutic gardens within dementia care

Lead author, year, location	Study aim	Study design	Participant characteristics (n) and age	Setting	Outcomes measured	Assessment tool or dataset	Results
Van der Riet *. 2014, Thailand (van der Riet, Jitsacorn, Junlapeeya, Dedkhard, & Thursby, 2014)	To explore nurses' stories of use of the garden	Focus groups	N = 8, nurse's	Children's hospital, Thailand	Access to the garden	Narrative enquiry	Increased acceptance and adherence to treatment Enhanced psycho-social and physical engagement
Van der Riet, * 2017, Thailand (van der Riet, Jitsacorn, Junlapeeya, Thursby, & Thursby, 2017)	To explore family member's experience of use of the garden	Focus groups	N = 8, Seven parents and one grandparent	Children's hospital, Thailand	Access to the garden	Narrative enquiry	Improved hospital experience for sick children and their families
Van der Riet, ** 2017, Thailand and Australia (van der Riet, Jitsacorn, Junlapeeya, & Thursby, 2017)	To explore student nurses' beliefs about care of sick children after experience of the garden	Interviews	N = 62 student nurses from Thailand and Australia	Children's hospital, Thailand	Development beyond biomedical approach to care of sick children	Narrative enquiry	Promoted holistic care for children with chronic illness
Whitehouse, 2001, USA (Whitehouse et al., 2001)	To determine whether the garden was effective at reducing stress, restoring hope and energy, and increasing consumer satisfaction	Post occupancy evaluation	Paediatric patients and visitors (n=22), adult families and staff (n=83)	Children's hospital garden, San Diego	Stress levels, feelings of hopefulness	Randomised participants surveyed and interviewed	Get 'away' from stress, relax and rest, improve mood

*From Uwajeh, (2019) **From van der Riet (2017)

3.6 NARRATIVE SYNTHESIS

Table 3.2 was synthesised into a narrative review following the PICO assessment tool (Liberati et al., 2009b). The PICO framework guides formulation of clinical questions (Liberati et al., 2009a). As sensory gardens are generally used within healthcare settings it was considered an appropriate framework to describe the data.

P (participants)

I (intervention: time in a sensory garden)

C (comparison: time outside a SG)

O (outcome: effect)

3.6.1 Participants

Participants ranged across special needs children (Hussein, 2010b), to paediatric in-patients and their families (Reeve et al., 2017; van der Riet, Jitsacorn, Junlapeeya, Thursby, et al., 2017; Whitehouse et al., 2001), depressed adult out-patients (Grahm, Pálsdóttir, et al., 2017; Tenngart Ivarsson & Grahm, 2012), hospital staff (Gonzalez & Kirkevold, 2015; van der Riet et al., 2014; van der Riet, Jitsacorn, Junlapeeya, & Thursby, 2017) and psychiatric in-patients (Ellis, 2011) to residential dementia patients (Edwards et al., 2013; Hernandez, 2007; Mitchell & Van Puymbroeck, 2019; Uwajeh et al., 2019). The studies were located principally in Europe but with three in Thailand, Australia and the United States of America and one each in Turkey and South Africa. Chronologically, the studies were set initially in a children's hospital, then special educational needs schools and then to a mix of healthcare settings.

3.6.2 Intervention

The 14 studies reviewed were a mix of clinical, case study, post occupancy evaluation and review study. All studies examined the effect of a sensory or therapeutic garden on psychosocial or physiological outcomes after the introduction of a sensory or therapeutic garden. In both the Tenngart Ivarsson and Grahm (Tenngart Ivarsson & Grahm, 2012) and Grahm et al (Grahm, Pálsdóttir, et al., 2017) studies, study participants were referred by their health

insurer to a structured programme in a therapeutic garden. All other studies were of in-patient or educational settings.

3.6.3 Comparison

Only one study compared outcomes with baseline values (Hernandez, 2007).

3.6.4 Outcomes

Outcomes were seen across dementia and psychiatric patients, sick and special educational needs children, and nurse participant groups. Edwards and colleagues examined quality of life for dementia patients after time in a therapeutic garden (Edwards et al., 2013). The clinical case study by Ellis examined the effect of the mixed exotic and indigenous shrubs and herbs in the sensory garden on mood, nostalgic memory in psychiatric dementia patients (Ellis, 2011). Gonzales completed a cross sectional study of the effect of use of sensory gardens in Norwegian nursing homes for dementia patients (Gonzalez & Kirkevold, 2015). Uwajeh et al studied the benefits of therapeutic gardens as a design approach for dementia patients within a narrative review (Uwajeh et al., 2019). The single person case study of a dementia patient studied medication use and coping skills within a residential care setting (Mitchell & Van Puymbroek, 2019). Tenngart et al studied the effect of a sensory garden on patients undergoing a treatment programme for stress-related diseases in Sweden (Tenngart Ivarsson & Grahn, 2012). Like Tenngart, Grahn et al examined the impact on stress and depression of the rehabilitation garden set within the campus at the Swedish Agricultural University at Alnarp (Grahn, Pálsdóttir, et al., 2017). The case studies by Hernandez were a post occupancy evaluation of a dementia unit garden to determine quality of life, mood and interest that correlated with the level of physical and psychological activity (Hernandez, 2007). Whitehouse et al conducted a post occupancy evaluation to evaluate the effect of therapeutic gardens on restoration of hope, relaxation and stress reduction in patients, families and staff in a children's hospital (Whitehouse et al., 2001).

The case studies by Hussein examined special education needs children's behaviour, acquisition of social skills, problem solving and cognitive development after time in a school-based sensory garden (Hussein, 2010b). The pro-social effect of a sensory garden on children's families was outlined in the study by van der Riet. This study also found family support for

adherence to medication was enhanced after time in the garden (van der Riet, Jitsacorn, Junlapeeya, Thursby, et al., 2017). Reeve et al examined visitor book comments to determine restorativeness of the children's hospital gardens (Reeve et al., 2017).

Van der Riet initially studied the effect of a sensory garden in a children's hospital in Thailand on nurses (van der Riet et al., 2014). Nurses' stress levels were reduced, and they felt better able to care for their patients. She later explored the effect of experience of the garden in the Thai children's hospital on student nurses in Australia and Thailand (van der Riet, Jitsacorn, Junlapeeya, & Thursby, 2017). The nursing students changed to a more person-centred approach after experience of the sensory garden.

3.7 RESULTS

Using the PRISMA guidelines (Liberati et al., 2009a), the initial database search yielded 55 studies, EbscoHost combined MEDLINE, CINAHL complete and GreenFILE (42), Scopus (13), hand search (12) and a further 31 studies hand-picked from reviews previously identified (Figure 3-1).

The abstracts of 77 studies were screened. A total of 39 studies were excluded as clearly irrelevant after reviewing titles and abstracts. Any that did not provide sufficient information to determine eligibility were retrieved for full text examination. A total of 38 articles were read as full texts to be assessed for eligibility to be included in the synthesis. After independent assessment by the second reviewer (EH), 14 studies met the inclusion criteria as eligible to be included in the synthesis. The characteristics and synthesised results for all 14 papers are detailed in Table 3-2.

Study quality was assessed using a risk of bias tool to determine validity (Table 3.3). The tool was created as an adaptation of the quantitative work of Hanson and Jones (2015) and the qualitative assessment of validity measures by Cresswell and Miller (2000).

Table 3-3 Study validity tool, adapted from Hanson & Jones and Cresswell and Miller

Item	Description	Scale
Methodological quality		
Reporting: hypothesis	Is the aim/objective of the study clearly reported?	1: Yes, clearly reported
		0: No
Reporting: outcome(s)	Are the main outcomes to be measured clearly reported in the Introduction or Methods section?	1: Yes, clearly reported in introduction/methods
		0: No, not clearly reported/first mentioned in results
Reporting: intervention	Are the interventions of interest (sensory garden, therapeutic garden, healing garden and control) clearly described?	1: Yes, clearly described
		0: No
Representativeness	Were the study sample populations described representative of the study population?	1: Yes – shown to be representative
		0: No, not shown to be representative
		N: Insufficiently described
Randomisation	Was there adequate description of randomisation process, or statistical test to show comparability between groups was justified?	1.: Yes, description of randomisation adequate
		0: No, no description of randomisation
Qualitative studies	Was validity established?	1: Yes
		0: No
		N: Quantitative study
Quantitative studies reliability	Were confidence intervals or p-values given?	1: Yes, results shown to be quantified
		0: No, – not shown to be quantified
		N: Qualitative study
Comparability	Were baseline intervention characteristics comparable with the control?	1: Yes
		0: No
		N: Insufficiently described

All studies reviewed met a minimum, 'medium,' or above standard for either qualitative or quantitative research (Table 3.4). Validity assessment was initially made by GSB and then cross checked by EH.

The studies were assessed for quality, using the tool described in Table 3.3. Only 7% of studies were assessed as 'High' quality (≥ 7). The 50% of studies that met most of the criteria were ranked 'Medium High' (5-6). The remaining 43% met over half of the criteria and were ranked 'Medium' (≥ 4).

Table 3-4 Results of quality assessment of reviewed studies

Study	Reporting: hypothesis	Reporting: outcome(s)	Reporting: intervention	Representative-ness	Randomisation	Qualitative studies	Quantitative studies	Comparability	Overall assessment score – 7/8(for mixed method studies)*
Ellis (2011)	1	1	1	1	0	0	N	0	4
Edwards et al. (2013)	1	1	1	0	0	N	1	1	5
Gonzalez and Kirkevold (2015)	1	1	1	1	0	N	0	0	4
Grahn, Pálsdóttir, et al. (2017)	1	1	1	1	0	N	0	1	5
Hernandez (2007)	1	1	1	1	0	0	N	1	5
Hussein (2010b)	1	1	0	1	0	1	N	0	4
Mitchell and Van Puymbroeck (2019)	1	1	1	1	0	15	N	0	4
Reeve et al. (2017)	1	1	1	1	0	1	N	1	6
Tenngart Ivarsson and Grahn (2012)	1	1	1	1	0	0	0	0	4
Uwajeh et al. (2019)	1	1	1	1	0	1	N	0	5
van der Riet et al. (2014)	1	1	1	1	0	1	N	0	5
van der Riet, Jitsacorn, Junlapeeya, Thursby, et al. (2017)	1	1	1	0	0	1	N	0	4
van der Riet, Jitsacorn, Junlapeeya, and Thursby (2017)	1	1	1	1	0	1	N	0	5
Whitehouse et al. (2001)	1	1	1	1	1	1		1	7

* 'High' quality (≥ 7), 'Medium High' (5 - 6), 'Medium' (≥ 4)

A qualitative description of the effect(s) of sensory or therapeutic gardens seen in the literature is detailed in Table 3.5. Some of the articles reference multiple effects. Discussion of the effects seen is detailed in 3.8. As the majority of studies were qualitative, effect sizes were not reported.

Table 3-5 Characteristics of studies reviewed with psycho-social or physiological effects

References	Effect	Population (setting *)	Number (%) of articles
Hussein (2010b); Grahn, Pálsdóttir, et al. (2017); Ellis (2011); Mitchell and Van Puymbroeck (2019); Edwards et al. (2013); Reeve et al. (2017)	Enhanced mood	Special needs children; stress and depression out-patients; Dementia in-patient; psychiatric in-patients (H, S)	6 (43)
Reeve et al. (2017); van der Riet, Jitsacorn, Junlapeeya, and Thursby (2017); Whitehouse et al. (2001)	Feelings of vigour	Caregivers (H)	3 (21)
Hussein (2010b); Mitchell and Van Puymbroeck (2019); van der Riet et al. (2014); van der Riet, Jitsacorn, Junlapeeya, and Thursby (2017)	Communication skills	Caregivers; special needs children; dementia in-patient (H, S)	4 (29)
Tenggart Ivarsson and Grahn (2012)	Physical activity - walking	Stress and depression, out-patients (T)	1 (7)
Edwards et al. (2013); Grahn, Pálsdóttir, et al. (2017); Reeve et al. (2017); Whitehouse et al. (2001)	Social support	Caregivers; stress and depression out-patients (H, T)	4 (29)
Mitchell and Van Puymbroeck (2019)	Healthy eating	Psychiatric in-patients	1 (7)
Uwajeh et al. (2019); Edwards et al. (2013); Ellis (2011); Gonzalez and Kirkevold (2015); Grahn, Pálsdóttir, et al. (2017); Reeve et al. (2017); van der Riet, Jitsacorn, Junlapeeya, Thursby, et al. (2017); van der Riet, Jitsacorn, Junlapeeya, and Thursby (2017);	Perceived stress	Dementia In-patients; psychiatric in-patients; nurses; paediatric patients; stress and depression out-patients (H, T)	8 (57)
Grahn, Pálsdóttir, et al. (2017); Mitchell and Van Puymbroeck (2019); Edwards et al. (2013)	Depression	Dementia in-patient; stress and depression out-patients (H, T)	3 (21)
Hussein (2010b) ; Mitchell and Van Puymbroeck (2019); Edwards et al. (2013)	Social skills	Special needs children (S), dementia patients (H)	3 (21)
Hussein (2010b)	Perceptual development	Special needs children (S)	1 (7)

References	Effect	Population (setting *)	Number (%) of articles
Uwajeh et al. (2019)	Natural Killer NK cell activity boosted	Dementia In-patients (H)	1 (7)
Uwajeh et al. (2019)	Cognitive health	Dementia In-patients (H)	1 (7)
Edwards et al. (2013); Ellis (2011)	Nostalgic memory	Alzheimer's in-patients, psychiatric in-patients (H)	2 (14)

**(location H = hospital, S = special school, T = therapy centre)*

3.8 DISCUSSION

The systematic review of 14 studies provided quantitative and qualitative evidence that experience of sensory gardens is associated with positive effects on health and well-being. Psycho-social and physiological effects were seen across social, physical, psychological and relational measures. Levels of stress and depression, reduction in use of medication, mood and feelings of being able to manage were all enhanced by time in sensory or therapeutic gardens.

The body of literature showed that children and adults dealing with stressful health conditions or circumstances benefited from exposure to a sensory garden. Study design varied considerably, with no randomised controlled trials conducted. Study size also varied, with a case study of one participant (Mitchell & Van Puymbroeck, 2019) contrasting with N = 106 participants in the Grahn et al study (2017).

The post occupancy evaluation (POE) by Whitehouse was assessed as providing high quality evidence (Table 3.4). The POE described the effect of families and young patients' experience of the hospital garden on feelings of reduced stress, social support, communication skills (Whitehouse et al., 2001). Studies assessed as 'medium high' quality found reduced perceived stress, enhanced mood, improved social support and communication skills and improved social skill acquisition (Edwards et al., 2013; Ellis, 2011; Grahn, Pálsdóttir, et al., 2017; Hernandez, 2007; Reeve et al., 2017; Uwajeh et al., 2019; van der Riet, Jitsacorn, Junlapeeya, Thursby, et al., 2017). These findings are important in a healthcare setting as staff, patients and their families are in a stressful situation where effective communication is important to support a wide range of outcomes. It must also be noted that these findings could be important for workplace well-being.

Van der Riet's three studies evaluated the effect of a garden in a Thai children's hospital from the perspective of three different user groups; nurses, family members and student nurses. Nature contact and reduced stress were found to 'humanise' the hospital experience, to move it beyond a biomedical model of care to a more person-centred approach (van der Riet et al., 2014; van der Riet, Jitsacorn, Junlapeeya, Thursby, et al., 2017; van der Riet, Jitsacorn, Junlapeeya, & Thursby, 2017).

Both Grahn et al and Tenngart and Grahn set their studies around the Alnarp rehabilitation garden (Grahn, Pálsdóttir, et al., 2017; Tenngart Ivarsson & Grahn, 2012). Grahn et al's quasi experimental study found a positive effect of the garden on participants' return to work occupational competence (Grahn, Pálsdóttir, et al., 2017), while Tenngart and Grahn found walking activity in participants changed to become more purposeful (Tenngart Ivarsson & Grahn, 2012).

The 2015 email cross-sectional survey (Gonzalez & Kirkevold, 2015) showed nursing home leaders' clinical impressions were consistent in their regard for the benefits of sensory gardens. Benefits included being able to take residents outdoors, offer convenient topics for communication and facilitate social privacy for relatives.

The observational case study by Hussein found that the behaviour, development and social interaction of children with special educational needs were enhanced by time in a sensory garden at school, across both study sites (Hussein, 2010b). The positive effect of a sensory garden on children was also in healthcare settings (Reeve et al., 2017; van der Riet et al., 2014; Whitehouse et al., 2001).

The Mitchel and Van Puymbroeck case study found the 76-year-old female with dementia symptoms of behavioural disturbances, depression, anxiety, and difficulty acclimating to Long Term Care all improved after 40-60 minutes sessions in the sensory garden three to four times per week. By discharge from the treatment programme, all treatment goals were met with significantly decreased symptoms of depression and anxiety (Mitchell & Van Puymbroeck, 2019). Dementia symptoms were also found to be relieved by time in a therapeutic garden by Ellis (Ellis, 2011) and Hernandez (Hernandez, 2007). Uwajeh et al and Edwards et al also studied the impact of therapeutic gardens on dementia. The Uwajeh et al narrative review found the health implications of therapeutic gardens for Alzheimer's Disease and other dementia patients encompass physical, social, psychological and cognitive effects (Uwajeh et al., 2019). The Edwards et al case study of the effect on quality of life for dementia in-patients showed effects across social skills, depression and enhanced mood (Edwards et al., 2013).

Results were published in 14 different journals, which included public health, landscape, medical, one education, mental health, forestry and a recreation journal. None of the

studies examined the effect of the sensory garden from the perspective of keeping healthy people well.

Of note, perceived stress was cited as reduced by 57% of the studies. Mood was found to be enhanced in 43% of the studies. Personal communication was cited as enhanced by time in the garden in 29% of the studies. Depression reduction and social skills enhancement were each seen in 21% of the studies. That the results were seen across the breadth of quantitative and qualitative studies is interesting. van der Riet from the caregiver perspective, Gonzales from the patient perspective and Hussein from a child development perspective all found communication skills enhanced by time in a sensory garden. Communication was found to be influenced through contact with nature, indirectly by the soothing of the sick and as an organisational influence by offering a new communication prompt (Reeve et al., 2017; van der Riet et al., 2014). Being able to appropriately express emotion and share experience is important to stress reduction (Hussein, 2010b). The combination of social, physical, psychological and relational benefit characteristics suggests a sensory garden could provide a systemic tool, to enhance well-being through interaction with a specifically designed place.

The sensory and therapeutic garden literature, as a subset of the nature and greenspace for health literature, show additional benefit over and above exposure to standard gardens. Being able to be outside in nature, to see and hear birds and beneficial insects, to feel a breeze on the skin, with views of sky, stars, sunsets, sounds of water and leaves rustling improved quality of life for children and older people undergoing treatment. It also provided a restorative effect for carers, reducing their stress and allowing them to see patients as people.

3.8.1 Strengths

The strength of the systematic review lies in its ability to clearly establish the evidence and locate the research gap. The systematic review allowed for high-level review of evidence related to the pre-defined question. Literature was systematically searched, with all processes, including data extraction and synthesis, checked and confirmed by EH.

3.8.2 Limitations

The majority (86%) of studies reviewed were qualitative. No mixed methods research was found and no randomised controlled trials.

3.9 CONCLUSION

This review suggests that sensory gardens are associated with a wide range of health benefits, with analysis of results showing statistically significant associations with dementia symptoms, stress, and self-reported well-being. However, studies were limited to health-related settings. This finding points to a gap in the literature around the potential for sensory gardens to be used to promote well-being as part of a settings-based health promotion campaign. Findings of this systematic review indicate that the creation, regeneration and maintenance of sensory gardens may aid workplace well-being. Further, sensory gardens could form part of a multi-faceted approach to improve wide-ranging health outcomes for staff and students of the university. Consequently, this thesis was designed to address the gaps in the literature around the effect of a sensory garden on apparently well people.

Chapter 4 METHODOLOGY AND METHODS

4.1 THEORETICAL BASIS FOR RESTORATIVE RESPONSE

To address pressing issues affecting health, it makes financial and social sense to focus on what works to prevent illness and promote well-being. Lifestyle-related conditions such as depression and anxiety are the most prevalent cause of disability globally (World Health Organization, 2017a) and are associated with chronic stress (McEwen, 2008). Mental fatigue is a key component of stress. To understand how well-being can be impacted by design, and gain a more complete understanding of the effects of the environment on well-being, this multidisciplinary study was set within the Socio Ecological and Salutogenesis models and based on the Attention Restoration Theory, and Stress Recovery Theory, which acknowledges the Biophilia hypothesis.

4.2 MIXED METHODS AS A METHODOLOGY

Mixed methods research is an approach to inquiry and research that combines quantitative and qualitative methods into one study to provide a broader perspective than monomethod designs (Molina Azorín & Cameron, 2010). Philosophically, although mixed methods is also a research design, this study agrees with Greene's contention that the theory of mixed methods represents a dynamic interplay between creative practice in practical fields and within the limits of traditional theory (Greene, 2008). Given the applied, multi-disciplinary nature of this research, utilising mixed methods as a methodology offered a pragmatic, functional blend of theory and practice. As such, the research was freed from the theoretical confines of each discipline to explore new meaning equally within both the qualitative and quantitative data.

Mixed methods research emphasizes the research problem and uses all approaches available in order to develop a better understanding. Mixed methods have become an increasingly popular approach in the fields of sociology, psychology, education and health sciences (Schoonenboom & Johnson, 2017). This study sought to explore the health effect of an intervention, within the art and science of nature-based design research. The limitations of a purely statistical approach to the concept of a sensory garden were recognised within a pragmatic motivation to design a mixed methods

study. Mixed methods research was thus appropriate as a methodology and as a method to more completely identify and describe any effects of the intervention.

To discover the effect of the Scholars' Garden on health and well-being (Thesis Aim 2) and determine whether the garden could be a sustainable self-help tool for staff and students (Thesis Aim 3) required research be split into two Studies. To set the parameters for Study 1, a sensory garden known as the Scholars' Garden (SG) was designed and established as a living laboratory (Thesis Aim 1. See Chapter 5 for details). Causality is difficult to ascribe to an environmental design intervention as any effect shown could be linked with multiple external factors. However, by comparing any effects of the SG with those of a similarly-sized traditional campus plaza and a control cohort, a variety of outcome measures were able to be investigated.

When ecologists Shanahan et al quantified the minimum 'dose of nature' for human health and well-being (2016), to establish a dose response they explored vegetative cover levels but did not state how that vegetation was laid out or what that nature looked like. The term 'dose' was used to signify a quantifiable treatment to enable the study to be comparable to a standard health treatment. This study, in leveraging the Shanahan et al dose response study, trialled the effect of different 'doses' of nature as determined by designed and managed biodiversity (see Chapter 5 for detail). As a design-based enquiry, Study 1 aimed to determine whether the type of nature contact, as dictated by biodiversity levels, layout and design elements of the space, made a difference. A randomised controlled trial (RCT) was chosen to further illustrate any environment-dependant response.

A typical urban environment is predominantly paved (Akbari, Shea Rose, & Taha, 2003). As the New Zealand Official Yearbook recorded Aotearoa/New Zealand as one of the most highly urbanised countries in the world, with 85.7 percent of its population living in urban areas (Statistics New Zealand, 2002), it was appropriate for the RCT comparison intervention to explore differences in effect between a predominantly paved plaza space and a biodiverse sensory garden. This approach had a number of attractive features. First, any physiological or psychological response from a typical, predominantly paved urban environment in comparison with an atypical but evidence-based environmental design was isolated. Second, by adding a third 'control' group, it could be

ascertained whether everyday life, for example simply being outside to and from the car or walking the dog, was enough to have a measurable effect.

Quantitative studies have determined the physical and psychological impacts of nature contact in an urban setting (Beil & Hanes, 2013; J Maas et al., 2009; Maller et al., 2006; McAllister et al., 2017). Qualitative studies have shown health-related effects of urban nature in general terms (Bjørn & Grete, 2009; Capaldi et al., 2015; Curtis, Gesler, Fabian, Francis, & Priebe, 2007; Gilchrist, Brown, & Montarzino, 2015; Irvine, Warber, Devine-Wright, & Gaston, 2013; Kyriakopoulos, 2011; Sonntag-Öström et al., 2015). Post occupancy evaluations are used by design researchers, but often lack baseline data. A mixed method approach allowed data analysis to draw from a broad background of analytical tools (Schoonenboom & Johnson, 2017).

Mechanisms related to well-being enhancement and well-being restoration were studied through quantitative and qualitative analysis of health-related outcomes (see 4.4 Quantitative outcome measures for description of the measure):

Physiological stress as measured by saliva cortisol levels

Flourishing Scale (vs languishing) as a measure of perceived well-being

Scale of Positive and Negative Experience as a measure of perceived stress

Nature Relatedness Scale as a measure of pro conservation behaviours

Perceived Work Output as a measure of productivity

Potential confounders were accounted for by surveying:

Competing experience (intentional access to green space e.g. time spent in public parks; unintentional experience e.g. in transit from indoors to outdoors; direct experience e.g. in a garden; and indirect experience e.g. view through a window)

Frequency of visits (to alternative greenspace)

Weather observations, such as rain, sun, windy, cloudy, cold, warm

Species richness (the number and variety of plants, birds and insects observed)

Age, sex, education, employment, ethnicity and health history

A qualitative approach allows development of theory, while quantitative enquiry tests it. In order to unpack the relationship between green space and well-being, qualitative

information was integrated into and enriched the quantitative data, to increase the depth and the breadth of the Study. Interviews added further depth to discover the context and background that informed participant behaviours.

The quantitative data collected included closed-end information that underwent statistical analysis to result in a numerical representation. Analysis of qualitative data allowed for the “voice” of the participants to be heard and interpreted.

4.2.1 Thematic analysis

Thematic analysis (TA) is a qualitative tool often used in health and the social sciences (Braun & Clarke, 2006). TA was appropriate in this mixed methods Study as it permitted exploration of perceptions of the garden as they related to participants’ positive mental health and productivity. Patterns of meaning were identified across the qualitative data set in order to answer the research question. In so doing, reflexive TA permitted the effect of the SG to be induced from the data. Where the topic is complex, as in this Study, TA allows a deeper understanding of the research problem through identifying, analysing, organizing, describing and reporting themes found within a data set. The inductive orientation allowed themes to be directed by the content of the data. Braun & Clarke’s (2006) reflexive thematic analytic approach was thus as an appropriate method for this Study.

Thematic analysis of the journal entries, quotes, one-on-one interviews, focus groups, and questionnaires’ comments was chosen as it is able to be used across the epistemological and ontological spectrum (Fereday & Muir-Cochrane, 2006). Patterns of common ideas with shared or similar meaning were sought and grouped into themes (Braun & Clarke, 2006). Using NVivo and manually, analysis was undertaken over six stages:

1. Familiarisation — familiarisation with the data by studying notes and reading the transcripts.
2. Coding – an initial coding of the entire dataset was followed by collation of all codes and relevant data extracts.

3. Generation of initial themes - through identification of key issues, concepts and recurrent themes. This was conducted by drawing on issues raised by the respondents themselves and their views or experiences. Note: codes and themes were verified by the research supervisor.
4. Reviewing themes — a thematic framework was applied to all the data in textual form by marking the transcripts with colour codes manually. Themes were then reviewed and refined.
5. Defining and naming themes — detailed analysis of each theme to ensure they told a coherent 'story' in line with the research question. The data items were rearranged according to the appropriate part of the thematic framework to which they relate.
6. Interpretation - the process of interpretation was influenced by the original research objective, identifying environmental design preferences, as well as by the themes that emerged from the data in relation to existing literature.

Once all data were collected, data were coded and manually arranged in broad themes, based on frequency of response, similarity and sensory attribute. Broad themes were collapsed into core and then sub-themes through removal of redundancies, removal of irrelevant themes and the merger of related themes. This aimed to induce patterns in response to the SG, to inform the future establishment of design guidelines. Evidence was triangulated across Attention Restoration Theory (ART), Stress Recovery Theory (SRT) and the Biophilia hypothesis to address the research question, to establish the effect of a sensory garden on indicators of well-being.

4.2.2 Triangulation of design research

Research through design is an active process of ideating, iterating and critiquing potential solutions. "It allows design researchers to continually reframe the problem as they attempt to make the right thing" (Zimmerman, Forlizzi, & Evenson, 2007, p. 6). Buchanan states that the significance of seeking a scientific basis for design lies in connecting and integrating useful knowledge from the arts and sciences suited to the problems and purposes of the present (1992, p. 6). Triangulation of qualitative and quantitative data required the researcher to establish a theoretical reference point

(Figure 4-1). Using biological, sociological and related psychological theory to prompt evidence-based design, data collection was thus triangulated across four basic datasets, qualitatively and quantitatively, pre and post intervention.

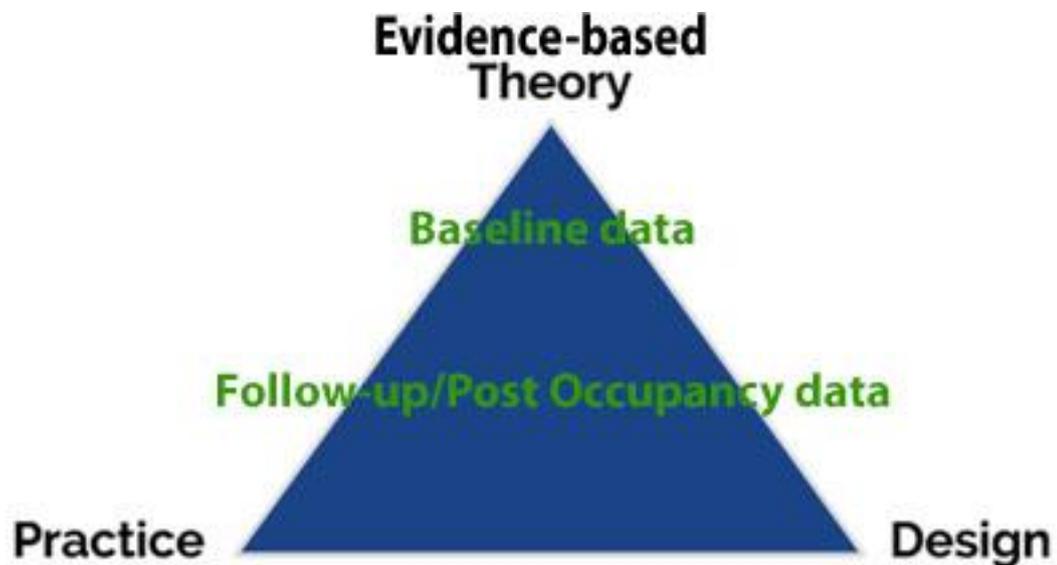


Figure 4-1 The top down evidence-based design approach is based on a theoretical perspective. This adds baseline data collection to design evaluation to prompt knowledge into design action, theory into practice

Triangulation is a way of assuring the validity of research through the use of a variety of methods to collect data on the same topic (J. Cresswell & Plano Clark, 2017).

While almost any greenspace can provide an association with natural elements, sensory gardens created using evidence-based principles are recognized as being most effective. When guided by a knowledgeable designer and appropriately implemented, gardens can promote stress reduction and enhance health outcomes. Concurrent triangulation research design was used such that each dataset cross validated findings from the other (J. Cresswell & Plano Clark, 2017). Pre-intervention quantitative data was collected. During and post intervention, participants were questioned to explore their experience, to increase the trustworthiness of the information gathered. In this Study saliva cortisol sampling, an in-depth survey, semi-structured interviews, focus groups, journals, observations and direct quotes were collected. Triangulation looks for any contradictions within the data.

4.2.3 Sampling strategy, avoiding bias

Our sampling strategy was randomised and stratified convenience sampling, across staff and students at AUT who volunteered to be part of the Study.

Randomised, controlled trials were introduced into clinical medicine when streptomycin was evaluated in the treatment of tuberculosis and have become the gold standard, or best practice, for assessing the effectiveness of therapeutic agents (Concato, Shah, & Horwitz, 2000). Randomisation was assumed important to avoid the potential for outcomes to be biased by researcher or participant self-selection to a particular study group. This 'gold standard' persists although observational studies have been shown to not systematically overestimate the magnitude of the effects of treatment as compared with those in randomized, controlled trials on the same topic. However, to ensure any enduring concern regarding potential for bias in Study participant selection unfairly weighting the outcome was negated, the sample was randomised and stratified.

4.2.4 Theories and model

Stress Recovery Theory (SRT) is a psycho-evolutionary model of stress reduction. The stress recovery theory was proposed through the seminal study by architecture Professor Roger Ulrich (Ulrich, 1984). Ulrich found stress recovery arises from an immediate, affective response to the visual stimulus of a natural setting, impacting the brain and neuroendocrine system (Ulrich et al., 1991). SRT suggests exposure to a natural environment can lead to recovery from excessive arousal states. According to the theory, the almost automatic response is evolutionary, which motivates one to leave the stressful environment. The evolutionary perspective argues that because humans evolved with and in natural environments, people are to a greater or lesser degree physiologically and psychologically adapted to nature and natural settings (Ulrich et al., 1991). Ulrich's original study required 120 subjects to view a stressor then be exposed to different scenes, of natural or urban environments. Physiological and verbal findings converged, indicating that recovery from stress was faster and more complete when people were exposed to natural instead of urban environments (Ulrich et al., 1991).

Attention Restoration Theory (ART) was based on a broad view of restorative environments (R. Kaplan, 1993b, 1995; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; S. Kaplan & Talbot, 1983). ART suggests that performance, mood and well-being are

enhanced by exposure to environments that have low demand for voluntary attention and attract effortless involuntary attention. In cognitive psychology, voluntary attention is the ability to focus on a task (R. Kaplan & Kaplan, 1989). Attention is finite and may be fatigued. Attentional fatigue is associated with poor decision making, reduced self-control and lifestyle-related health issues. Environmental psychology identifies involuntary attention as 'soft fascination', which occurs when one notices clouds in the sky or a beautiful sunset, hears a bird singing or the rain dripping through leaves (R. Kaplan, 1993a). Natural settings, rich in softly fascinating sensory stimuli, prompt involuntary attention, which supports restoration from mental fatigue (R. Kaplan & Kaplan, 1989). Although not exclusively available in natural environments, fascination is more easily distracted by the informational demands of urban settings (S. Kaplan, 1995).

Urban lifestyles impose growing demands on cognitive resources (S Kaplan & Berman, 2010). By taking time out from the attention-demanding tasks associated with modern living, and spending time in natural environments that demand less of one's cognitive resources, ART claims that people recover their attentional capacities (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995). Time in the natural world provides opportunity for reflection and consideration of unresolved issues, which is considered key to the restoration process (Herzog, Black, Fountaine, & Knotts, 1997 ; S Kaplan & Berman, 2010). ART assumes that the more an environment is compatible, fascinating, extensive and allows the feeling of being away from the everyday world, the greater its restorative potential. However, these properties are not immanent in the environment, but are perceived by users. As such, environmental qualities are not a matter of fact, but rather of people-environment transactions (Scopelliti & Giuliani, 2006). Hence, different users, with different needs, may perceive the same environment differently.

Attention Restoration Theory was tested specifically by measuring productivity (Berto, 2014; Groenewegen, Van den Berg, De Vries, & Verheij, 2006; Herzog et al., 1997 ; S. Kaplan, 1995). This was based on the assumption that if attention is restored, productivity will increase.

Salutogenesis is an assets model as a guide to health promotion. The assets-based system asks the question 'what makes one healthy?' rather than the deficit-based 'what makes one ill?' The aim of such asset-based practice is to promote and strengthen

factors that support health and well-being, while protecting against effects of poor health, and in the process nurture communities and networks that sustain health (Rippon & Hopkins, 2015). Antonovsky created the model to focus attention away from disease and towards a continuum emphasising health, stress and coping (Antonovsky, 1979; Mittelmark & Bull, 2013). The model offers a focus on factors supporting wellness (Antonovsky, 1996) for people for the 99.5% of the time they are not in a formal healthcare setting (Rippon & Hopkins, 2015).

The salutogenic perspective focuses on three aspects:

1. problem solving/finding solutions.
2. identification of generalised resistance resources that help people to move in the direction of positive health.
3. identification of the sense of coherence (SOC), a global and pervasive sense in individuals, groups, populations, or systems that serves as the overall mechanism or capacity for this process (Bengt Lindström & Monica Eriksson, 2005).

A 'sense of coherence' (SOC), whereby one's environment is predictable, makes it possible to make sense of the world. SOC comprises three components: comprehension, management and meaning (Antonovsky, 1979). Comprehension is the extent to which the environment is perceived as making logical sense, that events and spaces are ordered, consistent and structured. Management is the extent to which a person feels they can manage, adapt and control their environment. Meaning is the degree to which one feels that life makes sense, and challenges are worthy of commitment. Antonovsky believed that individuals with a strong SOC would be more likely to believe challenges were manageable and less likely to feel stressed (Antonovsky, 1979).

SOC seems to aid health promotion, which strengthens resilience and develops a positive subjective state of health (M. Eriksson & Lindström, 2006). Factors supporting well-being, such as the natural elements within greenspace, are key to a salutogenic design approach. Salutogenesis thus invokes design to function as a health promotion tool.

Landscape theory, in guiding *how* to plan, design and manage landscape for human use and enjoyment, states that designers should design *with* nature. Scottish Landscape Architect Ian McHarg, in his seminal book *Design with Nature*, showed how to break down a region into its appropriate uses (McHarg, 1995). Such functional use distinctions were designed into the Scholars' Garden, but form was equally important in creating emotional attachments to the setting. McHarg promoted an ecological view which was widely adopted across the Western world. Since McHarg's writings in the 1960's Postmodern and post-Postmodern landscape theory has added a cultural dimension to design with nature. This Study's results support an ecological approach to design, and a breakdown of landscapes into appropriate use. The functional design afforded restoration and recovery.

While nature reflects the natural world, seen within urban landscapes nature is a vital link back to our evolutionary roots, to the varied sensory experience of wildlife, plant life and landform. If landscape is a combination of physical origins and the cultural overlay of human presence, landscapes must reflect a living synthesis of people and place. Urban landscapes emphasise people and place to a greater degree than rural landscapes with a predominance of built environment forms. The character of a landscape helps define the self-image of the people who inhabit it and a sense of place that differentiates one region from other regions. It is the dynamic backdrop to people's lives.

Biophilia is a hypothesis that describes a deep connection or love of living things as an evolutionary response. Biophilia details the stress response to perceived threats and the restorative response of calming views (Heerwagen, 2009; Wilson, 1984). Wilson defined biophilia as "the innately emotional affiliation of human beings to other living organisms" (Wilson, 1993, p.31).

Biophilia's innate response is believed to determine the measurable neurological and physiological effects of natural environments. It is posited that should one lose connection or not forge early links with the natural world one can become stressed and depressed (Louv, 2012). Maladaptive lifestyle-related behaviours can be expressions of ways to replace the loss, often without being aware of the deficit or actions (Pretty, Peacock, Sellens, & Griffin, 2005). As such, nature experience is now linked with a range

of therapies for health and well-being, including forest-based and park-based programmes. In urban settings, nature-based design can affect exposure to restorative natural environments, with increased vitality, decreased burnout and depressive symptoms observed (Ryan et al., 2014) .

Although widely supported and promoted within design, the Biophilia hypothesis is not without its detractors. However, despite some deficiencies in scientific evidence of an evolutionary basis for nature attraction, clients seeking value-added design have welcomed biophilic design into offices, airports and hospitality settings. Whether design preferences for open environments are prompted by human evolution on the African plain, or whether individuals simply prefer the prospect to reveal potential threats, is considered immaterial to this Study. Regardless of cultural background or the type of landscape, the body of evidence shows that individuals have an emotional connection to nature, to non-manufactured natural elements and living things. This generally translates into a preference for nature over urban environments and man-made constructs.

Integrating theory with design recognizes the human health-promoting potential of design, and its ability to improve ecological health. Roger Ulrich, a Professor of Architecture, developed the SRT and applied the Biophilia hypothesis to his findings, (Ulrich et al., 1993) and is considered a leader in Evidence-Based Design (EBD). In landscape architecture, Brown and Corry refine EBD to Evidence Based Landscape Architecture (EBLA) as *“the deliberate and explicit use of scholarly evidence in making decisions about the use and shaping of land (R. D. Brown & Corry, 2011)”*. However, landscape architecture is far more than just design, so this Study must therefore leverage EBLA to add more than evidence, it must offer a practical solution to the research question.

The environmental implications of a population disconnected from nature feed the growing demand for human well-being to provide environmental benefits (The University of Exeter's Environment and Sustainability Institute, 2015). Nature connections, whether through forest walking or urban landscape design interventions have been shown to reduce stress (Capaldi et al., 2015). Stress is a known prompt for mental and physical illness (Canadian Mental Health Association, 2016). Hence, applying

a living salutogenic design approach to evoke attention restoration and stress recovery could show the effect of a sensory garden and may be a powerful self-care tool to promote health and well-being.

Bronfenbrenner's Socio Ecological Model (SEM) of health (Figure 4-2) is a conceptual framework depicting spheres of influence over human behaviour (Bronfenbrenner, 1992). It addresses multiple factors which support and maintain healthy behaviours, including the environment in which an individual lives, works and plays. The core principles of all variations of the SEM are the layers of influence over an individual's lifestyle choice or behaviour, the interactions between those influences, and multi-level approaches applied to interventions intended to modify behaviour. The SEM was an appropriate framework to place the research within as it is useful in the creation of sustainable solutions utilising social and behavioural change, as tested in Study 2 of this research.

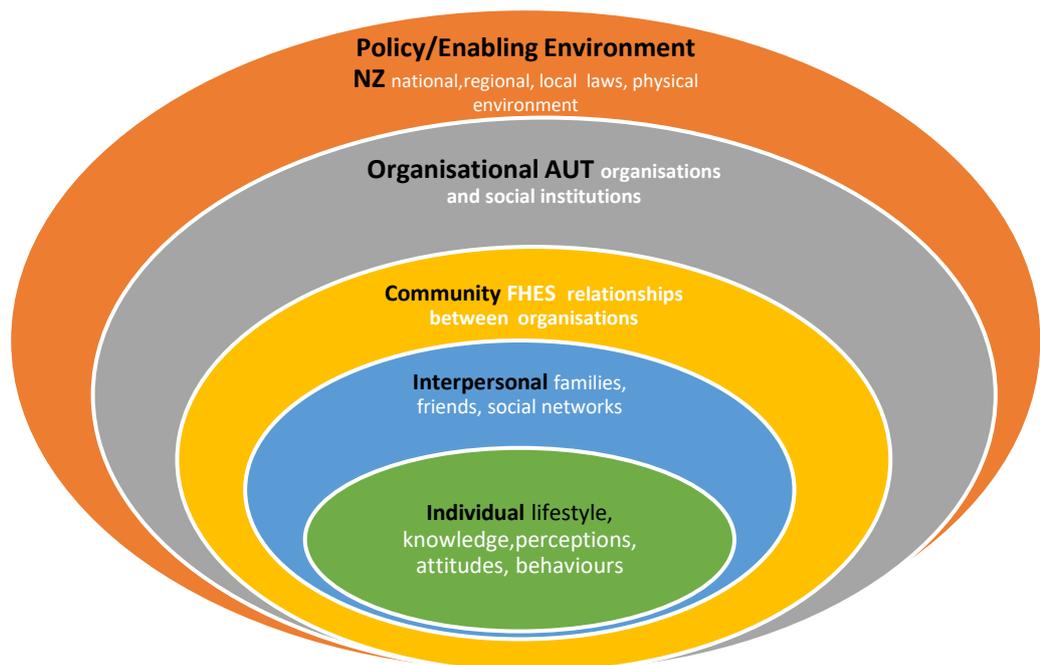


Figure 4-2 The socio-ecological model of health, adapted from (McLeroy, Bibeau, Steckler, & Glanz, 1988)

As per the model, this Study focussed from the individual out into the community. That community, in this instance, was centred within the university setting of the Faculty of Health and Environmental Sciences. Participants came from all Schools within the Faculty: Clinical Sciences, Interprofessional Health Studies, Public Health and

Psychosocial Studies, Sport and Recreation and Science. The sense of community created by participation in the sensory garden research project was communicated up through the organisational levels, to ensure enduring support for the garden. See Chapter 5 for further interpretation and Chapter 8 for reinterpretation of the Model.

4.3 METHODS

4.3.1 Sample size

Where an intervention is relatively inexpensive, as in this Study, it is worth detecting even a modest effect size; unlike an expensive intervention where only a large effect size would be justified for wider use (Sanders & Ni Chonaire, 2015). Sample size calculations were based on enabling the detection of at least a medium intervention effect using an ANCOVA model ($\alpha = 0.05$, $1-\beta = 0.8$) with three intervention groups and three covariates (baseline, age, sex; see Results). Using this model, a total sample size of 179 participants would enable the detection of an effect size (f) of 0.25 for salivary cortisol. As a field experiment, this Study's sample was both manageable and sufficiently powered to detect a larger effect, but would miss detection of smaller, trivial effects (Sullivan & Feinn, 2012). The target sample size was set to 179 to allow for 20% drop-out between T0 and T2.

4.3.2 Participants

Healthy staff and students, $N = 179$, between the ages of 18 and 65 years, working or studying at AUT North Campus, available during the 2017-2018 academic year initially opted in to the Study through an Auckland University of Technology Ethics Committee (AUTEK)-approved Consent process on 7 March 2017, 10 April 2017 and 7 July 2017, AUTEK Reference number 17/14 (see Appendix C).

Participants were stratified for age and sex as they applied to be part of the Study and informed in advance that they would be randomly selected for either of three groups being the new sensory garden 'Scholar's Garden' (SG), the existing plaza 'Awataha Plaza' (AP), or Control. On sign-up participants were asked to confirm whether they consented to their images being used when photos were being taken. All groups were offered access to Study findings in addition to access to the sensory garden during Study 2 of the intervention.

Participants were excluded if they required medication for a long-term health condition that would impact cortisol levels e.g. high blood pressure, high cholesterol, some antidepressants (Granger, Hibel, Fortunato, & Kapelewski, 2009).

4.3.3 Study design

To supplement the scoping literature review in Chapter 2, identify knowledge gaps and further situate the research, the researcher made personal visits to sensory gardens and research centres to guide study design. The visits provided an in-depth overview of the problem by elucidating it from many angles. Extensive experience of practical design of sensory gardens, together with visits to internationally renowned healing gardens, participation in international conferences, personal meetings and discussions with leaders in horticultural therapy: doctors, scientists, horticultural therapists and designers, provided the base from which the Study was formed.

To test the effect of the sensory garden the research was designed as a field trial. A field trial is defined by Smith et al as a trial conducted outside of clinical settings (Smith, Morrow, & Ross, 2015). This contrasts with a 'clinical trial' used for studies in health facilities. In contrast, field trials generally involve participants who live at home and are otherwise in their normal environment, rather than 'captive' in hospitals or outpatient clinics.

Study 1 was conducted as a randomised controlled trial (RCT). While unlikely that a single study would prove causality, randomization reduced bias and offered a rigorous tool to explore cause-effect relationships between intervention and outcomes.

Study 2 was conducted to test the sustainability of the SG as a self-care tool. In Study 2, participants from all three groups (Control, AP and SG) were given access to the Scholar's Garden. As in Study 1 they were asked to visit for 30 minutes once a week, but without the appointment system. This unstructured access was designed to test whether participants, some having experienced and others having heard the effect of the garden in Study 1, would take time out of their busy days to visit the sensory garden voluntarily.

The physical design of the sensory garden, as an evidence-based design (EBD) intervention, was assessed using case study analysis (see Chapter 5). A sensory garden is a design typology tested in care facilities (Bengtsson & Grahn, 2014; Gonzalez &

Kirkevold, 2014; Hussein, 2010a) but also used in schools, generally to reduce stress in young people with special educational needs. Case study analysis is an empirical enquiry that provides a conceptual framework and action plan for getting from a research question to a set of conclusions (Yin, 1994). As such it was appropriate to this applied research, which aimed to translate knowledge (design and health research) into action (design response). This project developed a methodology for an issue typology, in this case the use and users of Campus/Gardens as part of an institutional landscape. The sensory garden at AUT was designed with reference to appropriate theory and practice.

The Study was initially designed to be completed during semester one of 2017 (Figure 4-3). Due to unexpected delays in completion of the garden, the intervention start date was deferred from 'summer' at the start of semester one, to 'winter' at the start of semester two. Due to the delay and to account for the need for a continuous intervention within the academic calendar, Study 2 was pushed out until semester one of 2018. Initially the Study was designed with three time points as shown in Figure 4-3 below. A further time point was then added as the period between Studies 1 and 2 was six months. T2 became the baseline for Study 2 and T3 the follow up.

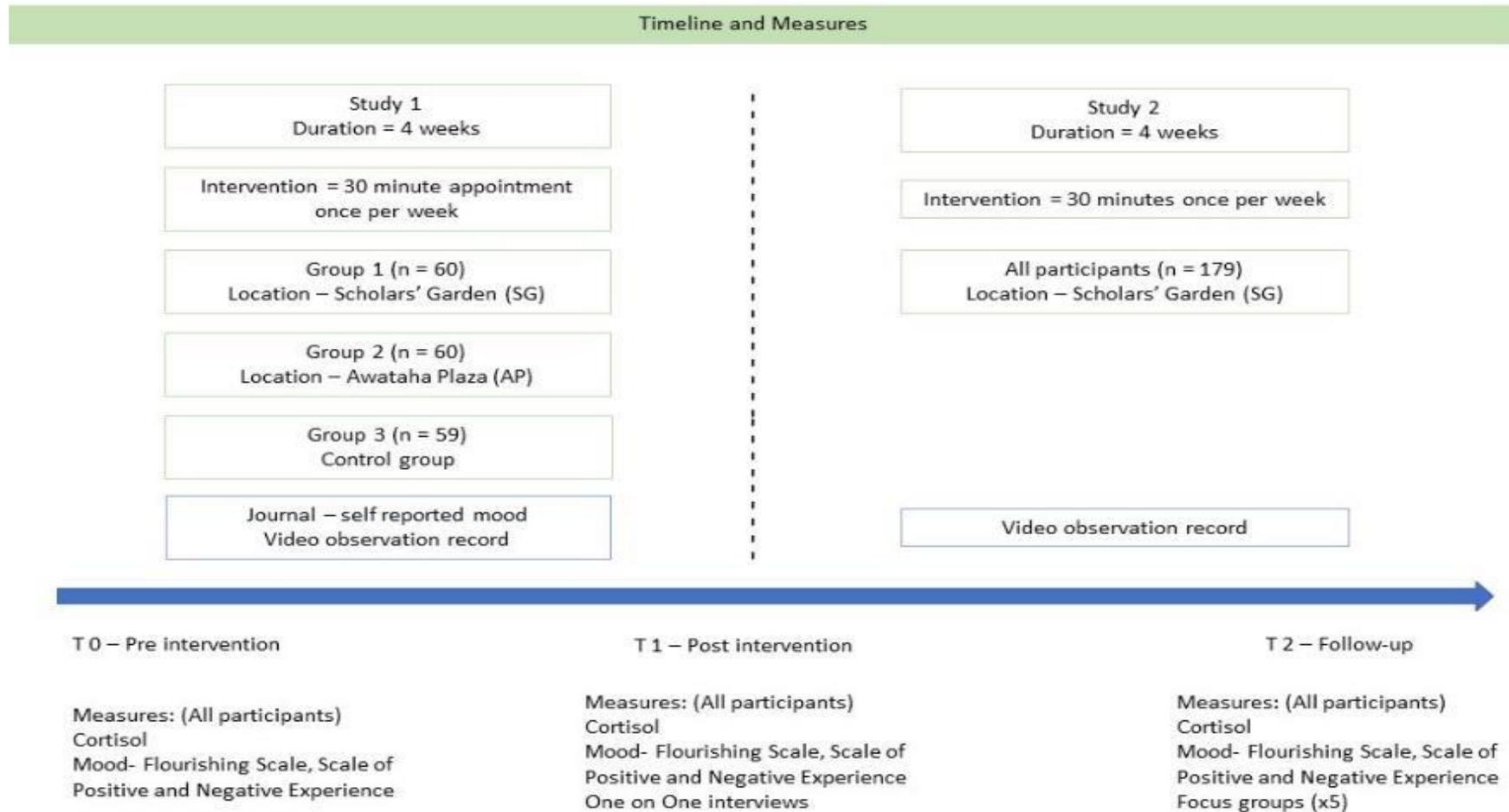


Figure 4-3 Proposed timeline and measures

Baseline testing of all participants took place in the laboratory in the week prior to each Study of the intervention starting, during the 90 minutes around midday, from 11:30 - 13:00. Mid-day was chosen as the optimal sampling time as being least intrusive on participants and most likely to capture work-related stress cortisol levels. Pilger et al's study found that multiple early-morning sampling involves more laborious methods and produces a greater range of variation (2018). Participants were asked to supply a saliva sample by spitting into a sample pot. They also completed a questionnaire which surveyed their demographics, Diener et al's Flourishing Scale (Diener et al., 2010), Nisbet et al's Nature Relatedness Scale (Nisbet, Zelenski, & Murphy, 2009), Diener et al's Scale of Positive and Negative Experience (Diener et al., 2010) and a modified World Health Organization's Work Performance Questionnaire (Ron Kessler, Petukhova, McInnes, & Üstün, 2007) (see Appendix E). In addition, participants were asked about their frequency and locational preferences for visits to greenspace.

Follow up testing of all participants took place in the laboratory in the week following the intervention at the end of each Study.

The Study design, from recruitment through to the end of Study 1 and through Study 2 is shown in Figure 4-5 and Figure 4.5.

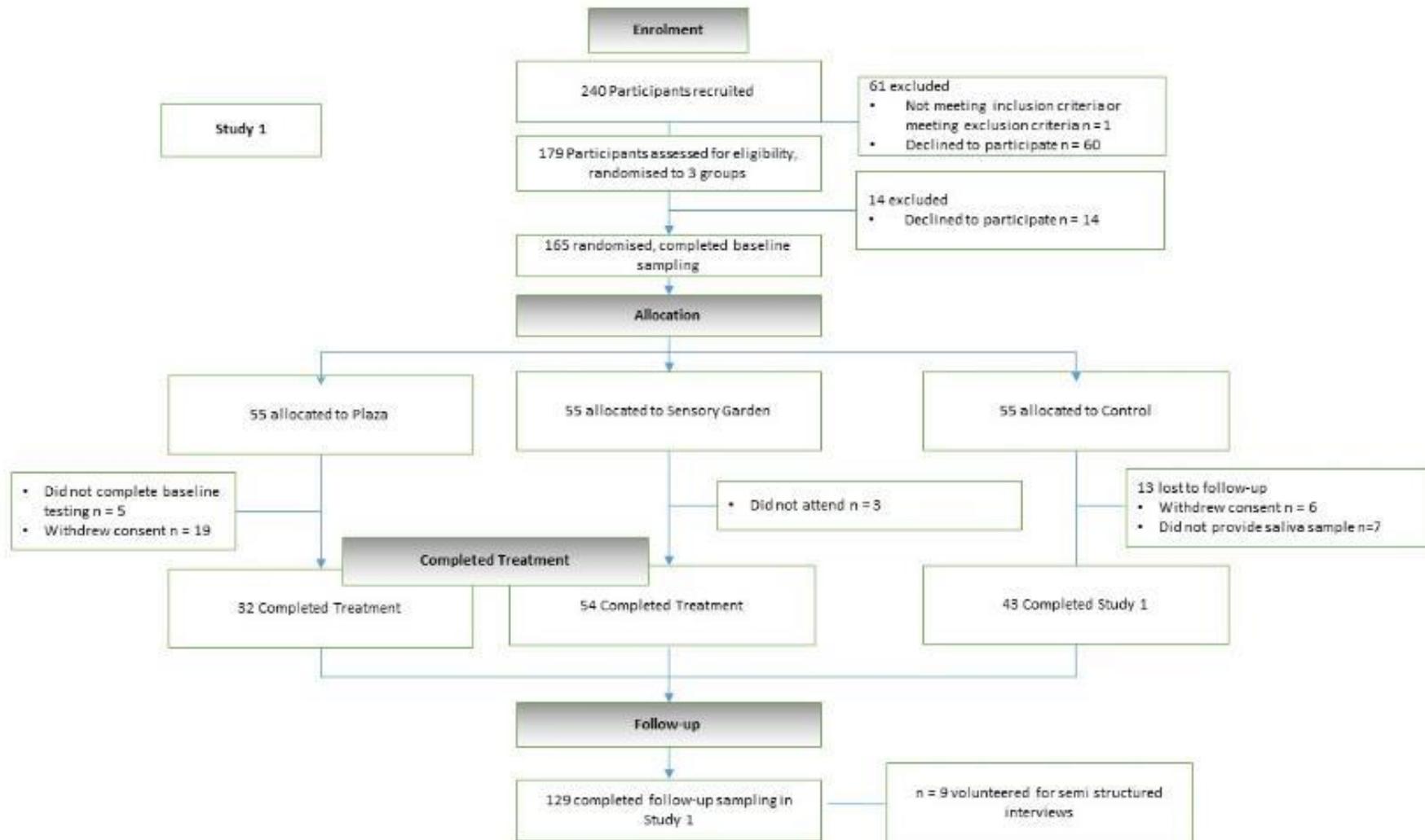


Figure 4-4 Study 1 final process flowchart

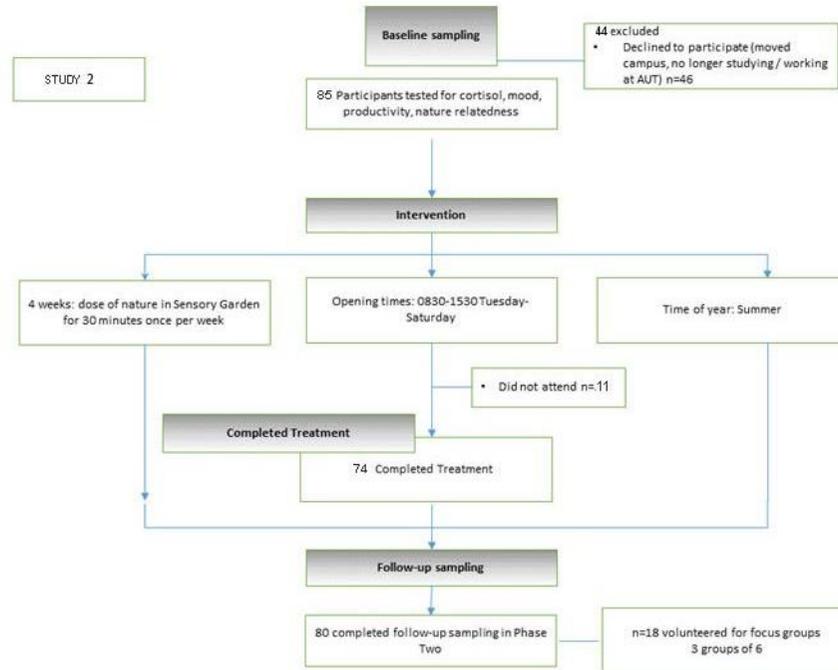


Figure 4-5 Final Study 2 study design

During the period the sensory garden was being developed and planted, general interest in the garden from around the university was high. This prompted the addition of the Productivity measure to the survey questionnaire, to supplement Cortisol and Mood, as of interest in the workplace setting.

Study 2 was designed to test two areas. Firstly, was to determine whether any effect shown in Study 1 could be seen across the whole sample population. Secondly, the research question asked whether people would make the effort to take time out of their day to access the garden, without the benefit of an appointment system. Accurate records of attendance were important at all stages, but particularly so during Study 2 when the potential of the garden to attract people in as a self-help tool was tested.

4.3.4 Protocol and Procedures

Participants came into an on-campus science laboratory for baseline and follow-up testing. The first time they entered, pre group allocation, they were told the research would explore effect of experience. To mitigate potential bias from any participant-expected outcome, participants were told the research would test “whether simply being outside, or experience of some trees and shrubs, or a species-rich sensory garden, was sufficient to show an effect”.

Study 1

Table 4.1 shows the two intervention groups, the dose of nature received and how it was delivered. To protect against participants opting out of the Study prior to the intervention participants were not told of their group allocation until they arrived in the lab for baseline sampling.

A trained Research Assistant (RA) was present in the Scholars’ Garden and Awataha Plaza during intervention sessions to greet participants on entry, note participation, observe and answer any questions as they arose.

The Scholars’ Garden was opened only to participants through an appointment system from 12pm – 2pm daily, Monday-Friday over the intervention period. By closing the sensory garden space to the wider university for the duration of the Study, it helped to reduce ‘noise’ in the

data through external influences. The perimeter screening of the SG further reduced distractions for participants once in the space.

The Plaza was left as an open access space. As so few people generally used it, there was no need to restrict access to prevent 'noise' as was expected in the redeveloped sensory garden.

The 30 minute treatment period corresponded with the minimum time required per week to reduce stress and improve well-being determined by Shanahan et al (2016). As Aim 2 of the Study was to determine the effect of the sensory garden on stress levels and well-being, it was appropriate for the intervention period to correspond to this programme. The intervention timing and duration were initially designed to correspond with the growing season of quick-germinating/fruited herbs and vegetables, so plants could be propagated and harvested within the Study cycle. Alternative quick-germinating vegetables were selected when the intervention was delayed until the second semester.

The actual 'dose' of nature received by both intervention groups was measured and reported by a RA in Study 1. The control group self-reported their access to nature through diaries and the survey questionnaire. The RA noted 'appointment kept', or not, against the participant's identifier. Any missed appointments were followed up and a new time made. The RA was available to assist and answer questions as needed. They informed participants where they would be during the session and what they would be working on. Participants could choose to join the RA or spend their time independently, as they wished.

Table 4.1 Study 1 intervention groups, dose and delivery

Who	Intervention 'dose' of nature	When taken	Restrictions	Accessories
Intervention Group 1 'Plaza' assigned their outdoor time in Awataha Plaza.	Prescribed one 30-minute session outdoors once a week for four weeks, using an appointment system for a set day at a set time to be spent in the Plaza relaxing, reading, walking, talking, sleeping, eating, with others from the same session or alone.	Via appointment system Monday – Friday 11:30-13:00 July-August 2017	No digital devices allowed to be used within the session time. Must sign in and out with RA	Blankets, foam squabs, supplied Journal questions supplied
Intervention Group 2 'Sensory Garden' assigned their outdoor time in Scholars' Garden	Prescribed one 30-minute session once a week for four weeks using an appointment system for a set day at a set time to be spent in the Garden relaxing, reading, walking, talking, sleeping, gardening, eating, with others from the same session or alone	Via appointment system Monday – Friday 11:30-13:00 July-August 2017	No digital devices allowed to be used within the session time. Must sign in and out with RA	Blankets, foam squabs, beanbags supplied Journal questions supplied
Control group	nil	Four weeks July-August 2017	none	Journal questions supplied

Both intervention groups were prescribed their outdoor time using an appointment system, as in traditional healthcare. The appointment system was used to ensure conformity across the prescribed 30-minute dose of nature, once per week for four consecutive weeks. Appointment times were set for each participant such that people in the intervention groups knew what time their session was. Participants were asked to state a preference for an appointment time at sign-up. Up to eight participants were booked an appointment to be in the gardens at any one time, as in the Alnarp garden (Stigsdotter & Grahn, 2003). Some flexibility was required with the booking system whereby participants could swap times or days. The maximum of eight at one time was maintained, however.

Sessions were Monday – Friday at 11:30-12.00, 12:00-12:30, 12:30-13:00, or 13:00-13:30. Some flexibility was tolerated, with late arrivals to their session being allowed to enter late,

with potential cross over into the next session. A trained research assistant (RA) checked participants' names off an appointment list and noted arrival and departure times so that 'dose' of nature could be measured. In cases where participants could not make their appointment, they were asked to rebook an alternative time for that session.

During Study 1 of the intervention, participants in both intervention groups and the control group were asked to complete and submit a weekly guided journal. Journal questions aimed to provide background to attitudes towards participants' nature experience outside of the Study (see Appendix D). While the intervention groups received their dose of nature, the Control group went about life as usual for the four-week intervention.

Study 2

Access to the Scholars' Garden was made available to participants from all groups during the 4-weeks of Study 2 of the intervention. The garden was opened, with a RA present, from 8:30 am – 3:30 pm Tuesday – Saturday. The weekend opening day and extended hours were chosen to facilitate ease of access for all participants. RAs again noted the dose of nature received. As this Study tested the efficacy of the sensory garden as a self-care tool, unlike Study 1 there was no follow up by the RA if the weekly session was missed.

While in the laboratory for baseline sampling, participants were briefed about the second Study of the experiment. They were informed verbally where to find and how to access the garden. A follow up email was sent to all participants with directions. They were invited to spend 30 minutes in the garden once a week over the 4-week intervention period. Participants were told that in this Study they could come at any time that suited them.

Table 4.2 shows similar protocols to Study 1, but with four important differences:

- i. The sensory garden was opened to all participants (previous intervention groups and control), while remaining closed to the wider campus.
- ii. Participants were told they were welcome to enjoy the garden whenever suited them, on the same dose basis as for Study 1: 30 minutes, once a week.

- iii. The garden was opened for longer hours, to include before, during and after work/study options, and a weekend day. In this way all participants had maximum opportunity to spend time in the sensory garden.
- iv. The appointment system was not used during Study 2 to mimic normal, unprompted access as much as possible.

Table 4.2 Study 2 intervention, dose and delivery

Who	Intervention 'dose' of nature	When taken	Restrictions	Accessories
All participants, regardless of previous group allocation	Able to access the Scholars' Garden for 30 minutes once a week, during the four-week intervention to be spent in the Garden relaxing, reading, walking, talking, sleeping, gardening, eating, with others or alone	Voluntarily, no set time, as convenient Tuesday – Saturday 08:30-16:30 for four weeks February - March, 2018	No digital devices to be used within the Garden. Must sign in and out with RA	Blankets, foam squabs, beanbags supplied

4.4 QUANTITATIVE: OUTCOME MEASURES

All outcome measures were recorded, using the same protocols, at baseline and follow up in Studies 1 and 2. During the intervention, participants' environmental preferences were noted by the researcher or RA using a tally chart system against time spent in pre-determined zones of the Plaza and Sensory Garden. The same people were sampled at each time period. All raw data, including questionnaire and guided journal recordings were collected by the researcher for processing and analysis.

Demographic variables/covariates

Age, sex, ethnicity, nature-relatedness, greenspace visitation – frequency, duration and intensity of experience, general campus grounds and specific SG characteristics were collected. Degree of nature relatedness was determined using a validated questionnaire (Nisbet et al., 2009).

Data were collected at four time periods, pre and post Study 1 and pre and post Study 2. It monitored intervention characteristics (exposure) and assessed change in a series of outcome measures: stress cortisol levels, type, frequency, intensity, duration and context of nature experience.

Exposure measures

Species richness has been found to influence the psycho-physiological effects of time outdoors. (Southon et al., 2018). As such, a simple count was made of observed plants and animals in the two intervention spaces during the intervention period.

Independent (causal) variables

Participants were allocated, in Study 1, or chose, in Study 2, a day and time for their weekly 'appointment with nature' as a self-care therapeutic programme. The appointment system in Study 1 replicated that of standard counselling treatment for stress. The sensory garden and plaza design permitted participant-determined activity within, or progression between, zones (see Chapter 5 for description of zones) depending on mood and individual need.

Participants from the two intervention groups had their appointment with nature in either the planted plaza or the sensory garden. They had one session outdoors per week for four weeks.

4.4.1 Salivary stress cortisol

Well-being is influenced by stress levels as a predictor of future health outcomes (Keyes et al., 2010; Sears et al., 2013). Cortisol is a physiological marker of stress. Salivary cortisol was established by Kirschbaum and others as a measure of stress (Kirschbaum & Hellhammer, 1994) which does not require invasive sampling, and so does not falsely elevate levels (blood tests are stressful).

Cortisol was the primary outcome measure, investigated in association with the dose of nature received (frequency, type, duration and intensity of experience) observed via RA observation and spatial preference(s) shown. Saliva was collected using passive drool into a sample pot. This method collects whole saliva (also called "mixed" saliva). Passive drool is

considered by many researchers to be best practice when collecting saliva samples for biological testing, because it provides the purest sample possible.

Saliva was collected by participants spitting a clean sample (no food residue) at least 30 minutes after eating, or drinking tea or coffee, into sample tubes. Samples were stored below 4C for up to 3 days before being transferred to the Roche Diagnostics Laboratory in AUT's Auckland City campus for analysis.

Cortisol is useful as an indicator of response to a therapeutic intervention (Strimbu & Tavel, 2010). Saliva cortisol was sampled four times, being pre and post each of the two Studies. Samples were taken between 11:30 am and 1:30 pm as suggested by (Pilger et al., 2018), as a superior method using salivary cortisol to establish patterns over time, rather than responses pre and post exposure to a particular environment at a single timepoint.

4.4.2 Flourishing Scale

Measuring and predicting student well-being is supported by use of the Flourishing Scale (Howell & Buro, 2015). To capture general mood of all participants, the validated Flourishing Scale was used as a measure of subjective psychological and social well-being (Diener et al., 2010). The Flourishing Scale is designed to measure aspects of social–psychological prosperity such as social relationships, having a purposeful and meaningful life, being engaged and interested in one's activities, self-respect and optimism and, feeling competent and capable. The Scale is composed of eight items. It was found to have good psychometric properties, with Cronbach's alpha higher than 0.80. Convergent validity also showed that the Flourishing Scale correlates at high levels with other well-being measures, such as the Basic Needs Satisfaction Scale, Ryff scales of Psychological Well-being and Satisfaction with Life scale (Junça & Caetano, 2011).

The possible range of scores is from 8 (lowest possible) to 56 (highest possible), with midpoint at 32 points. A high score represents a person with many self-perceived psychological resources and strengths. Respondents rated the extent to which they agreed with each of eight statements, from strongly agree to strongly disagree (see Appendix E, question 6).

4.4.3 The Scale of Positive and Negative Experience

The Scale of Positive and Negative Experience (SPANE) is designed as a balanced scale to measure perceived stress (Diener et al., 2010). SPANE is a 5-point Likert scale (from never to always) with 12 items, which includes 6 items (e.g., positive, good, pleasant) assessing positive feelings (SPANE-P) and 6 items (e.g., negative, bad, unpleasant) assessing negative feelings (SPANE-N) (Diener et al., 2010). The scores of SPANE-P and SPANE-N range from 6 to 30. The summed balanced between positive and negative feelings (SPANE-B) is the difference score between positive feeling items and negative feeling items and ranges from -24 to 24.

The Cronbach alpha shows the Scale to be reliable, and its temporal reliability is moderately high, showing some change across a one-month period. The alpha shows the internal consistency of the items, but a factor analysis of the items is needed as well because even a high alpha is consistent with the existence of more than one factor in a scale (Junça & Caetano, 2011; Silva & Caetano, 2013; Sumi, 2014). To score the SPANE, the sum of positive responses was deducted from the sum of the negative responses (see Appendix E, question 11).

4.4.4 Nature relatedness

Nisbet et al (2009) developed the nature relatedness scale (NR) as a way to measure the impact of environmental and conservation-based interventions. NR 21 is a validated scale that uses 21 questions and a 5-point Likert scale to assess the sum of affective, cognitive, and experiential aspects of individuals' connection to nature. (Gerofsky, Veron, & Giammarco, 2016; Nisbet et al., 2009). It was assessed for reliability and found to have a Cronbach alpha score of 0.87 (Nisbet & Zelenski, 2013). Negative questions are reverse scored to reduce the potential for bias in the response whereby respondents may tick the same box throughout the scale. Nature relatedness –was measured using Nisbet et al (Nisbet et al., 2009) NR 21. Results range from 1 lowest to 5 highest (see Appendix E, question 9).

4.4.5 Productivity – work output

Perceived work output was measured by adapting the World Health Organization's Health and Work Performance Questionnaire (HPQ). The questionnaire was found to have excellent reliability, validity and sensitivity to change, as reported by Kessler et al (2007, p. S23) using

relevant absenteeism and presenteeism questions averaged for final score (see Appendix E, question 10).

4.4.6 Frequency and duration of visits to greenspace

This measure was initially added as a confounder but was added as an outcome measure in Study 1 when observed to be affected by the intervention. As no statistically significant effect was observed it was included as a confounder only in Study 2 (see Chapter 6 Figure 6.2, and Appendix E, question 7).

4.4.7 Statistical analysis

Significance was set at $p > 0.05$, and all analyses were conducted using IBM Statistical Package for the Social Sciences (SPSS) v23 (IBM Corporation, 2014) to create a generalised linear mixed model with a multinomial logit link function.

Following baseline sampling (T0) any differences in the outcomes measures among intervention groups were then quantified at week 6 (T1) using ANCOVA adjusted for baseline values and other relevant covariates (age, gender, ethnicity, education, employment). More flexible models (i.e. generalised linear models) were used to investigate dependent variables that deviated from a normal distribution. Relationships between specific outcome variables and respondents' time spent in the garden (i.e. dose-response analysis) were also investigated. Analysis was repeated as per Study 1 in Study 2.

4.5 QUALITATIVE: OUTCOME MEASURES

Although some research has been carried out on the psychological aspects and impacts of design, no studies have been found which capture both the empirical data and the qualitative backstory.

Quotes

During the two intervention periods, participants occasionally shared spontaneous thoughts and impressions of their experience to the RA. If the comment was deemed of interest, the participant was asked if they could be quoted. If permission was granted direct quotes were noted, with participants' permission and the opportunity to read what had been written.

Comments

All participants were given the opportunity to add comments to their survey response. At the end of the questionnaire form was an open question 'any comments?' (See Appendix E). Where these were deemed of interest to the Study, findings were recorded. Where the comment was a simple "good luck with your research", it was not recorded for the purposes of analysis. Comments were unable to be identified to an individual as questionnaires were anonymised.

Observations

The effect of the garden was observed throughout the Study using field notes from RA. Direct observation of participants' response within the Study environments was made, along with observations of the weather and notable wildlife.

Zone use preferences

The SG and AP were categorised by design characteristics into zones. To explore whether design characteristics influenced use preferences, participant movements were noted by RAs using a simple tally chart. If a participant moved from one zone to another and back to the first, it was recorded as two visits to the first zone and one to the second.

4.5.1 All measures (qualitative and quantitative)

Table 4-3 shows all data, when they were collected and how.

Table 4.3 Table of Measures

Data collected	Collected method	Timing of collection
Individual Journals	Emailed	4 weeks during Study 1
Comments	Within questionnaires	Pre and post Study 1 and Study 2
Quotes	By RA during intervention sessions	8 weeks during Study 1 and Study 2 interventions
Interviews	One on one semi-structured	Post Study 1
Focus groups	Small group semi-structured	Post Study 2
Cortisol	Saliva sample	Pre and post Study 1 and Study 2
Flourishing (well-being)	Questionnaires	Pre and post Study 1 and Study 2
SPANE (perceived stress)	Questionnaires	
Nature Relatedness	Questionnaires	
Work Output	Questionnaires	
Frequency & Duration of Visit to Greenspace	Questionnaires	

4.5.2 Study 1 only

Zone use preferences were tallied for both Awataha Plaza and Scholars' Garden

Journals

To gauge general nature connection and gain an insight into physical activity and behaviour, all participants kept a written journal during the four weeks of Study 1 of the intervention period. A journal template was provided (see Appendix D) with priming questions. Participants recorded a summary of nature exposure, whether privately for those in the control group, in the intervention session or additionally externally. Activity, mood, weather, elements of interest, conversations whilst outdoors were also noted. Positive mental health was captured by self-reported mood. Questions were chosen to determine any change in attitude towards nature and outdoor experience over the four weeks. The same six questions were asked each week (see Appendix D) and responses emailed to the researcher.

The three components of attitude: Cognitive, Affective and Behavioural were covered in the questions, designed to elicit thoughts, feelings and from that to induce how those attitudes potentially influence behaviour. Questions were designed to assess nature connection,

physical activity and environmental design elements and social interaction. To maintain privacy, participants were told a RA would transcribe the journal entries and sort them into groups. Emailed responses were thus anonymised to give participants comfort that they could answer honestly.

One on one interviews

At the conclusion of Study 1, semi structured one on one interviews of individuals from each of the original Study groups were conducted, with 6-8 people from each group. Data saturation was seen after 10 interviews, with responses closely aligned. Participants were questioned in relation to mood and productivity to capture the general feelings of perceived ability to manage workload, attendance patterns within the SG, preferences, observations and ideas for improvements (See Appendix F). Transcription of recorded data was completed after each interview.

These qualitative data supported and informed a 'backstory' to the quantitative data.

4.5.3 Study 2 only

Focus groups

At the conclusion of Study 2, three guided focus groups were convened to capture final reflections (see Appendix G for focus group guiding questions). Thematic analysis of Study 1 data informed compilation of the focus group questions. Questions were designed to confirm opinions and perspectives of the wider group. Three groups of six people gathered to discuss their feelings around the Study in general and the sensory garden in particular.

4.5.4 Case study analysis

A case study analysis of the design and development of the Scholars Gardens (SG) was conducted to critically document and evaluate design elements (See Chapter 5). This method is described by the U.S Landscape Architecture Foundation as appropriate to the Study (Francis, 2001).

Chapter 5 THE DEVELOPMENT OF THE 'RESEARCH LABORATORY', THE SCHOLARS' GARDEN

5.1 INTRODUCTION

This analysis of the design and development of the Scholars' Garden describes an evidence-based restorative sensory garden, as a means to explore why it could be a viable self-care tool. The design was evaluated using field data collected by the Candidate and Research Assistants.

5.1.1 Context: The Alnarp method

Links between health and nature, and health and environment are well-known (Bratman et al., 2015; S. Kaplan, 1995; Ulrich et al., 1991; World Health Organization Europe, 2016). Chronic stress levels are recognised as a good predictor of future health outcomes (Schneiderman, Ironson, & Siegel, 2005). Nature contact is known to reduce stress (Louv, 2012; Maller et al., 2006; McMahan, 2018; Shanahan, Lin, et al., 2015; Stigsdotter et al., 2018; Velarde et al., 2007). Internationally, stress on university campuses is rising, across both the staff (Watts & Robertson, 2011) and student body (Akpinar, 2016; Oseyomon, 2015; Wong, Cheung, Chan, Ma, & Wa Tang, 2006). The situation in New Zealand is reflective of international trends (Boyd & Wylie, 1994; Gillespie, Walsh, Winefield, Dua, & Stough, 2001). Across New Zealand's universities, the mix of urban and peri urban/rural campuses allows for a variety of design typologies. None however are designed intentionally to optimise the health and well-being of the people who use the space.

The 'Alnarp method' was devised by researchers at the Swedish University of Agricultural Sciences Alnarp to treat patients with stress burnout syndrome. The method is used within a therapeutic garden space, designed on Alnarp's campus for a facilitated treatment programme to support psycho-social teaching programmes and local primary health objectives (Adevi & Lieberg, 2012; Lidén, 2015; Tenngart Ivarsson & Grahn, 2012).

5.1.2 Project background and history

The Scholar's Garden at Auckland University of Technology (AUT), New Zealand, was designed to test whether a restorative landscape, a campus garden such as at Alnarp, could be effective

to reduce stress in ‘apparently well’ people. Evidence for the design was gathered through client evaluation of personal professional practice, a literature search and site visits to healing gardens in Europe. The Swedish University of Agricultural Sciences Alnarp’s rehabilitation garden was of particular interest as it is designed as a series of progressive healing ‘garden rooms’, such as could be developed individually or together. The Alnarp Rehabilitation Garden is sensory rich, with features to attract wildlife as well as people. It was designed to treat people diagnosed with depression, burnout syndrome and post-traumatic stress disorder, referred through their primary health provider. Social and Therapeutic Horticulture¹ and the ‘Alnarp Method’ are the therapeutic tools used within the Alnarp garden.

For the purposes of this thesis, the rehabilitation garden at Alnarp was considered a ‘sensory garden’. Designed using a salutogenic approach, that is designed specifically to promote health and well-being, the Alnarp garden incorporates Stigsdotter and Grahn’s eight essential healing design elements (2002), which their (2010) perceived sensory dimensions (PSDs) (Figure 5.1) were later based on. Qiu and Nielsen (2015) established that the PSDs are a legitimate method to assess and map recreational experience of urban greenspace. These healing elements, combined with the concept of biotopes, are also seen within the fundamental building blocks of urban green space (Lockwood, 2017).

The sensory garden design at AUT, the Scholars’ Garden (SG), referenced Stigsdotter and Grahn’s original eight healing elements: *Serene, Wild, Rich in Species, Space, The Common, The Pleasure Garden, Festive, and Culture* (Stigsdotter & Grahn, 2002). The SG’s four Zones acknowledge the Alnarp garden within an accommodation of available space, budget constraint and existing features.

5.1.3 Project purpose

Recently, researchers have shown an increased interest in the use of urban greenspace as a prompt to improve or enhance health and well-being. A sensory garden, as a type of therapeutic garden, is designated greenspace designed to activate and integrate the senses. Therapeutic gardens have been shown to reduce stress (Cooper Marcus & Sachs, 2014;

¹ Social and therapeutic horticulture is the practice of using plants and active gardening to improve physical and mental health, as well as communication and thinking skills.

Corazon, Stigsdotter, Grete, Jensen, & Nilsson, 2010; Gonzalez & Kirkevold, 2014; Grahn & Stigsdotter, 2010; Hussein, 2010a, 2010b; Souter-Brown, 2015). Could a sensory garden reduce stress on campus? If yes, would staff and students use it? Antonovsky's concept of salutogenesis asserts that environment can act to prevent ill health and promote well-being (Antonovsky, 1996). A salutogenic design approach thus informed a sensory garden concept to reduce stress on AUT's campus.

5.2 CONCEPTUAL FRAMEWORK

5.2.1 The 'Alnarp method' of treatment

The Alnarp method was developed in the therapeutic gardens at the Swedish University of Agricultural Sciences following research into the fundamental building blocks for healing gardens (Grahn, 1991; Grahn et al., 2005; Grahn & van den Bosch, 2014; Stigsdotter & Grahn, 2002). The Alnarp method was established, combining the use of facilitated restorative natural areas with traditional horticultural therapy (Lidén, 2015).

Since 2004, the therapy gardens at Alnarp have been used to treat adults with diagnosed depression and anxiety. Multiple studies have shown their efficacy in treating stress-related disorders (Adevi & Lieberg, 2012). The design allows people to progress at their own pace from one gradated garden zone to another, depending on need and mood. The user experience at the Alnarp gardens is a structured, specialist-facilitated experience utilising a formal programme of therapeutic horticulture (Pálsdóttir, Persson, Persson, & Grahn, 2014).

5.2.2 Testing the Alnarp method as a self-care tool

Previous studies have reported the efficacy of sensory gardens to support health outcomes. Although the Alnarp method is untested as a self-care tool, practical application of the Attention Restoration and Stress Recovery literature (R. Kaplan & Kaplan, 1989; Ulrich et al., 1991) suggest that a modified form of Alnarp's gardens may be a viable non-specialist-facilitated self-care tool to manage stress.

This thesis builds on personal professional practice and the existing literature to fuse an understanding of the role of urban ecology, objectified through nature connection, in creating and sustaining health and well-being, and academic/work achievement. Although based on

the Alnarp method, the AUT gardens offer the essential essence of restorative space, to test whether the modified Alnarp sensory gardens are effective at impacting stress in 'apparently healthy' individuals.

It is worthwhile testing the effect of unfacilitated sensory gardens experience as social housing developments, care homes, schools and workplaces could benefit from a self-care health promotion design tool. The value of such a tool would be in its accessibility and relative low capital and operational maintenance cost. It would enable architects and facilities managers to promote their developments as the 'healthy option'.

5.2.3 Evidence based design

Evidence-based design (EBD), principally used in hospital design, has its origins in educational facility research (Marks 2009). It leverages the existing culture of evidence-based medicine as a theoretical framework intended to capture design variables such as audio and visual environments, staff and user support spaces (Ulrich, Berry, Quan, & Parish, 2010). Using Antonovsky's salutogenic approach (1996) to establish why a sensory garden could promote well-being as a self-care tool, the environment was tested against relevant theories: the Kaplan and Kaplan (1989) cognitively-based Attention Restoration Theory (ART) and Ulrich et al (1991) emotional and physiologically-based Stress Reduction Theory (SRT). Wilson's evolutionary-based Biophilia Hypothesis (1984) was also considered as it reflects the primal response.

5.2.4 Perceived sensory dimensions (PSD)

Sensory perception is essential to elicit a response to an environment. Grahn and Stigsdotter developed a design framework of perceived sensory dimensions (PSD) (Grahn & Stigsdotter, 2010), which incorporate the earlier prospect and refuge theory (Appleton, 1984) and update their list of healing elements (Stigsdotter & Grahn, 2002). The PSD nature replaces 'wild'. The PSD social replaces 'culture', 'pleasure' and 'the common'. Prospect and refuge are new sensory dimensions, not previously covered by the healing elements. The perceived sensory dimensions incorporate theory and are based on the eight general characteristics Stigsdotter (2005) found users demand of publicly-accessible urban green space (Figure 5-2).

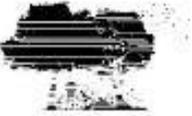
Nr.	PSD name	Images	Key nature qualities and features
1	Social		<ul style="list-style-type: none"> • Possible to watch entertainments • Possible to watch exhibitions • Possible to visit a restaurant or a simpler open-air restaurant
2	Prospect		<ul style="list-style-type: none"> • Plane and well-cut grass surfaces • Vistas over the surroundings • Cut lawns
3	Rich in species		<ul style="list-style-type: none"> • Several animals, like birds, insects, ect. • Natural plant and animal populations • Many native plants to study
4	Serene		<ul style="list-style-type: none"> • Silent and calm • No bikes • It is possible not to come into contact with too many people
5	Culture		<ul style="list-style-type: none"> • Decorated with fountains • Decorated with statues • A wide range of foreign plants, ornamental plants and kitchen plants
6	Space		<ul style="list-style-type: none"> • Spacious and free • Possible to find areas not crossed by roads and paths • Lots of trees
7	Nature		<ul style="list-style-type: none"> • Nature like • Wild and untouched • Free growing lawns
8	Refuge		<ul style="list-style-type: none"> • Many bushes • Kept animals that children and adults may feed and pet • Sandpits

Figure 5-1 Perceived sensory dimensions (From Stigsdotter et al, 2017)

People in need of psychological restoration, those suffering from chronic stress, were found to prefer natural environments dominated by the four dimensions:

- 1) *serene*, interpreted as “a haven, almost a holy place”
- 2) *refuge*, interpreted as a place “where people can feel safe”
- 3) *rich in species*; interpreted as “diverse in sensory experiences”
- 4) *nature*, interpreted as a “wild, free-growing, untouched room” (Grahn & Stigsdotter, 2010, pp. 267-269)

The other perceived sensory dimensions, *space*, *culture*, *prospect* and *social*, relate to qualities of being active, experiencing cultural objects and other people. They are generally rated lower in relation to psychological restoration.

While all PSDs were designed into the Scholars' Garden, the four preferred PSDs serene, refuge, nature and rich in species were given prominent design attention. A wide range of trees, shrubs, edible and non-edible herbaceous plants, moving and still water, and humus-rich friable soils were added to the extant space. With the rich organic content of the soils, a variety of fungi also appeared spontaneously from time to time. Into this mix, numerous species of native and exotic birds, insects and invertebrates were attracted and observed on multiple occasions during the intervention. In contrast, just two species of tree were extant in the Awataha Plaza. One spider and limited numbers of exotic birds were observed in the plaza throughout the entire intervention period.

The above conceptual framework combines landscape theory with architecture, biology and social psychology. An example of the framework in action is seen as a primal need for a sense of safety within a nature connection supported by the PSDs refuge, rich in species and nature.

5.2.5 Individual practice (the researcher's professional practice)

Design as provocation is an ideation technique whereby I take a client's needs and interpret them against the spatial qualities presented. The gap between what is there and what is desired is then balanced between evidence and theory, budget and site restrictions, environment and emotion. When I design a sensory garden, regardless of the setting, I believe three design features must predominate: the garden must entice, enrich and enable users' experience.

The sensory garden at AUT was co-designed, based loosely on the Swedish University of Agricultural Sciences at Alnarp's sensory-rich rehab garden. Stakeholder engagement, with Faculty, Estates, Security, Health and Safety, in the design process drew attention to Crew and Forsyth's political aspects and considerations of design (Crew & Forsyth, 2003 p. 37) and the need for the designer to balance multiple interests. The resultant design offered a synthesis of ecological design and cultivated expression.

To *entice* people to spend time in the space, *enrich* the user experience and *enable* them to do so regardless of the weather, a palette of elements to intrigue were included as shown in Table 5.1.

Table 5.1 Elements to entice, enrich, enable experience

Element	Action	Passive Educative Effect
a mindfulness walkway	entice	decomposers – fungi – at work
insect hotel (“high rise apartments” – three-storey pallet stack with different nesting materials on each level)	enrich	importance of beneficial insects
stumpery	enrich	decomposers – fungi – at work
soft, pip, stone and citrus fruit in orchard	enrich	edible fruits grow locally
herbs	enrich	edible herbs grow locally
wildflowers	enrich	importance of pollinators
natural log and boulder seating	entice	nature supports us
long meadow grass with looping mown pathways	entice and enable	sustainable living low-mow option, playable environment
composting and mixed native and exotic planting provide habitat for invertebrates	entice and enrich	decomposers, recycling, nutrient cycle
seasonal flowers	entice and enrich	beauty is ephemeral
planting to attract birds	entice and enrich	wildlife attracting plants grow locally
lightweight seating, chairs, tables and benches	enable	personalise and customise environment
popup tent and bean bags	enable	personalise and customise environment
potting shed	enable	personalise and customise environment
fish and other aquatic fauna	enrich	clean water supports life
butterfly nursery food	entice and enrich	beautiful pollinators
healthy soils and water	enrich and enable	human and ecological health starts with healthy soil and water

Path hierarchy was used to allow garden visitors to choose smaller cut-throughs or direct their attention to main routes. Attention restoration theory posits that time spent in nature

requires nothing to jar the senses, so manufactured noise, discordant colours and sharp shapes were eliminated or masked. A sense of flow and continuity was important within and between each space.

5.3 DESIGN METHODS

5.3.1 Project characteristics

Table 5.2 shows the details of the project, including budget, design brief and approvals process.

Table 5.2 Project summary

Project Name	The Scholars' Garden, AUT university
Location	AUT North campus, Auckland, New Zealand
Date designed	October-December 2016
Construction completed	May 2017
Construction cost	NZD \$29,000. Land for the 'laboratory' was provided by the University.
Size	900m ²
Landscape architects/designer	Gayle Souter-Brown, Jade Au Morris, Mikkel Hjort
Client	Gayle Souter-Brown for Vice Chancellor, AUT
Consultants	Terry Jenkins, Health & Safety; Rory Chako, Estates Manager
Stakeholders	Grounds Manager, Estates Manager, Pro Vice Chancellors, Dean, Finance Manager, Vice Chancellor
Design brief	To create a sensory garden on AUT North campus, within a limited, fixed budget, with minimal labour, capable of testing relevant theories, utilising existing knowledge.
Approvals process	<p>Concept presented to AUT University Grounds Manager, Estates Manager.</p> <p>Concept adjusted and presented to Associate Dean, Pro Vice Chancellors and Dean of Faculty of Health and Environmental Sciences</p> <p>Concept presented to University Finance Manager and Vice Chancellor</p> <p>Funding secured to develop Scholar's Garden on campus through Vice Chancellor</p>

5.3.2 Defining the dose of nature required for a therapeutic effect

Utilising the above framework, the sensory garden at AUT was designed as a space to visit together or alone, with comfort and interest year-round. The Scholar's Garden (SG) was conceived as a linked series of garden rooms, or Zones. As at Alnarp, the garden aimed to provide for the eight design characteristics, or perceived sensory dimensions, within the overall space. A hierarchy of paths, a variety of seating types and open and more secluded / enclosed locations and varied native and exotic trees, shrubs and perennials were designed to entice users into the garden.

The planting design was designed to attract visiting birds, bees and butterflies, with healthy, friable soils, edible planting and varied soft surfacings being additional attractants.

For a healing or a therapeutic effect to be observed, the literature suggests a nature connection of a minimum of 30 minutes once a week is beneficial (Shanahan et al., 2016). This dose duration was confirmed as effective (see Design evaluation 4.4). For users to connect with nature requires two things: 1) a nature-rich space, that is, rich in species and 2) the environment to be engaging, such that users are comfortable to remain in the space and hence more likely to observe nature. A sensory garden is an accessible, engaging, species-rich space (Souter-Brown, 2017) and so likely to offer a beneficial effect. It is also a comfortable space that provides a feeling of safety and security.

The therapeutic 'dose of nature' was designed, as with a pharmaceutical drug trial, to be measurable. In this case, the drug being trialled was 'Vitamin N', for nature, delivered as an experience of nature through perceived sensory dimensions (PSD). PSDs 'refuge', 'nature/wild' and 'rich-in-species' were hypothesised as influential to the experience and potential restorative effect. The Scholar's Garden's four, 225 m² interconnecting but distinct, zoned sensory gardens (Figure 5-2) incorporated the PSDs (Figure 5-4). The total 900m² was enclosed during the intervention with sympathetic brushwood screening.

Although based on the 'Alnarp method' gardens, the SG at AUT North were modified to suit an untested non-facilitated experience, local budget and environmental constraints. As at Alnarp, the 'nature dose' included planting, orientation and materials, which referenced salutogenesis through attention restoration, stress recovery and the biophilia hypothesis.

Native and wildlife-attracting exotic planting, for example swan plants for Monarch butterflies, were chosen to provide seasonal interest throughout the study period. This maximised the hypothesised therapeutic effect, at the lowest possible installation cost.



Figure 5-2 Concept plan of the Scholar's Garden

Figure 5-2 shows the sensory garden concept as progressing from a passive, reflective space, through a more sensory-rich moderate physical activity zone, opening onto an active social growing space and beyond to an informal socially engaged zone.

Entry and exit to / from the sensory garden were controlled. During the RCT in Study 1, access was through the existing Potting Shed (left, central Figure 5-2) into Zone 1, which opens into Zone 2 and Zone 3, and Zone 3 into Zone 4. The journey sequence was themed around the genius loci or spirit of the place, with the zones referencing the campus peri-urban coastal location with 'beach', woodland, horticultural growing space and open grassland. Each zone was designed to stimulate childhood memory, and / or reference Kaplan's (1995) Attention Restoration Theory with feelings of being 'away'.

The design ideation to build process is shown in Figure 5-3.



Figure 5-3 Scholars' Garden before, as proposed and as built

5.3.3 The planting plan

The planting plan for the 1000sqm sensory garden was designed to 'living laboratory' principles, being value, influence, realism, sustainability and openness (Schuurman, De Marez, & Ballon, 2016). As such the garden was planned for seasonal impact during the period of the study. Careful analysis of the soils, sunlight, prevailing wind, drainage and assessment of what grows well locally informed plant choices. Existing mature trees needed to be showcased and shady areas made attractive. Some immature specimens required relocation. The planting in each zone was designed to meet the diverse needs of the garden visitor with height, colour, leaf shape, texture, fragrance, fruit, flower, seeds and nectar all considered. Rongoā Māori (healing plants) and edible 'kitchen' plants (herbs, fruit, vegetables) were included for their traditional cultural use as well as textural form, colour and fragrance. When designing planting to reduce stress and enhance well-being, visitor needs include a sense of

safe refuge as derived from soft, rounded leaf forms, species-richness, and a sense of 'wildness'. Fragrant planting was chosen to be at head height, e.g. Jasmine *Jasminium officinale* grown up tee pees or located where a breeze would waft the fragrance across the space, e.g. *Daphne odora*. Each planting type supported a restorative user experience.

The planting plan included core plants for impact. The yellow-flowering Kowhai *Sophora microphylla* was planted to attract nectar-feeding song birds such as Tui *Prosthemadera novaeseelandiae*. Yellow spring flowers corresponds to exam preparation time and the colour is said to stimulate intellect, so was deemed appropriate. *Olearia Olearia albida* was planted for fragrance and to attract smaller native birds. Pittosporum *Pittosporum tenuifolium* 'Mountain Green' was chosen for boundary planting as their columnar shape is reflective of pillars of cloistered walks of traditional scholars' gardens, as seen in Arabia, China and European universities.

Semi mature plantings were used to both border and within the sensory gardens to ensure an 'instant effect', such as used in temporary Show exhibition gardens. Plantings were chosen to be in keeping with AUT's sustainable development plans.

In the orchard area, fruit trees were chosen for their ability to withstand local conditions. A selection of citrus, pip fruit and stone fruit were designed to provide fragrance, spring blossom, a steady supply of fruit throughout the season, autumn leaf colour and in the case of the citrus, an evergreen anchor to the space.

5.3.4 Maintenance, management, policy and practice

The development, management, use, and maintenance of a biodiverse sensory garden is a departure from plaza and parkland style landscapes. For example, standard-practice estate management does not support picking and eating the plants. Likewise, standard-practice maintenance practices do not support biodiversity. During development of the SG, University Estates maintenance contractors' staff perceived the garden as 'messy' and so mowed and then sprayed the meadow grasses and wildflower seedlings with herbicide. This required staff education and a second sowing of wildflowers once the glyphosate had dissipated in the ground, delaying the start of the intervention and show of wildflowers by 12 weeks. For the effect of the biodiverse garden to be readily maintained, bio-organic gardening practices

utilising layered planting and mulch to suppress weeds and reduce watering requirements, is recommended to be added to landscape management practices.

The low maintenance requirements of the design brief aligned with University Estates' policy. Requirements were based firstly on the social and therapeutic horticulture nature of the garden requiring maintenance to be able to be managed by volunteer garden users, and secondly on the joint practicalities of maintenance budget allocation and labour availability. This was a positive influence on the design, as Qvistrom found in his analysis of the Gyllins' community gardens. He noted that the community took 'ownership' of the gardens. Rather than wait for Council, or accept the usual municipal style of estate maintenance, community members bring secateurs from home to trim 'their' trees, remove weeds impacting 'their' plants (Qvistrom, 2012). Participation, through being actively involved in the management of the garden adds to the sense of place and empowers communities (Manzo & Perkins, 2006). It was hoped that a similar community-based management system would work in the Scholars' Garden.

In practice, budget constraints, labour availability and the difficulties of training Estates management staff to an organic management regime meant some design changes were necessary. In Zone 2, roots and compacted dry earth under mature oak and magnolia trees limited in-ground planting options. Soil conditions were ameliorated with 30cms of well-rotted bark compost, spread on top of the existing (dead) grass.

Estates, although initially supportive, would not authorise installation of irrigation to Zone 2 planting. Hand watering was required. Although initially designed as a temporary 'above ground' in-pot garden the lack of water and available labour meant that the plants were planted into the ground, requiring a review of the plant schedule to specifically address plant habit re shaded location. A range of exotic plants were chosen to supplement and complement the limited number of native plants that provide colour and fragrance in shaded conditions. The planting plan for Zone 2 was further impacted as the 'season of interest' changed. Initially, as plants were to be on display for three months only, a wide range of native plants were selected for their ability to attract wildlife, leaf shape, texture, colour and fragrance. Given the temporary nature of the 'planting' the deep shade would not have adversely affected the display. Exotics were later added to the plant palette to increase

sensory interest when delays in garden development changed season of interest requirements.

In Zone 3, roots of mature trees were found on the undulating surface planned to be levelled for raised beds. To protect the roots the ground was built up as an earth mound with material excavated from site, to create a feature within the garden. The 'daisy' of raised beds proposed and shown in Figure 5-3 thus had to be moved to the centre of the garden. The resulting space was developed as a mindfulness walkway, with central raised beds (Figure 5-4 and Figure 5-7).



Figure 5-4 Zone 3 under development, showing mindfulness walkway

Annual re-sowing of wildflower seeds and annual herbs and vegetables is required. Hand weeding of self-sown seedlings in the mulch, sand and shell chip areas (one person, for one hour, once a week) has kept the garden in good condition.

5.3.5 Comparison site

In describing the design of the sensory garden, in terms of its effectiveness as a self-care tool, it was important to have a comparison site nearby. Awataha Plaza was designed as a typical urban plaza (Hargrove & Dillon, 2009), as open space for students to gather. It features two single species blocks of trees and seating, with mixed boundary planting of shrubs to the west.

It is approximately 900m² and located centrally on campus (

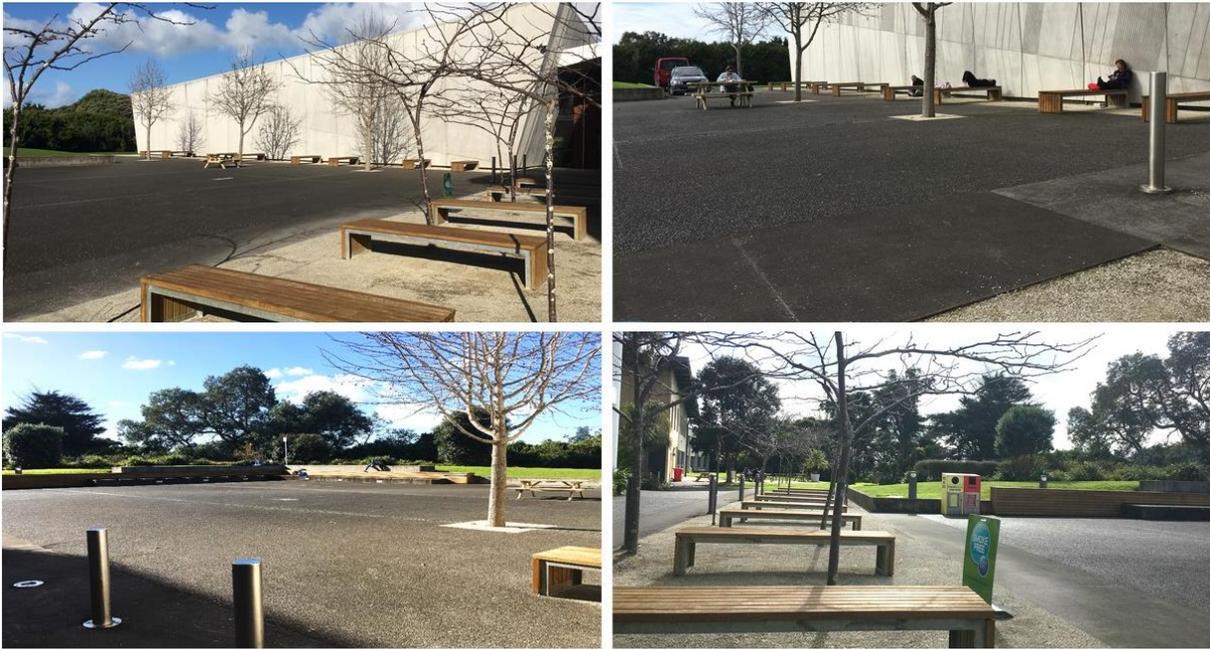


Figure 5-5).

Study participants randomly assigned to the Plaza group were prescribed the same 30-minute dose of nature once per week for four weeks as for participants assigned to the sensory garden group. As in the Scholar's Garden, participants were given blankets and foam squabs to make the space more comfortable and allowed to roam, sit, chat, sleep and eat in the space as they wished. Images of the plaza are shown in Figure 5-5.



Figure 5-5 Awataha Plaza fixed seating, paving and architectural trees

Grahn and Stigsdotter's (2010) perceived sensory dimensions offered within the Plaza space were 'social', 'prospect', and 'space'. The dimensions 'refuge', 'nature', 'serene' and 'culture', as described in Figure 5-1, were not evident.

To unpack whether the generic architectural campus typology of planted plaza was more or less effective than a sensory garden, a control group for the experiment was needed. This group went about life as per normal but were tested pre and post intervention for stress cortisol, well-being, productivity, nature relatedness and perceived stress, as for participants in the two intervention groups (see Chapter 6 for results).

5.3.6 Design of The Scholars' Garden at AUT

The AUT sensory garden is located centrally on campus, marked with a  in Figure 5-8.

As in Awataha Plaza, the sensory garden is easily accessible and viewable from commonly used indoor spaces e.g. the Library (shown on the map as AL), adjacent classrooms and overlooking offices. Both the Plaza and Sensory Garden are centrally located on campus.



Figure 5-6 Location of Scholars' Garden, the sensory garden on AUT North campus

The Scholars' Garden, as built, is shown in Figure 5-7. The proposed exit point from Zone 4 did not eventuate. This meant that the overall space became a 'destination' rather than a through-route, which added to the sense of being 'away'.



Figure 5-7 As-built plan of the Sensory Garden

5.3.7 The zones

Zone 1 was designed as a passive/reflective space. Entry to the garden was through this zone, via the potting shed. On entry, it was assumed users would arrive carrying a degree of stress. Depending on their level of stress they could pause or stay and restore in this reflective space or move directly on to other more sensory-rich areas. It was furnished with individual deck chairs and bean bags, a pop-up tent, an urban 'beach', and buckets and spades were provided for adults to play, build sandcastles, and generally engage with their environment. A private, shaded lawn area to the southern rear edge of the zone provides a sense of 'refuge' and became the perfect location for a hammock and pop up tent. Other PSDs in this zone include *social*, *prospect*, *serene*, *culture* and *space*. The northern 4m of the zone had 30cms of sand added to the sunny 'front' as an 'urban beach', designed to provide a cultural reference and place to 'play'. It was appreciated by some users and ignored by others. Those who appreciated it had fond childhood memories of playing at the beach, had moved from coastal settlements to the city, loved the feeling of the sand or had never had the opportunity to make a sandcastle or 'play' at the beach before. Views from the grassed mound were maintained in acknowledgment of the element 'prospect'. Existing mature shrubs, ground covers and spectacular Willow Myrtle *Agonis flexuosa*, Silver fern *Cyathea dealbata* and Black tree fern Mamaku *Cyathea medullaris*, maples, camellias, fish pond, artificial stream and waterfall anchored the space.

Figure 5-10 shows photos of users within the zone. The *Agonis* was popular with some users as a climbing tree where they would lie down and sleep, or admire the view over the garden below or out to the distant horizon to Rangitoto Island.



Figure 5-8 Zone 1 beach, waterfall, climbing tree, hidden lawn

Zone 2 was designed with more sensory-richness to promote mild-moderate physical activity. Perceived Sensory Dimensions (PSD)s *rich in species, serene, space* and *refuge* were designed into the space. It connected with Zone 1 through a woodland-style garden under mature exotic trees. To enhance *serenity*, soften the overall acoustic of the space, and improve the soil, the full 225sqm area was covered with 30cms of bark mulch. A 15m tall English Oak *Quercus robur* canopies the space, with mature Magnolia *Magnolia grandiflora* and Crack willow *Salix fragilis* providing additional vertical interest and shade. To add 'species richness', native ferns *Asplenium gracillimum*, *Botrychium australe* and *Christella dentata*, Coastal Flax (Harakeke) *Phormium cookianum subsp. hookeri*, shrubs Manuka *Leptospermum*, Hebes *Hebe angustissima*, 'Emerald Gem', 'Wiri Mist', Astelia (Kakaha) *Astelia fragrans*, Olearia *Olearia albida*, Poroporo *Solanum aviculare*, and ground cover *Fuschia Fuschia procumbens*, and Korokio *Corokia cotoneaster*, were planted in the mulch. For additional seasonal interest,

exotic *Hydrangea macrophylla*, *Cyclamen hederifolium*, Bottlebrush *Callistemon viminalis* and *Daphne odora* were added. The *Daphne* walk cuts across the main planting bed connecting the two sides of the looped path as a cut-through, with seating to pause and enjoy the fragrance. A *Hebe* walk loops up to a secret seat surrounded by *Manuka* and *Olearia*. Star jasmine *Trachelospermum jasminoides* and sweet peas are grown up tee pees beside the zone entry from Zone 3 as a vertical accent and as a fragrant focus at the turn of the *Hebe* walk. Buttercup bush *Senna septemtrionalis*, perennial blue-flowered *Aster* daisies *Callistephus chinensis*, pink Marguerite daisies *Argyranthemum frutescens*. Shrubs and vines in Zone 2 were chosen for their traditional Māori health-giving properties (Rongoā), and/or to attract wildlife. A log-edged looping bark chip main path, with two sub-order narrow bark chip paths, passed through colourful, fragrant, tactile, traditional Māori Rongoā planting, to encourage and enable exploration, and hence prompt non-goal-oriented physical exercise. Views and glimpses across the garden, with strategically placed bench seating options for one to two people, encouraged garden users to be more socially engaged.



Figure 5-9 Zone 2 - woodland walkway

Zone 3 was planned as an active growing space, with edibles and the backstory of wildflowers for pollinators, an insect hotel and stumpery for beneficial wildlife, including vertebrates and invertebrates and mulch for fungi (Figure 5-9). All of the PSDs except *space* were included within this zone. The use of accessible and more challenging mindfulness paths throughout this zone made *space* impractical to include. The zone's diverse elements reference the healing characteristics *rich in species, nature, prospect, culture, serene* and *social*. An old,

rotten, rose arbour was removed, along with broken paving. The open space was made brighter and lighter with the addition of crushed shell laid over weed matting. Crushed shell chip surfacing referenced the adjacent sandy 'beach' area of Zone 1 and provides acoustic and tactile interest when walked on. A mindfulness walkway of unevenly placed timber sleepers allowed users alternative access to the southern boundary of the zone (see Figure 5-6 top right image and Figure 5-8). The mindfulness walkway forces a heightened level of awareness as it requires careful placement of feet and a good sense of balance. Existing mature trees in the zone included a Puriri *Vitex lucens* and Sweet Gum *Liquidambar styraciflua*.

The zone promotes moderate-active physical activity with raised growing beds where people can plant, tend, pick and eat fruit and vegetable crops. Flexible light-weight, moveable seating, with bistro style tables and chairs allowed users to be social or solitary, as they wished. Central to the zone are four raised beds designed as durable, coloured, tactile Colour Steel® corrugated iron beds. The iron is a good material for passive thermal gain, as it heats the soil for early spring seed germination. The beds were filled with compost and planted with a selection of vegetables and herbs (see Figure 5-10, bottom, middle).



Figure 5-10 Zone 3 - sociable, active growing

Three pallet raised beds were installed between the sleeper paths on the shell chip as modified Lesotho keyhole gardens (World Vision International, 2015) (Figure 5-11, left). Keyhole gardens are designed as accessible raised gardens. They are a highly effective low-

cost intervention, built using recycled materials. They improve soil fertility and require minimal watering. In the SG recycled timber shipping pallets were used to make low raised gardens. The keyhole gardens have a central 'chute' made from wire mesh supported by bamboo poles where food scraps are placed for composting. The soil is ramped, pyramid-style up the sides of the chute to create more growing space, enclose the 'compost' and to deter rodents. Gross-feeding blueberries and strawberries thrive in such as environment. Watering is applied down the wire mesh chute only, creating a mineral-rich 'soup', which leaches out into the bed.



Figure 5-11 Keyhole pallet garden and tactile corrugated iron raised beds



Figure 5-12 Zone 3 accessible sleeper path and mindfulness walkway

To the rear of Zone 3, a mound was created using spoil from digging out the defunct rose arbour and sown with Lowfield Meadow wildflower seeds. The wildflowers attract pollinators and add colourful, fragrant, life to the garden. An insect hotel was created using three pallets stacked and filled with different nesting materials on each level. It was placed under the trees along with a stumpery of logs. Decomposers are gradually covering the logs with beautiful fungi and gently tell the story of the circle of life. Timber sleeper paths to either side of the raised beds offer wheelchair accessible access on one side and a mindfulness walkway on the other (Figure 5-12).

Zone 4 was designed as an informal space, with soft-underfoot mown paths through long meadow grass (Figure 5-13). PSDs *social*, *space* and *nature* are expressed within this zone. Fruit trees were planted largely according to the availability of good drainage. Some tree pits were dug but had to be abandoned when drainage-tested. The resulting planting layout is a pleasing grove of fragrant citrus *Citris limon*, *C. reticulata* and *C. X sinensis* around log seating to the eastern side, adjacent to the woodland/urban forest zone. A plum tree *Prunus domestica* was placed to the eastern side with rustic boulder and timber plank seating underneath, with fruiting shrubs *Feijoa Acca sellowiana* in the south-east corner, espaliered

apples *Malus pumila* along the eastern boundary, and fig trees *Ficus carica*, and a Tamarillo *Solanum betaceum* planted beside the path near the entrance into the zone.

Themed around informal activity, a mown path looping through meadow planting under fruit trees created an orchard-in-a-meadow. This space references the healing element 'nature' with a sense of the wild coming from the long grass. The only existing tree in the space was a favourite of native birds, a mature Puriri *Vitex lucens*. The predominantly open space was defined by log seating, set out in an open square, in the north western corner. A winding path mown through the grass loops around the exterior of the zone, with a main access way directly from Zone 3 to the log seating as the principle focus. With approval for a fire pit and informal log and boulder seating, individuals and small groups were able to come together to read, play music, take a walking meeting, or sit and chat. A citrus grove was planted around the log seating area to provide fruit, fragrance and future shade.



Figure 5-13 Zone 4 – Informal orchard-in-a-meadow

The four zones are designed as functional environments that allow users to find space alone or together. The component spaces were also designed to be readily translated into stand-alone gardens or courtyards, indoors or out.

Sustainable urban drainage (stormwater runoff management) featured within the intervention gardens' design with durable permeable surfacing, e.g. sand around the pond in Zone 1, bark chip paths in Zone 2 and crushed shell surfacing in Zone 3. Zone 4 has mown paths through meadow grasses. The SG was developed to enhance existing mature trees and other landscape features, such as the pond and waterfall. These 'cultural' or constructed elements were not included to necessarily enhance any restorative response, but rather to ensure maximum biodiversity through aerated soils.

Minimal disruption to the existing space reduced development costs and maintained staff and students' existing emotional bond with the space. The mature trees and pond gave a feeling of permanence and history to the SG. Retention of mature elements also gave comfort to previous users of the space who did not opt in to the study but who expressed concern at being excluded from the SG during the duration of the research. Security was maintained with entry and exit controlled by locked gates for the duration of the study. Upon completion of the study, access was opened to allow general use of the space. The wider university community instantly made use of the space and continue to do so.

Overall the garden is bounded by a brush screen fence, with columnar *Pittosporum tenuifolium* planted at 3m intervals inside the fence.

5.3.8 Garden design process

The design process adopted an iterative approach. This was led by the design task, which was to create a sensory garden as a living laboratory.

Design steps

- i. Vision and ideation, based on a clear research question with clear objectives The product of the first design activity is described by Popper (1963) as essential to scientific progress. A vision of a 'solution in principle' developed early in the design process parallels a researcher's working hypothesis. In designing the sensory garden

as a research laboratory, the working hypothesis that species richness would make a difference was refined to include elements to captivate and activate the perceived sensory dimensions (Stigsdotter et al., 2017).

- ii. Identification of existing knowledge about healing gardens e.g. hierarchy of paths, >70% green / soft landscaping (Cooper Marcus, 2017)
- iii. Evaluation of the conceptual framework within context analysis to ensure design elements were locally appropriate.
- iv. Presentation of the concept, which gained a positive reaction from Faculty and an initial negative reaction from Estates, who were concerned at the potential for an unbudgeted additional maintenance requirement. Note: this concern was answered by developing a volunteer labour Friends of the Garden group and honesty-based donation system to harvest edibles and flowers
- v. Applied the evidence base to the design project. Developed matrix, as shown in Table 5.3, identifying sensory dimension for each of the four zones, referencing the eight healing elements (Grahn & Stigsdotter, 2010). Determined zones and progression from one space to next, joining points, logical progression (including new and existing paths).

Table 5.3 Matrix showing PSDs against zones of the sensory garden

Perceived sensory dimensions	Zone 1	Zone 2	Zone 3	Zone 4
social	√		√	√
prospect	√		√	
rich in species		√	√	
serene	√	√	√	
culture	√		√	
space	√	√		√
nature			√	√
refuge	√	√	√	√

5.4 DESIGN EVALUATION: THE EFFECT OF THE DESIGN

5.4.1 Sources of data

Multi-criteria analysis of the design was triangulated through Direct Observation, Quotes from participants and Zone Preference data.

5.4.2 Site baseline enquiry

Prior to the development of the sensory garden the 900m² site was flat, under-utilised and poorly maintained, with compacted clay soils, desiccated grass, broken paving and a rotting timber rose arbour. Some mature specimen native and exotic trees, areas of sub-tropical shrubs, small ornamental waterfall feeding a stream and fishpond were edged with a glyphosate-sprayed margin. The plant palette was best described as 'random'.

Grid-based ecological sampling was conducted prior to work starting on site, and subsequently at weekly intervals for the next 12 weeks. Where there were large areas of grass or bark mulch a random sample was taken. Where there were existing shrubs the area was stratified and treated separately. No insects or birds were observed within the site over the first four weeks of sampling. Planting occurred continuously for the first six weeks. In week five one beetle was seen. In week six, one beetle and one millipede were observed within the 900m² space. In week seven, multiple beetles, earth worms and insect-eating birds were observed. By week eight, nectar-feeding birds were observed in addition to the previous species. Over the subsequent four weeks, numbers of insects and birds observed steadily increased as planting densities increased.

5.4.3 Evaluation of The Effect of the Design – Study 1

The effect of the design was evaluated through the randomised controlled trial and qualitatively, as described in Chapter 4. To maintain objectivity, field observations by the candidate and Research Assistants (RA's) were collated, discussed, and cross-checked weekly during the intervention.

5.4.4 Evaluation of The Effect of the Design: Study 2

In Study 2, the effect of the design was evaluated quantitatively using visit data and qualitatively through field notes of the candidate's and RA's direct observation of participants' response

within the study environment, comments from the participants, through focus groups and by zone use preferences.

5.4.5 Knowledge to action

To facilitate the KTA process the study tested the restorative response to salutogenic design. According to Bowen and Graham (2013), there is a significant divergence between the knowledge available and what is actually being used in design practice. To enhance the quality of the design and to secure a specific use of the facility, objective knowledge had to be embedded in the design. For the process of Knowledge to Action (KTA) to work in an architecture practice the gap between the existing objective knowledge on healing gardens and the subjective knowledge architects use must be closed. In order to do this the knowledge that exists about healing gardens must be identified and transferred to architects, as in (Souter-Brown, 2015). This process takes place in a complex system of interaction between researchers and those who need knowledge, and the process will vary in intensity, complexity and engagement depending on what is needed (Ibid.). Before this knowledge can be disseminated, it is important that there is an interaction between users, architects and researchers who have the necessary knowledge of healing gardens. As user needs may change over time, so design research must maintain an on-going enquiry.

Sensory gardens can be scaled to fit any sized setting, or budget

In practice, the smallest fully functional sensory garden I designed was just 5m² and cost \$10,000. In that small courtyard setting, the design emphasised the vertical plane with plants and planters up walls and hanging from overhead beams. The design balanced planting with built features, including a small water feature to attract birds to drink and offer a gentle masking acoustic from the world outside.

This study's sensory garden cost just \$29,000 to redevelop the 900m² site. Materiality of the Scholars' Garden included minimal built elements, (corrugated steel raised planters, recycled pallet raised planters, recycled pallet insect hotel, relocatable timber and galvanised steel furniture, timber sleeper paths), recycled log and boulder seating and reuse of existing features wherever possible. Materiality of Awataha Plaza included extensive concrete paving,

tiered concrete seating, fixed steel and timber benches, bollard lighting, permeable paving to tree pits, signage and rubbish bins.

Significance and uniqueness of the project

A focus on health promotion presented this study with opportunities and challenges. This research was important as a case study for future studies due to its small budget, physical size and zone scalability. As Milat et al (2013) state, the future value of research is related to its scalability. They defined scalability as “the ability of a health intervention shown to be efficacious on a small scale and or under controlled conditions to be expanded under real world conditions to reach a greater proportion of the eligible population, while retaining effectiveness ... in health promotion research, insufficient attention is given to issues of effectiveness, reach and adoption; human, technical and organizational resources; costs; intervention delivery; contextual factors and appropriate evaluation approaches. If these issues were addressed in the funding, design and reporting of intervention research, it would advance the quality and usability of research for policy-makers and by doing so improve uptake and expansion of promising programs into practice” (Milat et al., 2013, p. 285). Human, technical and organisational resources are addressed by this study when evaluating the university estates’ development, management and maintenance role in health promotion.

5.5 CONCLUSION AND FUTURE RECOMMENDATIONS

While traditionally used with multi-sensory, sight or memory-impaired individuals, sensory gardens can offer positive effects for everyone, regardless of age, ability, disability or diagnosis. A sensory garden can be developed anywhere (Hussein, 2010b; Souter-Brown, 2015). Design explorations using the principles of perceived sensory dimensions could benefit a wide range of users and settings.

Chapter 6 RESULTS OF STUDY 1

6.1 RANDOMISED CONTROLLED TRIAL (RCT)

6.1.1 Participants

Participants (n = 164) were predominantly female (77%, compared with 65% females in the University student body overall) from Auckland University of Technology, New Zealand (Table 6.1). Employment status was mixed across staff (35%) and students (65%, of which 16% also work part-time). Groups, Awataha Plaza (AP), Scholars' Garden (SG) and Control, showed similar demographics (Table 6.1).

Table 6.1 Demographics

	All groups	AP ^a	SG ^b	Control
Overall N	164	51	57	56
Mean Age (SD)	33.7 (12.02)	32.1 (8.5)	35.7 (3.5)	33.7 (4)
Gender % female	77.6	86.3	80.7	69.6
Education %				
Secondary	31.1	33.3	28.1	32.2
Under-graduate	20.1	21.5	17.5	21.4
Graduate	25.6	31.4	21.1	25.0
Post grad- Masters	11.1	7.8	14.0	10.7
Post grad- Doctorate	12.1	5.8	19.3	10.7
Ethnicity %				
NZ European	58.5	23.2	17.1	18.2
Maori	3.6	1.8	0.6	1.2
Pasifika	3.0	1.2	0.6	1.2
Other	34.8	9.8	16.5	8.5
Other ethnicity %				
Other Asian	24.6	7.0	12.2	5.3
Indian	22.8	7.0	5.2	10.6
European	15.8	0.0	8.7	7.1
Chinese	14.0	7.0	7.0	0.0
African	10.5	5.2	3.5	1.7
North American	7.0	1.8	5.2	0.0
Australian	3.5	0.0	3.5	0.0
South American	1.8	0.0	1.8	0.0
Employment %				
AUT academic	20.7	13.7	28.1	19.6
AUT allied	11.6	5.9	15.7	12.5
AUT Student	56.1	66.7	47.4	55.3
AUT Student + other working	9.1	9.8	8.8	8.9
AUT Staff + student	2.4	3.9	0	3.6

^a AP = Awataha Plaza (Group One), ^b SG = Scholars' Garden (Group Two)

6.1.2 Who opted out of the study?

During recruitment, 61 people were excluded or subsequently declined to participate (see Figure 4-4). As the season changed from summer to winter, of the 179 participants assessed as eligible, 14 dropped out. The remaining 165 participants were randomised to the three groups (55 in each group). However, that number dropped to 164 as a participant opted out of the study directly after being allocated to the Awataha Plaza (AP) group. The Plaza group size was further reduced after two participants assigned to the Plaza group self-selected to move to the Scholars' Garden (SG) and attended a session there without authorisation. They were allowed to continue in the study but to maintain integrity within the RCT their data have not been included in the analysis. Similarly, the Control group gained one participant who self-selected to move from the Plaza group to the Control post baseline sampling. Their data, likewise, were not included in the analysis. The resulting numbers in each group are shown in Table 6.1.

6.1.3 Dose of nature

Engagement in the study varied between groups. Of participants assigned to AP group, 76% accepted the invitation to attend one or more of the scheduled intervention 30-minute 'nature' appointments. In comparison, 87% of the SG group attended their intervention session. Sessions were undertaken by participants in both intervention groups at the same time on the same days, regardless of the weather, with the same comfort accessories (blankets and foam cushions).

Attendance by AP participants reduced after experience in the plaza. Of participants in the Plaza group, just 27%, or 14/51 received their full 2-hour intervention dose of nature. This contrasts with participants in the Garden group, 70% of whom, or 40/57 received a full 2-hour dose of nature. The high attendance rate was again supported by qualitative data (see 5.3.1 Feel/ Touch/ Mood). While no statistically significant causal dose response was shown in relation to the attendance data, associations were seen.

Follow-up cortisol data were collected from 95% of participants in the SG group compared with 62% from AP group participants, (Table 6.2). Missing data at baseline was due to viscosity

of sample. At follow-up, no data was lost to poor quality samples (cold and flu season had passed).

Table 6.2 Participant engagement in the Study by group, laboratory attendance for cortisol sampling, and session attendance for intervention groups

Group Name	N	Attendance for Baseline (%)	Attendance for Follow-up (%)	Attended ≥ 1 session (%)	Attended ≥ 3 sessions (%)
Plaza	51	46 (90)	32 (62)	39 (76)	28 (55)
Garden	57	52 (91)	54 (95)	50 (87)	47 (82)
Control	56	53 (94)	42 (75)	n/a	n/a

6.1.4 Descriptive data showing changes to salivary cortisol, productivity, well-being, nature relatedness, perceived stress and visits to greenspace.

The descriptive data showed changes over time in outcome measures across the two intervention groups and control. Salivary cortisol, productivity (measured through the perceived work output scale), well-being (measured through flourishing scale), nature relatedness, physical activity (measured through visits to greenspace) and perceived stress (as measured through the scale of positive and negative effect) are shown in **Error! Reference source not found.**

Differences in the raw data showed the effect of the sensory garden in comparison to the plaza (Figure 6.1). Cortisol levels dropped over time by almost 20% after one or more doses of nature-rich time in the sensory garden. In comparison, plaza group participants' cortisol levels reduced by just 7%. Well-being, as measured on the Flourishing Scale, improved by almost 10% after one or more sessions in the sensory garden. However, after time in the plaza, well-being *reduced* by almost 5%. Productivity, as measured by Perceived Work Output, was reported as increased by 2% after one or more sessions in the SG. As with well-being, after one or more appointments with nature in AP, participants reported a *decline* in productivity, here of - 1%.

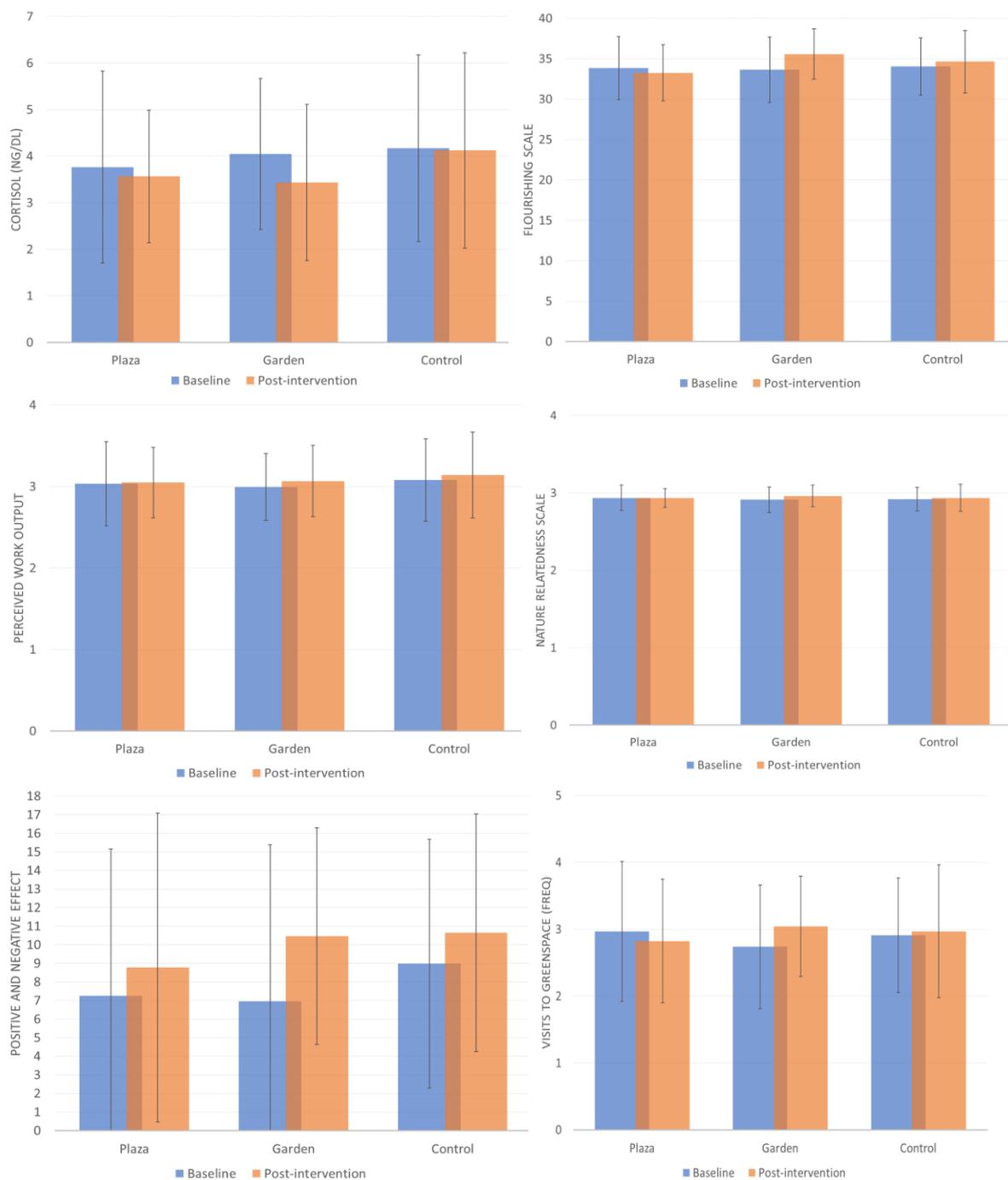


Figure 6-1 Descriptive data showing changes over time in cortisol, well-being (flourishing scale), productivity (perceived work output), nature relatedness, perceived stress (scale of positive and negative effect) and physical activity (visits to greenspace).

6.1.5 Investigating the effects of the intervention

To establish the stress response to the intervention, cortisol was the primary outcome measure. Using a generalised linear model with a multinomial logit link function, statistically significant differences were seen for the physiological measure salivary stress cortisol, and the psycho-social measures of well-being and productivity, as highlighted in Figure 6-2. Compared with the Control group, the Garden group showed a **significantly greater decrease in stress cortisol post-intervention, with an intervention effect of -16.1% (95% CI: -32.0%, 0.2%; p = 0.04)**. Other significant differences were seen between the Garden group and the Plaza group, with intervention effects of 6.9% (95% CI: 2.7%, 11.1%) for the flourishing scale and 2.8% (95% CI: 0.1%, 5.5%, $p < 0.05$) for perceived work output. **Statistically significant differences in Visit frequency to greenspace were observed between control and garden groups (P= .002)** but not between Control and Plaza groups (P=0.841).

The estimated marginal means presented in Figure 6-2 express the pairwise comparison of all possible relative intervention effects associated with the Garden group (when compared to the Plaza and Control group) and the Plaza group (when compared to the Garden and Control group). A positive effect (greater than zero) indicates that the change in outcome measure in the 'intervention' group (Garden or Plaza, depending on the comparison) was greater than the 'Control' group (Plaza or Control, depending on the comparison). A negative effect (less than zero) indicates that the change in outcome measure in the 'intervention' group (Garden or Plaza, depending on the comparison) was less than the 'Control' group.

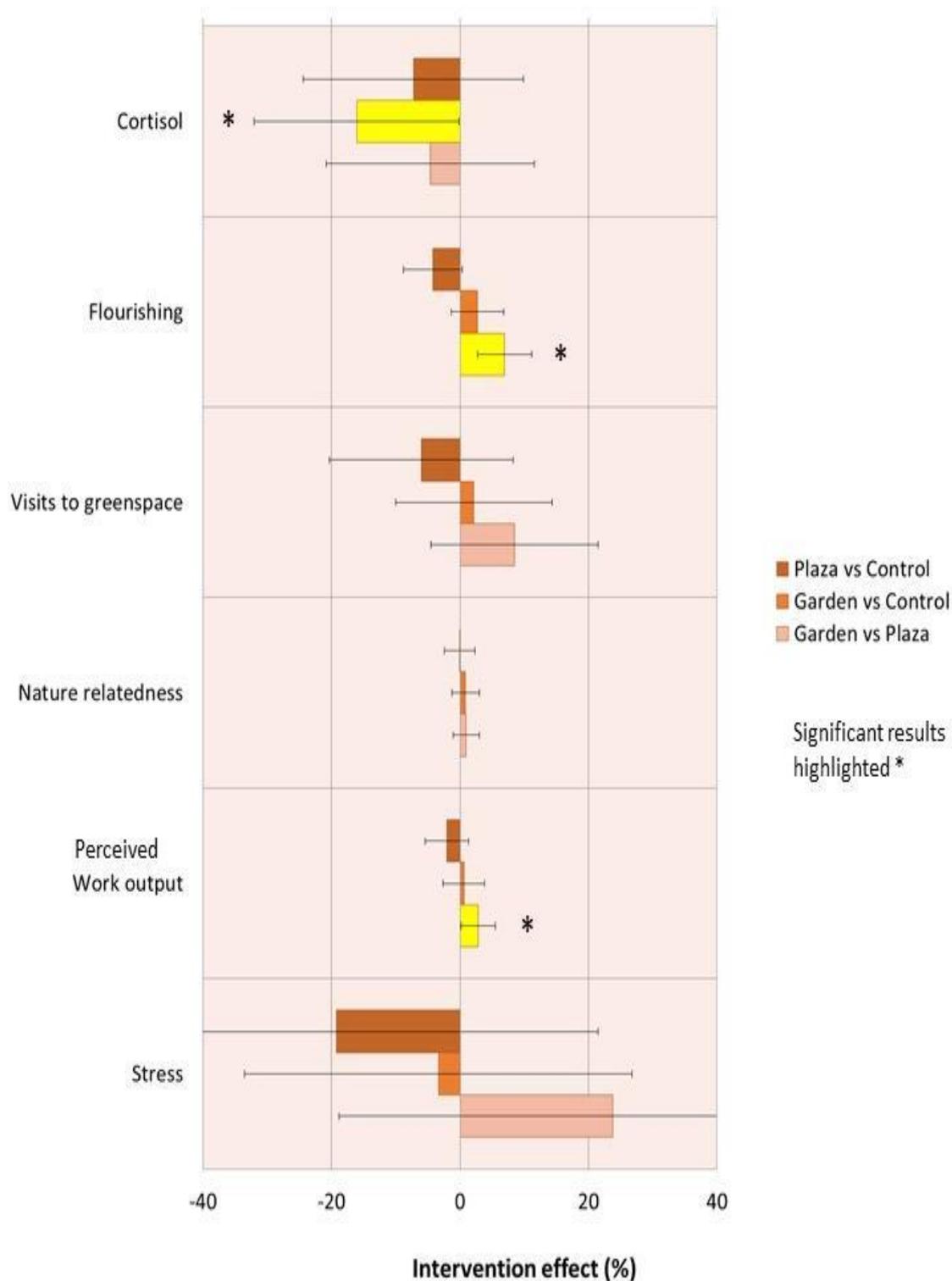


Figure 6-2 Generalised linear model showing percentage intervention effects for each outcome measure. Data are expressed as mean \pm 95% confidence limits. *Highlighted bars are statistically significant effects ($P < 0.05$).

6.2 QUALITATIVE RESULTS

Qualitative data were analysed using inductive thematic analysis and reported in relation to the five main senses: sight, hearing, feel, taste and smell. Sources included: semi structured one-on-one interviews, weekly diary entries, trained Research Assistant (RA) observations, oral quotes and written comments. The quantitative data were supported by well-being-related themes, concepts and issues.

Participants were told at sign up that they were taking part in a restorative response study. To ascertain whether participants had a pre-conceived notion of potential outcomes of the study, when interviewed they were asked what the term 'sensory garden' meant to them. Their aggregated response was: *"somewhere a little bit wild, that stimulates the senses, where you are allowed to actively engage with nature"*.

Responses across all qualitative data sources were analysed thematically.

6.2.1 Thematic Analysis

Transcripts from all data sources were read repeatedly to become familiar with the data. They were then coded with key words or phrases that described the content. After repeated analysis of the coded documents, related codes were grouped together into major themes, sub themes and sensory affect (full description of method in Chapter 4).

Four main themes were discerned around the effect of environment, identified as a response to the Scholars' Garden (SG), or Awataha Plaza (AP).

Theme 1 (Foundation theme): *Nature connection* was conceived as a developing awareness, appreciation and feeling part of one's surroundings, sometimes for the first time, after spending time outdoors. It was most pronounced in the SG group. Nature connection was found to be the foundation, or 'root' theme that fed, with a sub-theme of wildness, into the three further themes identified (Figure 5.3).

Theme 2: Productivity was the perception of feeling creative, motivated to work, inspired to achieve, with clarity of thought. It fed into a perception of work output. Again, this theme was most evident after time in the SG.

Theme 3: *Social connection* was conceived as a connection between stress management, relaxation, face-to-face interaction, problem solving and a sharing of experience with other people. This theme manifested differently in AP and SG participants.

Theme 4 (Umbrella theme): *Well-being* manifested as feelings of safety, security and contentment. Sub-themes of a sense of ownership of the space and control over the experience, childhood memory and a sense of playful experimentation and risk taking categorised as playfulness were also evident. This theme and sub-themes were only noticeable in SG participants.

The pictorial of the tree in Figure 5.3 represented the four themes and subthemes. Nature connection to be at the 'root' of a restorative response. The tree theme then 'grows' up through smaller branches, the sub-themes:

1. childhood memories of playing and exploring gardens and landscapes, categorised as 'childhood memory',
2. nature untamed, unmanicured, unpredictable, experienced as a metaphor for the apparently random nature of life, categorised as 'wildness',
3. 'playfulness' conceived as a desire to have fun and try new tastes, relationships and experiences
4. 'sense of ownership', a feeling that the participants belonged to the space and the space to them, both temporally and physically.

The branches then reach the canopy, the umbrella themes, which link ideas of similar meaning together. These themes feed into the crown of the tree of potential 'benefits gained' from nature connection, well-being, as the restorative response.

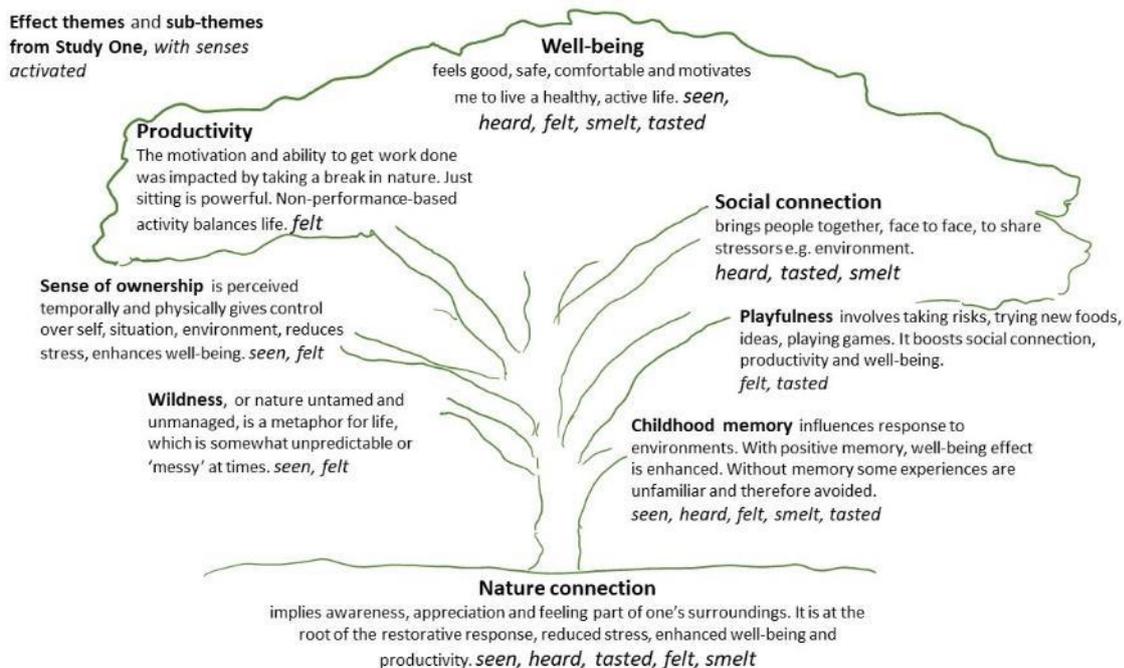


Figure 6-3 The restorative response visualised in themes and sub-themes framing common ideas with similar meaning, together with senses activated.

The five main senses were activated at different times, in response to the environment. Of the four main theme categories, nature connection and well-being were the two that each activated all five senses (Table 6.3).

Table 6.3 Senses ranked in order of importance to relax, with associated themes and sub-themes

Sense	Theme	Sub-theme	Comment
Sight	nature connection	childhood memory a sense of ownership wildness	In the semi structured interviews, when participants were asked to rank the five main senses in order of importance to relax, sight was consistently most important.
Hearing / soundscape	nature connection social connection well-being	childhood memory	Acoustics or soundscape were ranked by participants as second most important for relaxation.
Feel/ touch/ mood	nature connection well-being productivity	childhood memory playfulness a sense of ownership	How a space makes individuals feel, the textures experienced, the mood it creates was listed as 3 rd most important in terms of being necessary for relaxation.
Taste / experience	nature connection social connection well-being	childhood memory playfulness	The one theme that integrates all 5 senses. Listed as 4 th most important in terms of relaxation. Childhood memories of the act of picking and eating fresh from the garden or the taste of freshly harvested fruit and vegetables influenced participants ranking of this sense.
Smell	nature connection social connection well-being	childhood memory	Participants said that smell was least important to them. Interviewees noted that they could not relax with a 'bad smell', but a 'good smell' was relaxing as it often had positive memories attached.

Nature connection

Nature connection as a theme was described as the experience of becoming aware, noticing one's natural surroundings and feeling part of, and appreciative of them. In the SG, RAs noted on the Observation Sheet birds noisily flying through the garden, wind in the trees and the sound of rain on the leaves and splashing onto the path. They observed participants highly engaged with the environment. Participants took off their shoes to get a better feel for the space. Participants' spontaneous description of their emotional response, experience and connection to nature were highly detailed. On entry to the SG, participants variously exclaimed: *"I love the trees. They feel old, timeless."* *"Look at the colours of the fungi, the way it clings to the end of the log!"* *"It [the garden is so beautiful it] made me cry!"* and *"[it feels like] paradise."*

Responses from the SG showed an awareness of their surroundings. Participant comments showed a strength of feeling for their newfound nature connection seen in: “*wow, I hadn’t noticed the waterfall before*”, “*the sky was particularly blue on Tuesday*”, “*the birdsong was constant*”, “[I love the] *sound of water*” and “*who knew? The birds sit in the palms and sing every day as I come into work*”. “*Being able to pick and eat fresh herbs with my lunch is wonderful*”, “*I ate the first strawberry...delicious. So much better than bought ones*”, “*You can eat the flowers (nasturtium)?! I’m cooking flat dinner tonight. I’m taking some home for my flatmates [big smile]*”. Other participants in the SG commented: “[Look at the] *trees!*”, “*wildflowers*”, “*sandcastles*”, “*colours!*”, “*fungi*”, “[Look, I found a] *butterfly*”, “*bumble bee*”, “*woodland seats*”.

Diary entries mentioned behavioural changes after time in the SG. “*I took myself off long term anti-depressants*”, “[I feel less stressed at the end of the day so] *drink less wine*”. Participants also ventured that they ‘*ate more mindfully*’, were ‘*happy to eat healthy foods*’, [enjoyed] ‘*sitting outside to eat, even in winter!*’ Participants commented they “*noticed the [fragrance of] spring blossom on my dog walk*”, “*noticed the smell of the sea when I went for a run.*” Diary entries consistently mentioned birdsong. Participants commented that they “*noticed the bird song [at home, on the way to university, while walking the dog]*”, often for the first time in years.

In the one on one interviews, trees and birdsong were consistently listed as the most important elements to have nearby to relax (Figure 5.4). Water, both still and flowing, added to the restorative experience.



Figure 6-4 Word cloud from semi structured interviews of elements necessary to have nearby to relax

Healthy soils were listed as semi-important. Grass was considered unimportant for relaxation. Participants felt that their, often newly found, awareness of their surroundings fed into a restorative response.

Research Assistants in the SG also observed awareness of and appreciation of nature through: [participants] leaning on a branch over the waterfall, sniffing vegetables and herbs, picking and eating herbs, vegetables and flowers, and sitting in the sunshine to eat. Participants in the SG commented: *“the [smell of] daphne hit me as I entered the garden”*, *“the sweet peas smell so sweet”* and *“[the herbs] taste so good.”*

Research Assistants in the AP observed: while the experience appeared relaxing, it was at a basic level. However, participants appreciated taking a break from work and study indoors to be outdoors. A participant in the AP commented: *“[The] trees look ‘decorated’ for Christmas.”*

The urban acoustic varied over the two intervention sites. Audible nature, or lack of, was a feature of the experience. Participants in the AP noticed their surroundings and commented: *“the sound of the motorway intrudes”*, *“it was too noisy to relax”*, *“there was a distant bird singing”*.



Figure 6-5 Wildflowers covered the mound in the SG in a changing profusion of colour, texture, fragrance, sound and movement as busy pollinators buzzed through the flowers.

Wildness

Wildness, ‘wild’ or nature untamed, is rare in an urban area, where life is usually controlled, managed, curated. It was identified as a sub-theme. Conceptually, the sense of wildness, as part of the connection with nature, influenced the sensory experience of the SG. Some participants had not previously visited a beach, seen long grass, or an unruly profusion of wildflowers (Figure 5-5). When they saw these things in the SG a participant commented: *“It [the garden] is messier than I imagined it would be”*. With the diversity of visiting birds and insects, flowers and fruit, others noted *“[I am] noticing more”*, *“I like to explore [to see what is flowering this week]”*, *“there is so much here; it looks small from the outside but wow!”* The joy of seeing some wild nature at the university was summed up by the comment: *“It feels like nature arrived at the university.”*

In the diaries, some participants commented that since being in the study they noticed more wild, untamed areas of nature when they walked to work.

AP participants made no comments in relation to wildness.

Productivity

Feeling productive, the motivation, creativity and ability to get work done, showed an effect after taking a break from work or study in both intervention settings. The theme captures feelings of ownership, and an understanding and acceptance of life as a little 'wild' and unpredictable.



Figure 6-6 Participant taking a 'refreshing break' in the orchard in SG

The theme was expressed in comments by participants to the RAs. Some participants in the SG said “[I like to] *take a break*”, “[taking time out outside during the working day] *made me question my lifestyle. I need to do this more*” and “*during my 30 minutes outside on Friday I felt this quiet time was very rewarding and refreshing, and I went back to my desk with a clear head*”. One commented: “*after a particularly stressful morning, I couldn’t take any more. I came to my session early. Within five minutes I felt so much calmer. It was amazing. I left [the SG] after my thirty minutes ready to tackle challenges refreshed, feeling good, feeling creative in a way I can’t manage at my desk*”.

Others said “*The 30 minutes away from the office really helped me, as it was a very busy day and being outside to read was very rewarding. I retained more*”, “*what I read outside made sense*”, and “*reading and hand writing notes outside brought clarity to my work*” (Figure 5-6). Others delighted in the lack of performance requirement, “*even while being on the stress response study ‘self-improvement programme’ [I feel I am] being allowed to be me, for the first time*”. “*I feel so good after time in the Garden I am getting more work done back at my*

desk” and “[I feel] restored.” Another commented: “You have to tell my manager. This is good for us and good for our work.”

Participants from the AP commented in diaries and to RAs: “I don’t think this [experience] has affected me at all” and “nothing has changed”. However, one said: “I like to relax [in the plaza] with coffee” and another said, “just taking a break outside helps [me work better].” In the diary one participant commented “my writing was inspired by the Scholar’s Garden simply looking [out at it] through the postgraduate lab window. It removed lots of pressure from me. I sat in the lab for hours and wrote nothing. Normally I would be worried, but not this time. I simply read for hours pleasantly. Next morning lots of good ideas came to me in early morning, and I wrote them down.”

The weather was noted by participants in AP with observations made to the RA such as: “[I feel] cold”, “[I feel] cool”, “[I feel] damp”. Participants in the SG did not comment on the weather as affecting their experience of the garden, other than to delight in sitting in the sunshine. It was expected that a pattern between perceptions of weather and feelings of productivity would show, but this was not found. Some participants in the Plaza group remarked on the positive effect of the sunshine but reported they still felt overwhelmed by their workload.



Figure 6-7 Participants in AP 'getting comfortable'

Social connection

Social connection, the coming together face-to-face with others of the same species, is part of being human and considered necessary for stress management, particularly in females (S. E. Taylor et al., 2000).

In the SG RAs observed: no real talking, people spread out, bit of a chat while people walk around, more interaction if people knew each other. One participant said: *"this was my time. I didn't want to share it"*. Another said: *"I had everything I needed. I loved the silence. I didn't need to share it with anyone"*.

In the on-on-one interviews, one participant said, *“touch is unimportant to me. I have been divorced for years. But in the garden, I was hugged [by another female participant] and now seek more contact with people.”*

In the diaries, after time in the SG participants commented on spending more time with their friends and family, outdoors. Parents talked of playing with their children more than previously, purposefully seeking nature-rich experiences such as puddles and bush walks and others of chatting with their partners more. One participant commented, *“[having discovered the joy of being rugged up outside in winter I] get outside with the kids more.”*

In the follow-up survey comments, participants noted changes in their relationships after time in the SG: *“I found it easier to talk through the problems we’ve been having”* and *“I now know what I need from a relationship.”*

During the sessions, social connection and interaction were considerably greater in AP than the SG. RAs in AP observed: participants chatted most of the time, if they sat on the amphitheatre seating, they [participants] were talking to each other. The bench seats did not promote communication. Participants tried to get comfortable as best they could (Figure 5-7). One Plaza group participant told the RA *“the plaza was so stark, so boring I could not go in without a friend. We had to chat to distract ourselves from the sound of motorway and depressing view”*.

Influenced by childhood memory and playfulness, social connection was principally observed as a direct effect of lack of nature connection, in AP, and an indirect effect of nature connection in the SG. A lack of nature gave rise to a desire for shared experience. However, while participants in the SG did not generally display a need to connect socially during the intervention session, outside of the study their social relationships were improved, and more time was spent with family and friends.

Well-being

Well-being is conceptually similar to an all-over feeling of safety, satisfaction or contentment. Feeling safe was demonstrated by participants’ actions. On entry to the garden, the researcher and RAs observed participants transition from walking in stiff with stress to physically relaxing, within minutes. One staff member participant commented that they

needed to 'get away from students', then took a beanbag and found a space tucked away under the trees. As they were slightly agitated the researcher followed to check they were OK. The participant then expressed an anxiety that they may fall asleep; the space made them feel so comfortable. Once reassured they would be woken when it was time to go back to work, that participant slept each session. Likewise, a student commented to the RA when they first entered the SG, they had multiple deadlines looming, and felt extremely stressed. They took a beanbag and collapsed with a deep exhale. They commented on how grateful they were for the opportunity and how good they felt just by being in the garden. They also slept each session (Figure 5-8). On waking the student commented on their surprise at how quickly they "*decompressed*" on arrival into the SG. Another participant, another staff member, commented: "*how amazing is it to feel so safe, so comfortable, so away from everyone, so restored as to be able to sleep, in the middle of campus?*"



Figure 6-8 Participant sleeping on beanbag under the old oak tree, SG

Well-being was seen as an accumulation of sub-themes and the natural culmination of the main themes. The experience of being in the SG was credited with changing behaviours. Participants who did not previously spend much time outdoors in winter reported that they now sought a healthy active lifestyle, with increased visits to local parks and gardens, more time simply relaxing, more mindful eating and reduced alcohol consumption.

The feel-good nature of well-being was mirrored in quotes from participants from the SG: *"Nature makes me feel good."* The effect on physical activity as part of a healthy active lifestyle was evinced through comments such as: *"I feel motivated to be healthy and active."* Some participants in the SG commented: *"The mindfulness walkways are wonderful. They remind me that life is not straightforward, logical and nor does it run in straight lines. It feels natural. You don't need to be taught what to do, you just do it"* and *"a change of view is important, this is just what I need."* Others said: *"[I was] reluctant to leave"*, *"[I felt] sheltered, safe"*, *"[I feel] relaxed"*, *"[I feel] peaceful"*, *"[time in the sensory garden is] what I needed"*, *"[I feel] happy"*, *"[I feel] delighted."*

Although, as in the SG a research assistant was present throughout the sessions, feelings of safety, security and contentment were not mentioned in relation to the plaza AP.

Ownership and control

A sense of ownership of the space and control over the experience were identified as sub themes. A sense of ownership is related to workplace well-being and productivity (Avey, Avolio, Crossley, & Luthans, 2009). The sensory garden's moveable furniture and furnishings (bean bags, light-weight bistro table and chairs, garden tools, blankets and foam squabs) allowed users to define their experience and hence boost their sense of well-being. Giuliani (2003) suggests Attachment Theory describes an affective bond, important to develop a sense of place and further, a sense of ownership or belonging.



Figure 6-9 A selection of bean bags and lightweight bistro tables in the SG facilitated customisation of experience

Participants from the SG commented: *“this is my spot [where I place the bean bag each session]”* (Figure 5-9) and *“this is my time.”* Another participant in the SG said *“[It is] not ‘til you leave you realise the impact.”* Some participants noted dismay over a lack of control of the duration of sessions in the garden *“[the sensory garden is] beautiful, [but] time went so fast”* and *“[I] wish I had more time”*.

Plaza group participants noticed their environment, but no sense of ownership emerged. The design of the plaza did not allow for customisation of experience beyond a choice of which bench to sit on. As such the plaza did not promote attachment, wellbeing or productivity.

While there was no ability to control the environment in the plaza, one AP participant commented: *“[the important thing for me was] being given permission to stop.”*

Childhood memory

Childhood memory, whether the individual had seen something before, tried it when young, or smelt it previously, influenced the way participants saw, ‘read’ and responded to the environment. It was identified as a sub theme that influenced other sub themes, and the main themes. The sensory garden offered multiple positive memory prompts in the form of edible plants, winding paths, fragrant flowers, birdsong. One participant in the SG commented: *“the long grass feels like being back on the farm. As a kid I always picked a piece of grass. Look, I’ve done it again.”* Another said, *“my grandmother had a large garden in England, where we*

could lose ourselves. This doesn't look like England but feels comfortable, like my grandmother's place." A participant commented in the diary that "[just like when I was young] I wished I could have spent a little more time outside [in the SG]. Others said "[the SG] feels like my childhood", "the herbs and veges [in the raised beds] are just like my grandfather grew", "I like to sit beside the plants to eat my lunch" (Figure 5-10), "[I feel] interested [in the world around me]", "[I feel] serene", "[I feel] positive", "[I feel] comfortable." Another participant commented: "I haven't been in there [the orchard]. I wasn't sure what it was."



Figure 6-10 Bistro tables and chairs were often placed near raised beds of herbs, vegetables and companion plants in the central area of the SG

Childhood memory can evoke strong emotions, both positive and negative. Participants in the SG commented: "[The birdsong] reminds me of my childhood", "[I love the] sound of the waterfall", "it is such a quiet oasis in here", "I don't like to talk to anyone, this is my chillout time." One participant in the one on one Interview shared that as their childhood memories were negative, it was a relief just to listen to sounds of nature, with no loud voices.

No participants in AP referred to childhood memory.

Playfulness

Playfulness involves taking risks, trying things out and is linked with happiness and social connection. It was identified as a sub-theme and is influenced by childhood memory. Participants in the SG commented: "when, as an adult, are you allowed to just sit and watch rain splash in the puddles?", "I learnt it's lovely [to be outdoors] in the winter sun", "I would

never previously have sat outside in winter”, “[in the garden] there is always somewhere to get out of the wind, or the rain”, “I feel great! I made a new friend today while playing with the sand”.



Figure 6-11 Participant playing with buckets and spades building sandcastles in the SG

Plaza participants made no comments in relation to playfulness.

6.2.2 Zone preference and Perceived Sensory Dimensions (PSD)s

Both the sensory garden and plaza were divided into predetermined zones. Differences were seen in zone preference by tally total, shown in Table 6.4. Usage of each zone has been aggregated over the four treatment sessions.

Table 6.4 Zone preferences during RCT for sensory garden and plaza

Zone	Garden [†]	Zone	Plaza [†]
One ^a Beach, pond, waterfall	142	One ^a Fixed seating under trees	44
Two Shaded, sensory-rich woodland	99	Two Paved open space	23
Three ^b Raised beds, bistro tables, wildflowers	160	Three ^b Tiered amphitheatre seating	66
Four Orchard in a meadow	64	N/A	

[†] total tally ^a second most popular ^b most popular

The established efficacy of Perceived Sensory Dimensions (PSD) (Grahn & Stigsdotter, 2010) were reflected in zone use.

In the sensory garden, Zone Three was the most used space. Zone Three was particularly rich in species, with wild area, insect hotel, stumpery, diverse planting providing a nature connection and cultural connections with bench and bistro table seating, and edible planting. This zone offered a sense of ownership, allowed retreat to sheltered refuge space and control, with sociable moveable bistro tables and chairs. Zone Three of the SG also offered a playful mindfulness walkway, a wildflower-planted mound attracting a variety of pollinator insects, a butterfly garden, an insect hotel, stumpery, trees and shrubs.

Zone One was the second most popular in the SG. It offered the attraction of the waterfall, sandy 'beach', climbable tree, stream and pond, supported by themes of nature connection, wildness, a sense of ownership, playfulness and childhood memory.

Zone Two offered a quiet acoustic with bark chip paths and densely-planted, wildlife-attracting, sensory-rich woodland gardens. Two bench seats were hidden away on the path edge, behind planting, providing a sense of refuge.

Zone Four, was subject to occasional flooding across the paths during the intervention period. It was also more open, with less species richness or opportunity to find refuge. Although gumboots were supplied, relatively few participants availed themselves of the opportunity to spend time in this area.

Table 6.5 Perceived Sensory Dimensions (PSD) by zone, as designed into each zone of the Sensory Garden ✓ and as existing in Plaza ‡

PSD	Zone 1	Zone 2	Zone 3	Zone 4 †
Rich in species	✓	✓	✓	
Nature	✓	✓	✓	✓
Serene	✓	✓	✓	
Wild		✓	✓	✓
Culture	✓		✓ ‡	
Social	‡		✓ ‡	✓
Refuge	✓	✓	✓	
Prospect	✓ ‡	‡	✓ ‡	

†not applicable to Plaza as only 3 zones

PSDs ‘Nature’ and ‘Rich in Species’ were consistently noted by participants from both intervention groups as beneficial. From the semi structured interviews, two levels of response were observed in relation to participants’ understanding of a sensory garden: [a place] “where you are *enveloped* in the delight”, to [a place that provides] “an opportunity to *engage* the senses”. The PSD ‘Social’ is not generally considered to be associated with stress reduction (Grahn & Stigsdotter, 2010; Memari et al., 2017). However, participants in AP found they needed to talk to other participants to reduce feelings of boredom. This finding contrasts with Stigsdotter et al finding that the PSD ‘Social’ is negatively related to psychological restoration by stressed individuals (Stigsdotter et al., 2017, p. 2). However, comments made by participants in the SG that they enjoyed sitting at the bistro tables but did not want to talk to anyone is supportive of the PSD ‘Social’ not being related to stress reduction.

In semi structured interviews, the experience of trees, water, birds and flowers were considered important to have nearby to relax. When questioned in detail, trees and plants with rounded leaf forms consistently provided the most restorative effect. Palm trees, spiky-leaf plants and cacti did not have the same effect. Being able to feel alone, coupled with a nature-rich soft acoustic provided a sense of serenity. Places that allowed participants to hide, to feel ‘away’, but with an outlook, were mentioned by participants in the SG as important.

In summary, trees (Nature), biodiversity (Rich in Species) and a sense of serenity and refuge were key influences on participants’ restorative response. The PSDs ‘Rich in Species’, ‘Nature’,

'Serenity' and 'Refuge' were pursued as participants sought a restorative place that met their individual need.

Attendance

Attendance was influenced by participants' response to perceptions of the weather as it was sensed in each intervention environment.

Observations were made by SG group members such as [the garden is] "*warm*" and [the space is so] "*engaging*", even though the SG is only 100m from the AP and the intervention was run for both groups simultaneously in the middle of winter. The positive perception of the environment by SG participants was reflected in their high attendance rate. This contrasted with observations made by AP group members such as [it, the plaza, was] "*boring*" and [it is too] "*cold*". Such comments were reflected in the lower attendance rate in the plaza. One participant in the AP group commented "*I did not come last week as it was cold*". When the RA mentioned that it was cold in the SG also, the participant expressed surprise and said, "*I had not thought of that*".

6.3 CONCLUSION

Study 1 showed the effect of the sensory garden across a wide range of physiological and psycho-social indicators of well-being. It met three of the four research aims, being:

1. To develop a sensory garden as a salutogenic environmental design intervention on AUT 's North Shore campus
2. To determine the effects of the use of a sensory garden on staff and students' stress levels, well-being and productivity at AUT
3. To explore environmental design preferences to enhance mental health and productivity in a tertiary education setting

The fourth aim, 'to determine whether use of the sensory gardens offers a sustainable self-care approach on maintaining mental health and productivity of staff and students at AUT' was explored in Study 2. Chapter 7 reports analysis of that Study.

Chapter 7 RESULTS OF STUDY 2

7.1 USABILITY STUDY

To investigate the viability of the sensory garden as a self-care tool, in Study 2 participants from all three previous groups (Awataha Plaza (AP), Scholars' Garden (SG) and Control) were given unregulated access to the sensory garden. As in Study 1, participants were invited to take a break for 30 minutes once a week for four weeks and required to sign in, but this time only in the SG and without the appointment system. Opening hours of the SG were extended (from 3 hours per day in Study 1, to 7 hours per day, including Saturday) to facilitate maximum opportunity for spontaneous use. Participants' use of the garden was again observed by the Candidate and a trained Research Assistant (RA).

There was a 6-month period between the research studies, which spanned two academic years (2017-2018).

7.1.1 Participants

Eighty-five participants returned to the study (see Figure 4-5) and completed the survey questionnaire and cortisol sampling (Table 7.1). There were 81% female staff and students (compared with 78% in Study 1) of the Auckland University of Technology, New Zealand. The mean age was slightly higher (35.3 ± 15 years, compared with 33.7 ± 12.02 years in Study 1). The biggest changes in demographics (compared with Study 1) were observed in education, with a 6% increase in the proportion of participants with a secondary education (equivalent to First Year university students) and the almost 4% reduction in undergraduate and graduate participation; however, these changes were not statistically significant.

Table 7.1 Demographics of Study 2 by previous group (showing comparative data from Study 1)

	AP*	SG*	Control	Total
Overall N	19 (51)	42 (57)	24 (56)	85 (164)
Mean Age (SD)	31.9 (14.8)	38.7 (15.0)	33.9 (14.9)	35.3 (15.0)
Mean Age Study 1 (SD)	32.8 (8.5)	35.7 (3.5)	33.7 (4.0)	33.7 (12.02)
Gender % Female	88.9 (86.3)	84.6 (80.7)	100 (69.6)	80.7 (77.6)
Education %				
Secondary	35.3 (33.3)	33.3 (28.1)	45.5 (32.2)	37.1 (31.1)
Under-graduate	17.6 (21.5)	12.8 (17.5)	22.7 (21.4)	16.6 (20.1)
Graduate	35.2 (31.4)	23.1 (21.1)	9.1 (25.0)	21.8 (25.6)
Post grad- Masters	11.8 (7.8)	10.2 (14.0)	9.1 (10.7)	10.3 (11.1)
Post grad- Doctorate	0.0 (5.8)	20.5 (19.3)	13.6 (10.7)	14.1 (12.1)
Ethnicity %				
NZ European	9.4 (23.2)	25.9 (17.1)	18.8 (18.2)	54.1 (58.5)
Maori	2.3 (1.8)	1.2 (0.6)	1.2 (1.2)	4.7 (3.6)
Pasifika	1.2 (1.2)	1.2 (0.6)	1.1 (1.2)	3.5 (3.0)
Other	9.4 (9.8)	21.1 (16.5)	7.1 (8.5)	37.6 (34.8)
Other ethnicity %				
Other Asian	6.2 (7.0)	9.4 (12.2)	3.1 (5.3)	18.7 (24.6)
Indian	3.1 (7.0)	3.1 (5.2)	9.3 (10.6)	15.5 (22.8)
European	0.0 (0.0)	12.5 (8.7)	3.1 (7.1)	15.6 (15.8)
Chinese	9.3 (7.0)	12.5 (7.0)	0.0 (0.0)	21.8 (14.0)
African	3.1 (5.2)	3.1 (3.5)	3.1 (1.7)	9.3 (10.5)
North American	3.1 (1.8)	9.4 (5.2)	0.0 (0.0)	12.5 (7.0)
Australian	0.0 (0.0)	6.2 (3.5)	0.0 (0.0)	6.2 (3.5)
South American	0.0 (0.0)	0.0 (1.8)	0.0 (0.0)	0.0 (1.8)
Employment %				
AUT academic	5.9 (13.7)	25.6 (28.1)	13.6 (19.6)	17.9 (20.7)
AUT allied	5.9 (5.9)	12.8 (15.7)	18.2 (12.5)	12.8 (11.6)
AUT Student	70.6 (66.7)	55.3 (47.4)	59.1 (55.3)	59.1 (56.1)
AUT Student + other working	11.7 (9.8)	7.7 (8.8)	9.1 (8.9)	8.9 (9.1)
AUT Staff + student	5.8 (3.9)	0.0 (0.0)	0.0 (3.6)	1.2 (2.4)

*AP = Awataha Plaza, SG = Scholar's Garden

A T-test was performed on all measures from participants who returned in Study 2 (Table 7-1), which found no statistically significant difference between follow-up data from Study 1 and baseline data for Study 2.

7.1.2 Attendance

Due to the 6-month gap between research studies, participant drop-outs occurred; some students graduated, others moved campus, some staff moved on. However, although only 45% of total Study 1 participants returned to access the sensory garden during Study 2, 87% of those chose to attend one or more sessions (Figure 7-1).

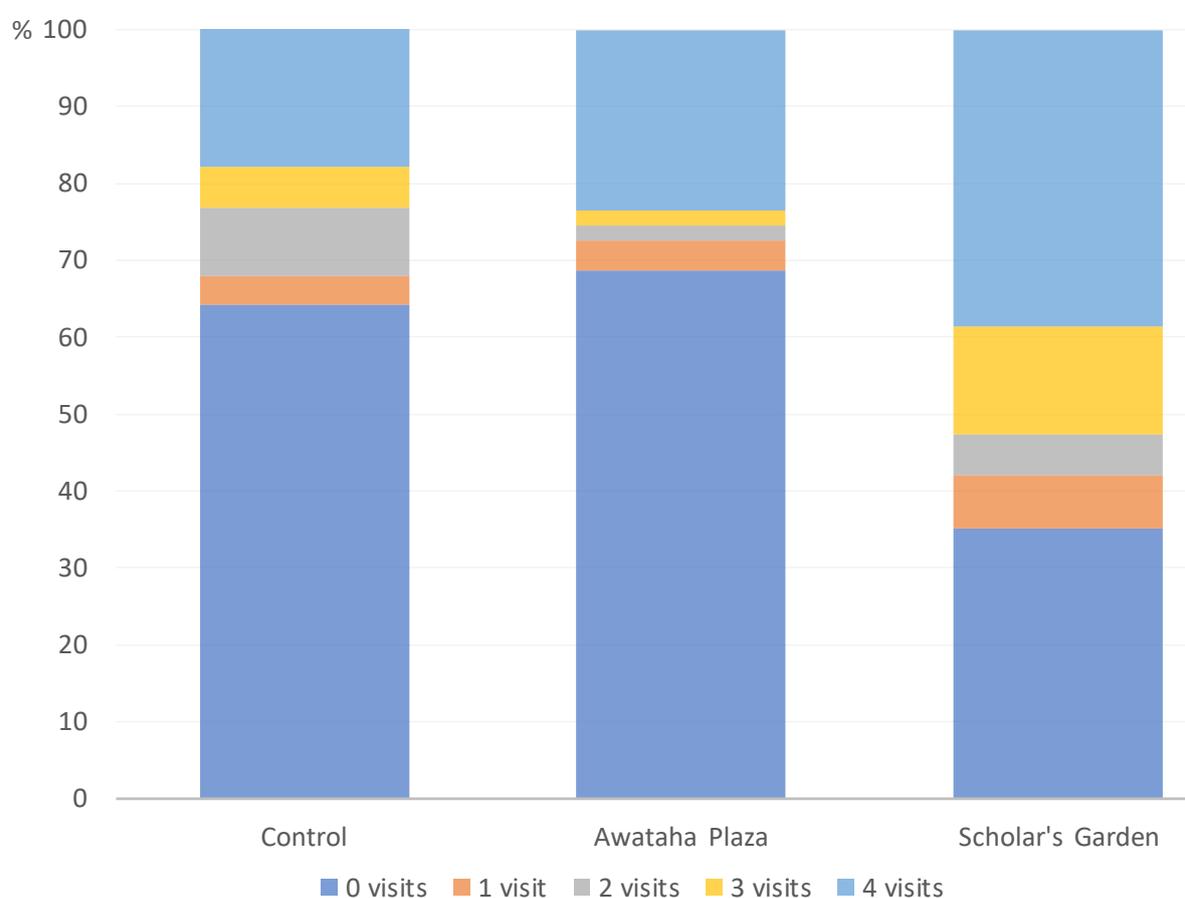


Figure 7-1 Percentage of participants from previous Study 1 groups who attended sessions during Study 2.

Using a generalised linear model with a multinomial logit link function, significant differences in visit frequency were observed between participants who were previously assigned to the control and garden groups ($P = 0.002$) but not between control and plaza groups ($P = 0.841$) (Figure 7.1).

7.1.3 Are the effects of exposure to a sensory garden related to the dose of nature received?

Attendance for all participants was higher in Study 2 than Study 1 (Table 7.2). The increased attendance was particularly pronounced for participants who had been in the plaza (AP).

Table 7.2 Comparison of attendance of participants who received one or more doses of nature during Study 2, by previous group

Previous group	AP	SG	Control	Total
Study 2	84% ^a	90% ^b	83% ^c	87% [^]
Study 1	76%	88%	0%	82%
n = Study 2 : Study 1	^a 16 : 39	^b 38 : 50	^c 20 : 0	[^] 74:85

Examination of the outcome measures showed the following:

Cortisol

Analysis of changes in salivary stress cortisol in relation to dose of nature received, recorded as number of sessions attended in Study 2, showed no statistically significant differences over time (Figure 7.2). While temporal trends of cortisol reduction were observed (as in Study 1), the wide confidence intervals at each time point precluded statistical significance.

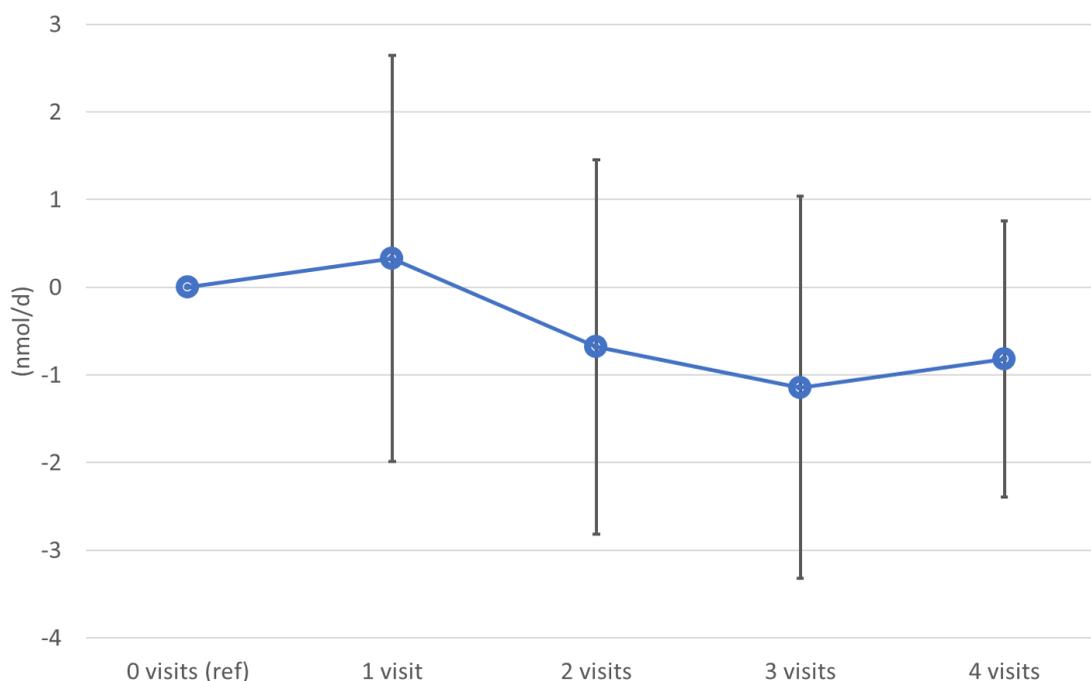


Figure 7-2 Graph of Study 2 Dose effect on salivary cortisol levels by visit to the SG

Flourishing Scale

Analysis of degree of flourishing, as a measure of perceived well-being, showed no statistically significant differences in relation to dose of nature received in the SG (Figure 7.3). Random fluctuations were observed, but notwithstanding, a trend towards maximum degree of flourishing after four visits to the garden was seen.

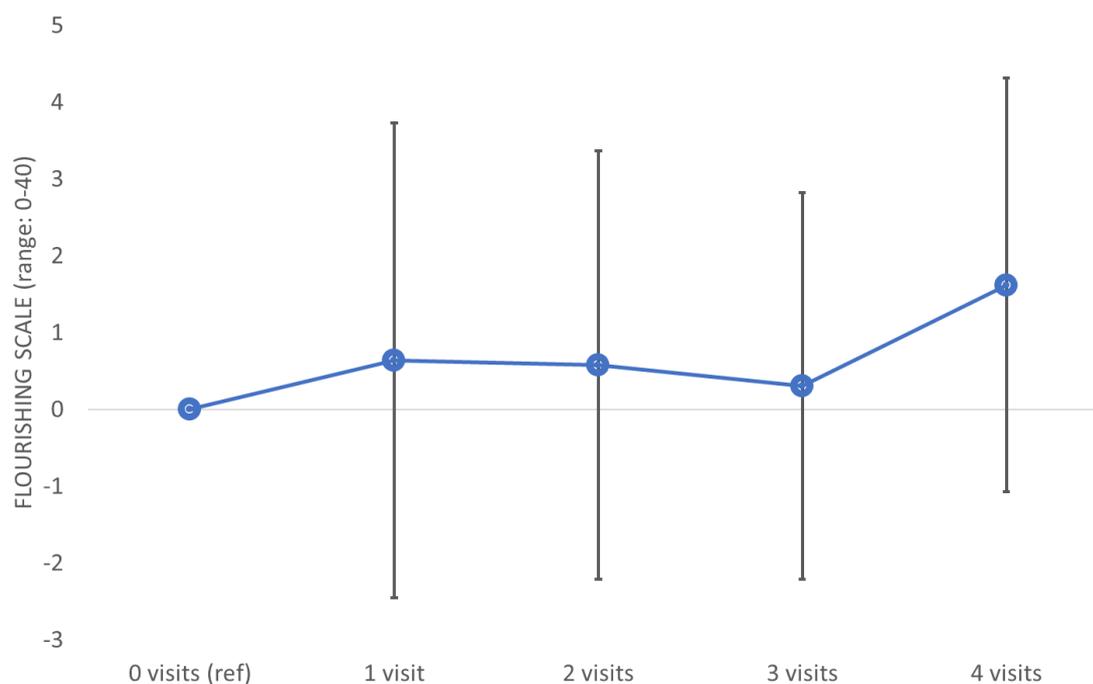


Figure 7-3 Graph of dose effect of SG on perceived well-being (Flourishing Scale)

Nature Relatedness

Random fluctuations in Nature Relatedness in relation to dose of nature received showed no clear trends or significance (Figure 7.4).

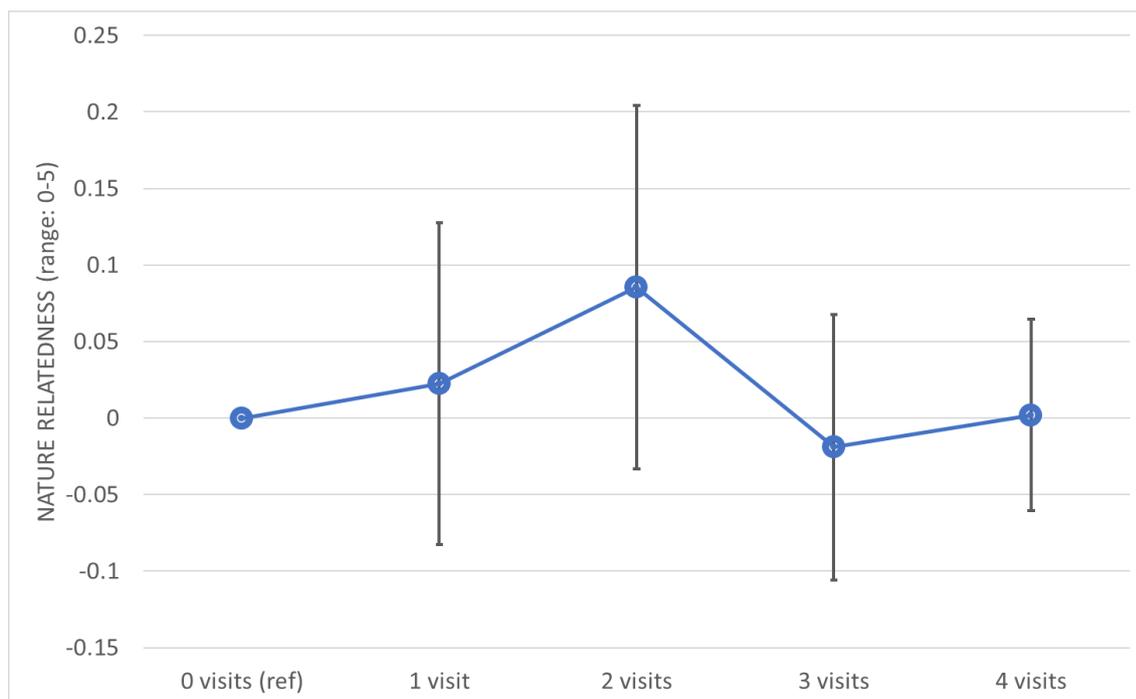


Figure 7-4 Graph of dose effect of time in SG on Nature Relatedness

Productivity

Perceived Work Output data, as a measure of productivity, showed no trends or statistically significant effect after time in the SG (Figure 7.5).

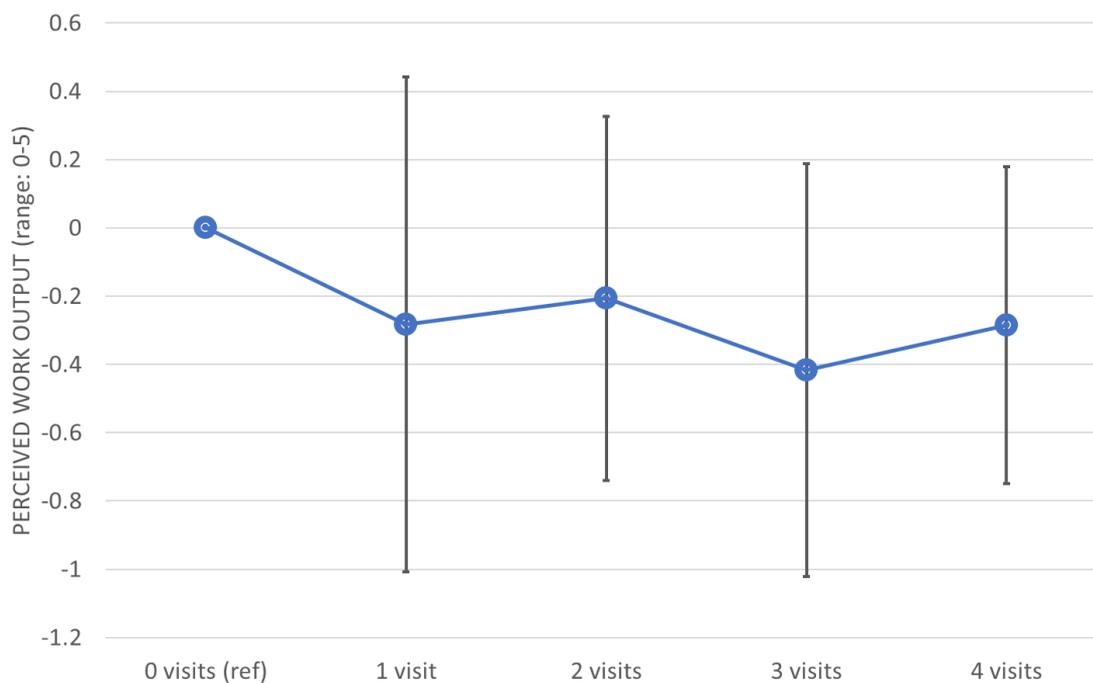


Figure 7-5 Graph of dose effect of time in SG on Perceived Work Output as measure of Productivity

Perceived Stress: Scale of Positive and Negative Effect

There was no statistically significant effect seen. However, a clear trend towards a positive effect or improved outlook was observed in relation to number of visits to the Scholars' Garden (Figure 7.6). This enhanced positive outlook suggests a reduction in perceived stress.

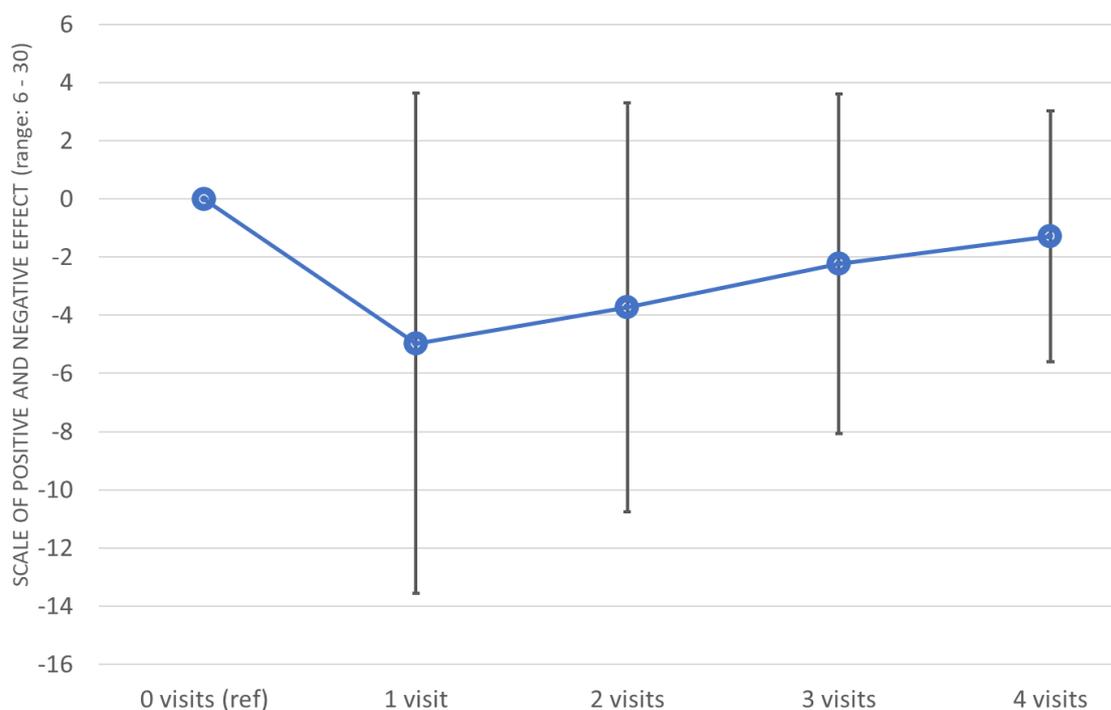


Figure 7-6 Graph of dose effect of time in SG on perceived stress as measured through Scale of Positive and Negative Effect

7.2 THEMATIC ANALYSIS

As in Study 1, an inductive thematic analysis approach was used to analyse the focus group transcripts, RA direct observations, quotes and comments. This approach focused on identifying and describing implicit and explicit ideas within the data (Guest, MacQueen, & Namey, 2012). Educated people outside of a clinical setting are not often studied. The richness of personal insights and observations, description of user's experience quoted, was particularly enlightening.

Four main themes were discerned around the attraction and hence viability of the SG as a self-help tool. They included upstream and downstream factors as determinants of health and well-being. The impact of Perceived Sensory Dimensions (PSD) remained consistent with Study 1, as shown in Chapter 6, so were not reported here.

Theme 1 (upstream): Nature connection, represented a growing awareness of and appreciation of the complexity of nature, expressed as biodiversity as a function of more general ecological health. Nature connection (NC) was found to be the upstream determinant that fuelled downstream well-being benefits (Figure 7.7).

Theme 2: Social connection, face-to-face interaction with people was evinced as a shared restorative experience.

Theme 3 (downstream): Well-being was observed as the downstream result of upstream nature and social connection. It encompassed a sense of safety, respite and restoration. This was subtly different from Study's 1's well-being emphasis on comfort, satisfaction and contentment.

Theme 4: Productivity flowed from a feeling of well-being. In Study 2, it was induced from work output being influenced by mental clarity, memory and creativity. This was perceptively different from Study 1's focus on motivation and inspiration.

The pictorial of the waterfall in Figure 7.7 shows nature connection as the upstream factor that influences downstream themes and sub-themes. In Study 2, two meaningful new sub-themes were induced:

1. 'management practices' that dictated whether participants were given permission by a manager, or gave themselves permission to take a break, influenced access to the restorative landscape
2. 'healthy, active lifestyles' flowed from a sense of well-being. From the data, a sense of coherence, an ability to understand and relate to the environment, was suggested as of importance to a healthy, active lifestyle.

The third sub-theme, a 'sense of control' was evinced as control over self and the environment. This was a re-interpretation of the sub-theme a 'sense of ownership' from Study 1 (Figure 7.7).

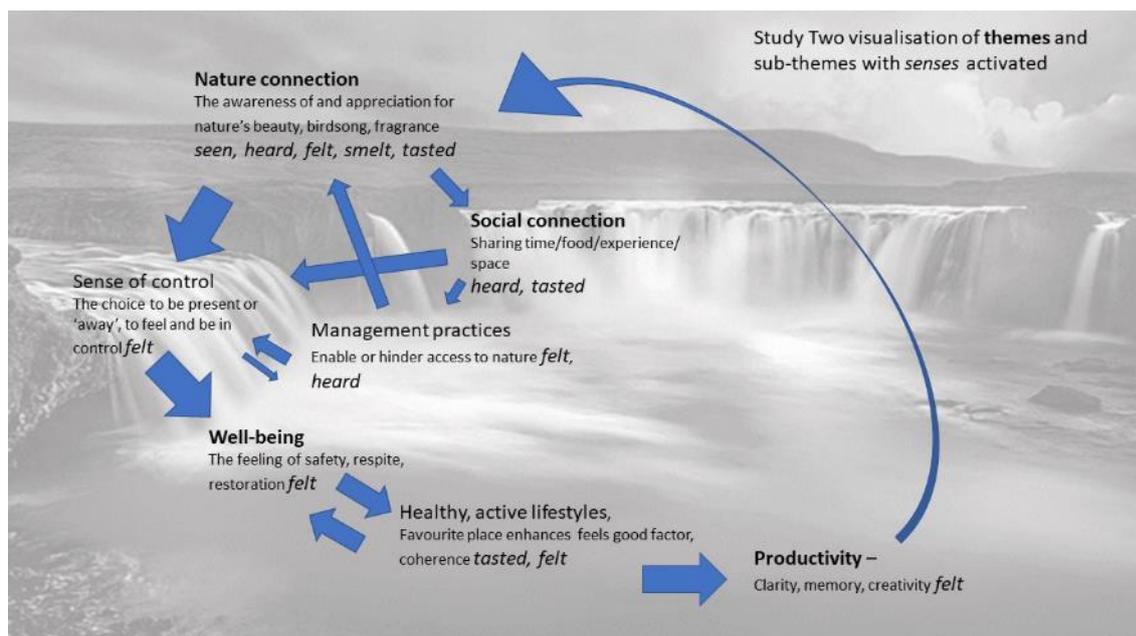


Figure 7-7 A visualisation of Study 2 themes as influences on well-being showing the induced cascade of themes, sub-themes and senses activated, framing common ideas with similar meaning

Using the analogy of a waterfall, the well-being effect starts upstream with nature connection. It then cascades down through sense of control and social connection, gains momentum and turbulence as it negotiates and is negotiated by internal (feelings of safety, listening to one's inner voice) and external (management, relationships with friends and colleagues) influences. As it breaks through the turmoil it flows downstream through well-being, healthy active lifestyles and productivity. Individuals enriched with this life force seek out further nature connection to recharge the cycle.

Downstream effects were observed in terms of well-being, lifestyle and productivity. As a sense of well-being improved, behaviour change towards a healthier active lifestyle was reported by participants. This in turn was related to a perception of increased productivity. Participants then sought out increased time outdoors in nature. A sense of control is known as key to managing stress (Medina, 2008). Being able to manipulate the environment, by moving seating, adding blankets for extra comfort, deciding whether to interact socially or not, provided the sense of control participants described as invigorating and potentially strengthening. Once the nature connection was sufficiently formed and stress levels had reduced, the initial individual journey described in Study 1 as 'my time' allowed more social connection.

Necessary additional ingredients were seen in subthemes of management practices “will my manager let me take a break?”, “can I afford to take time away from this assignment?”, “is this kale organic?” That the greenspace was managed organically, with healthy soils, biodiverse planting (Figure 7. 8) and wildlife, with spaces to retreat and spaces to connect, was considered beneficial by study participants. If a staff member’s manager or colleagues supported the individual to use the SG, it was likewise considered enabling and further enhanced well-being. If the individual took the personal decision to take a break from their indoor activities to spend time outdoors in the SG, that seemed to signal that a ‘therapeutic process’ was in progress and they were open to receive the nature experience. Management practices of green space, of the individual and by the individual were hence found to influence well-being.



Figure 7-8 Wildflowers in Zone 3 of the SG.

Themes categorised as nature connection, social connection, well-being, and productivity, along with management practices, sense of control and healthy active lifestyles, as described above, conveyed a sense of the potential and limitations of the SG as a self-help tool.

The 98.4% positive response to the intervention suggests that the Scholar’s Garden may be an effective self-care tool.

Themes and sub themes were reported against the five main senses stimulated (Table 7.3). ‘Nature connection’ was the only theme category to activate all five senses. The next strongest activator was ‘social connection’.

Table 7.3 Senses activated by exposure to SG during Study 2 with themes and sub-themes

Sense	Theme	Sub-theme	Comment
Sight	nature connection		Sight was again the dominant sense
Hearing/soundscape	nature connection social connection		Hearing was activated by nature connection and social connection.
Feel/touch/mood	nature connection social connection well-being productivity	Healthy active lifestyles Sense of control	The sense of touch prompted feelings activated by nature connection, social connection, well-being, productivity, sense of control and healthy active lifestyle.
Taste/experience	nature connection social connection	Healthy active lifestyles	The experience of nature was expressed as a delight, prompting feelings of happiness
Smell	nature connection		The fragrance of the flowers, soil, mown grass enhanced nature connection

Where appropriate, reference to previous group assignment was used in the thematic analysis. The main themes in Study 2 were the same as in Study 1, although evidenced in a slightly different order. Subtle differences in sub-themes became apparent during analysis.

7.2.1 Nature connection: The awareness of and an appreciation for nature

Within the data, an awareness of and an appreciation for nature was identified after time in the nature-rich sensory garden. This ‘nature connection’ was expressed in a similar way in Study 1. Participants commented to RAs: *“We have been looking for an apartment, but [after time in the SG] I have realised that I need nature around me. Time in the garden has reminded me of the important things in life”, “This [nature-rich garden] is a healing place.” “The trees, the birds, the water, [and in such a small space] is magical.”* While others said, *“This is beautiful, unlike anywhere else on campus”* and *“I love the flowers!”, “I’m trying to find the best place [in the sensory garden] but that’s difficult.”*

One participant commented: *“The plaza was so boring I sat and faced the building [windows] for my session ‘coz I didn’t want to look at all that concrete. The contrast [the garden] is just beautiful.”* Another said *“We searched for life in the plaza and found one spider in the whole four weeks. In the garden there is so much to see; it makes you feel alive.”*



Figure 7-9 Sand castle decorated with materials from the SG by a participant

RAs observed participants sit under or stare in awe at the ‘majesty’ of the big, old oak tree. Participants variously commented on their fascination with fungi, fish, butterflies, song birds, parrots and wading birds visiting the garden. One participant was quietly in awe of the garden and commented to the Candidate *“Listen, the waterfall is trickling away and nothing else,*

nothing mechanical, gets in. In here you can only hear the birds, occasionally the wind in the leaves and the quiet voices of people chatting at the tables or building sandcastles."

Focus groups were asked if they had a favourite place in the garden.

Respondent A said: *"I like that each area [in looks and feel] is different, which brings back different memories. My favourite is the meadow, but I liked them all, all are engaging".*

Respondent B said: *"I like to mix it up. I might spend time beside the raised beds for my lunch, but then walk around the orchard, or explore to see what is flowering this week."*

Hearing nature (rain, birdsong, wind through the leaves) and other people playing or quietly chatting was described as *"comforting"* and part of the *"pleasant medicine"*.

The value of the nature connection afforded by the garden was commented on by participants. One said: *"The forest [woodland garden, Zone Two] restores me."* Another said: *"I spend a lot of time outdoors competing in many sports. This has been tough for me, to just stop. But I'm noticing so much more. I'm getting more work done and I'm taking time to relax. This garden feels so right."*



Figure 7-10 Stink horn fungi in the SG fascinated participants with their beauty and ephemeral presence.

“Nature connection offered the varied scents of wildflowers, fungi, bark mulch, mown grass. While most smells in the SG were pleasant, *Aseroe rubra*, the anemone stinkhorn, is a common fungus known for its smell of carrion. Some participants found its smell unpleasant and avoided the woodland where it appeared, but others were fascinated that a fungus could be so clever as to attract flies to spread its spores. The simple fascination with the malodour proved an attraction for younger and older participants, particularly those who had not spent much time in gardens previously. This finding supports ART as requiring soft fascination as part of the restorative effect.

7.2.2 Sense of control: The choice to be 'present' or 'away'

Feeling in control was important to participants. The sub-theme was induced as linked with nature connection and social connection. Management practices either reduced or enhanced that sensation of choice, where physically to be and whether to be temporally present or 'away'. One participant commented, *"I loved that I could choose where to put the bean bag. One week it was beside the daphne walk in the woodland, another time it was on the beach."* Others said, *"Some days I just wanted to hide from students, so I took one of the white chairs to behind the big tree. From there, you're not overlooked. No-one can see you"*, *"How often do you get to just sit?"* and *"One day I'd had a tough lecture, really confronting. I chose to go outside and spend my time in the garden, right then. It worked! I felt better in moments"*.



Figure 7-11 Dense planting allowed participants to feel 'away' and provided a sense of refuge

Another participant commented that *"The garden focusses attention in, so you are not aware of the world outside. It's a curious thing that people can be walking past, just outside the [brushwood screen] fence, but in the sensory garden you're away in another world and don't hear or see them."*

In the focus groups, Respondent D, former AP, said *“I loved the blankets and the foam cushions. We had them in the Plaza but in the garden they felt special. Even though it was summer it felt like “hygge”, cosy. The plaza isn’t sheltered in any way. There was no shade, no shelter from rain. It’s good to get people outside, even in the rain. In the garden you can get away from everyone, find your own space. A roofed shelter [in the garden] would be good though.”*

In the survey, one participant commented: *“being in this study has really brought to my attention my awareness of my relationship with the outdoors - this awareness has encouraged me to actually spend more time outdoors. Thank you for the opportunity! Filling out the diary really stimulated my thinking about how little time I spent outdoors (especially in winter) and I have WANTED to be outside more - I CAN feel the benefit and difference!”*

7.2.3 Social connection: The sharing of food, time and experience with another person

Social skills are an important part of being human. In Study 2, the data showed that how one negotiates the opportunity and ability to connect with others of the same species influenced feelings of well-being. The theme categorised as ‘social connection’ happened within and beyond the Scholars’ Garden. Several participants commented in relation to navigating relationships: *“My relationship had been a major stress for me. Now [after time in the SG] I have a sense of clarity and know what decisions to make.” “My emotions have been all over the place over the past 18 months but since spending time in nature [in the SG] it calms me down & makes me feel stronger.”* Another said *“I had relationship issues, so anxiety has been higher than usual. But after time in the garden I am generally pretty positive and content.”*



Figure 7-12 Sharing a moment in the late afternoon sunshine

One participant who had previously been in the SG group, with access restricted to just eight participants at one time, said *“I was worried that with everyone in here now it would be too busy, too noisy, but because there is somewhere to go, to be away, you can find a quiet spot and the sound of talking does not intrude”*.

Social connection was observed by the RAs as small groups of two - three people chatting quietly, with some participants still taking time to be alone. Participants who were feeling social variously enjoyed sharing the experience with freshly harvested food from the garden, building sandcastles in the ‘beach’, conversing, or sharing listening to birdsong *“do you hear the tuis singing?”*

The sensory garden touched participants in different ways, depending on previous experience. One focus group Respondent C, former Control, said: *“If I came in and saw someone I knew, I would just wave as I felt they would want to be alone, like me”*. Respondent G, former SG, commented: *“it was lovely to be able to go with a friend this time. We were in different groups [in Study 1]. We were so happy to be in the garden”*.

One participant commented: *“the secret garden is where I go when I am feeling stressed, when I can’t take another moment in the office!”*

Management practices: Permission from oneself and permission from others enables or hinders access to nature

Giving oneself permission and being allowed by others induced use patterns of the Scholars’ Garden. How the space itself was managed also influenced participants’ response to the experience. Categorised as ‘management practices’, this sub-theme flowed into sense of control, as was in turn shaped by the individual’s ability to control their situation and their environment.

In the focus groups the principles of co-design were used to engage participant (stakeholder’s) perceptions and practical realities. To potentially improve design outcomes, focus group participants were asked if there was anything about the garden they would change. Just 20% wanted to add or subtract from the design. It was generally agreed that *“Once the Scholar’s Garden returns to wider use by the University community, don’t make it a thorough fare. Just have one gate open from the orchard (unlocked) as appropriate. Encourage people to enter and enjoy but discourage its use as a short-cut which would undermine its benefit as an accessible haven.”*

Two people observed that they had never used the sand, preferred the real beach so suggested it could be replaced with grass. Of those who enjoyed the sand, many had had limited experience of a real beach and valued the opportunity to ‘escape’ the day-to-day university routine, play with the buckets and spades or simply sit in the sand. Of those who wanted change, all wanted the garden to remain enclosed, to provide the sense of being away, but did not know how best to enclose it, whether with hedging or a fence. One person commented in the survey and again in the focus group that when they first went into the garden: *“It [the enclosed sensory garden] felt like a zoo. A nice zoo, but a bit weird.”* However, on reflection they agreed with the group that the enclosing brushwood screening added to the experience and made the feeling of being ‘away’ more powerful.



Figure 7-13 The brushwood screen fence provided a sense of enclosure

Some members of the focus group, formerly Control and AP, wanted interpretive signs added throughout the garden to explain what was where and why it was designed in that way. With the extended opening hours of Study 2 and scattered participants during their session, it was acknowledged that some respondents had missed explanations from RAs.

Participants commented to the RA that management practices could help or hinder their access to the garden. Some spoke of being teased by colleagues, some of being asked questions as to where they were going, others commented that it was *“hard to get there without the appointment system”*. One reflected that *“perhaps eating lunch at your desk isn’t the badge of honour it is made out to be. We are so much better for having taken a break and been in the garden”*.

Being allowed and being able to find and make places to be away from others was considered valuable. Participants observed to RAs that the garden experience was *“powerful medicine”*, *“healing”*, *“like a holiday in the middle of the day”*. Giving themselves permission to be outside felt good. Being allowed to pick and eat herbs and vegetables, move the furniture, and climb a tree meant that garden visitors felt in control of their environment, and hence felt more in control of their life.

The logistical challenges related to accessing the garden were expressed in feelings of frustration and gratitude. One participant commented *“you have no idea how hard it was to get here”*. Without the appointment system, some experienced difficulties with managers and co-workers questioning why they were going outside and taking a break during the working day. One commented in the survey: *“Management need to take some chill pills.”* However,

although participants may have found it harder to get their dose of nature, the data shows they appreciated the positive effect of the sensory garden's design.

Others said: *"With the garden on campus I now feel valued, as if the bosses care about me and my welfare."* *"This garden is the best thing that has happened on campus in all my years at AUT."* *"We need sensory gardens on the city campus and South as well."*

7.2.4 Well-being: The feeling of safety, respite and restoration

A feeling of safety was an important part of the experience of the garden. The feeling of respite, of being away from the stressors of the university while in a safe environment, helped participants relax. One commented: *"I slept! In public! In the middle of the campus! Imagine! I just felt so safe there [in the garden] enclosed within the fence, in the secret garden."*

Similarly, having time that was unstructured, and hence self-directed (being able to determine activity levels from passive engagement with the space from the comfort of a beanbag to actively gardening), was perceived as important for the restorative effect. An older participant commented: *"On a Saturday, when no one was around, I hitched my skirt and got the sun on my knee. When it was nice and warm, I tried the mindfulness walkway. Not being judged, and not being part of a performance-based therapy 'programme', [the garden] is so powerful."*

Another said *"Cool! I didn't know you were allowed, to climb, to pick and eat. Knowing that it's safe, that you won't get into trouble for touching, is so rare in the city. It makes the [sensory] garden extra special."*

The restorative effect was induced through heart-felt gratitude expressed by participants. One said: *"this process has been amazing, the little time to relax and take in nature has been amazing on my stress relief. Thank you for this experience."*



Figure 7-14 Engaging with the space in any way participants chose was permitted, including tree climbing.

Self-care and self-compassion were evident in comments relating to happiness at being outdoors: *“The sensory garden is a peaceful place to relax and become mindful, away from work distractions.”* Feeling so safe as to fall asleep was commonly observed by the RAs. Comments made by participants observed feelings of being restored: *“The garden is beautiful and always relaxing. Thank you!”* Another said: *“My experience in the garden was really calming, it felt relieving, as if it wasn’t in university. I was quite motivated after my sessions to do my work. Also felt more energised.”* While another said *“[I] Thoroughly enjoyed my time in the garden, a really private inner sanctuary. Thanks.”*

In the survey, participants commented: *“When I was planning my session in the garden, I chose my food [to have for my lunch] more carefully.” “After time in the garden I ate more mindfully.” “I feel balanced.” “This was a profound experience for me. Thank you.”* Another said: *“I have really enjoyed having access to the garden during work hours. Finding it grounding, and a speedy way to get back on track if pressure is building.”*



Figure 7-15 Keyhole gardens for composting provided enriched soil for fruit such as strawberries and rhubarb to harvest

7.2.5 Healthy active lifestyles: Having a special place outdoors in nature enhances the feel-good factor

Being able to comprehend, manage and make meaningful the environment in the SG were the three components of coherence induced by the data as affecting healthy active lifestyles. The first thing one participant observed when entering the SG was *“Everything is in here, everything you need”*. Others said: *“It’s bigger than I thought, there is so much here [in the sensory garden].”* and *“I love the paths that lead you on a journey. I walk to explore because I want to know what’s there.”*

The quiet acoustic of the woodland garden in Zone 2 was appreciated. In the focus group, Respondent A said: *“I love how soft the bark [of the woodland paths] feels underfoot. You just want to walk on it. It is so quiet in the summertime. Last year, in winter, crunching through the fallen leaves [on the woodland path] reminded me of the fun we had as kids.”*

“I am amazed at how powerful this place is, at how quickly I decompressed. It was an effort to get here, but so worthwhile.”

In the comments section of the survey, one participant commented *“after time in the garden I felt like I didn’t need wine every evening”*. Another wrote *“I hadn’t really thought about it, but I’ve just noticed that I took myself off long-term antidepressants. I was thinking about it earlier in the year, but after time in the garden I just felt better, happier, restored somehow.”*

The experience of eating, touching and tasting the food prompted feelings of delight and happiness. Herbs, salad greens, edible flowers and fruit were available to pick and eat during the intervention period. One participant commented: *“I shared the first fig, with Isobel²!”* [big grin], *“yum!”* Another said: *“Weirdly, I am happy to eat healthy food now [after trying fresh food in the garden]. I didn’t know what the plants were at first!”* In the focus groups Participant M, a staff member, said: *“I made a new friend while playing in the sand. Having something to ‘do’ brings people together. I’d like to have more ‘games’ to play – quoits would be fun.”*

² Not her real name

The experience of the garden also prompted observations of childhood memories. *“I very much enjoyed the garden. It helped me relax and reduce my stress level. It reminded me of my childhood where I spent my time outdoors and realising being outdoors as a child made me a happy child.”*

Depending on whether a design element was familiar or not influenced how it was perceived. In the focus groups Respondent F said: *“the [wildflowers on the] mound are messy.”* When asked the sort of garden ‘F’ had had as a child they said *“we did not have a garden at home. There was a park down the road.”* Parks in Auckland are not known for their flowers, and indeed with high site coverage permitted around commercial and housing developments, predominantly non-flowering native municipal planting, and a contemporary design preference that equates ‘low maintenance’ with ‘low biodiversity’, means the local urban experience offers few flowers. Respondent G said: *“At first I didn’t like the messiness of the long grass in the orchard, but then Gayle explained it’s for the insects and the trees. She also told us we can lie in it. That was so much fun. We played hide and seek, lying in the long grass!”*

One participant on entry to the SG for the first time, expressed surprise and a degree of unease at the unfamiliar experience of being in a nature-rich space. They said, *“it is more wild than I expected. It’s not like other places. But I like it.”* Another participant with little previous exposure to nature, in an urban or remote setting, felt inspired to try new experiences in the sensory garden. They told the RA *“next time I’m going to lie in the long grass - that would be amazing.”* Another participant was observed sniffing the flowers and picking a bunch to take home. When asked by the RA if they had a garden at home, the participant said *“No, this is magic.”*

The experience of the garden also influenced behaviour. One participant commented in the survey: *“I found the awareness brought about by being in the garden has encouraged me to be more adventurous. I have walked (twice) to AUT instead of catching the bus and notice the flowers/blossoms on the trees, the birds that have returned and the bees. Very encouraging!”*

“I’ve noticed that I’ve drunk a lot less alcohol in the last few weeks. I wonder if I haven’t felt the need to relax at the end of the day?”

7.2.6 Productivity: The clarity, memory and creativity to get work done

The data showed a theme of mental clarity, functioning memory and creative problem-solving induced as affecting perceived workout or 'productivity'. Overall the experience was perceived as beneficial to clarity, memory and creativity. Participants commented that after time in the SG they could: concentrate better, remember what they had read, make sense of things better and write more succinctly. They felt they gained mental clarity and more creativity during and after time in the garden. On the last day of the intervention, one participant commented: *"On this last day I really noticed that I really miss the idea of being in the garden and how much I've looked forward to it each week - reading, sitting or chatting. I also feel like the reading I've done in the garden was really productive, it sunk in well and I can remember it better. I think I was really relaxed and focussed, so more receptive to thinking and reading."* In the follow-up survey comments, one participant said *"I miss the garden already. When will it be open to the public? I need it."* In the focus group Respondent H commented *"the 4 weeks is over...I feel so sad."*

Other participants said, *"I had had a horrid morning, I couldn't face another moment in my office. Now I'm ready to go back, I feel so relaxed, so much better."* And *"I have always been an indoors sort of kid, I still am, but in the garden, I find myself climbing the tree, sculpting a sand pyramid. I like the balance now and feel more focussed indoors."*



Figure 7-16 Creating sand castles and other sculptures fed the creative spirit

7.2.7 Zone preference

In salutogenesis a sense of coherence is important to gain a sense of wellbeing from a place. This was confirmed through focus group comments whereby if participants did not have childhood memory to enable the environment in the sensory garden to be ‘read’ they stayed with the familiar. This was also seen in zone use preference. Respondents who had childhood memory of nature connections expressed most joy from the experience of being in the sensory garden, which reinforced health promotion through enhanced well-being and behaviour change.

Overall use of the sensory garden increased from 465 visits in Study 1 to 588 visits in Study 2, when the garden was opened to participants from all three groups. With the enclosed garden providing an overall sense of refuge, the species-rich active growing space in Zone Three was again the most used, followed by the quiet, contemplative serenity of Zone One. Zone One’s playful urban beach, soothing waterfall and enclosed shade provided a sensory balance to the hot summer sun.

With the change of season and hence altered light and shade within the garden overall, there was an altered perception, particularly of the meadow (Zone Four) and woodland (Zone Two). Where Zone Two had enjoyed dappled light through the bare deciduous canopy in winter, in the full leaf of summer the zone became relatively dark. Despite the attraction of the quiet acoustic of the woodland garden its popularity in Study 1 was replaced in Study 2 by the sunny, open, orchard-in-a-meadow, Zone Four. The reversal in zone use preferences for these two areas was seen in zone preference data. Interestingly, the cooler dense shade of the woodland attracted fewer visits even on a hot summer's day.

The season also affected the display of flowering, fruiting and fragrant plants. The differences were most noticeable in Zones Two and Three. The abundant, species rich, Zone Three enjoyed a reduced range of fragrance and flowers in mid-late summer but retained its overall attraction.

Table 7.4 shows participants' zone preferences in the sensory garden. Preferences were noted by RAs using a tally chart, with each instance of use of a zone marked as one entry. In this way multiple visits by one participant, or a variety of participants, to an area are shown in the count for that zone. Once again, Zone Three was preferred.

Table 7.4 SG zone preferences by tally total

Zone		Tally total
1†	Beach, pond, waterfall	165
2	Shaded, sensory-rich woodland	73
3‡	Raised beds, wildflowers	270
4	Orchard in a meadow	80

† second most popular ‡ most popular



Figure 7-17 Relaxing, playing cards, in Zone Three, beside edible plants at head height in raised beds

7.2.8 Negative perceptions

Of the approximately 300 pieces of qualitative data reviewed across both studies, including diary entries, comments, quotes, observations, interviews and focus groups, five responses included a negative perception of the sensory garden (1.6%):

- One participant felt that the garden looked 'messy',
- One said on entering the garden the enclosed space felt like being in a zoo,
- One participant thought the long grass in the meadow looked 'untidy',
- Two participants preferred a real beach to the sand, so thought it a 'waste of time'.

The implications of the study's findings are explored in Chapter 8.

Chapter 8 GENERAL DISCUSSION

This thesis measured the experience effect of a sensory garden across a broad range of measures. Through triangulating, ecological health and design preferences with quantitative and qualitative measures of health and well-being, and exploring socioecological and biopsychosocial models to understand human connection to nature, discussion of the data induced a new model of well-being.

8.1 THE RESULTS QUANTIFIED

In addressing the research question “what are the effects of the sensory garden on ‘apparently well’ people and could it be a viable self-help tool for staff and students on campus?” salivary cortisol, (as an objective measure of stress), perceived well-being, work output, nature relatedness, perceived stress and visits to greenspace were measured. In this research, a positive effect of the sensory garden was seen in physiological and psycho-social data in a New Zealand tertiary education population sample of a broad mix of ages, ethnicities, staff and students. ‘Positive’ in this sense refers to the combination of measured reductions in salivary cortisol and gains in levels of well-being and productivity. Attendance levels suggest that the Scholars’ Garden offered a sustainable self-care tool for ‘apparently well’ staff and students on campus.

8.1.1 Cortisol

It is established that time in greenspace (Bowler et al., 2010; Corazon et al., 2018; Hunter et al., 2019; Roe et al., 2013; Stigsdotter et al., 2018; Ulrich et al., 1991; Van den Berg & Custers, 2011), physical activity (Akpınar, 2016; Thompson Coon et al., 2011; World Health Organization, 2018), good sleep (Akerstedt, 2006) and diet (Kleinert & Horton, 2016; Ng & Jeffery, 2003) reduce stress. In the literature, words like ‘greenspace’, and ‘nature’, are seldom defined in any detail (L. Taylor & Hochuli, 2017). That is why Study 1 sought to establish if there was any difference in effect on cortisol from usual time outdoors (Control), or a prescribed dose of nature in a ubiquitous urban setting such as the plaza (AP), or the same prescribed time, but in a biodiverse sensory-rich setting (SG).

In this study participants came from across the Faculty of Health and Environmental Sciences and could be considered predisposed to an awareness of healthy lifestyles as stress management. It was interesting therefore in Study 1 to see the Control group's stress levels remain constant over time, whereas participants in the AP showed cortisol levels drop 7%, against the statistically significant 16% reduction for the SG group. Clinical and social significance, being the 'practical importance' of the treatment effect, were also suggested by the supporting qualitative data. The intervention was observed to have a 'real, palpable, noticeable effect on daily life', which Pintea asserts is necessary for clinical significance (Pintea, 2010). Behaviour change outside of the study was self-reported by participants in the SG as stress levels decreased.

The effects seen in this study are consistent with other studies of greenspace (Twohig-Bennett & Jones, 2018); however, the magnitude of outcome in the present study were considerably higher. A meta-analysis of 143 studies showed increased greenspace exposure was associated with a mean change in salivary cortisol of -0.05 nmol/L (95% CI -0.07 , -0.04) (Twohig-Bennett & Jones, 2018). In their discussion they did not comment on the quality of the greenspace in terms of design or biodiversity. They state their results are "really important because in the UK, 11.7 million working days are lost annually due to stress, depression or anxiety" (Twohig-Bennett & Jones, 2018).

While research on the effect of greenspace is growing almost daily, research on the effect of plaza environments is scarce. Only three studies were found. One investigated public plaza design in relation to biotopes and perceived sensory dimensions in Canada, but did not measure effect (Lockwood, 2017). Another study examined a university plaza design in Turkey (Aydin & Ter, 2008), but while findings were critical of the value of the place, did not quantify effect. The third study examined the restorative potential of the plaza as a place for social connection for the well-being of older residents (Scopelliti & Giuliani, 2006). Scopelliti and Giuliani found a "positive association between the perception of restorative qualities and healthy psychological outcomes in both natural and built environments" (Scopelliti & Giuliani, 2006).

Effect differences between this study's plaza and sensory garden were most likely due to the design of each space, which was apparent in both an ability to control the environment and

biodiversity. The effect of this difference was seen in an inverse relationship whereby as the dose of nature delivered through species richness increased, stress cortisol levels further reduced.

The difference in magnitude of the outcomes compared to other studies reported in this thesis has important implications for developing self-care-based health promotion interventions. Chronically elevated cortisol levels are linked with blood sugar imbalance and diabetes, excessive weight gain, immune system suppression, gastrointestinal problems, cardiovascular disease and fertility problems (Andrews R. C, Herlihy O, D., Andrew R, & B., 2002; Epel, Lapidus, McEwen, & Brownell, 2001; Epel, McEwen, Seeman, & al., 2000; Jones & Quinn, 2006; Sher, 2005; Weinstein, 2004). Given the social and economic cost of treating these problems, visiting a sensory garden that can reduce salivary stress cortisol levels by almost 20% could potentially offer considerable benefit to the institution as well as the individual. Although massage therapy offers cortisol reductions of 30%, treatment sessions are costly, and affect only the individual undergoing the massage (Field, Hernandez-Reif, Diego, Schanberg, & Kuhn, 2005).

In a randomised comparison study of yoga and traditional counselling using cognitive behavioural therapy (CBT), physiological and psychological stress reductions were seen with no significant difference observed between the effect of each intervention (Granath, Ingvarsson, von Thiele, & Lundberg, 2006). A comparison between CBT and a nature-based therapy programme (Corazon et al., 2018) found an equivalent reduction in stress as measured through visits to a general practitioner. However, given the present study showed a significant effect with short time commitment, zero user entry cost and no requirement for a trained healthcare professional on site, the sensory garden intervention offers a potentially equitable and sustainable solution for all.

Findings from this thesis offer promise to other universities interested in outcomes around reduced stress on campus. Although the data are relevant to the population examined only, developers, engineers, urban strategists, public health officials and workplace managers could use this information to prompt further study into diverse settings.

8.1.2 Flourishing

To flourish, according to Merriam-Webster's dictionary, is to grow luxuriantly, to thrive. Well-being encapsulates that sense of personal growth within a concept of happiness and comfort, of feeling safe and content. The Flourishing Scale (see Appendix 4 for full Scale) measured this. Given the broad evidence of flourishing with time spent outdoors (Capaldi et al., 2015; Hone, Jarden, & Schofield, 2014; Howell & Buro, 2015; Tong & Wang, 2017), the reduction in well-being seen in Study 1 after exposure to Awataha Plaza (AP) was one of the biggest surprises during the study. No other studies have been found that describe this. With the ubiquity of predominantly paved urban settings, whether in workplaces, schools, hospitals or residential care facilities, the fact that spending time in such a setting had a measurable negative impact on well-being is concerning. Previous studies of campus design have not measured well-being per se, but instead simply confirmed Ulrich's finding that viewing nature is restorative (Abu-Ghazze, 1999; Felsten, 2009). Thus, as a field study, as opposed to the more common indoor laboratory experimental study designs, this research has 'real world' impact.

While well-being, like other lifestyle-related health measures, is subjective, multi-factorial and responds to different stimuli, Study 1 suggested that exposure to the sensory garden had a protective effect. This was different to the well-being enhancement that accompanied cortisol reductions in the SG group. Generally, after experience of the SG, stress cortisol levels reduced, and well-being levels rose, unlike in AP where participants' cortisol dropped but perceived well-being also dropped. However, for some individuals, even after exposure to the sensory garden, on the day of testing, their cortisol levels were increased above baseline. Of note however was that for each of the individuals from the SG group who experienced increased stress cortisol, their perceived well-being *improved*, despite the increase in physiological stress. The data suggest it was possible to improve well-being through an unfacilitated experience of the SG; no 'programme' was required. Being in the garden for 30 minutes once a week, whether sitting, reading, gardening, chatting, walking, exploring, playing, sleeping or eating, had a significant effect. Given perceived well-being is established as a predictor of future health outcomes (Canadian Mental Health Association, 2016; Sears et al., 2013) and morbidity is negatively associated with access to greenspace (J Maas et al., 2009), the positive effects found in this thesis are also 'clinically' important. As Kazdin stated,

clinical significance occurs where an intervention makes a real difference to the quality of life of the participants or others whom they interact with or encounter (Kazdin, 1999).

In terms of limitations, in Study 2, while no statistically significant dose-response relationships were observed, there was a trend towards participants' well-being improving after time in the Scholars' Garden. With a bigger sample size statistical significance may have been detected. The reduced seasonal biodiversity on offer in late summer, with the diminished wildflower display, may have affected findings from this study. The lack of significant effects in Study 2 may also be linked with a reduced facilitation of experience. In Study 1, the restricted session times enabled RAs to interpret the SG as questions arose. With the extended opening hours of Study 2, and more freedom to come and go, participants did not always ask when they were unsure of a new experience. While improved flourishing trends were seen, it is possible that a low-level interpretation of the SG, such as with plant labelling and feature identification, would boost the effect. Planting to extend the season of interest may also enhance the effect.

8.1.3 Perceived work output

Productivity, or perceived work output, is affected by well-being (Johnson et al., 2017; Miller, 2016; Organization for Economic Cooperation and Development, 2015). The significant increase in work output observed after time in the SG suggests that a sustainable, adaptable, bio-diverse environmental-design based workplace well-being initiative could be an effective tool to boost productivity in staff and students. This is in line with Thatcher and Milner's finding that working in a 'green' building impacted productivity, psychological well-being and physical well-being (Thatcher & Milner, 2014). That biodiversity, through increased soil health, plant cover, species richness, water quality, and general 'feel' of the space was impactful across a range of measures is interesting.

While the association between nature connection, through exposure to greenspace, and a range of well-being indicators is known, there is a gap in the literature that shows the effect of time spent outdoors in a green workplace on productivity. The assumption that people stay at their desks during the working day has seen some improvements in office design. However, a Canadian study showed that even with Leadership in Energy and Environmental Design (LEED) certified buildings, thermal conditions, lighting, noise and workstation designs were

not always better in the green buildings, with impacts for well-being and hence productivity (Hedge, Miller, & Dorsey, 2014). This study's findings are therefore a useful prompt for a systematic review of campus design, to include both how buildings operate, the vital spaces in between and the effect on users. Although there is discussion in the literature around the impact of green buildings and biophilic design on stress reduction and improved well-being (Bell, Leyshon, Foley, & Kearns, 2018; Geoffrey et al., 2015; Maller et al., 2006; Ryan et al., 2014), little research has been done on the effect of an accessible nature-rich outdoor environment in either a university setting or other workplace as in the case of this research.

In Study 1, time in the Scholars' Garden positively impacted perceived work output, which should be of interest to educators and administrators. Similarly, the reduction in productivity observed after time in Awataha Plaza suggests campuses review their estates, indoors and out, to ensure optimal environmental design for academic achievement. Of note, passive exposure, via views of the garden, also positively affected work output.

8.1.4 Impact of dose of nature

A biodiverse natural environment is known to be a health-promoting resource (Cartwright, White, & Clitherow 2018; Cook et al., 2019; Sarkar, Webster, & Gallacher, 2018; Shanahan, Fuller, et al., 2015; Sugiyama, Carver, Koohsari, & Veitch, 2018; Wolch, Byrne, & Newell, 2014). Study 1 showed statistically significant changes in cortisol, well-being and productivity in participants exposed to the biodiverse SG, compared to the Control. However, attendance across the intervention groups varied, which may have influenced results. In Study 1, 87% of participants in the SG attended one or more sessions, compared to 76% in AP. In Study 2, participants who had been in the SG in Study 1 attended more than twice as often as participants from the other groups, although the lack of observed significant dose-response relationship was possibly due to the reduced sample size. In summary, while the SG was found to have a statistically significant effect on salivary cortisol when compared to people who did not visit, no clinical dose-response relationship was observed.

The positive impact of experience of the SG was consistent with other studies of the effect of sensory or therapeutic gardens. However, as noted in Chapter 3, previous studies have focussed on patient populations. In a study on dementia patients, Edwards found a 10% reduction in depression rates, and reduced demand for GP visits, after exposure to a sensory

garden (Edwards et al., 2013). The focus of the current thesis on ‘apparently well’ people noted considerably greater impact, with both statistically and clinically significant effects observed.

8.1.5 Perceived stress

Trends observed in this thesis support the literature that experience of nature can reduce perceived stress (Gillespie et al., 2001; Lottrup, Grahn, & Stigsdotter, 2013; Mangone et al., 2017). Stress-related disorders are widely recognised. The U.K. Department of Health estimated that 80 million working days were lost due to anxiety and depression, at a cost of £5.3 billion, with expenditure on the treatment of anxiety and depression estimated at over £1 billion (Noblet & LaMontagne, 2006). Chronic stress has been linked to health priority areas including cancer, coronary heart disease/stroke, type 2 diabetes accidents and mental health/suicide (A. H. Taylor, 2001).

Previous research observed that communities where levels of greenspace are generally lower have higher perceived stress levels (Grahn & Stigsdotter, 2010; Perry, 2016; Roe et al., 2013; Stigsdotter et al., 2010; Van den Berg, Maas, Verheij, & Groenewegen, 2010; Catharine Ward Thompson et al., 2012). A survey of 128 park users in Bradford, U.K. found that biodiversity predicts psychological restorative benefits from urban green space (Wood et al., 2018). Knowing the association between increased stress and urbanisation (Godfrey & Julien, 2005), it is possible that the reduced species richness in the predominantly paved plaza, as an ubiquitous urban form, was perceived as a stressor. Distracting man-made noise was commented on by participants in the Awataha Plaza (AP) in Study 1. Auditory stress is a known stressor in urban environments (Herranz-Pascual et al., 2019). In the SG, natural sounds of wind through trees, birdsong and splashing water may have altered perception of the nearby motorway.

Perception is important to well-being (Southon et al., 2018). Perceived Sensory Dimension (PSD) research, described in Chapter 5.2.4, found that the PSD ‘social’ is negatively associated with stress reduction (Grahn & Stigsdotter, 2010). This implies that environments perceived as or designed for socialising, while valuable for social connection once individuals are relaxed, do not help reduce stress. Of note, it was interesting to observe that as stress levels reduced over the course of Study 2, participants became more sociable and chose to create

more sociable seating arrangements. The fixed seating design of AP, with associated social constructs, may have influenced observed trends towards increased perceived stress after time in AP.

8.1.6 Nature relatedness

Nature relatedness (NR), or an affinity with nature, is important in promoting pro-conservation behaviours (Charles et al., 2018; Nisbet et al., 2009). NR may also influence healthy active lifestyles (Dean et al., 2018; Emma Lawton, Eric Brymer, P. Clough, & Andrew Denovan, 2017). Nisbet et al found that NR affected well-being (Nisbet et al., 2011). Nature relatedness and linked nature connectedness are also associated with happiness (Capaldi, Dopko, & Zelenski, 2014), pro-social behaviours and emotions such as caring and sharing (Zelenski, Dopko, & Capaldi, 2015). While no significant effect was observed in this study, attitudes changed towards more pro-conservation behaviours as seen in support for a Friends of the Garden group. The group was established by the researcher to enable interested staff and students to maintain the garden at the conclusion of the study. Almost 20% of study participants volunteered to this on-going connection with the garden, beyond simple visits. Of the group, only one was an active gardener prior to the study.

A previous study of a Turkish university campus (Aydin & Ter, 2008) found that a plaza's sensory impact affects users and determines its profiles/values. A Singaporean study found a significant positive relationship between nature relatedness and creative thought (Leong, Fischer, & McClure, 2014). The impact of the built environment on aspects of well-being can be significant (Chu, 2004). This has implications for line managers, health and safety managers, sustainability managers and administrators within the University. Externally, as Kent and Thompson suggested (Kent & Thompson, 2012), with biodiversity loss and impacts of climate change, urban planners, health commissioners and developers would be well advised to work together to sponsor further research into the effect of nature relatedness as it influences downstream health and well-being outcomes.

Pro environmental behaviours are associated with health promotion via nature connection through a downstream mechanism (as shown in Figure 7-1). As the data have shown, ecological health influences well-being. With nature relatedness, it is easier to engender

support for environmental enhancement programmes. Thus, as Gary Cohen suggested, by supporting community health, planetary health is improved (Cohen, 2016).

8.1.7 Visits to greenspace

Nisbet et al (2009) found that Nature Relatedness is related to greenspace visits and time in an ecologically rich setting. Observational studies such as Sarkar et al (2018) found a protective effect of greenness consistently observed on depressive disorders. White et al observed a positive association between good health and well-being with 120 minutes per week in green space (M. P. White et al., 2019). Stress is linked with physical activity (A. H. Taylor, 2001). Similarly, Ward Thompson et al found “physical activity, frequency of visits to green space in winter months, and views from the home were predictors of general health” (2016). In a study of workplace settings, Gilchrist et al found greenspace use contributed to employee well-being (Gilchrist et al., 2015). Given the literature, it was expected that individuals predisposed to spending time outdoors may have been more interested in attending sessions in the SG, or that they may have shown a greater effect in terms of cortisol reduction and well-being enhancement. However, this was not observed in the present study. In fact, all other significant effects were independent of visits to greenspace.

To improve public and mental health, physical activity is recommended (Canadian Mental Health Association, 2016). Physical activity in greenspace is known to have a greater effect on well-being than exercise indoors (Dinas, Koutedakis, & Flouris, 2011; E. Lawton, E. Brymer, P. Clough, & A. Denovan, 2017; Rogerson, Brown, Sandercock, Wooller, & Barton, 2016; Schipperijn, Bentsen, Troelsen, Toftager, & Stigsdotter, 2013). Agency and autonomy are strengthened by access to a non-proscriptive intervention. This was true of the SG where nothing was reproached, except the use of digital devices. As stress levels were reduced and well-being improved, it was expected that interest in visits to greenspace, as both a proxy for physical activity and in association with nature relatedness, would significantly increase. However, possibly due to small sample size, and the season of Study 1, no statistically significant effect was observed, although a trend was seen.

8.2 THE RESULTS QUALIFIED

The inductive method of thematic analysis allowed the researcher to approach the data with an open mind, to search for patterns of meaning. Rather than simply prove existing theory, it created the academic space to potentially create a new theory or model. Interestingly, the thematic analysis did confirm previous theories, but then went further to explore the urban design implications and ecological relationship to the restorative response as part of Research by Design. As a self-care tool, attendance data showed the vivid, full-of-life sensory garden was attractive to participants. The unfacilitated access, or lack of formal 'programme', removed perceived stigma and allowed the experience to be reframed from 'therapy' to 'self-care'. Previous research has largely concentrated on the stress reduction effect of horticulture therapy within therapeutic and healing gardens (Corazon et al., 2010; Detweiler et al., 2012; Dunnett, 2000; Sempik, Aldridge, & Becker, 2005; Tenngart Ivarsson, 2011), or health benefits from visiting parks and gardens (Carrus et al., 2015; Gilchrist et al., 2015; Schnell et al., 2019; Soga, Gaston, & Yamaura, 2016; World Health Organization Europe, 2016). Study 1 allowed a more detailed examination of the effect of perceptions of nature as influenced by the environment. The main themes crossed multiple senses. While the SG differed from AP in many different ways, findings generally support the hypothesis that biodiversity would predict a restorative effect of the SG and support recent research on biodiverse urban green space by Wood et al (2018).

Links between environment and appreciation of nature, increased productivity, reasons for happiness and relief from stressors were seen across the intervention groups. Improved mental clarity, memory, creativity and work volume were all cited by participants as benefits from being exposed to the SG. Participant response to the Scholars' Garden and Awataha Plaza reflected the effect of the sensory garden on health and well-being. The perception of the Scholar's Garden was positive. Of the approximately 300 pieces of qualitative data, including diary entries, comments, quotes, observations, interviews and focus groups reviewed, just five responses could be considered negative (1.6%). The 98.4% positive response to the intervention suggest that the sensory garden may be an effective self-care tool. Of the comment that the SG looked 'messy', there is a body of research around ecological values and messiness (Gobster, Nassauer, Daniel, & Fry, 2007). Landscape architect Joan Nassauer contends that if the natural 'messiness' of nature is bounded through design,

it becomes acceptable (Nassauer, 1995). This was confirmed when paths were mown crisply through the long grass of the 'meadow' in the orchard. Once people could discern the intentionality of the space, they were able to comprehend it.

The value of the multiple-stream qualitative data collection process was evidenced through the detailed descriptive data produced. The varied sources enabled exploration of participants' understanding, beliefs and interpretation of environment, whether plaza, sensory garden or everyday life. An unexpected level of emotion was noted in the participants' response, even after the relatively brief exposure to the intervention environments, with a maximum of two hours over four weeks. That emotion suggested a rapid response to the study and to the environment. In the SG a real sense of flourishing was expressed. In Awataha Plaza, a contrasting effect was seen. Also surprising were the behavioural changes observed.

Participants' childhood memory, previous experience, cultural, social and spiritual beliefs influenced their connection with the environment. Interestingly, although smell is known to be the sense most important in terms of memory (Bowring, 2007), sight was ranked the most important to relaxation. Participants from across the demographic used the word 'love' frequently as they described their reaction to the SG. In contrast, response to AP showed a predominantly negative reaction. Participants in the Control group also responded to their environment in new ways, which was considered a passive educational effect of the study. Qualitative findings from Study 1 and Study 2 were integrated with the quantitative data to establish that the sensory garden had a positive effect on participants overall.

Nature connection, the experience and awareness of being within the biodiverse SG environment which provided a sense of place, were found to be central for a sense of flourishing. The five main senses interpret the environment through psycho-social elements such as emotion, behaviour and understanding. In Study 1, the presence of tall trees, species richness, somewhere to hide away for 'me time' in 'my space' and the ability to manipulate and control the environment and hence the experience were reported to anchor a health-affirming dose of nature. In contrast, although Awataha Plaza has trees, and some mixed shrubs planted to the periphery, the difference in effect between the two intervention sites is thought to be related to sensory experience within the space. The plaza's smaller trees,

more open feeling, reduced biodiversity, predominance of paving, harsh acoustic, high visual glare and hard surface underfoot, coupled with lack of availability of a sense of refuge where one may retreat to recharge, created differences in the overall sensory experience.

In the AP, nature connection did not occur. This observation was validated by the Nature Relatedness scale in Study 1, which found that levels of nature relatedness actually reduced after time in the AP.

The intensity of emotional response to the SG was surprising. While a sensory garden could be expected to be a pleasant experience, to have participants swearing when they were allocated to the AP group, opting out of the study completely or opting out of the AP group, and crying with joy when in the sensory garden, suggests an unmet need within the 'apparently well' university staff and student body. That participants opted into the overall study may show an element of self-selection, whereby, whether consciously or unconsciously staff and students recognised that they would benefit from time in nature. However, that idea was not supported by participant comments such as: *"I hadn't realised how little time I spend outside"* or, *"it's not until you leave that you realise the impact of the garden."* More likely is the pervasive prevalence of nature deficit disorder, described by Richard Louv (Louv, 2012).

Social connection, the experience of face-to-face building and nurturing of relationships, was a theme across both studies. In Study 2, participants who had previously been in the SG enjoyed more social connection. They entered the garden with existing friends or met them there, often for lunch or to discuss a work-related issue. This contrasted with participants who had previously been in AP or Control who, in Study 2, enjoyed the 'me time' seen in the SG in Study 1. It appeared that participants used the sensory garden, firstly, to relax and then reached out socially as the next stage of restoration.

Extinction of experience is one of the great dangers of reliance on technology and the digital world. Engineering solutions that offer a machine that creates oxygen while absorbing carbon dioxide, set within an artificially lit and mechanically ventilated built environment featuring digital images of reality are with us today. Digital communication tools mean text can replace the complexities of voice, eye contact and body language. The people who participated in this

study live in today's world. How they responded to the environments they were exposed to shows the impact of sensory deficit and the effect of ecological health.

In Study 2, the usability of the sensory garden was established. Through Thematic Analysis a recurring strength of nature connection, social interaction and sense of control merged with insights around management practices as it influenced well-being, lifestyle and productivity. This was described through participants' emotional response, mood. Mood is described by Thayer (1996) as "a background feeling that persists over time" (Thayer, 1996, p. 5). That background feeling was the one consistent sensory element common to all themes suggested by the data. Reflexive analysis suggested nature connection was the starting point, or upstream health intervention, which then prompted a cascade of effects.

Themes of human connection to nature, supportive relationships with others of the same species and an enhanced ability to study and work suggest upstream and downstream effects on well-being from an ecological health perspective. Humans as bio-psychosocial entities pervade the research. Multi-disciplinary approaches to well-being are not new. However, an acknowledgement of the importance of the interactions of organisms to one another and to their physical surroundings, as the basis of healthy ecology in relation to a Eurocentric concept of human health and well-being, is.

8.2.1 Rongoā Māori (healing plants)

Design of the SG included an area of locally appropriate traditional Māori healing plants (rongoā Māori) within the woodland zone (see Chapter 5 for details). With recent increased press coverage of poor health outcomes for Māori and a resurgent interest in traditional and nature-based healing (Hurihanganu, 2019), it was important to incorporate rongoā in the SG. However, although indigenous connection with the land (whenua) is culturally important and rongoā Māori is undergoing something of a renaissance, while some people were comfortable to pick and eat fruit and vegetables commonly available in the supermarket, many did not recognise the edible plants. Similarly, although the traditional healing plants were pointed out to participants there was no engagement at that level. A possible explanation for the lack of engagement may be that suppression of traditional nature-based healing through the Tohunga Suppression Act (Voyce, 1989), in conjunction with an urban culture that discourages harvesting from a public place, with consequent loss of knowledge, widespread societal

disconnection from food growing and more general traditional healing practices, contributed to this aspect of the results. However, while there was no evidence of interaction with the rongoā plantings, their interesting textural form and colourful, fragrant, wildlife-attracting flowers would have contributed to the sensory experience of the garden.

8.2.2 Attendance

Attendance varied across groups in Study 1 and showed a difference in relation to previous group exposure in Study 2. In Study 1, unlike participants in the SG, attendance by AP participants reduced after their nature experience in the plaza. This may be due to Ulrich's Stress Recovery Theory which asserts that people are motivated to leave, or not enter, stressful environments (Ulrich et al., 1991). There was a general feeling amongst participants that they had "drawn the short straw" in being randomised to the plaza group, which was evidenced in two participants self-selecting to switch to the SG group, one who opted out of the study completely and another who self-selected to move to the Control group, rather than spend any time in the plaza. Of those who stayed in the study, attendance numbers per session were comparatively low in the plaza. Participants in the AP described the time out from work as not worth their while if the weather was bad. In contrast, participants in the SG arrived for their session, regardless of the weather. In one instance, a participant ignored the researcher's suggestion to perhaps sit out the worst of the rainstorm in the potting shed, and took a foam squab, blanket, pop up tent and umbrella out into the garden. Upon the researcher checking during the downpour, they expressed delight at being *allowed* to be out in the weather. The sense of permission implicit in the SG was a recurring theme within a sense of control and management of the experience. This is in line with Antonovsky's Sense of Coherence requiring management and meaning (Antonovsky, 1979).

In the garden, when the weather was inclement shelter could be sought under the pergola or mature trees. The visual and auditory sensory attraction of the environment was maintained. The sound of rain falling was described as 'therapeutic', and plants as 'washed clean'. In the AP, the lack of sensory interest remained, regardless of the weather, with building eaves offering the only respite from the rain. Rarity of direct experience may account for reluctance to be outside in winter in an unattractive space. Cox et al surveyed 1,023 urban residents in the U.K. (Cox et al., 2017) and found that for the majority of people, their most common

means of experiencing nature was indirectly, not by actually being present in it. This scarcity of direct experience may be associated with an indoor lifestyle and reflect a lack of nature orientation. While the U.K. data likely hold true for New Zealand, of the participants in the SG who commented about being outdoors in winter, interestingly, all were positive. While many people had not previously spent much time outdoors, at any time of the year, they were happy to do so in the restorative, biodiverse sensory garden.

Participants in both SG and AP groups were provided with blankets and foam squabs, to minimise the impact of cold winter weather. Even with comfort accessories, participants in the AP group still felt cold and damp, while at the same time participants in the garden did not comment on the physical conditions but instead noticed wildlife, colours, sounds. This is in line with the restorative effect from 'soft fascination' with natural elements and the importance of a feeling of being 'away' described in the Attention Restoration Theory (R. Kaplan, 1993b; R. Kaplan, Kaplan, & Ryan, 1998; S. Kaplan, 1995).

Similarly, AP group participants noticed their environment, but no sense of ownership emerged. A sense of ownership is related to a sense of control over the environment and to workplace well-being and productivity (Avey et al., 2009). The sensory garden's moveable furniture and furnishings (bean bags, light-weight bistro table and chairs, garden tools, blankets and foam squabs) allowed users to define their experience and hence boost their sense of well-being. Giuliani (2003) suggests Attachment Theory describes an affective bond, important to develop a sense of place and further, a sense of ownership or belonging. The design of the plaza did not allow for customisation of experience beyond a choice of which bench to sit on. As such the plaza did not promote attachment, well-being or productivity.

In Study 2, low usage of the SG by participants who had previously been in the Control group is possibly indicative of a passive involvement in the experiment overall. Former control group outdoors participants had not previously experienced the 30-minute break from work/study so perhaps could not conceive the potential benefits from doing so. If correct, this could suggest that a level of 'timetabling' would benefit future use of the garden. If students had 30 minutes per week 'timetabled' as nature break time, and staff had a regular appointment with nature diarised, further well-being gains may be seen. Generally however, attendance during Study 2, and subsequent on-going use of the garden post experiment, suggest that the

Scholars' Garden did offer a sustainable self-care tool for maintaining and improving mental health and productivity of staff and students at AUT.

8.2.3 Summary of findings

The enclosed, adaptable, biodiverse sensory garden provided measurable benefit across themes relating to well-being. Design preferences showed that to relax and restore, participants preferred to be near plants with rounded leaf forms, in view of tall trees, to sit with their back supported and near edible plants. In Study 1, the clear preference for abundant, vibrantly coloured and fragrant planting was likely to have been influenced by the wildflowers and spring flowering shrubs. Results from the RCT further suggest that the SG's biodiverse planting, which attracted and supported a wide variety of birds and insect life, likely also influenced results. Participants particularly enjoyed being able to adapt the space, and their experience of it, to meet their needs. Meandering paths facilitated activity for those who prefer to relax actively. The mindfulness walkway was popular with participants traversing the garden to reach the orchard, as a personal challenge to 'get in the mood' to relax.

Post-intervention behaviour change was observed across perceived social connection, diet, exercise and lifestyle. Previous research found opportunities to enhance stress recovery and attention restoration were related to access to nearby green space (Corazon et al., 2018; Mangone et al., 2017; van den Bosch, Östergren, Grahn, Skärbäck, & Währborg, 2015; Wang et al., 2016). This thesis, centred on the university setting as an example of a workplace, focussed on the effect of the nature-rich sensory garden. Qualitative data supported quantitative outcomes, except for cortisol. In the small minority of participants (<5%) with raised cortisol levels post intervention, in 100% of those participants, after taking a 30-minute dose of nature in the SG, perceived well-being was improved. That the SG impacted the psycho-social through productivity and well-being, and the physiological through cortisol, suggests time in the SG could be advantageous to staff and student health on campus. Access to nature through a sensory garden may thus promote significant gains towards workplace well-being.

8.3 THE ROLE OF DESIGN: EXPLORING MODELS OF HEALTH AND WELL-BEING

In an urban setting, both the built and so-called 'natural environment' are designed, and managed to meet social and economic requirements. Almost 25 years ago Daniel Stokols stated that health promotion programmes were often based on narrowly conceived conceptual models (Stokols, 1996). Stokols' criticism came from the lack of emphasis on the role of environment in health behaviour. Wellness models like Te Whare Tapa Whā (Ministry of Health, 2017b) show connection between people and land and are thus considered holistic. Such holistic models as outlined in the Ottawa Charter mention generic 'protection from environmental factors', as an emphasis on air and water quality only (World Health Organization, 1986). To achieve the goal of health promotion, salutogenesis says interventions must address the social determinants of health (Mittelmark & Bull, 2013). Ecological approaches to health promotion are used as foundations for planning and evaluation of programmes and considered comprehensive (Golden & Earp, 2012). However, none of the existing models or approaches mention the impact of designed environments or of the quality of those environments.

This thesis was set within the socioecological framework (as described in 4.2.4). Bronfenbrenner includes the environment as the enabling layer of influence within his socioecological model. However, as with other models of well-being, the Socio Ecological Model (SEM) only partially captures the sense of 'environment' as a determinant of health. Use of the word 'environment' connotes political, social, and economic influences, alongside air and water quality, but does not speak to ecological health as a biodiverse landscape. The influence of the natural environment, and need for a degree of control over that environment, are not presented as a barrier to well-being within the SEM.

Biopsychosocial models of well-being are used within medicine to acknowledge the importance of the social determinants of disease; poverty, access to health care, education, stigma, and racism, as they affect mental, spiritual, social and physical health (Graham & White, 2016). Psychiatrist George Engel devised the Bio Psycho Socio-ecological model (BPS) (see Appendix J) because the social and psychological influences on contemporary health problems did not fit the narrower framework of the biomedical model (Margaret Grace

Stineman & Joel E. Streim, 2010). As Engel said “for understanding the determinants of disease ... a medical model must also take into account the patient, the social context in which he lives, and the complementary system devised by society to deal with the disruptive effects of illness, that is, the physician role and the health care system”(Engel, 1977, p. 386).

Although the Bio Psycho Socio-ecological model is accepted within medicine to capture social and psychological influences, it does not include influences of the natural environmental on well-being. However, in an article on ‘What is a good doctor and how can we make one’ Mc Inerney noted that the Bio Psycho Socio-ecological model is ideally suited to acknowledging stress as a determinant of disease (Mc Inerney, 2002). This study’s findings that environmental design can reduce chronic stress address both the social context in which the individual lives and barriers to wellbeing, the inequalities around need for education, payment to access, stigma, and consideration of race.

Behaviour change and self-empowerment, the basic principles of the Socio-Ecological Model, focus on lifestyle behaviours and the individual’s ability to control their own health, known as the ‘enabling environment’. For entrenched behaviours such as food choice and exercise levels, prompting behaviour change can be difficult. An obesity review suggested the SEM be reframed to emphasise the reciprocal nature of the interaction between the environment and the individual (Roberto et al., 2015). Findings from Study 1 and Study 2 showed that attributes of environmental design influenced behaviour. While the Socio-Ecological Model was an appropriate framework to place this research within, the SEM overlooks the influence of the *quality* of the environment and prompted further exploration of the models.

Ecological health describes a bio-diverse balance of relationships within an environment (F. White, Stallones, & Last, 2013). This thesis found ecological health prompted nature connection, experienced during and after time in the sensory garden. Nature connection was observed as the trigger, or necessary first step, towards activating an increased perception of well-being. Biodiversity and an ability to control the environment were evident in the design of the SG, but not in AP.

Using a design lens, triangulation of this study’s findings with concurrent integration of existing knowledge, and acknowledgement of a desire for broadened multi-disciplinary

collaboration, induced an expanded, integrated SEM and BPS. Well-being, as a health promotion concept, acknowledges more than an absence of the social determinants of disease. The foundational effect of nature connection on that individual's behaviours, attitudes and perceptions, recognises that experience of healthy environments is self-reinforcing.

Self-care requires a level of self-awareness, such that when an individual experiences physiological or psychological stress, one can seek restorative experience to regain health (Ward, 2014). Any new model of health must acknowledge the importance of the quality of the environment, as it is designed and managed, as it influences experience. To ensure appropriate quality is attained, what aspects must be integrated to create a salutogenic landscape designed for well-being? Study 1 showed a biodiverse environment, as supports ecological health, provides sensory richness at the heart of a self-reinforcing cycle of well-being. Soil quality, species-rich plantings and visiting wildlife (chapter 5) created the 'biodiverse environment' necessary to achieve significant stress reduction and well-being and productivity gains. Species richness was seen to prompt nature connection, which awakened the senses. As part of a sensory awakening, a spiritual awareness became apparent, whereby the beauty of nature and trees in particular created a sense of awe and wonder. As chronic stress levels reduced, a sense of calm and safety ensued. From this position individuals became open to connection. A sense of well-being was experienced as a sensation of wholeness, connected with self, nature and the wider community. From restored individuals, society benefits through interpersonal connection and renewed nature connection.

To conceptualise these results, the candidate conceived a new integrated model of well-being (Figure 8.1) to include recognition of the foundational importance of biodiversity. The role of design is implicit within the model as urban biodiversity is facilitated by the design and management of a setting. Within the candidate's model of Integrated Salutogenic Design for Well-being (ISDW), nature connection is seen to prompt a self-reinforcing cycle of stress reduction and well-being. With an understanding of healthy ecology implicit within 'nature connection', ecological health, as the enabling environment for nature connection to occur, is therefore shown as an effective stress-reducing health promotion tool for 'apparently well' people.

8.3.1 The new model of Integrated Salutogenic Design for Well-being (ISDW)

Salutogenic design elements for well-being:

Biodiverse environment – prompts virtuous cycle through sensory-rich space

creates sense of awe and wonder (spiritualelement)

Nature connection – awakens the senses

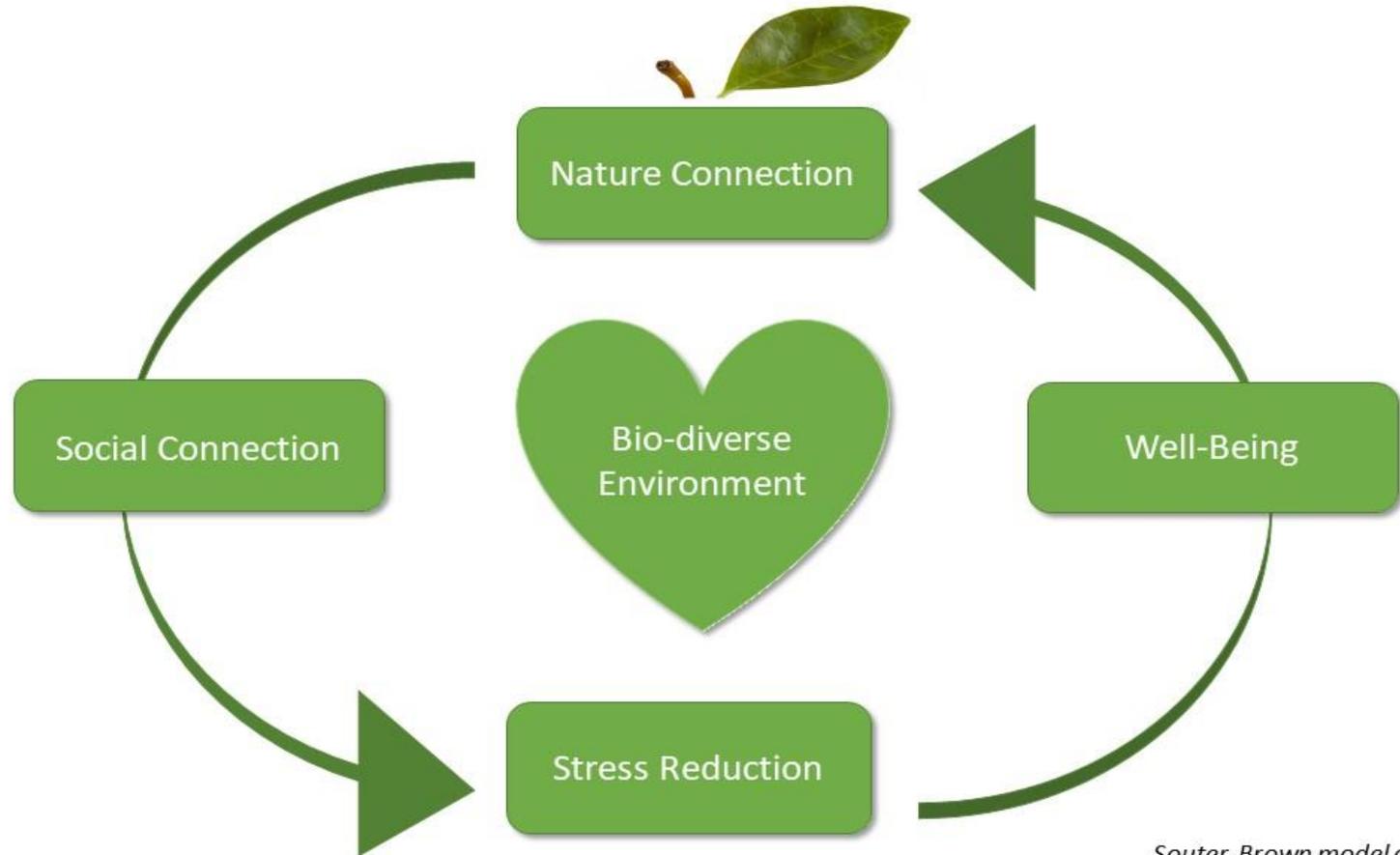
opens individual to connection

Social Connection – builds relationship with self and others

Stress reduction - enables sense of calm and safety, sense of control

restores individuals, benefiting community and society (interpersonal element)

Well-being – creates sensation of wholeness, connected with self, nature and community, prompts healthy active lifestyle, productivity, and seeks renewed nature connection



Souter-Brown model of Integrated Salutogenic Design for Well-being (ISDW)

Figure 8-1 The Integrated Salutogenic Design for Well-being (ISDW) model builds on the SEM and-BPS models of health and well-being to show a dynamic ecosystems approach, where environmental quality drives the system.

The ISDW integrates the SEM and BPS to capture evidence of the importance of quality of the natural environment for well-being. A biodiverse environment is named as the heart of the model to describe the key design quality necessary to fuel the virtuous cycle. In creating a healthy workplace setting, or indeed a health creating society, salutogenic landscape design must work from a starting position of ecological health. As such the ISDW broadens discussion of the effect of the sensory garden to include the main themes induced from the Study data as they relate to the ecological and psychosocial, without sacrificing the benefits of the biomedical approach, and while acknowledging the SEM. In practice, 'biodiverse environments for human health and well-being' means that spaces need to be designed and managed to support healthy ecosystems. Land use design and management policies and practices thus influence the effect of the ISDW.

Influencing an individual's well-being are elements needed in the environment to prompt well-being behaviours: nature connection, sense of control, healthy active lifestyle. Community and interpersonal motivations towards well-being are seen in personnel and environmental management and social connection, which also influence productivity. Notably, the ISDW adds nature connection as of upstream importance to chronic stress reduction, to effect well-being. By utilising the ISDW, people within the healthcare system would be treated within a community of care that recognised the importance of nature connection to support and promote health and well-being outcomes.

8.4 IMPLICATIONS OF STUDY FINDINGS

Health, landscape architecture and ecology were brought together in this study to investigate the effect of a sensory garden and the potential value of a designed natural environment as a self-care initiative. To improve health affordability and equity for individuals and nations, the World Health Organization recently announced a research programme around self-care. "The contribution of self-care may help avoid stigma, bring improved mental well-being and increase the agency and autonomy, particularly for vulnerable populations. For the health system too, there are many advantages to promoting self-care interventions, while remaining responsible and not putting additional burden on individuals. Health systems can thus

optimise self-care as one of the most innovative approaches to improving health coverage for all” (World Health Organization, 2019b).

Like landscape architecture, public health is both an art and a science. “Public health is the art and science of preventing disease, prolonging life and promoting health through the organised efforts of society” (Acheson, 1988). It focuses not only on the eradication of disease, but the entire spectrum of health and well-being. Since the mid-20th century, technology has been increasingly relied on to provide health outcomes. Pharmaceuticals, food additives and gym equipment providers now offer a synthesis of what historically was provided free-of-charge by nature. From a public health perspective, self-care plays an important role both for individuals and for health systems.

Design has been important in connecting people to nature for health and well-being for thousands of years. Early Persians and Chinese acknowledged the harmony of people and nature through art. In the 17th century, English scholar Sir Francis Bacon advanced a conception of the garden in his essay *Of Gardens*. He saw gardens as a place that should be planted for year-round enjoyment, offering a wide range of experiences through colour, form and scent, exercise and repose (Henderson, 2008). His sophisticated and almost modern assessment is closely aligned with the sensory garden concept presented in this study. More recently, New Zealand author and environmental historian Catherine Knight visited a sensory-rich garden in Christchurch, New Zealand, created on the site of an earthquake-damaged and subsequently demolished building. The garden, called a ‘garden of tranquillity,’ is maintained and visited by the people of Christchurch. The day she visited people from Addiction Services were working in the garden. She wrote regarding resilience in the face of the 2010 and 2011 earthquakes that our towns and cities should not wait for a natural disaster to create these kinds of spaces – every community should be able to access a garden of tranquillity (Knight, 2019).

Sensory gardens designed as health-promoting, ecologically-rich spaces provide a place where individuals can experience and connect with nature. The essentials for survival: clean air, clean water, shelter, food and sleep are provided and enhanced by nature connection. Green infrastructure (GI) describes the utility of that nature connection in an urban setting. GI connects urban areas through soil, vegetation and storm water management, to improve

water quality and create more resilient communities. That utility is measured financially, environmentally and socially. Better soil quality and vegetation cover increase permeability, improve air and water quality, enhance urban ecology and mitigate climate change. Given that climate change is the defining issue of our time and now is the defining moment to do something about it, biodiverse sensory gardens offer promise.

The effect of the Scholars' Garden on indicators of well-being was demonstrated through the use of a Randomised Controlled Trial in Study 1. The World Health Organization's indicators, encapsulating happiness, contentment, productivity, prosperity (2019a), were aggregated with Organization for Economic Cooperation and Development's focus on current and future well-being (2019). The Flourishing Scale (Diener et al., 2010) and supporting qualitative data captured quality of life and sense of purpose to integrate well-being into the workplace setting. Sociological and environmental factors influencing well-being showed Harter et al's work on workplace well-being (2003) needs to include the natural environment. Themes induced by the data in Study 1 accord with those of Study 2 and further, they directly support the significant results of Study 1. This integration of mixed methods added depth to the quantitative data. Subsequent usage of the garden suggests that sensory gardens on campus could be an effective public health tool in the fight against student and staff workplace stress, and burnout.

8.5 THE RELEVANCE OF THEORY TO PRACTICE

Design is inherently flexible. An iterative process, it acknowledges constraints as varied as budget and physical topography. That design can change to meet the needs of site, client or desired outcome makes it unique as a potential health promotion tool. Health outcomes can literally be 'designed in'. Nature has been viewed through a Eurocentric lens that objectifies nature, by architects, urban planners and property managers/developers as simply raw material to be transformed through technology, or a desirable but unnecessary recreational and aesthetic amenity. This research supports landscape architecture as it seeks to effect environmental and social change. Experience of nature, in its living, biodiverse form, has been observed to be not only desirable, but necessary to promote health and well-being, across all cultures.

8.5.1 Evidence based design

For thousands of years, plants have been used to ease symptoms of anxiety and depression. Pliny the Elder recommended borage and the Roman military doctor Proscurides favoured Saint John's Wort as early as the first century AD. The U.K. Landscape Institute states that "throughout history landscape architecture can be linked to the need to create places that were beneficial for people's health and well-being" (Landscape Institute, 2015). However, the relevance of theory to design practice is not often acknowledged. Although Roger Ulrich's pioneering work in Evidence Based Design (EBD) placed Stress Recovery Theory (SRT) firmly within a design framework, its focus has remained limited to healthcare settings. While improved patient outcomes are increasingly recognised, the wider landscape design profession has been slow to acknowledge and act on the burgeoning evidence. Why? It may stem from a distrust of the science as most of the theory about the effect of landscape originally derived from outside of the design community, from environmental psychology (Attention Restoration Theory, 'ART') and behavioural geography (Stress Recovery Theory, 'SRT') respectively. In this salutogenic design study, theory was observed as relevant to design. Emotions expressed were coded, analysed and fit the SRT. Effects on well-being fit the ART. The biophilia hypothesis was evidenced in the recurring importance of nature connection and experience. Sub themes reported across the dataset in relation to the Perceived Sensory Dimensions (PSD), the basis of which the sensory garden was designed upon, were partially validated.

Design is intuitively understood to be culturally sensitive. What appeals to one cultural group, does not necessarily appeal to another. In practice, this is observed in parks and playgrounds where, for instance, some demographics desire segregation, or formal gardens in preference to wildflowers. This study found that biodiversity can be applied to positive effect across the demographic. It can therefore be assumed that the Scholars' Garden is effective as a self-care tool regardless of age, gender, employment, education or cultural background.

8.5.2 Perceived sensory dimensions

Perceived Sensory Dimensions (PSD) are central to sensory design. Observed by designers Grahn and Stigsdotter (2010) PSDs encapsulate psycho-evolutionary theory in a way that rests firmly within the importance of designed nature contact. Themes relating to all PSDs except

'prospect' and the five main senses conveyed a measurable effect of the sensory garden on health and well-being. As Peschardt and Stigsdotter found, the PSD 'nature' was most valued by the staff and students of the university (Peschardt & Stigsdotter, 2013).

PSDs affected zone preference in both the SG and AP. In Study 2, that Zone Three was again most popular was possibly influenced by the SG zone having the most PSDs, seven out of the total eight. Zone One was the second most used, with six PSDs.

On an evolutionary level, nature is familiar to us all. However, for a variety of reasons outside the scope of this study, adults and children have become progressively disconnected from nature and natural processes, while relying increasingly on technological solutions to everyday problems. Designers are no different, and have embraced manufactured solutions with soilless gardens, concrete seating, above-ground gardens and virtual reality landscapes. This study challenged contemporary perceptions of nature by including design elements suggestive of the wildness of the natural world. As an example, participants unfamiliar with the PSD 'wild' perceived long grass in the sensory garden as disquieting or threatening. With no lived experience of long grass, there was an initial primal reaction: 'could it hold threats?', which soon gave way to delight: "can we lie in it?!" Once garden visitors understood they were allowed to 'play' with and in the long grass they loved the experience, engaged playfully with the space (played in the grass, made grass 'snow' angels). The stumpy and 'pollinator palace' bug hotel, which had been considered 'messy', became 'interesting'. As perceptions of the space changed, participants delighted in engaging and exploring, evidenced by their close inspection of fungi underneath the log seating, climbing the tree over the waterfall, investigating birds' nests and watching for bugs emerging from the pollinator palace.

Sensory gardens are based on perceptions. To maximise their restorative, health-promoting potential, designers need to acknowledge the importance of ancient wisdom, while also referencing scientific understandings. The salutogenic landscape architect or designer thus needs to balance art with science. In Study 1, participants were asked in semi-structured interviews to rank various natural elements as perceived necessary for relaxation. Although Ulrich's Attention Restoration Theory is psycho-evolutionary and Wilson's Biophilia Hypothesis contends that humans are hardwired to respond to savannah grasslands, grass

was considered unimportant for relaxation. Broad canopy trees were instead perceived as necessary in a restorative landscape.

Initially, the university's Estates contractors poisoned the wildflower seedlings, twice, before understanding that the biodiverse, wildlife-attractive planting was an intentional part of the garden. Likewise, they wanted to mow the long grass of the 'meadow' in the orchard as it was anathema to them, and within their performance indicators to remove. With the contractors' different relationship to the sensory garden, they were unable to perceive or fully experience it. They could not enjoy long grass they were tasked with mowing. Training to achieve the necessary sense of coherence to understand and relate to the environment, and amended performance indicators, were absent, so contractors were slow to change their perception from discomfort to comfort.

8.6 A CULTURAL SHIFT TOWARDS HEALING LANDSCAPES?

Since this research started, a cultural shift has begun. Although research and policy have increasingly, over the past ten years, recognised links between ecological health and human health and well-being, beliefs and behaviours were slower to adjust. In Aotearoa New Zealand there is now a growing *appetite* for change. Since 2016 there have been two Summits to review progress and plan action towards achieving the United Nations' 17 Sustainable Development Goals (SDGs). The SDGs are acknowledged within New Zealand's first Well-Being Budget through a spirit of partnership, action towards conservation of biodiversity, eradication of poverty, a focus on mental health, health equity for Māori and all other people, de-carbonisation of the economy and flourishing in the digital age (Treasury, 2019). At Auckland University of Technology, in the two years since the sensory garden was developed, the Student Association has been given permission to develop food-growing gardens on two campuses, bee hives have been installed by Estates on the field of North campus, an orchard has been planted by Estates to link with the sensory garden, an outdoor classroom has been built by Outdoor Education staff and students and a Sustainability team is supported at Executive level. The University's student and staff Health Service prescribe patients with stress and depression symptoms time in the sensory garden. Outdoor meetings are now held in the garden, and a broad cross section of the University make use of the SG on a regular basis.

Public policy is indicative of a changing society's challenges and aspirations (Adema, Clarke, Eunkyung, & Thévenon, 2019). New Zealand's recent policy shift towards improved wellbeing through *prevention*, enhanced health outcomes supported by a focus on health *equity* and improved *mental well-being*, is indicative of contemporary societal challenges (Ministry of Health, 2019/20). Although the links between environment and health had been ignored by the technological age, like the cyclical nature of Nature, sustainable evidence-based natural solutions are returning to prominence. Findings from across the participant demographic in Study 1 and Study 2 showed no health literacy was required to produce the observed effects. This suggests healing landscapes could aid health equity. The impact of the effects seen support improved wellbeing through prevention and mental well-being programmes. To achieve the SDGs and create measurable outcomes in line with New Zealand's 2019 Well-Being Budget, landscape-led solutions offer hope. As President Nursultan Nazarbayev said at the Global Challenges Summit in Astana in 2018, "Technology does not build equality. It does not reach the poorest people". To flourish in the digital age, conveniently located, low-cost, high-impact sensory gardens could reach traditionally hard-to-reach people. Culturally, for Māori, nature is vital, as essential to their sense of being. As a non-stigmatising, accessible, equitable intervention, nature-based health promotion tools may feed a broad appetite for change across New Zealand.

8.6.1 Collaboration

The advancement of science requires finding new relationships between variables. In this study, as species richness and sensory experience of environment were manipulated by design, cortisol, well-being and productivity were impacted. A shift in thinking to embrace a multi-disciplinary collaborative approach would encourage design researchers and practitioners to actively support healthcare research and practice.

In recognition of this, the University's Health Services are already prescribing time in the SG for staff and students. Given the low cost and high impact of the SG, biodiverse sensory gardens could be trialled as a self-help tool in other workplace settings and areas currently lacking mental health services.

8.7 IMPLICATIONS FOR POLICY

Health policy needs to support and promote self-care, to boost well-being, prevent stress rising and adapt to the immediate threats of climate change and unsustainable levels of lifestyle-related diseases. While there are known, effective treatments for stress and depression, fewer than half of those affected (less than 10% in many countries) receive appropriate treatment (World Health Organization, 2017a). Barriers to effective care include inadequate or insufficient resources, lack of trained health-care professionals and the social stigma associated with mental disorder. The evidence suggests that workplace practices need to promote breaks away from the desk, as time outdoors connecting with nature. A sensory garden offers a low-cost, high impact intervention. It removes stigma and does not require attendant healthcare providers. As such an evidence-based sensory garden could provide a valuable health promotion tool for apparently well people in the community, while prompting positive health behaviours and helping mitigate climate change.

8.8 STRENGTHS AND LIMITATIONS

A main strength of the research in this thesis was the design of the study, a randomised controlled trial, whereby environmental design was evaluated objectively, without bias. This research was the first known design to directly compare effects of a biodiverse sensory garden against the predominant urban open space form, a paved plaza, and control. The consolidated results of two complementary literature reviews facilitated a clear understanding of existing gaps in the knowledge base between subjective and objective multi-disciplinary design, health and ecological theory and practice. Results of the reviews showed this research to be the first in New Zealand, and possibly the world, to investigate the effect of a sensory garden on 'apparently well' people. The RCT was the first to study salivary cortisol on campus anywhere and was one of the largest field-based studies of its nature.

There were some technical and administrative limitations to the study reported in this thesis. Attempts were made, however, to account for these. Costs to develop the SG did not originally include a labour component as it was suggested that the University Estates contractors would supply free labour in return for free training in organic and salutogenic maintenance practice. The resulting budget shortfall meant some planting and the cabin had

to be removed from the plan. To mitigate the effect donated plants were sought from the community.

Construction delays meant that Study 1 intervention season changed from summer/autumn to winter/spring, and that the Studies were conducted with a 6-month gap. To alleviate the hardships of winter, blankets and foam squabs were supplied to both intervention sites. To manage the 6-month gap an additional baseline sample was taken across all measures at the start of Study 2.

Video observation was planned for the SG but did not eventuate due to unavailability of cameras. To retain an ability to observe participants' response and use patterns within the SG, four RAs were trained to observe directly and record their observations. No interrater reliability between RAs was conducted, but the candidate reviewed observations at the end of each session and queried any unusual notes with the RA.

Cortisol levels can change from one moment to the next and follow a diurnal pattern. To maintain data integrity measurement was set around midday. This sampling technique is validated by Pilger et al (2018).

The relatively low sample size in Study 2 may have impacted the lack of significant effects observed. To reduce the likelihood of drops outs between Studies, future research could be timetabled during the same academic year, as originally designed in this study.

8.8.1 Did the design work as intended?

Although the sensory garden attracted people into the space and provided measurable well-being benefits, it did not work as intended. The assumption that individuals would enter the SG and progress over time from a solitary to a more gregarious state from Zones One – Four was not supported. Individuals chose locations anywhere in the garden they fancied. Behaviour varied. Some participants had a 'favourite' location in Zone One or Two and only sat there. Others explored at the start of each session to check changes in the garden or moved to a different location each week. While it was observed that participants did start to gather in small groups in Study 2, they did so not in Zone Four as predicted, but in Zone Three. Some participants found the alone time valuable as a balance to a need to be socially engaged in the rest of their lives. For the broad variety of people who participated in the study, the

design provided sufficient options for people to receive the individual restorative experience they needed.

8.8.2 Proof of concept

Initially the garden was designed and developed as a temporary exhibit, a 'Show garden', to be used as a proof of concept for an atrium in the new Environmental Sciences building on campus. Plants were thus chosen for relocation after temporary display. The budget, which was set to account for seasonal interest plants, was stretched when it became apparent that year-round interest was needed. As a result, planting was not as dense as first envisaged.

8.8.3 Generalisable features and lessons

Security concerns vetoed the proposed 4m spacing of Pittosporum boundary planting. The proposal was designed to provide a porous hedge effect, whereby the garden would feel enclosed, while allowing a glimpse of the world outside. To account for the concern, boundary planting spacing was extended to 6-8m. As spacing had been chosen to enhance a sense of refuge and enclosure, a screen fence was required to re-create that sensory perception. Brushwood was used to create the sense of privacy and of being 'away' while allowing a glimpse into the secret world within, and the wider campus outside the garden.

University Security and Estates observed the sensory garden closely during and after the intervention for vandalism and anti-social behaviour. There was no cause for concern. Prior research confirms this and suggests that a biophilic design approach creates a sense of pride (Ohmer, Meadowcroft, Freed, & Lewis, 2009) and 'eyes on the street' create a sense of security (Rojas, 2012). Anecdotal evidence from co-designed community greening initiatives adds further depth to the observation that anti-social behaviour is seldom seen in relation to community greening.

With increasing numbers of international students and staff across the university, the lack of hazardous animals in the New Zealand setting may need to be explained. Given the generally low existing levels of nature connection and nature literacy within even the local community, to maximise the effect of a sensory garden as a self-care resource, it may be desirable to include some interpretation, whether in pamphlet form or as a smart phone app. As such, some facilitation may still be important even in the self-care tool approach.

8.9 FUTURE RESEARCH AND RECOMMENDATIONS

In the future, outcome-based research utilising the Scholars' Garden could be an important part of the garden's evaluation and will aid the development of the field of health-promoting sensory garden design. Researchers from Occupational Therapy, Psychotherapy and Physiotherapy have already expressed interest in basing research projects in the garden.

Further research could come from a variety of disciplines to unpack the full effect of the plaza environment compared to the sensory garden. Exploration of the design potential of sensory gardens could investigate the breadth of design typologies used in healthcare settings to test particular design elements in the field. Comments made by AP participants that they had to talk to people to mitigate feelings of boredom in the Plaza is an area for further investigation. Research questions that could be asked include 'if a water feature, wildlife-attracting planting and permeable paving were retrofitted to the plaza space, could it mitigate the negative perceptions of the plaza reported in this study?' or, 'would a retrofitted living 'green' wall be sufficient to mitigate negative perceptions of the plaza?' or 'is sense of place a factor in the effect of a plaza?'

To investigate the generalisability of the study, a broad range of workplace and community settings are an important area for future research. In future investigations, a larger sample size is recommended to increase the likelihood of finding statistical significance. A longitudinal study could aid understanding of the duration of the effect. Further work is required to establish the effect of the sensory garden on physical activity and diet. To establish commercial application of the research, future research around the well-being potential of sensory gardens within resort design could add depth to the data.

This thesis reported on the effect of an ecologically rich sensory garden, designed to promote a restorative response. Given the positive effect of biodiverse green space, and pressures on vegetation cover across Auckland, this study recommends the University offer sensory gardens on each campus, as part of their wider duty of care to students, health and safety of staff and commitment to meeting UN Sustainable Development Goals. Development of design guidelines for other workplaces, educational settings and public space would also be helpful. Prospective longitudinal and intervention studies are a critical next step in developing

possible design-based nature exposure guidelines, comparable to those for nutrition or physical activity.

8.9.1 Findings that we did not anticipate

The aim of this research was four-fold: firstly, to develop a sensory garden as a salutogenic environmental design intervention; secondly, determine its effect; thirdly, examine whether use of a sensory garden offers a sustainable self-care tool to promote well-being and productivity of staff and students at university campus. Lastly, surprisingly, in meeting the fourth aim, to explore environmental design preferences to enhance mental health and productivity in a tertiary education setting, the contextual factors and mechanisms regularly associated with simply being outdoors did not apply equally to time in AP, the SG or general, everyday outdoor activity. It was not expected that the SG would evoke such a strong emotional response, nor that there would be such a sense of “jealousy” around group allocation, to groups other than the SG, within Study 1. The trend towards a negative effect of being in the plaza seen across all measures, except cortisol, was also unexpected. Given that the plaza is representative of the predominant, paved, low biodiversity, urban form this is worthy of further exploration in a future study. The effect we did not anticipate was on behaviour change, towards a healthy active lifestyle. Participants reported, unprompted, that they had changed their behaviour following the intervention. Environmental quality affected behaviour. With no facilitated or self-directed programme, that participants who experienced the SG noted improved lifestyle behaviours is extremely promising as a health promotion tool.

8.9.2 Research gaps

To develop a full picture of the potential of a sensory garden as a health promotion tool several questions remain to be asked. There was no participation from the rural community. As this community, like their urban counterparts, are equally affected in terms of mental health, could a publicly-accessible sensory garden affect well-being in a rural setting? Other demographics were likewise unrepresented by the data. There was no participation from unemployed peoples and low participation from people of Māori and Pacific cultural backgrounds. With high rates of stress within these demographics, could a sensory garden be effective within the community, close to social and affordable housing or Māori and Pacific population centres? Given cortisol’s relationship with the top four Non-Communicable

Diseases - cardiovascular disease, cancer, respiratory diseases and diabetes - it is desirable to leverage this study to further explore the potential of sensory gardens as a self-care tool. Behaviour change needs to be explored in the context of effects of chronic stress reduction and environment. Further studies investigating the effect of using biodiverse sensory gardens to reduce stress in association with diabetes risk, inflammation and heart disease are recommended. The potential application of sensory gardens as a health promotion tool could be investigated in settings such as marae and schools, business parks and new housing developments.

The effect of the sensory garden on pro-environmental behaviours associated with nature connection and nature relatedness could also be further explored. With the imperative to meet Sustainable Development Goals there is potential for exploration of development of sensory gardens to build community nature connection and effect positive lifestyle behaviour change.

8.10 CONCLUSION

In meeting the aims of the research and answering the research question: *What is the effect of a sensory garden on 'apparently well' people and could it be a sustainable self-care tool for staff and students on campus?* the effect of the Scholars' Garden was established with statistically and clinically significant results. The broad range of outcome measures were supported by qualitative data. Stress recovery and attention restoration were shown to be influenced by a salutogenic design approach that emphasised vivid, healthy ecology within a setting that offered both prospect and refuge. As an environmental design intervention, the effect of the sensory garden showed a positive association between ecological health and human well-being, confirmed through results of the randomised controlled trial.

In determining the sustainability of the Scholars' Garden as a self-care tool, the sensory garden was found to provide a valuable health-promoting environment. The Scholars' Garden's design was attractive to and engaging of users as a setting for self-care during the intervention and subsequently, with on-going high levels of use. A synthesis of the study's findings suggests a salutogenic environmental design approach can provide a powerful self-care tool to reduce stress, improve and enhance well-being and productivity in the university community. A medical biopsychosocial approach suggests individual behaviour and lifestyle

are key to health promotion. As Dr Ruth Bromley, GP and chair of Manchester Health and Care Commissioning, U.K. said, "So much of what keeps people happy and well isn't medical" (Hurst, 2019). The socioecological paradigm suggests settings are important. This research bridges the two approaches to offer a sensory garden as an adaptable, bio-diverse space on campus, designed as a place of refuge, that effects positive behaviour and lifestyle by reducing stress. Further, the evidence suggests design preferences are linked to the effects seen. Therefore, when universities design and build, to foster and support well-being it is recommended they incorporate adaptable, natural elements to a far greater extent, both indoors and outdoors.

To develop and sustain the health-promoting sensory garden on campus, the commitment and active engagement of senior University executives was essential. Auckland University of Technology recognised the strategic opportunity to test a novel stress restoration intervention as workplace well-being initiative. As Agis Tsouros, Head of Urban Health Centre WHO Regional Office for Europe said "Universities can potentially develop into model health-promoting settings. They have the intellectual capacities, the skills, the authority and the credibility for this purpose" (Tsouros et al., 1998). With further research, this study could be leveraged to explore the broad potential of biodiverse sensory gardens for apparently well people. Set within 'green' universities, sensory gardens as integrated eco-biopsychosocial model environments, could offer a sustainable development option appropriate to the challenges of the 21st century. It is hoped that this study will help guide design professionals and decision makers in prioritising health-promoting environments using salutogenic design principles.

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APPENDICES

APPENDIX A : PARTICIPANT INFORMATION SHEET



Participant Information Sheet

Project Title

Scholars' Garden restorative response study

An Invitation

Hi, my name is Gayle Souter-Brown from Auckland University of Technology (AUT). I would like to invite you to be part of our research into the impact of the new Scholars' Garden on the North campus. The gardens have been designed to a formula used by the University of Alnarp, in Sweden. This research will evaluate the effect of the gardens on stress cortisol levels and general mood.

I am interested to measure the health and wellbeing impact, if any, of the new garden. Your participation in this research is voluntary and you may withdraw at any time prior to the completion of data collection in June 2017. We hope to publish the results in scientific journals, conferences, and through the media.

What is the purpose of this research?

This research aims to develop design guidelines for the university to improve staff and student health and wellbeing and work outcomes. In order to know if the design works we need to investigate whether the new garden has any impact on you. My hope is that we will see an improvement in stress levels, and enhanced mood, social, academic and work outcomes. The university is funding this research as it supports improved health and well-being for all staff and students.

Why am I being invited to participate in this research?

Everyone between the ages of 18-30 who studies or works at AUT is being invited to be part of this research.

What will happen in this research?

The study will start at the beginning of semester one 2017. The research will take place in two phases of 4 weeks each during April -June. Participants will be randomly assigned to one of three groups. In Phase One, one group will be prescribed access to the Scholars' Gardens at a mutually agreed set time on a set day, for 30 minutes per week, for 4 weeks. The Scholars' Garden will offer the opportunity to choose to relax in comfortable seating, wander through beautiful planting, grow tasty fruit, herbs and vegetables, and/or prepare and eat it in a communal space. The second group will be prescribed 30 mins per week for 4 weeks in Awataha Plaza. The third group will be a control. All participants' saliva stress cortisol levels will be measured. Participants will be asked to keep a journal to note mood and time outdoors. The gardens will be videoed so that I can see where people choose to spend their time while in the garden. In Phase two the research will be repeated with all groups, including the control, accessing the gardens for 4 weeks. At the end of Phase Two a sub group of participants will be invited to be part of focus groups to discuss the garden experience in more detail.

What are the discomforts and risks?

Cortisol is taken from a saliva sample by spitting into a tube so there should be no discomfort. There is no more risk in the Garden than during normal time outdoors. To reduce security risks from being videoed we will ensure that all video footage will only be used for academic purposes and will not be shared or uploaded to any public internet platform or any media sources. No photos of participants will be taken without prior permission.

What are the benefits?

The benefits from this research are potentially important, in New Zealand and internationally. We hope to show that staff and students are happier, less stressed and do better generally when they have more species-rich, comfortable natural outdoor areas to relax in.

How will our privacy be protected?

The records of this study will be kept private. However, we will provide you with a summary report of the programme if requested. You will be given access to any information we collect about you. In any sort of report we publish, we will not include information that will make it possible to identify you in any way. Research records will be kept in a locked file and sorted by number codes, not by names; only the researchers involved in the study will have access to the records. Please note that data from this study will be retained by AUT for comparison with future research. Data will be stored for 10 years and will be permanently destroyed after this period.

APPENDIX B : CONSENT AND RELEASE FORM

Consent and Release Form

Project title: Scholars' Garden restorative response study

Project Supervisor: Erica Hinckson

Researcher: Gayle Souter-Brown

We respect your privacy. No names will be collected during this study. Please tick when you have read the following:

- I have read and understood the information provided about this research project in the Participant Information Sheet dated 07.03.17
- I have had an opportunity to ask questions and to have them answered.
- I understand that the videos will be used for academic purposes only and will not be published in any form outside of this project without my written permission.
- I permit the researcher to use videos that are part of this project solely and exclusively for the researcher's study
- I understand that any copyright material created by the video is deemed to be owned by the researcher and that I do not own copyright of any of the photographs.
- I understand that identity of my fellow participants and our discussions is confidential to the group and I agree to keep this information confidential.
- I understand that notes will be taken during the study
- I understand that I may withdraw any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- If I withdraw, I understand that while it may not be possible to destroy all records of the focus group or general gardens video of which I was part, the relevant information about myself will not be used.
- I agree to take part in this research.
- I wish to receive a copy of the report from the research (please tick one): Yes No

I wish to have my journal returned at the completion of the study (please tick one): Yes No

Participant's signature:

Participant's name:

Participant's Contact Details (if you would like to receive the report):

.....
.....
.....
.....

Date:

Approved by the Auckland University of Technology Ethics Committee on, 7th March 2017 AUTEK Reference number 17/14

Note: The Participant should retain a copy of this form.

APPENDIX C : APPROVAL LETTER(S) FROM ETHICS COMMITTEE



AUTEC Secretariat

Auckland University of Technology
 D-88, WU406 Level 4 WU Building City Campus
 T: +64 9 921 9999 ext. 8316
 E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

7 July 2017

Erica Hinckson
 Faculty of Health and Environmental Sciences

Dear Erica

Re: Ethics Application: **17/14 The effects of the scholars' garden on health and well-being: Is it a sustainable self-help tool for staff and students**

Thank you for your request for approval of amendments to your ethics application.

The amendment to modify data collection with the addition of 3 new scales to the survey is approved.

I remind you of the Standard Conditions of Approval.

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through <http://www.aut.ac.nz/researchethics>.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through <http://www.aut.ac.nz/researchethics>.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: <http://www.aut.ac.nz/researchethics>.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. If the research is undertaken outside New Zealand, you need to meet all locality legal and ethical obligations and requirements.

For any enquiries please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
 Executive Manager
 Auckland University of Technology Ethics Committee

Cc: gayle.souter-brown@aut.ac.nz; scott.duncan@aut.ac.nz

AUTEC Secretariat

Auckland University of Technology
 D-88, WU406 Level 4 WU Building City Campus
 T: +64 9 921 9999 ext. 8316
 E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

10 April 2017

Erica Hinckson
 Faculty of Health and Environmental Sciences

Dear Erica

Re: Ethics Application: **17/14 The effects of the scholars' garden on health and well-being: Is it a sustainable self-help tool for staff and students**

Thank you for your request for approval of an amendment to your ethics application.

The amendment to the inclusion criteria (age) is approved.

I remind you that as part of the ethics approval process, you are required to submit the following to the Auckland University of Technology Ethics Committee (AUTEC):

- A brief annual progress report using form EA2, which is available online through <http://www.aut.ac.nz/researchethics>. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 6 March 2020;
- A brief report on the status of the project using form EA3, which is available online through <http://www.aut.ac.nz/researchethics>. This report is to be submitted either when the approval expires on 6 March 2020 or on completion of the project.

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this.

To enable us to provide you with efficient service, please use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,



Kate O'Connor
 Executive Secretary
 Auckland University of Technology Ethics Committee



AUTEC Secretariat

Auckland University of Technology
 D-88, WU406 Level 4 WU Building City Campus
 T: +64 9 921 9999 ext. 8316
 E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

7 March 2017

Erica Hinckson
 Faculty of Health and Environmental Sciences

Dear Erica

Re Ethics Application: **17/14 The effects of the scholars' garden on health and well-being: Is it a sustainable self-help tool for staff and students**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 6 March 2020.

As part of the ethics approval process, you are required to submit the following to AUTEC:

- A brief annual progress report using form EA2, which is available online through <http://www.aut.ac.nz/researchethics>. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 6 March 2020;
- A brief report on the status of the project using form EA3, which is available online through <http://www.aut.ac.nz/researchethics>. This report is to be submitted either when the approval expires on 6 March 2020 or on completion of the project.

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this. If your research is undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply there.

To enable us to provide you with efficient service, please use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,

Kate O'Connor
 Executive Secretary
 Auckland University of Technology Ethics Committee

Cc: gayle.souter-brown@aut.ac.nz; scott.duncan@aut.ac.nz

APPENDIX D : JOURNAL QUESTIONS

*Completed weekly during Phase One of the study

Question 1. Please describe your time outdoors this week (Where did you go? Where did you spend most time? E.g. just to and from the car, walking the dog, time in the garden)

Question 2. What was the weather like?

Question 3. Was there anything that especially captured your attention? If yes, what?

Question 4. Did you talk to anyone while outdoors? (phone conversations don't count!)

Question 5. How do you feel about your studies / work? (E.g. inspired, disengaged, productive, tired, engaged, unproductive)

Question 6. Underline your level of agreement with this statement "I enjoyed my time outside" - agree strongly, agree, neutral, disagree, disagree strongly

APPENDIX E: SURVEY QUESTIONNAIRES

ID code: _____

Scholars' Garden study 1 Baseline questionnaire

The survey questions ask about your general health, well-being, relatedness to nature, productivity and response to recent experiences. Each section uses a slightly different scale, but most ask you to ✓ the level of agreement with a statement from strongly disagree / rarely – strongly agree / always. The questions asked are externally validated.

Please respond honestly. Your response is anonymous.

Please tick or answer the questions below as appropriate.

6. Age (in years) _____

7. Gender

- a. Female _____
 b. Male _____
 c. Unspecified _____

8. Education Completed

- a. Secondary _____
 b. Undergraduate _____
 c. Graduate (Certificate or Diploma) _____
 d. Post graduate (Masters) _____
 e. Post graduate (Doctorate) _____

9. Ethnicity

- a. NZ European _____
 b. Maori _____
 c. Pacific peoples _____
 d. Other (please specify) _____

10. Employment

- a. AUT academic staff _____
 b. AUT allied staff _____
 c. AUT student _____
 d. Other (please specify) _____

11. The following questions ask about your general well-being

Instructions Below are 8 statements with which you may agree or disagree. Using the 1–7 scale, indicate your degree of agreement or disagreement with each item by indicating ✓ that response for each statement.

		Strongly Disagree	Disagree	Neither agree nor disagree (neutral)	Agree	Strongly Agree
✓		1	2	3	4	5
E.G	I like maths tests	✓				
1	I lead a purposeful and meaningful life					
2	My social relationships are supportive and rewarding					
3	I am engaged and interested in my daily activities					
4	I actively contribute to the happiness and well-being of others					
5	I am competent and capable in the activities that are important to me					
6	I am a good person and live a good life					
7	I am optimistic about my future					
8	People respect me					

Frequency and duration of visits to green spaces:

In the last 4 weeks please ✓ how often did you visit on purpose the following green spaces? (Where greenspace is forest, parks, gardens, fields, sea, lake, river)

		Never	Once	2-3 x per month	1-4 x per week	Daily
✓		1	2	3	4	5
1	Close to your home (less than 15 min by foot or bike)					
2	In your city or town (more than 15 min by foot or bike)					
3	Close to your city or town					

12. The following questions ask about your general health.

- a. Approximately how many times have you seen your General Practitioner (GP) in the last 12 months? (please tick ✓)

Never ___ Once ___ Two or Three times ___ Four or Five times ___ > Five times ___

- b. Have you ever been told by a health professional (doctor, nurse, counsellor, physio etc) that you have any of the following ailments? Please tick all those that apply

High blood pressure ___ Diabetes ___ Kidney or renal disease ___ Heart disease ___ Stroke ___

Arthritis ___ Asthma ___ Cancer (excluding skin cancer) ___ Skin cancer ___ Dementia ___

Alzheimer's ___ Psychosis or Schizophrenia ___ Depression ___ Other serious ailment ___

- c. Are you having treatment or medication for high blood pressure? please tick ✓

Yes ___ No ___

13. The following statements ask about your relatedness to nature

Instruction For each of the following, please ✓ to rate the extent to which you agree with each statement, using the scale from 1 to 5, where 1 is strongly disagree and 5 is strongly agree. Please respond as you really feel, rather than how you think “most people” feel.

		Strongly Disagree	Disagree	Neither agree nor disagree (neutral)	Agree	Strongly Agree
✓		1	2	3	4	5
1	I enjoy being outdoors, even in unpleasant weather.					
2	Some species are just meant to die out or become extinct					
3	I always think about how my actions affect the environment.					
4	Humans have the right to use natural resources any way we want.					
5	My connection to nature and the environment is a part of my spirituality.					
6	I enjoy digging in the earth and getting dirt on my hands					
7	I don't often go out in nature					
8	I take notice of wildlife wherever I am.					

		Strongly Disagree	Disagree	Neither agree nor disagree (neutral)	Agree	Strongly Agree
9	Nothing I do will change problems in other places on the planet					
10	My relationship to nature is an important part of who I am.					
11	Conservation is unnecessary because nature is strong enough to recover from any human impact					
12	Even in the middle of the city, I notice nature around me					
13	My feelings about nature do not affect how I live my life					
14	Animals, birds and plants should have fewer rights than humans.					
15	The state of non-human species is an indicator of the future for humans.					
16	I feel very connected to all living things and the earth					

		Strongly Disagree	Disagree	Neither agree nor disagree (neutral)	Agree	Strongly Agree
17	The thought of being deep in the woods, away from civilization, is frightening					
18	I am very aware of environmental issues					
19	My ideal vacation spot would be a remote, wilderness area					
20	I am not separate from nature but a part of nature					
21	I think a lot about the suffering of animals.					

14. The following questions assess the degree of competing experiences

- a. In an average week, please ✓ how much time do you spend at home / work with a view of nearby 'nature' (within 500m)? (Where no view is 0 and 'nature' is trees, parks, gardens, fields, sea, lake, river)

0 ___ <1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

- b. In an average week, how much time do you spend outdoors?

<1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

- c. In an average week, how much time do you spend in private gardens?

<1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

- d. In an average week, how much time do you spend in public parks?

<1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

- e. In an average week how much time do you spend at the beach?

<1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

15. The following questions ask about your productivity

- a. **How many hours does your employer expect you to work in a typical 7-day week? (If you are a full-time student, how many hours do you expect to study a week? If you combine work + study, combine the hours)**

If it varies, estimate the average. If you are self-employed, estimate the number of hours you would consider a full work week. If you have more than one job, combine total number of hours for all jobs.

- i. _____ TOTAL NUMBER OF HOURS
- ii. How many of those hours are indoors? _____
- iii. How many of those hours are outdoors? _____

- b. **Now please think of your work / study experiences in the past 7 days. In the spaces provided below, write the number of days you spent in each of the following situations.**

In the past 7 days, how many days did you... (Fill in the NUMBER OF DAYS _____)

- i. miss an **entire** work/study day because of problems with your physical or mental health? _____
- ii. miss an **entire** work/study day for any other reason (including holiday / vacation)? _____
- iii. miss **part** of a work/study day because of problems with your physical or mental health? _____
- iv. miss **part** of a work/study day for any other reason (including holiday / vacation)? _____
- v. come in early, go home late, or work/study on your day off? _____

- c. **The next questions are about the time you spent during your hours at work / study in the past 7 days. Circle the one number from each question that comes closest to your experience.**

- i. How often was your performance higher than most?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- ii. How often was your performance lower than most?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- iii. How often did you do no work at times when you were supposed to be working?..

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- iv. How often did you find yourself not working as carefully as you should?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- v. How often was the quality of your work lower than it should have been?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- vi. How often did you not concentrate enough on your work?....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- vii. How often did health problems limit the kind or amount of work you could do?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

16. The following asks questions about your recent experiences, both positive and negative

Instruction Please think about what you have been doing and experiencing during the past four weeks. Then ✓ as appropriate to report how much you experienced each of the following feelings, using the scale.

		Very Rarely / Never	Not often	Sometimes	Often	Very Often / Always
✓		1	2	3	4	5
1	Positive					
2	Negative					
3	Good					
4	Bad					
5	Pleasant					
6	Unpleasant					
7	Happy					
8	Sad					
9	Afraid					
10	Joyful					
11	Angry					
12	Contented					

Is there anything else you would like to add?

Thank you! Gayle Souter-Brown, Researcher, PhD candidate

ID code: _____

Scholars' garden study baseline Study 2 questionnaire

The survey questions ask about your well-being, relatedness to nature, productivity and response to recent experiences. Each section uses a slightly different scale, but most ask you to ✓ the level of agreement with a statement from strongly disagree / rarely – strongly agree / always. The questions asked are externally validated.

Please respond honestly. Your response is anonymous.

Please tick or answer the questions below as appropriate.

**Approved by the Auckland University of Technology Ethics Committee on 7 March 2017, 10 April 2017 & 7 July 2017.
AUTEC Reference number 17/14.**

17. The following questions ask about your general well-being

Instructions Below are 8 statements with which you may agree or disagree. Using the 1–5 scale, indicate your degree of agreement or disagreement with each item by indicating ✓ that response for each statement.

		Strongly Disagree	Disagree	Neither agree nor disagree (neutral)	Agree	Strongly Agree
✓		1	2	3	4	5
E.G	I like maths tests	✓				
1	I lead a purposeful and meaningful life					
2	My social relationships are supportive and rewarding					
3	I am engaged and interested in my daily activities					
4	I actively contribute to the happiness and well-being of others					
5	I am competent and capable in the activities that are important to me					
6	I am a good person and live a good life					
7	I am optimistic about my future					
8	People respect me					

18. Frequency and duration of visits to green spaces:

In the last 4 weeks please ✓ how often did you visit on purpose the following green spaces? (Where greenspace is forest, parks, gardens, fields, sea, lake, river)

		Never	Once	2-3 x per month	1-4 x per week	Daily
✓		1	2	3	4	5
1	Close to your home (less than 15 min by foot or bike)					
2	In your city or town (more than 15 min by foot or bike)					
3	Close to your city or town					

9. The following statements ask about your relatedness to nature

Instruction For each of the following, please ✓ to rate the extent to which you agree with each statement, using the scale from 1 to 5, where 1 is strongly disagree and 5 is strongly agree. Please respond as you really feel, rather than how you think “most people” feel.

		Strongly Disagree	Disagree	Neither agree nor disagree (neutral)	Agree	Strongly Agree
✓		1	2	3	4	5
1	I enjoy being outdoors, even in unpleasant weather.					
2	Some species are just meant to die out or become extinct					
3	I always think about how my actions affect the environment.					
4	Humans have the right to use natural resources any way we want.					
5	My connection to nature and the environment is a part of my spirituality.					
6	I enjoy digging in the earth and getting dirt on my hands					
7	I don't often go out in nature					
8	I take notice of wildlife wherever I am.					

		Strongly Disagree	Disagree	Neither agree nor disagree (neutral)	Agree	Strongly Agree
9	Nothing I do will change problems in other places on the planet					
10	My relationship to nature is an important part of who I am.					
11	Conservation is unnecessary because nature is strong enough to recover from any human impact					
12	Even in the middle of the city, I notice nature around me					
13	My feelings about nature do not affect how I live my life					
14	Animals, birds and plants should have fewer rights than humans.					
15	The state of non-human species is an indicator of the future for humans.					
16	I feel very connected to all living things and the earth					

		Strongly Disagree	Disagree	Neither agree nor disagree (neutral)	Agree	Strongly Agree
17	The thought of being deep in the woods, away from civilization, is frightening					
18	I am very aware of environmental issues					
19	My ideal vacation spot would be a remote, wilderness area					
20	I am not separate from nature but a part of nature					
21	I think a lot about the suffering of animals.					

10. The following questions assess the degree of competing experiences

- a. In an average week, please ✓ how much time do you spend at home / work with a view of nearby 'nature' (within 500m)? (Where no view is 0 and 'nature' is trees, parks, gardens, fields, sea, lake, river)

0 ___ <1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

- b. In an average week, how much time do you spend outdoors?

<1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

- c. In an average week, how much time do you spend in private gardens?

<1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

- d. In an average week, how much time do you spend in public parks?

<1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

- e. In an average week how much time do you spend at the beach?

<1hr ___ 1-2h ___ 2-4h ___ 4-6h ___ 6-8h ___ 8-10h ___ 10-12h ___ >12h ___

11. The following questions ask about your productivity

- a. How many hours does your employer expect you to work in a typical 7-day week? (If you are a full-time student, how many hours do you expect to study a week? If you combine work + study, combine the hours)**

If it varies, estimate the average. If you are self-employed, estimate the number of hours you would consider a full work week. If you have more than one job, combine total number of hours for all jobs.

- iv. _____ TOTAL NUMBER OF HOURS
- v. How many of those hours are indoors? _____
- vi. How many of those hours are outdoors? _____

- b. Now please think of your work / study experiences in the past 7 days. In the spaces provided below, write the number of days you spent in each of the following situations.**

In the past 7 days, how many days did you... (Fill in the NUMBER OF DAYS _____)

- vi. miss an **entire** work/study day because of problems with your physical or mental health? _____
- vii. miss an **entire** work/study day for any other reason (including holiday / vacation)? _____
- viii. miss **part** of a work/study day because of problems with your physical or mental health? _____
- ix. miss **part** of a work/study day for any other reason (including holiday / vacation)? _____
- x. come in early, go home late, or work/study on your day off? _____

- c. The next questions are about the time you spent during your hours at work / study in the past 7 days. Circle the one number from each question that comes closest to your experience.**

- i. How often was your performance higher than most other people?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- ii. How often was your performance lower than most other people?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- iii. How often did you do no work at times when you were supposed to be working?..

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- iv. How often did you find yourself not working as carefully as you should?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- v. How often was the quality of your work lower than it should have been?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- vi. How often did you not concentrate enough on your work?....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

- vii. How often did health problems limit the kind or amount of work you could do?.....

All of the time	Most of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5

12. The following asks questions about your recent experiences, both positive and negative

Instruction Please think about what you have been doing and experiencing during the past four weeks. Then ✓ as appropriate to report how much you experienced each of the following feelings, using the scale.

		Very Rarely / Never	Not often	Sometimes	Often	Very Often / Always
✓		1	2	3	4	5
1	Positive					
2	Negative					
3	Good					
4	Bad					
5	Pleasant					
6	Unpleasant					
7	Happy					
8	Sad					
9	Afraid					
10	Joyful					
11	Angry					
12	Contented					

Is there anything else you would like to add?

Thank you! Gayle Souter-Brown, Researcher, PhD candidate

APPENDIX F: ONE-ON-ONE SEMI-STRUCTURED INTERVIEW QUESTIONS

*End of Study One

Question 1: What does the term 'sensory garden' mean to you?

Question 2: Do you have a 'happy place' you imagine or actually go to to relax? Describe.

Question 3: How does childhood memory affect your happy place?

Question 4: if you rank sight, smell, taste, touch, sound in order of importance, what comes out on top? Why?

Question 5: If you rank birds, trees, butterflies, frogs, grass, flowers, soil, water in order of importance, what is most important to have near you to relax? Why?

Question 6: Previously, would you feel bad / unproductive if you just sat? How do you feel now about just sitting?

Question 7: What would you say to people too busy to visit the sensory garden, or involved in active or programmed relaxation, stress management activities?

APPENDIX G: FOCUS GROUP QUESTIONS

*End of Study Two

Question 1: Do you have a favourite place in the garden?

Question 2: What would make it (the SG) better for you? Is there anything you would like to change?

Question 3: Have you noticed any changes in your health since the study?

Question 4: Do you know the Scholars' Garden is now open? Have you visited since the study finished?

Question 5: Do you intend to use the Scholars' Garden in the future?

APPENDIX H: DESIGN PROPOSAL

To show how research can be translated into professional practice, the design proposal is attached here.

The concept plan initially envisaged the entire garden, and each of the zones, being bordered by hedging. It was also envisaged that during the intervention phase the exit from the garden would be via a gate from zone 4.

Due to cost constraints the gate was not installed, the cabin was omitted, and the hedging became pillar-style spaced *Pittosporum tenuifolium*, to reference the contemplative cloister gardens of the old Oxbridge universities. Other design modifications were also required, to take account of surface tree roots and drainage issues.

Concept



Zone 1 as it was



Zone 1 in concept



Zone 2 as it was



Zone 2 as in concept



Zone 3 as it was



Zone 3 as per concept



Zone 4 as it was



Zone 4 as per concept





INTERNATIONAL SOCIETY OF BIOURBANISM
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Issue poems by Michaela Lamdan with photographs by Sara Bissen and Stefano Serafini

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THE THEORETICAL BASIS OF WELL-BEING AS A MOTIVATION FOR DESIGN

Gayle Souter-Brown

Auckland University of Technology, New Zealand

ABSTRACT

Recent rapid urbanization is associated with increased stress and reduced sense of well-being. The environment where we live, work, learn, and play affects us. What are the co-benefits of design for well-being? Addressing socio-environmental factors through design interventions leads to better health outcomes, faster. Well-being crosses theory and practice as a valuable epistemic foundation for design. Standard design practice no longer matches the multi-disciplinary theories that intersect well-being, requiring a focused, new design culture to offset and mitigate impacts of urbanization. Urbanism that explores only the interaction of inhabitants with the built environment misses the natural environment in which a city is set. Philosophically, design enquiry relies on doubt. This paper will critically review the literature to define well-being as a sound principle of design, to remove doubt, and to create a design paradigm on which designers are prepared to act.

Keywords: biophilia, salutogenesis, salutogenic design, attention restoration theory, stress recovery, public health, urbanism, urban design, urban ecology, well-being, positive mental health

INTRODUCTION

One could exemplify salutogenic design by confronting two city streets: one street has leafy trees and places to sit, while the other does not. Generally speaking, the first street is likely to attract more passersby because of the peaceful feeling that it produces, and compared to the second street, to become a preferred location for businesses and shops.

Rapid urbanization requires a new design culture to offset and mitigate the impacts of change. Negative impacts on society, the environment, and economy have been greatest in places where change has happened most rapidly, where the triple bottom line has been crossed (Elkington, 2004). While contemporary design evolved with political and economic influence, inclusion of elements effecting environmental and social outcomes can aid public health and well-being.

A search for urban design assessment models from the past 30 years shows little progress towards a new urban design approach that interfaces equity, culture, politics, and the environment. Standard healthcare still treats people when they are ill. Standard architecture still treats people as if they are well (Souter-Brown, 2015). At the same time, so-called lifestyle-related non-communicable diseases such as stress, depression, obesity, and some cancers now kill more people than the old communicable diseases such as measles, cholera, and malaria. In large part, this is due to improvements in sanitation and food safety, vaccines, antibiotics, and nutrition. However, the early success of medicine and early urban planning has created a problem. It has led people to put their faith in the notion that medical science would succeed in overcoming the remaining obstacles (Schlipkoter & Flahault,

2010). At the turn of the 20th century, health practitioners worked closely with urban planners (Kent & Thompson, 2012). As health improved and the war years intervened, the focus of urbanism moved away from health towards facilitating rapid economic recovery. Kent and Thompson noted that "despite closely linked origins, the contemporary professions of public health and urban planning largely operate within the neoliberal framework of academic, political, and policy silos" (Kent & Thompson, 2012).

BEYOND SILO THINKING:

THE CASE FOR AN INTEGRATED, MULTI-DISCIPLINARY APPROACH

Existing assessment models are based on outdated scientific patterns that analyze cities and their features as separated and disconnected pieces. But cities are complex systems, whose infrastructural, economic, and social components are strongly interrelated, and it is therefore impossible to understand them separately. The result is an ineffective policy, often leading to unfortunate and sometimes disastrous unintended consequences (Bettencourt & West, 2010).

We now know that health and well-being are intrinsically linked with sociological and environmental factors, the so-called "social determinants of disease" (Diener et al., 2010; Harter, Schmidt, & Keyes, 2003). Gary Cohen, a pioneer in the environmental health movement for over 30 years, believes that healthy environments are like a vaccine against illness. The environment where we live, work, learn, and play affects us. Likewise, it can offset stress and reduced well-being resulting from urban migration and densification. Co-benefits of design for well-being allows for co-designing services and settings, addressing socio-environmental factors through design interventions, and leads to better health outcomes faster (Cohen, 2016). Well-being crosses theory and practice as a valuable epistemic foundation for design. Standard design practice no longer matches the multi-disciplinary theories that intersect well-being,

requiring a focused, new design approach to mitigate the impact of urbanization. Urbanism that explores only the interaction of inhabitants with the built environment misses the natural environment in which a city is set.

Philosophically, design enquiry relies on doubt. This paper will critically review the literature to define well-being as a sound principle of design, to remove doubt, and to create a design paradigm in which designers are prepared to act.

As urban planning has successfully addressed public health in the past, we look there to find inspiration for the well-being of the future. In 1902, the father of modern town planning, Sir Ebenezer Howard, wrote in his book *Garden Cities of Tomorrow*, "in these days of strong party feeling and keenly contested social and religious issues it might be thought difficult to find a single question having a vital bearing on national life and well-being on which all persons... can agree. It is deeply to be deplored that people should continue to stream into the already overcrowded cities" (Howard, 1902, pp. 2-3).

Howard's "deplorable" migration to overcrowded cities has continued, with a backdrop of growing health challenges. Thirty years ago the emergent concept of lifestyle and the rise of lifestyle-related disease were noted by Coreil and colleagues (Coreil, Levin, & Jaco, 1985). Since then, researchers from multiple disciplines have recognized the need to formally link nature with urban studies but each have tended to come with a monofocal, reductionist lens. In 1986, the biophilia hypothesis was promulgated by Edward O. Wilson as a way of explaining humans' innate attraction to living things (Wilson, 1986). Ten years later, medical sociologist Aaron Antonovsky developed the concept of salutogenesis, an approach that focuses on factors that support human health and well-being rather than on factors that cause disease (pathogenesis) (Antonovsky, 1996). Although evidence of the health impacts of environmental design were growing, at that stage biophilia and salutogenesis were not linked. In 2003, ecologists led by Alberti

proposed an integrated framework to test hypotheses of the evolution on human-dominated ecosystems from interaction between humans and ecological processes. They observed that both the natural and social sciences have adopted complex systems theory to study emergent phenomena. They further stated that "while human and ecological processes are studied as separate phenomena decision making will remain fragmented" (Alberti et al., 2003, p. 1169).

At the same time, while ecologists were connecting humans and ecological processes, eco- psychology was growing as a new discipline. Kaplan and Kaplan were among the first to document the health benefits of a green view in post-operative patients (Kaplan & Kaplan, 1989). Soon after, Ulrich noted the stress-reducing effect of plants through experiments with unthreatening natural environments. He successfully predicted that nature-rich environments will have a reducing or restorative influence, whereas many urban environments will hamper recuperation (Ulrich et al., 1991). The resultant stress recovery and attention restoration theories developed as a response to the growing awareness of the potential health benefits of nature.

While ecology and psychology have been the major sources of literature on the impact of design, disciplines as diverse as forestry, real estate, workplace productivity, and accountancy have studied linkages with improved well-being on their area of interest. In 2008, the analytic hierarchy process was developed to determine the most sustainable design proposal for an area undergoing urban renewal (Lee & Chan, 2008). This process does not address lifestyle and well-being per se, but by looking beyond economic factors to include environmental sustainability in the design process, it rather addresses health and well-being by default.

Environmental degradation, inequality, stress, and depression add their weight to struggling infrastructure data. While urbanism attends to the interaction of inhabitants with the built environment, it misses the natural environment in which the city is set (Northridge, Sclar, & Biswas, 2003). While design has moved towards the politics of fashion and material convenience, the incidence

of lifestyle-related disease has reached unsustainable levels (Chan & Bloomberg, 2016). Multi-disciplinary research now unequivocally shows what has been long suspected: nature reduces stress and improves well-being (Harter et al., 2003; Kaplan, 1995; Maller, Townsend, Pryor, Brown, & St Leger, 2006; Stigsdotter, 2005; Tenngart Ivarsson & Grahn, 2012). Sensory gardens, by their biophilic, salutogenic, attention-restoring, and stress-reducing nature, offer an opportunity to provide a therapeutic dose of nature where people live, work, learn, and play (Gonzalez & Kirkevold, 2014; Hussein, 2010a; 2010b; Soderback, Soderstrom, & Schalander, 2004). The broad general perspective aims to join the dots to break down the silos. While as individuals we may intuitively know that connecting with nature is good for us, the discipline of design still views the natural environment with ambivalence. However, as the marketplace shifts to demand more for money, one way to add value to the design process is through understanding well-being as motivation for a new paradigm.

SPATIAL IMPACTS OF BIOPHILIC DESIGN

As urbanization has sped up, the environment has suffered increasing degradation and the incidence of lifestyle-related diseases. This led to pockets of interest devoted to the intersection between health and well-being on one side and urban ecology, architecture, socio-economic, and academic/work outcomes on the other. To date, researchers have used a relatively narrow, discipline-defined lens to examine potential linkages. The theories of personality of socio-psychologist Eric Fromm first raised the term "biophilia", our love for living things, as a potential cue for many innate behaviors (Fromm, 1964). The ecologist Edward O. Wilson took the idea further, to propose the biophilia hypothesis. In his book *Biophilia*, he stated that "our natural affinity for life—biophilia—is the very essence of our humanity and binds us to all other living things" (Wilson, 1986). This approach asserts that humans have an innate connection with nature that assists in making the urban environment more effective with

supportive, human abodes. In an urban context, opportunities to connect with nature can be problematic. For the purposes of this study we offer "landscape", "gardens", and "environmental design" as a means to facilitate the necessary nature connection within an urban setting (Souter-Brown, 2015). Biophilic design is thus articulated by the design profession as the relationships between nature, human biology, and the built environment (Browning, Ryan, & Clancy, 2014).

Edward O. Wilson's work brought together scholars from diverse fields. From this assemblage of intellectuals emerged the book *The Biophilia Hypothesis* (Kellert & Wilson, 1993). In 2006, academia, industry, government, finance, and civil sectors came together at a conference in Rhode Island, USA to further discuss the biophilia hypothesis. This prompted a search for potentially alternative "green" or nature-based therapies. As disease rates have grown, health commissioners, sociologists, and health economists have looked to nature for facing the growing burden of lifestyle-related disease (Figueras & McKee, 2012). For all the work of academia, it took a journalist, Richard Louv, to note the condition and coin the term "nature deficit disorder" in his book *Last Child in the Woods* (2005). Louv's work documents the impact of contemporary Western lifestyles against the amount of time children and adults spend outdoors. With the rise of technology has come a disconnection from nature. A study of 12,000 parents with children aged 5-12 years in 10 countries found that almost a third of children play outside for just 30 minutes or less a day. One in two children spend less than one hour outside per day, in contrast to prisoners who are guaranteed two hours in the open air every day (Packham, 2016). At the same time, mainstream media, as purveyors of the public see, create headlines that sell. Recently we have been told that trees are dangerous and must be carefully managed near children (Murphy, 2016). Trees have also been accused of adding pollution (Vidal, 2016). In some parts of certain cities, there are up to three generations with no lived experience of a tree (J. Wing-Long, personal communication, June 24, 2012). While quick to point out that his is not a medical diagnosis per se, Louv suggests that nature deficit disorder is real and has far-reaching effects on child and adult health and well-being. Wilson's biophilia hypothesis explains why,

subconsciously or consciously, we seek out leafy oases in the city. In his address to Santa Fe College students, Louv states that "the future will belong to the nature-smart—those individuals, families, businesses and political leaders who develop a deeper understanding of the transformative power of the natural world, and who balance the virtual with the real. The more high-tech we become, the more nature we need" (Louv, 2012, p. 4).

As a backdrop to a growing disconnection from nature, in the last 30 years two significant cultural events have occurred. Firstly, there has been increasing urban migration with the costs of city living requiring long work hours, reduced leisure time, and increased stress. Secondly, the advent of the digital age has seen people connect to devices and disconnect from nature (Louv, 2012). In 1983, the U.S. education policy statement, *A Nation at Risk*, told parents that their children needed to work harder to be competitive. Further, U.S. federal policies like *Race to the Top* "fomented an achievement culture, putting additional stress on students" (Lythcott-Haims, 2015). This pressure to succeed has extended into tertiary education. Third, Lythcott-Haims noted that the rise of the self-esteem movement saw a fundamental shift from the outcomes approach (raising a student to be resilient, responsible, and resourceful) to valuing personhood (raising a student to be aware of their rights, which in turn gave rise to the "me" generation). As mothers entered the workforce in record numbers, they struggled to find time to allow children to play outdoors. When parents began scheduling play, daycare for younger children morphed into organized after-school activities for older children (Lythcott-Haims, 2015). As a result, students entering university may have had little time to connect with nature through their programmed, focused childhood.

At the same time as the cultural shift, a change was observed in young adult health and well-being statistics. In the UK, teenage rates of depression and anxiety increased by 70% since the mid-1980s, particularly in the past 25 years (YoungMinds, 2016). A similar picture emerges in New Zealand where youth suicide, anxiety disorders, eating disorders, behavior problems, and obesity increased

as social skills, problem solving, and personal resilience deteriorated (Disley, 1997). Research by architects, eco-psychologists, foresters, and economists hinted at a potential three-way link between cultural changes, access to nature, and child health and well-being (Hagerhall et al., 2010; Ulrich et al., 1991). Their studies show that stress reduction, attention restoration, and general health improvements were seen to follow exposure to a green (nature) view.

In acknowledgement of this, public money has been lavished on parks and playgrounds as part of health promotion programs (Blanck et al., 2012). However, while research showing the health benefits of nature grows, fashion in architecture has become hard-edged. This has added to urban stress levels as we disconnect from nature (Newman & Soderlund, 2015). The book *Landscape and Urban Design for Health and Well-Being* showed that although some parks display an awareness of the need for nature connection, most new parks and playgrounds still show little awareness of their health promotion potential (Souter-Brown, 2015). While much work has been done in the area of connecting health with environmental design, there is still a disconnection between empirical knowledge, perception, and belief.

ATTENTION RESTORATION AND STRESS RECOVERY THEORY

Positive mental health focuses on well-being rather than the negatively connotated conditions such as depression, anxiety, and autism spectrum disorders (Keyes, Dhingra, & Simoes, 2010). Stress reduction is key to positive mental health (Wilkinson & Marmot, 2003). In the 1970s early eco- psychologists Greenway and Shapiro began to explore links between green views and health. Eco-psychology (or environmental psychology) explores the emotional bond between human beings and the environment out of which we evolve. Roger Ulrich's seminal study on the effect of a green view on patient recovery times established the basis for use of nature for health outcomes (Ulrich, 1984). Steven and Rachel Kaplan took the exploration further with their attention restoration theory

about restorative environments. Their book, *The Experience of Nature*, brought a health-promoting focus to psychology and ecology (Kaplan & Kaplan, 1989). "Eco-psychologists are drawing upon the ecological sciences to re-examine the human psyche as an integral part of the web of nature" (Brown, 1995). Maller's study, *Healthy Nature Healthy People: Contact with Nature as an Upstream Health Promotion Intervention*, shifted design thinking to focus on active lifestyles (Maller, Townsend, Pryor, Brown, & St Leger, 2006). Cycle ways and walkability were shown as necessary for healthy cities. Maas and colleagues' 2006 study, *Green Space, Urbanity, and Health: How Strong is the Relation?* took attention restoration and stress recovery further into the realm of health promotion (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). Green space was found to be strongly associated with stress recovery. However, for all the work of eco- psychologists and epidemiologists to "set the scene" for nature-based treatments, traditional views continue to influence health service delivery.

COGNITIVE BEHAVIOR THERAPY

Cognitive Behavior Therapy is considered the most cost-effective treatment choice for mild- moderate stress and depression (Churchill et al., 2002). However, the clinical effectiveness of such a standard treatment was reviewed and it was found that "although there is support for the effectiveness of cognitive behaviour therapy, the finding that the reviewed randomized controlled trials had limited effectiveness within routine clinical practice demonstrates that the evidence is not conclusive" (Coull & Morris, 2011, p. 2239). Given such inconclusiveness and the growing evidence of the efficacy of green or nature-based interventions (World Health Organization Europe, 2016), this paper challenges standard design practice to propose a translational nature-rich space. When cost effectiveness and cost efficiencies are important, as they are across housing, business parks, the university estate, and elsewhere, evidence-based design is the methodology of choice (Frumkin, 2003).

Mindfulness is increasingly used as a stress reduction intervention (Shapiro, Astin, Bishop, & Cordova, 2005). Mindfulness Based Stress Reduction and Mindfulness Based Cognitive Therapy were reviewed by Fjorback and colleagues with mixed results. Mindfulness Based Stress Reduction is recommended as a useful method for improving mental health and reducing symptoms of stress, anxiety, and depression. However, results are generalizable only to individuals who have the interest and ability to participate in such a program (Fjorback, Arendt, Ornbol, Fink, & Walach, 2011). A meta-analysis of nature-environment studies by Bowler and colleagues found "testing for direct health benefits of nature is problematic given the variety of aspects of a natural environment and way in which they might impact on health" (Bowler, Buyung-Ali, Knight, & Pullin, 2010).

The more urbanization increases and our cities grow, the more design-based health promotion and prevention tools are critical. However, perhaps due to research problems in knowing what to study, design theory and practice have been slow to adapt. Steel louvers are still attached to buildings for shade instead of planting adjacent street trees. For example, the theory behind crime prevention through environmental design has promoted vandal-proof steel and concrete street furniture and "landscapes" to become commonplace across urban settings. Hard, square-edged materials are used instead of softer, rounded, more sustainable and salutogenic timber. The environment is thus perceived as aggressive. Contemporary design paradigms, whereby form has prevailed over function, have negatively influenced the current health statistics (Souter-Brown, 2015). Therapeutic landscapes and humanist concepts such as sense of place and symbolic landscapes are under-recognized. Contemporary design archetypes do not offer a particular solution but rather the underlying system of ideas causes a range of solutions to be "normal" (Williams, 2002).

SALUTOGENESIS AS A DESIGN APPROACH

An alternative to traditional healthcare, the "salutogenic model" as a theory to guide health promotion, was first mooted by Aaron Antonovsky (1996). Traditional healthcare waits until one is ill and then treats the person back to health. Salutogenesis undertakes a better and less expensive path from preventing disease to address the social determinants of health (Mittelmark & Bull, 2013) within the community. The Landscape Institute states that "throughout history landscape architecture can be linked to the need to create places that were beneficial for people's health and well-being" (Landscape Institute, 2015). Mental health is closely linked to physical health (Canadian Mental Health Association, 2016). If we focus on physical health alone, then we miss a key driver for the overall well-being. Architecture recognizes the potential health impacts of design (Sadler et al., 2011), and ecologists concerned with the environmental implications of a population disconnected from nature are looking to the growing demand for human well-being to provide environmental benefits (European Centre for Environment & Human Health, 2017). Nature connections, whether through forest walking or urban landscape design interventions, have been shown to reduce stress (Capaldi, Passmore, Nisbet, Zelenski, & Dopko, 2015). Stress is a primary prompt for mental and physical illness. Hence, a salutogenic design approach could be a powerful tool for health and well-being.

Young people with special or additional educational needs have been found to respond positively to nature-based design interventions (Stigsdotter et al., 2011). Likewise, a variety of lifestyle-related non-communicable diseases such as obesity, type 2 diabetes, cardiac and upper respiratory tract disease, depression, anxiety, and dementia can be effectively managed and prevented at a community level (Maller, Townsend, Pryor, Brown, & St Leger, 2006). A salutogenic approach to healthcare utilizes factors that support human health and well-being as a cost-effective, preventative tool (Lindstrom & Eriksson, 2005).

The literature has identified the eco-psychological basis for green, nature-based interventions (Grahn & Stigsdotter, 2010), and opportunities for community-based improved health outcomes (Roe et al., 2013). The World Health Organization's Healthy Settings movement came out of the World Health Organization strategy of Health for All in 1980. The approach was more clearly laid out in the 1986 Ottawa Charter for Health Promotion (World Health Organization Europe, 2016). The successes of settings-based approaches have been validated through internal and external evaluation and experience (Bloch et al., 2014). Optimal spatial forms (the settings that make users feel good) derived from the environmental design formula to promote and enhance well-being. They are innovative and take a multi-disciplinary approach to health promotion and prevention (Carmichael, Barton, Gray, Lease, & Pilkington, 2012). Biophilic architecture and green buildings are two examples of this innovative approach. However, knowledge about the interplay of cultural structures on design typology or the potential for nature-based interventions in a place is insufficient. We know culture and ethnic background impacts appreciation and use of an environment, but do they impact the efficacy of gardens as a treatment for stress? In 2013, landscape architect Catharine Ward Thompson researched the stress levels in deprived urban communities and the effect of community-based greenspace to pedestrian exposure (Roe et al., 2013). Ward Thomson found that regular exposure to street trees decreased stress cortisol levels across the sample population. Roadside trees are also thought to decrease driver stress levels. Speed was reduced in tree-lined streets in Baltimore, and in Toronto accident rates were up to 20% lower in tree-lined streets (Battaglia, 2010).

To add weight to the case for environmental design interventions as a social good, in 2011 Lynn Ilo investigated whether education equality can trickle down to economic growth. Her study found a strong correlation between education and economic growth in Korea. The national UK schools survey looked at the effects of introducing nature and social connection points. Social and educational effects were noticed with decreases in absenteeism, bullying, vandalism, and increases in attendance, attention in class, aspiration,

and outcomes. Home-school partnerships were also enhanced with parents more involved in their community (Learning Through Landscapes, n.d.). So, by extension, can environmental interventions enhance economic growth? Think tanks such as Terrapin Bright Green agree with Ilon's conclusion that "education's power to bring about social change, to stabilise or destabilise communities, and to increase global competitiveness places it firmly within the purview of national policy as well as market forces" (Ilon, 2011). He thus suggests that environmental design can be important as a social good (Terrapin Bright Green, 2012).

Stress on campus was examined in a study in Nigeria. The research, which interestingly was reported in an accountancy journal, looked to the need for students to perform at their peak in order to promote overall national development. As in the Korean study, education is seen as an important medium that facilitates improvement of leadership qualities and turns out excellent future managers and professionals in different fields (Oseyomon, 2015). The authors observed that undergraduate students at the University of Benin were moderately stressed and that an inverse relationship exists between perceived stress levels and academic performance. The study recommended the university to develop stress-coping techniques to lift academic/work performance, but did not suggest how to go about it. More recent research has addressed possible environmental design interventions for stress reduction. The impact of landscape views on stress and mental fatigue reduction has been studied by Li and Sullivan. They found positive correlations between attention levels and green views from classrooms, and that attention restoration and stress recovery are two distinct processes (Li & Sullivan, 2016).

WELL-BEING AS A DESIGN FOCUS: INTRODUCING SENSORY GARDENS

A defined "dose" of nature, within a controlled, specialist-facilitated, social, and therapeutic horticulture program can reduce stress and depression (Hartig et al., 2011). Hartig tested the restorative environments theory through a meta-analysis to prove its efficacy

(Hartig, 1993). Dose responses for both intensity and duration show large benefits from short engagements in green exercise and diminishing but positive returns (Barton et al., 2010). Every green environment improved both self-esteem and mood; the presence of water generated greater effect. As such, they found that the environment provides an important health service (Barton & Pretty, 2010). As new urban areas are developed, whether town centers, housing, universities, or business parks, one should consider the opportunity for stress reduction through environmental design. Well-being can be "designed-in".

Shanahan and colleagues investigated human response to natural parks in Brisbane, Australia. They sought to determine the required "dose" of nature for human health and well-being. In summary they found that, people who made long visits to green spaces had lower rates of depression and high blood pressure, and those who visited more frequently had greater social cohesion. Higher levels of physical activity were linked to both duration and frequency of green space visits. A dose-response analysis for depression and high blood pressure suggest that visits to outdoor green spaces of 30 minutes or more during the course of a week could reduce the population prevalence of these illnesses by up to 7% and 9% respectively. (Shanahan et al., 2016, p. 4)

Researchers at the Universities of Alnarp, Sweden and Copenhagen, Denmark, have created therapeutic sensory gardens to support psycho-social teaching programs with local primary health objectives. The University of Alnarp created them on campus. The University of Copenhagen's Gronska therapeutic garden is situated in a private green area. Like Alnarp, the Gronska garden is zoned according to the eight characters—or fundamental elements—of garden spaces, where Social and Therapeutic Horticulture and the "Alnarp Method" are the therapeutic tools (University of Copenhagen, n.d.). Therapeutic horticulture is the process of using plants and gardens to improve physical and mental health, as well as communication and thinking skills. The Alnarp method was developed as a result of research into the fundamental building blocks of healing gardens (Grahn, 1991; Grahn, Stigsdotter, & Berggren-Barring,

2005; Hedfors & Grahn, 1998; Stigsdotter & Grahn, 2002). The Alnarp gardens have been used for 13 years to treat adults with depression and anxiety, and multiple studies have shown their efficacy in treating stress related disorders (Adevi & Lieberg, 2012). The eight fundamental design elements are:

1) serenity; 2) wild; 3) rich in species; 4) space; common; 6) the pleasure garden; 7) festive, and 8) culture.

These design elements can be combined within a zone or separated, but must be included for optimal effect (Grahn, Stigsdotter, & Berggren-Barring, 2005).

The Alnarp method allows people to progress at their own pace from one gradated garden zone to another, depending on need and mood. The zones progress from a passive reflective space through a garden designed to facilitate moderate physical exercise to a physically active tending, growing, edible, and ornamental plant space, to a space designed for social engagement. The sensory gardens provide key opportunities for:

- Improving mental health through a sense of purpose and achievement.
- Learning how to structure the weekday, to focus on the present moment, and to allow breaks and rest in order to avoid new relapse from stress and burnout.
- Bettering physical health through exercise, and learning how to use or strengthen muscles to improve mobility.
- Connecting with others by reducing feelings of isolation or exclusion.
- Acquiring new skills to improve the chances of finding employment.
- Simply feeling better for being outside, in touch with nature, and in the "great outdoors". (University of Copenhagen, n.d.).

The attention restoration theory and stress recovery from green space literature (Kaplan & Kaplan, 1989; Ulrich et al., 1991) suggests that a modified, non-specialist-facilitated form of Alnarp's sensory garden may be a viable self-help tool to manage stress. A future study will build on the existing literature to fuse an understanding of the role of urban ecology, objectified through nature connection, in creating and sustaining health and well-being as it influences academic or work achievements. It will test whether experience in a non-facilitated sensory garden is effective at reducing stress and improving work output in a New Zealand setting. Although based on the highly structured, managed experience of the Alnarp method, if the study shows the modified Alnarp sensory gardens to be effective at impacting stress, it may be possible to provide sensory gardens in diverse settings where people can self-heal. In addition to the university, social housing developments, care homes, schools, and workplaces could benefit from a self-help health promotion design tool. If proven, the value of such a tool would be in its accessibility and relative low capital and operational maintenance cost. It would enable architects and facilities managers to promote their developments as the "healthy option".

How we look after the well-being of students and faculty within the institution of a university setting has parallels with care homes. Kane identifies the value of "quality-of-life domains—namely security, comfort, meaningful activity, relationships, enjoyment, dignity, autonomy, privacy, individuality, spiritual well-being, and functional competence" (Kane, 2001, p. 293). The author adds: "these kinds of quality-of-life outcomes are minimized in current quality assessment and given credence only after health and safety outcomes are considered" (ibidem). Similarly, environments for younger students, especially pre-schoolers, are often designed around perceived safety and practicality. An emphasis on indoor environments and rubber-matted, hose down-able outdoor spaces, rather than around the health and well-being of the users, has impacted child health statistics (Souter-Brown, 2015, p. 105). As a result of a largely sedentary life indoors, many children today have weaker bones, poor muscular coordination (although their thumbs

and index fingers may be well developed), rickets, and such a low life expectancy that today's children are expected to live five years less than their parents (National Institutes of Health, 2005).

Focus on prevention presents opportunities and challenges. In 2016, Japanese and British ecologists recognized the ongoing loss of human interactions with nature, the so-called "extinction of experience", as one of the major obstacles to addressing global environmental challenges (Soga, Gaston, Yamaura, Kurisu, & Hanaki, 2016). Their study of schoolchildren found that affective attitudes (individuals' emotional feelings) toward and willingness to conserve biodiversity are positively associated with the frequency of both direct and vicarious experiences of nature. In the Japanese study, path analysis showed that these experiences on children's willingness to conserve biodiversity were mediated by their affective attitudes. Children who frequently experience nature are likely to develop greater emotional affinity to and support for protecting biodiversity. If sensory gardens connect people with nature, these will likely develop greater emotional affinity to and support for protecting biodiversity and become advocates for nature-based health and education initiatives.

COULD SENSORY GARDENS BE AN EFFECTIVE AID TO WELL-BEING?

Sensory gardens are accessible, species-rich environments within urban settings. They are designed to address specific social, emotional, cognitive, spiritual, and physical health needs of adults and children (Souter-Brown, 2015). The health-giving benefits of urban green space and nature are generally well defined. In an urban setting, where opportunities for nature connections are often managed, confined, and access-controlled, sensory gardens provide an ecologically-balanced environment where sensory inputs are planned in terms of access, comfort, acoustics, color, scent, sights, and sounds. Sensory gardens can bring a health-giving "dose" of nature.

The landscape architect Hazreena Hussein found that sensory gardens are effective as a tool to enhance the educational development and social interaction of children with special needs (Hussein, 2010b). In 2014, another landscape architect, Rita Berto, asked how attention restoration works and what is the role of nature in coping with psycho-physiological stress. She conducted a comprehensive literature review on restorativeness. Ecological restoration, through the development of sensory gardens or other nature-rich environments, were found to enhance and restore attention (Berto, 2014). As community stress levels grow and as urbanization increases pace, the incidence of adults and children suffering stress and diminished attention is growing. The World Health Organization has stated that the rising burden of non-communicable, lifestyle-related disease is unsustainable. The evidence is unequivocal. Sensory gardens afford opportunities to connect socially and with nature, which has been seen to promote well-being and community resilience (World Health Organization Europe, 2016).

Lifestyle-related stress, depression, and physical inactivity are global challenges that require local solutions. On a local level, city mayors are well positioned to play a preventive role through the provision of green space for rest and recreation, clean air, and locally grown food (Chan & Bloomberg, 2016). Concomitantly, despite the growing body of literature showing causal relationships between health, well-being, education, and design (architecture) or nature, and between stress, environment, and lifestyle-related disease (British Association for Counselling & Psychotherapy, 2016), nature-based interventions are not routinely used as a prevention and health promotion tool.

MOTIVATION FOR DESIGN

Designers have an increased opportunity and responsibility to work collaboratively within multi-disciplinary teams. What are the designer's motivations? Do they live in art or science, or in the liminal space in between? Do designers desire to be known for an iconic piece of art, or to be part of a movement towards the science-art amalgam of beautiful forms that enhance functional well-being? Architect and educator Jonathan Hill believes that a subject creating, occupying, and even destroying a space moves spatial design beyond a subject that occupies an object (Hill, 2001). Green buildings are likely to become more popular with clients as corporations work to enhance both their image and human capital (Eichholtz, Kok, & Quigley, 2016). Green infrastructure has to become the norm if design is to tackle the dual challenges of public health and climate change. The spaces in between the buildings as well as the buildings themselves must be considered in their totality.

Placemaking has been supplanted by placekeeping. Places for both social and natural connections are required.

CONCLUSIONS AND FUTURE DIRECTIONS

Design for well-being is a departure from the mainstream. A salutogenic approach to well-being asks design's focus on forms to be redirected toward function. For human well-being, we need functioning, healthy, urban ecologies. Sensory gardens, from their species-rich serenity spaces, opportunities for culture, pleasure, and festivity, and view of wildlife-attracting water, sunlight, and shade, attract people. Urban street trees bring low-dose sensory delight, while sensory gardens can bring high-dose nature experience to users.

Well-being has been defined as more than the absence of disease. For people already disconnected from nature, when faced with increasing societal and perhaps personal stress, it might seem easy to maintain the concrete-and-steel urbanism. However, this is not true, and disconnected designers and their clients need to be awakened to the potential of design for well-being.

Design has been shown to be efficacious as a support for a sense of well-being. Reflecting on the epistemology of design and the blend of practice and theory helps us understand both the theoretical basis for well-being as design motivation and the very practical nature of such an approach. The evidence presented shows design to be ready and able to play its part in public health and well-being. The past 50 years have seen a design emphasis on cities as centers of commerce. Cities of the future will judge their environments by how well people function. Functional urbanism requires a reinjection of nature. Our well-being depends on it.

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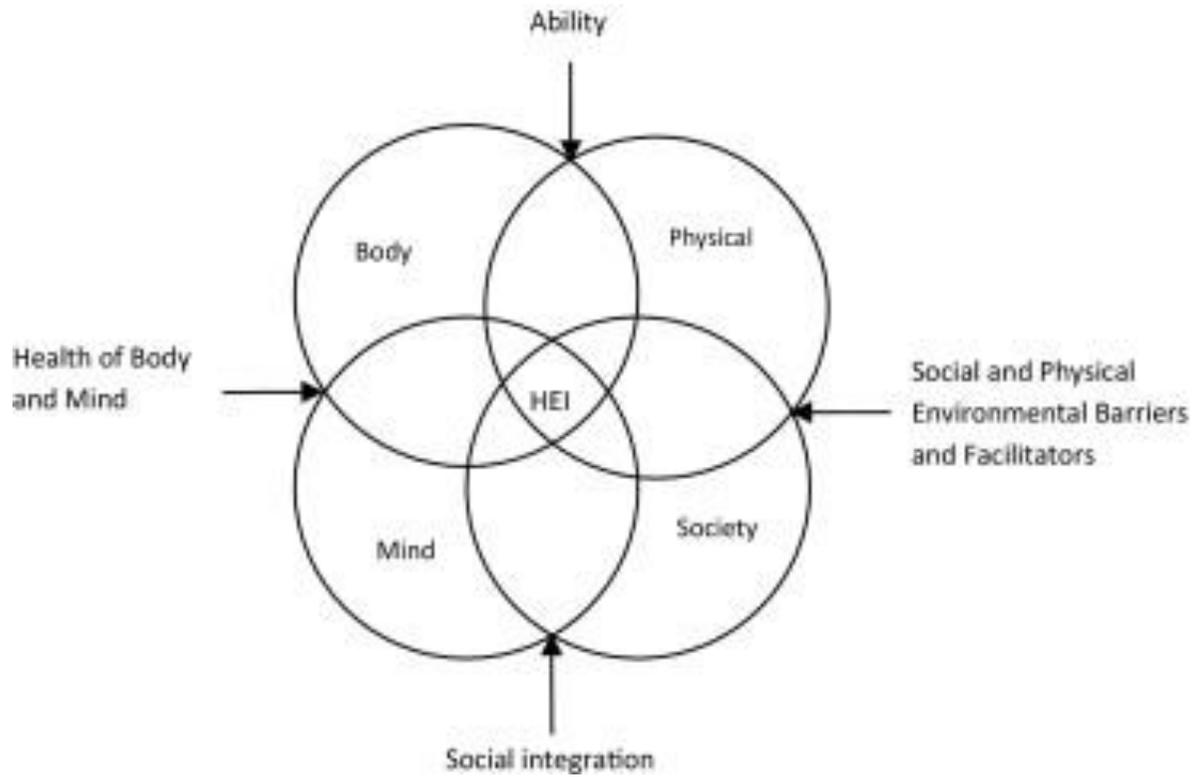
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APPENDIX J: THE BIO PSYCHO SOCIO-ECOLOGICAL MODEL OF HEALTH

Engel's Bio Psycho Socio-ecological model of health, from (M. G. Stineman & J. E. Streim, 2010)



APPENDIX K: MIND MAP OF THE SYSTEMATIC LITERATURE REVIEW

