



Nature and psychological wellbeing - investigating the role of perceptions and nature connection within an urban context

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**Nature and psychological wellbeing – investigating the role of
perceptions and nature connection within an urban context**

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Abstract

This thesis explores the relationship between nature and psychological wellbeing. It does this within an urban context, examining how people's perceptions of and connection to nature relate to psychological wellbeing and exploring factors that are associated with an individual's subjective relationship with nature. First, I investigate how changes in perceptions of the quality and quantity of local urban nature relate to psychological wellbeing over time. Then I build on the concept of an individual's subjective *perceptions* of nature to explore their subjective *relationship* with nature, or their nature connection, and how this relates to psychological wellbeing. Finally, to assist with the practical application of the research, I explore factors that may relate to nature connection within an urban context. This final component aims to address the numerous policy and planning documents which include objectives on nature connection enhancement. Hence, through exploring factors that are related to nature connection this research may help inform the design and delivery of such nature connection enhancing objectives and initiatives.

This research used a multi-phased, sequential, survey-based design to explore how perceptions of and connection to nature relate to psychological wellbeing and to investigate factors that may be associated with nature connection. Using longitudinal mail-based survey data from 5,014 mid-aged Brisbane urban residents, I explored the first research question of this thesis - How do changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing? This research question emerged from the review of the nature and mental health literature which highlighted the preponderance of cross-sectional study designs investigating how objective measures of nature relate to measures of mental ill-health. To move the field forward I used longitudinal data to assess how changes in perceptions of the quality and quantity of nature relate to mental wellbeing over time – which, to the best of my knowledge, is the first time this relationship has been investigated within a longitudinal study design. Results of the longitudinal, fixed effects, two-period difference regression showed that within-person

changes in perceptions of urban nature were positively associated with changes in psychological wellbeing.

These findings provided justification for further exploration of people's subjective relationship with nature and how this relates to wellbeing and hence shaped the second research question of this thesis - How is nature connection associated with psychological wellbeing? Nature connection refers to the affective, cognitive and experiential aspects of an individual's subjective relationship with nature. To answer this question, I designed and administered a cross-sectional, web-based survey of 1,000 adult Brisbane urban residents. Based on Self Determination Theory I identified potential mediators of the nature connection-wellbeing relationship. Through a parallel, multiple mediator model I tested the indirect effect of non-human relatedness and intrinsic values on the relationship between nature connection and psychological wellbeing. The results show that the relationship between nature connection and wellbeing is mediated by non-human relatedness and intrinsic values, which operate as parallel mediators. This suggests that people who experience greater connection to nature also experience greater wellbeing and this may be because nature connection satisfies the psychological need for relatedness and reinforces intrinsic values.

These findings provide further evidence of nature connection's positive relationship with psychological wellbeing and provide support for the cultivation of nature connection among urban residents for wellbeing promotion. Building on this finding the research sought to understand factors that may relate to an individual's nature connection and hence formed the third and final research question of this thesis - What is the relationship between childhood and adult nature experiences and nature connection? The same cross-sectional, web-based survey data from 1,000 adult Brisbane urban residents was used to answer this question. Multiple regression analysis showed that childhood nature experiences and duration of adult nature experiences have a positive relationship, of comparable strength, with current nature connection levels. To further tease apart the role of childhood and adult nature experiences I carried out a moderation analysis which revealed that childhood nature experience was not a significant

moderator of the positive relationship between duration of adult nature experiences and nature connection. This suggests that nature experiences should be encouraged at all life stages if enhanced nature connection is the goal.

In summary, this research used a multi-phased, sequential, survey-based design to answer three overarching research questions. This thesis has contributed to the nature and mental health research field through providing evidence of the positive associations between people's perceptions of and connection to nature and their psychological wellbeing, and through providing evidence on the positive relationship between nature experience and nature connection. This provides justification for looking beyond objective measures of nature exposure to start exploring and disentangling how people perceive and interpret nature and how these interpretations affect the psychological wellbeing outcomes from nature. Similarly, this thesis encourages further investigation of the relationship between nature experiences and nature connection across the life course, as well as the further exploration of other factors that may cultivate a person's nature connection. Much remains to be explored in this space with key gaps in our understanding of what factors influence an individual's nature connection, how perceptions and interpretations of nature vary across individuals and groups, across the life course and across diverse types, quantities and qualities of nature. Nevertheless, the findings of this thesis provide a useful basis for future exploration of people's subjective relationship with nature, the factors that shape it and the wellbeing outcomes that derive from it. With additional research the findings from this thesis may help inform the design of, and enhance the wellbeing outcomes from, nature connection promoting initiatives.

Statement of Originality

This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

Signed:
(Anne Cleary)

Publications during candidature

Peer-reviewed papers

Cleary, A., Fielding, K. S., Bell, S. L., Murray, Z., & Roiko, A. (2017). Exploring potential mechanisms involved in the relationship between eudaimonic wellbeing and nature connection. *Landscape and Urban Planning*, 158, 119-128.

Cleary, A., Fielding, K. S., Murray, Z., & Roiko, A. (2018). Predictors of nature connection among urban residents: Assessing the role of childhood and adult nature experiences. *Environment and Behavior*. <https://doi.org/10.1177/0013916518811431>

Cleary, A., Roiko, A., Burton, N., Fielding, K. S., Murray, Z., & Turrell, G. (under review). Changes in perceptions of urban green space are related to changes in psychological well-being: Cross-sectional and longitudinal study of mid-aged urban residents. Submitted to *Health and Place* on 07 August 2018.

Cleary, A., Fielding, K. S., Murray, Z., & Roiko, A. (in preparation). Nature connection and psychological wellbeing: The mediating role of non-human relatedness and intrinsic values.

Hunter, R., Cleary, A., Cleland, C., Wheeler, B., Sinnett, D., Nieuwenhuijsen, M., Braubach, M., (in preparation). Systematic review of the environmental, health, wellbeing and equity effects of urban green space interventions: Recommendations for policymakers, practitioners and researchers.

Book chapters

Hunter, R., Cleary, A., Braubach, M., (accepted and in press). Environmental, health and equity effects of urban green space interventions - Biodiversity and health in the face of climate change. Springer Nature

Roiko, A., Kozak, S., Cleary, A., Murray, Z., (under review). Managing the public health paradox: benefits and risks associated with waterway use

Reports

Note: These reports were the result of a three-month placement with the World Health Organization's European Centre for Environment and Health in Bonn, Germany (Jul – Sept 2016).

Urban Green Space Interventions and Health: A review of impacts and effectiveness (2017) Copenhagen: WHO Regional Office for Europe

This report draws from three working papers prepared for a WHO expert meeting on urban green space interventions (see Appendices 1-3). I co-authored two of the three working papers as follows:

- Ruth Hunter, Anne Cleary and Claire Cleland (Working Paper 1: Evidence review on the environmental, health and equity effects of urban green space interventions);
- Annette Rebmann, Anne Cleary and Matthias Braubach (Working Paper 2: Good practice and lessons learned. A review of urban green space intervention case studies);

Urban green spaces and health: A review of the evidence (2016) Copenhagen: WHO Regional Office for Europe

I am a recognised contributor to this report for reviewing and editing drafts of this report.

Urban green spaces and health: A brief for action (2017) Copenhagen: WHO Regional Office for Europe

This succinct, practitioner focused document does not identify authors. However, this document is the result of the work I completed with WHO during my placement and I co-authored early drafts and reviewed later versions. This document has since been translated into four other languages.

Media

Cleary, A., Hunter, R., Green space - how much is enough, and what's the best way to deliver it? (26 May 2017) The Conversation

Cleary, A., Kendal, D., Can virtual nature and poo transplants solve city dweller' health problems? (01 Nov 2017) The Conversation

Dedication

For Shane.

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Included in this thesis are papers in *Chapters 2, 4, 5 and 6* which are co-authored with other researchers. My contribution to each co-authored paper is outlined at the front of the relevant chapter. The bibliographic details and status for these papers including all authors, are:

Cleary, A., Fielding, K. S., Bell, S. L., Murray, Z., & Roiko, A. (2017). Exploring potential mechanisms involved in the relationship between eudaimonic wellbeing and nature connection. *Landscape and Urban Planning*, *158*, 119-128.

Cleary, A., Turrell, G., Burton, N., Fielding, K. S., Murray, Z., & Roiko, A. (under review). Changes in perceptions of urban green space are related to changes in psychological well-being: Cross-sectional and longitudinal study of mid-aged urban residents. Submitted to *Health and Place* on 07 August 2018.

Cleary, A., Fielding, K. S., Murray, Z., & Roiko, A. (in preparation) Nature connection and psychological wellbeing: The mediating role of non-human relatedness and intrinsic values.

Cleary, A., Fielding, K. S., Murray, Z., & Roiko, A. (2018) Predictors of nature connection among urban residents: Assessing the role of childhood and adult nature experiences. *Environment and Behavior*. <https://doi.org/10.1177/0013916518811431>

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Signed:
(Anne Cleary)

Date: 31 August 2018

Countersigned:
(Anne Roiko)

Date: 31 August 2018

Chapter 1. Introduction

1.1 Nature and health

Ulrich's 1984 landmark paper 'View through a window may influence recovery from surgery' helped ignite research focusing on the positive relationship between nature and human health (Ulrich, 1984). Ulrich's study showed that postoperative patients whose hospital room windows overlooked a natural scene had shorter hospital stays, less negative nurses' evaluations and less use of painkillers in comparison to similar patients whose hospital room windows faced a brick wall. Since then there has been growing interest in exploration of the relationship between nature and human health with researchers seeking to identify and understand the multiple pathways through which nature may influence positive health outcomes. As a result, there is now a well-established and well-recognised evidence base showing that presence of nature in the living environment is associated with numerous positive physical, social and mental health outcomes (Hartig, Mitchell, De Vries, & Frumkin, 2014). Some health outcomes and associated pathways have been well researched and as a result are well understood, for example, the role of nature in air purification and its association with respiratory health (Thiering et al., 2016; Tong, Baldauf, Isakov, Deshmukh, & Max Zhang, 2016). Other pathways are only starting to be explored with much remaining unknown about the multiple contributing factors and mechanisms at play between the nature exposure and health outcome. The complex and nuanced relationship between nature and mental health outcomes is a good example of a pathway with key knowledge gaps. Within the research on nature and mental health most of the attention has been devoted to the role of nature in combating rates of mental ill-health with studies showing positive associations between nature exposure and recovery from cognitive fatigue and reduced rates of anxiety, stress and depression. For example, nature exposure has been shown to be associated with lower rates of anxiety (Nutsford, Pearson, & Kingham, 2013), stress (Fan, Das, & Chen, 2011), psychological distress (Sturm & Cohen, 2014, Astell-Burt et al., 2013, Feng & Astell-Burt, 2018) major depressive disorders (Mukherjee et al., 2017; Sarkar, Webster, &

Gallacher, 2018), antidepressant prescription rates (Taylor, Wheeler, White, Economou, & Osborne, 2015) and suicide risk (Helbich, de Beurs, Kwan, O'Connor, & Groenewegen, 2018). Less well researched is the relationship between nature and mental wellbeing.

1.2 Nature and mental wellbeing

There is growing recognition that mental health care requires the promotion of mental wellbeing in addition to the treatment and prevention of mental health disorders (WHO, 2013). While there remains much debate on how to define mental wellbeing, there tends to be general agreement that individual or subjective wellbeing can be described as encompassing four components – an evaluative perspective, positive experience perspective, negative experience perspective and eudaimonic perspective (O'Donnell, Deaton, Durand, Halpern, & Layard, 2014). Collectively, positive experience and negative experience can be described as affective wellbeing or hedonic wellbeing, which tends to evaluate the range of positive and negative emotions that an individual experiences in the short-term (Deci & Ryan, 2008). Conversely, eudaimonic wellbeing refers to a deeper sense of wellbeing experienced over the longer-term. Eudaimonic wellbeing is also known as psychological wellbeing and includes aspects such as life purpose, sense of achievement and personal growth (Deci & Ryan, 2008). There is interest in the promotion of eudaimonic wellbeing as it is considered fundamental to the delivery of thriving and flourishing communities – a key goal of many mental health plans (NMHC, 2014).

There is much discussion in the literature about what factors influence mental wellbeing. In England, the Office of National Statistics identified access to green space as one of the measures of national wellbeing (ONS, 2018). This is based on evidence in the literature that shows that nature exposure is positively associated with indicators of mental wellbeing, such as life satisfaction (Fleming, Manning, & Ambrey, 2016), happiness (Van Herzele & de Vries, 2012) and eudaimonic wellbeing (White, Pahl, Wheeler, Depledge, & Fleming, 2017). There are a number of well-researched theories, such as Stress Recovery Theory (Ulrich et al., 1991) and Attention Restoration Theory (Kaplan, 1995), that aim to explain how exposure to nature can

provide restorative and recovery functions for people suffering from cognitive fatigue, or one-off/cumulative episodes of stress. While these theories provide insight to the relationship between nature exposure and mental health they don't provide a comprehensive explanation for the reported positive associations between nature exposure and mental wellbeing, particularly eudaimonic wellbeing. We therefore lack a comprehensive understanding of the pathways by which people *without* chronic or acute mental ailments derive mental wellbeing benefits through nature. Lack of an underpinning theory to explain the relationship between nature and improved wellbeing limits our ability to optimise the wellbeing outcomes from nature-based interventions.

There is a need for better understanding of how nature promotes mental wellbeing. One way to achieve this may be to look beyond objective measures of nature exposure, which tend to dominate the current literature. While objective measures are convenient and useful, it can be argued that an individual's perception of a given situation, which can differ greatly from the actual situation, can have a substantial effect on mental wellbeing (Conversano et al., 2010; Korn, Sharot, Walter, Heekeren, & Dolan, 2014). The few studies that have used subjective measures of nature exposure, where participants are asked to rate how much nature they perceive to be present, how accessible they perceive nature to be or how they perceive the quality of the nature, have found positive correlations between perceptions of urban green space and mental health outcomes (de Jong, Albin, Skärbäck, Grahn, & Björk, 2012; Sugiyama, Leslie, Giles-Corti, & Owen, 2008). Interestingly some studies have assessed the relationship between mental health and both objective and subjective measures of nature exposure. Coldwell and Evans (2018) have shown that people's perceptions of the quantity of urban nature differed subtly from objective measures. Furthermore, Gubbels et al. (2016) showed that perceiving more nature in neighbourhoods was related to a decrease in depressive symptoms among Dutch urban residents but no such association was found with objective measures of urban nature. This suggests that when assessing associations with mental health, subjective measures of nature may provide unique insights that are not captured by objective measures alone. Hence, it is important

to assess how people's perceptions of nature relate to mental wellbeing. This is an under-researched relationship, particularly within longitudinal study designs.

1.3 Nature connection and wellbeing

Building on the concept of people's perceptions of nature is the idea of an individual's subjective relationship with nature. The human relationship with nature has been explored from many perspectives and has been labelled many things within the literature, for example, love and care for nature (Perkins, 2010), inclusion of nature in self (Schultz, 2001), connectivity with nature (Dutcher, Finley, Luloff, & Johnson, 2007), nature relatedness (Nisbet, Zelenski, & Murphy, 2008) and emotional affinity towards nature (Kals, Schumacher, & Montada, 1999). Collectively, this body of work can be described as *nature connection*, and refers to the subjective sense of our experiential, cognitive and affective relationship with nature (Ives et al., 2017; Restall & Conrad, 2015; Russell et al., 2013). Interest in nature connection is growing with the number of nature connection related publications rising rapidly (Ives et al., 2017). The resulting evidence base suggests that nature connection may have a positive influence on mental wellbeing (Cervinka, Röderer, & Hefler, 2011; Howell, Dopko, Passmore, & Buro, 2011; Nisbet, Zelenski, & Murphy, 2011) and pro-environmental behaviours (Nisbet et al., 2008; Zelenski, Dopko, & Capaldi, 2015). Based on these findings numerous nature connection enhancing initiatives have been established (e.g., ICUN's #NatureForAll program, Wildlife Trusts 30 Days Wild campaign), and nature connection objectives are starting to appear in various planning and policy documents (HM Government, 2018; Victoria State Government, 2017). The aim of such programs, initiatives and policies is ultimately to improve wellbeing and promote pro-environmental behaviour through enhancing nature connection. However, much remains unknown about nature connection.

While some evidence on the relationship between nature connection and wellbeing has been derived from general population samples (Nisbet & Zelenski, 2013; Nisbet, Zelenski, & Murphy, 2011), the majority of evidence tends to be drawn from small scale studies sampling

atypical populations (e.g., female dominant student samples; Capaldi, Dopko, & Zelenski, 2014). This has led to recommendations for larger studies representing general populations (Kamitsis & Francis, 2013). Furthermore, theory to explain the reported positive associations between higher nature connection and greater psychological wellbeing is lacking. While associations have been identified between nature connection and increased wellbeing (Cervinka et al., 2011; Nisbet et al., 2011) and reduced anxiety (Martyn & Brymer, 2016), there is little explanation as to why such associations have been found, with mediators and moderators of such relationships remaining largely unexplored. A mediator explains how or why there is a relation between the independent and dependent variable. A moderator affects the strength of the relation between the independent and dependent variable.

Only a very limited number of studies have tested mediators of the nature connection and wellbeing relationship with spirituality being identified as one possible mediator (Kamitsis & Francis, 2013; Trigwell, Francis, & Bagot, 2014). Lack of understanding of how nature connection relates to wellbeing restricts the interpretation of nature connection research and impedes the optimisation of wellbeing outcomes from nature connection-enhancing initiatives.

Despite the growing number of nature connection enhancing initiatives and policy objectives, there is still meagre understanding of what factors influence and shape an individual's nature connection. This is a key knowledge gap that may lead to misinformed design and delivery of such nature connection enhancing initiatives and objectives. Some studies have investigated different pathways to nature connection, for example, exploring the role of biological values (Lumber, Richardson, & Sheffield, 2017), environmental education (Ernst & Theimer, 2011) and nature experiences, including childhood nature experiences (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2008; Nisbet & Zelenski, 2011; Schultz & Tabanico, 2007). Nature connection initiatives and objectives tend to target urban populations and hence it can be argued that pathways to nature connection need to be accessible within an urban environment. Some studies have investigated the role of urban nature experiences in relation to nature connection but have only focused on a narrow type of urban nature experience, such as a visit to an urban

park (Lin, Fuller, Bush, Gaston, & Shanahan, 2014; Scopelliti et al., 2016). Urban environments contain diverse types of nature which are of varying quantity and quality. Certain types of urban nature may be more conducive to fostering a sense of nature connection for certain people in comparison to others. Hence, there is a need to understand how experiencing diverse types of urban nature relates to nature connection. Furthermore, there is a lack of understanding of how nature experiences relate to nature connection at different stages in life. Very few studies have assessed the effect of both childhood and adult nature experiences simultaneously on current nature connection levels. Those that have tend to use small atypical samples limiting the conclusions that can be drawn from such study findings (Colléony, Prévot, Saint Jalme, & Clayton, 2017). If nature connection initiatives and objectives are to achieve their aim of cultivating nature connection among urban residents, then there is a need for a better understanding of factors that may relate to nature connection, particularly within an urban context.

1.4 Research questions

There is a well-established evidence base on the relationship between nature and mental ill-health. However, as outlined above, there is less focus on the relationship between nature and mental wellbeing. The aim of this thesis is to address this gap by exploring within an urban context how nature relates to psychological wellbeing. This will be achieved by investigating how changes in subjective perceptions of the quality and quantity of local urban nature relate to psychological wellbeing. I will then build on the concept of an individual's subjective *perceptions* of nature to explore their subjective *relationship* with nature, or their nature connection. Nature connection has been shown to be related to psychological wellbeing but there is little understanding of how this association occurs. I will therefore investigate mediators of the relationship between nature connection and psychological wellbeing. Finally, to assist with the practical application of the research, factors that relate to nature connection within an urban context will also be explored. Through exploring factors that may be associated with

nature connection, this final component of the research aims to help inform the design and delivery of nature connection enhancing objectives and initiatives.

To address these aims, this thesis explores three overarching research questions:

Research Question 1. (RQ1) How do changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing?

Research Question 2. (RQ2) How is nature connection associated with psychological wellbeing?

Research Question 3. (RQ3) What is the relationship between childhood and adult nature experiences and nature connection?

A multi-phased, survey-based methodology that uses both longitudinal and cross-sectional survey data is used to answer these research questions. An overview of the nature and psychological wellbeing relationship is provided in Figure 1.1, with indication of what components of this relationship are addressed by each research question.

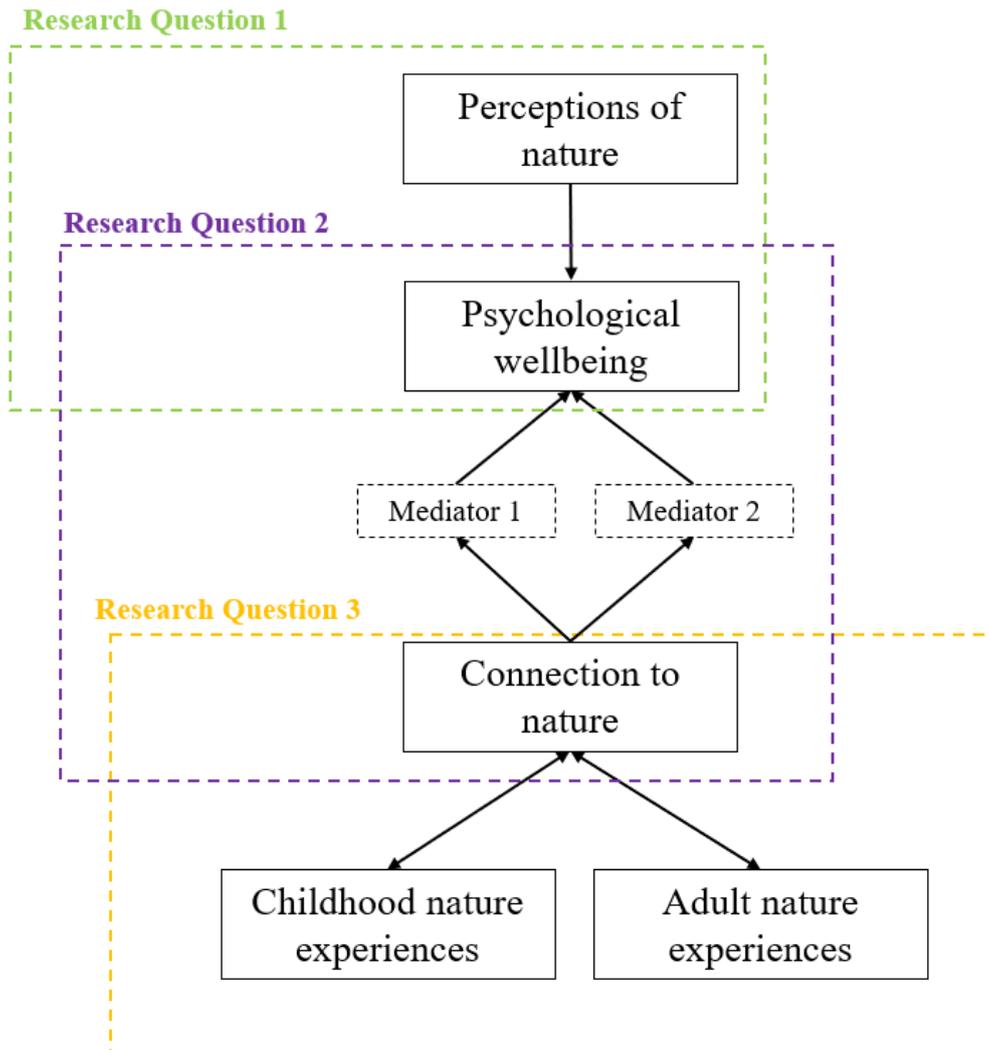


Figure 1.1. Schematic of how the research questions relate to the relationship between perceptions of and connection to nature and psychological wellbeing

1.5 Key terms

Researchers from the disciplines of psychology, sociology, anthropology, environmental management, public health, tourism, geography, education and urban planning are all actively exploring the relationship between nature and health. As a result, there is a plethora of terms being used to describe similar concepts. In a bid to provide clarity, this section outlines the terms and definitions used for the purposes of this research and thesis.

Urban nature

There are numerous terms used to describe urban nature, for example, green space, blue space, natural environments, green infrastructure, nature-based solutions, ecosystem services, urban greening, urban forests as well as public open space which can contain urban nature. For the purposes of this thesis I use the term urban nature, which is considered to be all the plants and animals that live in an urban environment. A full definition was developed for the purposes of this research as follows: *‘All cities contain nature. Parks, street trees, riverside walkways, creeks, bushland reserves, sports fields and even home gardens are all part of what makes up nature in Brisbane City. Urban nature includes all the plants and wildlife that live in the city’*. This definition was shared with participants of the cross-sectional survey. Hence it was developed in a way that could be easily understood. In doing so it was intended to promote a shared understanding among survey participants and aid them with the interpretation and answering of the survey questions that related to urban nature. I adopted this broad definition of urban nature as I did not want to limit the type of nature an individual perceives or relates to. In Chapter 4, urban nature is referred to as urban green space as this nomenclature was better suited to the journal that this paper was submitted to. Despite this different term, urban green space still refers to the same definition of urban nature as described above.

Psychological wellbeing

Mental health promotion is seen as a key approach to combating increasing rates of mental ill-health. Mental health promotion reconceptualizes mental health in positive rather than negative terms and shifts the focus towards positive indicators of mental wellbeing (WHO, 2004, 2013). However, there is still much debate in the literature about how best to define and measure mental wellbeing. Subjective wellbeing is how individuals evaluate their life and is considered as one way to assess mental wellbeing (Diener, Suh, Lucas, & Smith, 1999). There is growing consensus that subjective wellbeing comprises four components (White et al., 2017). These are evaluative wellbeing, eudaimonic wellbeing (also known as psychological wellbeing) and affective wellbeing (also known as hedonic wellbeing) of which there are two types - positive and negative affective wellbeing. This thesis focuses on the eudaimonic or psychological

wellbeing component of mental wellbeing. Psychological wellbeing encompasses prime psychological functioning and personal growth and living life in a full and purposeful way (Deci & Ryan, 2008).

Nature Connection

The study of the human-nature relationship seeks to reveal how people identify themselves with nature and how people form relationships with nature (Restall & Conrad, 2015). The human-nature relationship has been explored from a variety of perspectives, such as the Biophilia Hypothesis (Wilson, 1984), therapeutic landscapes (Bell, Foley, Houghton, Maddrell, & Williams, 2018; Gesler, 1992, 1993) and place attachment (Scannell & Gifford, 2016). As a result, there are a plethora of terms to describe the human-nature relationship, for example, love and care for nature (Perkins, 2010), inclusion of nature in self (Schultz, 2001), connectivity with nature (Dutcher et al., 2007), nature relatedness (Nisbet et al., 2008) and emotional affinity towards nature (Kals et al., 1999). In this thesis, the term *nature connection* will be used. Nature connection refers to individuals' subjective sense of their relationship with nature and encompasses the affective, cognitive and experiential aspects of that relationship (Ives et al., 2017; Restall & Conrad, 2015; Russell et al., 2013).

1.6 Navigating the thesis

This section aims to help the reader navigate the thesis by explaining the layout of the thesis. As depicted in Figure 1.2, published and unpublished papers are incorporated into chapters 2, 4, 5 and 6. The four papers included in this thesis are in various stages of the publication process, varying from published, accepted but not yet published, under review by a peer-review journal and in preparation. A statement of contribution for each paper is provided at the start of the relevant chapters. Given the structure of peer-reviewed papers, there is some overlapping content between chapters, particularly the introduction and methods sections of chapter 5 and 6, which both investigate nature connection and analyse data from the same cross-sectional survey.

Chapter 2 provides a detailed literature review on the nature and mental health evidence base exploring how perceptions of and connection to nature may affect eudaimonic wellbeing.

Chapter 3 presents the paradigmatic positioning of this research and methodological approach applied to answer the research questions. The research adopts a pragmatic worldview and as such the focus is on the research problem and using all approaches available to understand the problem. This resulted in a multi-phased, survey-based methodology that uses both longitudinal and cross-sectional survey data. First, longitudinal data from the HABITAT (How Areas in Brisbane Influence Health and Activity) study is used to explore the relationship between perceptions of quality and quantity of urban nature and psychological wellbeing (RQ1). Based on the findings from this first phase, a web-based, cross-sectional survey was then designed and administered to an urban population to assess how nature connection affects psychological wellbeing (RQ2) and also to explore potential predictors of nature connection (RQ3).

Chapter 4 reports the findings from the analyses of the HABITAT longitudinal dataset to explore the relationship between changes in perceptions of quality and quantity of urban nature and psychological wellbeing (RQ1). A fixed effects regression analysis was conducted to assess how changes in perceptions of urban nature (in the form of perceived quantity of neighbourhood green space such as street trees and greenery and perceived quality of natural features) relates to changes in psychological wellbeing (N = 5014).

Chapter 5 reports findings from the analyses of the cross-sectional survey that was designed and administered to Brisbane urban residents in May 2017 (N = 1000). A multiple regression and parallel mediation analysis were undertaken to explore mediators of the relationship between psychological wellbeing and nature connection (RQ2). Chapter 6 again reports findings from the cross-sectional survey, this time from a multiple regression and moderation analysis that were carried out to explore how retrospectively reported childhood and current adult urban nature experiences relate to nature connection (RQ3).

Chapter 7 discusses the overall findings of the thesis, outlining the theoretical and practical implications of the research and challenges and implications for future research.

<p>Chapter 1 Introduction</p> <p>Purpose: To provide the rationale for the thesis and assist the reader with understanding and navigating the thesis Papers included: N/A</p>
<p>Chapter 2 What we know about the relationship between nature and wellbeing</p> <p>Purpose: To provide a literature review of the nature and mental health evidence base and to identify key knowledge gaps. Papers included: Cleary, A., Fielding, K. S., Bell, S. L., Murray, Z., & Roiko, A. (2017). Exploring potential mechanisms involved in the relationship between eudaimonic wellbeing and nature connection. <i>Landscape and Urban Planning</i>, 158, 119-128.</p>
<p>Chapter 3 Methodology</p> <p>Purpose: To provide the rationale and justification for the chosen research design along with details of the methodology. Papers included: N/A</p>
<p>Chapter 4 The relationship between perceptions of nature and psychological wellbeing</p> <p>Purpose: Analysing longitudinal data to explore how changes in perceptions of urban nature affect changes in psychological wellbeing (RQ1). Papers included: Cleary, A., Roiko, A., Burton, N., Fielding, K. S., Murray, Z. & Turrell, G. (under review). Changes in perceptions of urban green space are related to changes in psychological well-being: Cross-sectional and longitudinal study of mid-aged urban residents. Submitted to <i>Health and Place</i> on 07 August 2018.</p>
<p>Chapter 5 The relationship between nature connection and psychological wellbeing</p> <p>Purpose: Analysing cross-sectional data to explore mediators of the relationship between nature connection and psychological wellbeing (RQ2). Papers included: Cleary, A., Fielding, K. S., Murray, Z., & Roiko, A. (in preparation) Nature connection and psychological wellbeing: The mediating role of non-human relatedness and intrinsic values.</p>
<p>Chapter 6 The relationship between nature experiences and nature connection</p> <p>Purpose: Analysing cross-sectional data to assess how current and childhood nature experiences relate to current nature connection (RQ3). Papers included: Cleary, A., Fielding, K. S., Murray, Z., & Roiko, A. (accepted and in press) Predictors of nature connection among urban residents: Assessing the role of childhood and adult nature experiences. <i>Environment and Behavior</i>.</p>
<p>Chapter 7 Discussion</p> <p>Purpose: To tie together the findings from chapters 4, 5 and 6 and discuss methodological contributions and challenges, the practical and theoretical contributions of this study and the implications for future research. Papers included: N/A</p>

Figure 1.2. Navigating the thesis

1.7 References

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Chapter 2.

What we know about the relationship between nature and wellbeing

2.1 Overview

This chapter provides a review of the literature on nature and mental wellbeing. I highlight the strengths and weaknesses of the evidence base identifying key knowledge gaps namely; the lack of understanding and theoretical underpinning of the relationship between nature and mental wellbeing; limited understanding of the mediators involved in the relationship between nature connection and eudaimonic wellbeing; and meagre knowledge on what factors shape an individual's nature connection. While this chapter itself does not address a specific research question it does provide the background knowledge and justification for the exploration of these research questions.

This chapter includes a co-authored published paper. The bibliographic details of the co-authored paper, including all authors, are:

Cleary, A., Fielding, K. S., Bell, S. L., Murray, Z., & Roiko, A. (2017). Exploring potential mechanisms involved in the relationship between eudaimonic wellbeing and nature connection. *Landscape and Urban Planning*, 158, 119-128.

STATEMENT OF CONTRIBUTION TO CO-AUTHORED PUBLISHED PAPER

Contributor	Statement of contribution
Cleary, A.	Searched the literature identifying relevant papers (100%) Reviewed and analysed the literature (100%) Wrote paper (100%)
Fielding, K.	Edited paper and provided critical feedback (25%)
Bell, S. L.	Edited paper and provided critical feedback (25%)
Murray, Z.	Edited paper and provided critical feedback (25%)
Roiko, A.	Edited paper and provided critical feedback (25%)

My specific contributions to the paper involved:

- Developing a search strategy using key word terms to search academic databases and literature cataloguing systems for relevant papers.
- Searching for additional relevant literature through using alternative sources such as scanning reference lists of relevant papers and examining publication lists of prominent researchers in the field.
- Identifying, reading and reviewing relevant papers to extract key information on theories discussed, relevant contextual information, references to wellbeing outcomes and pathways explored.
- Synthesis of the data to summarise what the current evidence base tells us about the relationship between nature and psychological wellbeing, identifying key gaps and providing recommendations for addressing these identified gaps.
- Writing a paper summarising the findings from the literature review.

Signed:
(Anne Cleary)

Date: 31 August 2018

Countersigned:
(Anne Roiko)

Date: 31 August 2018

2.2 Abstract

A growing body of research demonstrates associations between nature connection and a wide variety of positive health and wellbeing outcomes. Yet, the interpretation of this research is restricted because underpinning mechanisms - particularly the psychological mechanisms of wellbeing enhancement as opposed to wellbeing restoration - remain largely unexplored. Understanding such mechanisms is important for theory development and for assisting policy-makers and urban planners to translate this theory into practice effectively. This essay examines the limitations in our current understanding of the psychological mechanisms involved in the relationship between nature connection and eudaimonic wellbeing. It also advances opportunities to move the field forward through exploring two potential mechanisms, namely satisfying the psychological need for relatedness and fostering intrinsic value orientation. These mechanisms may explain how an individual's level of nature connection enhances their psychological wellbeing. Understanding such mechanisms could improve the implementation of targeted nature connection policies and interventions designed to enhance psychological wellbeing among complex urban populations with diverse needs.

2.3 Introduction

Nature exposure has been associated with significant physiological and psychological health benefits. Positive associations have been identified between presence of nature in the living environment and self-reported health (De Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003; Van den Berg, Maas, Verheij, & Groenewegen, 2010), as well as reduced morbidity, mortality, stress, psychological distress, obesity and cardiovascular and respiratory disease (James, Hart, Banay, & Laden, 2016; Maas et al., 2009; Nielsen & Hansen, 2007; Richardson, Pearce, Mitchell, Day, & Kingham, 2010, Astell-Burt et al., 2013). Evidence is starting to elucidate a variety of pathways through which such associations might arise. Indeed, several pathway frameworks have been proposed in the literature, with Hartig's four pathways of stress, air quality, physical activity and social contacts being the most commonly cited (Hartig, Mitchell, De Vries, & Frumkin, 2014). Other frameworks have expanded on this, with one particular framework identifying up to 21 plausible pathways while proposing enhanced

immune function as the potential central pathway through which nature delivers multiple health benefits (Kuo, 2015). However, such frameworks fail to distinctly link these identified pathways with specific types of nature exposures within varying nature settings. Hence, our understanding of how to target specific pathways through the design and delivery of different types of nature exposures remains limited.

What is known, however, is that some pathways are direct and potentially involuntary, such as direct physiological restoration from stress (Ulrich et al., 1991), buffering of anthropogenic noise (Gidlöf-Gunnarsson & Öhrström, 2010; Pathak, Tripathi, & Mishra, 2008) and production of natural sounds (Galbrun & Ali, 2013), reduced urban heat island effect (Loughner et al., 2012), exposure to enhanced air quality (Nowak, Crane, & Stevens, 2006), airborne phytoncides and negative ions (Craig, Logan, & Prescott, 2016), ultra violet light which generates vitamin D (Grant & Holick, 2005), and biologically diverse macro and microbiota that improves the human microbiota (von Hertzen et al., 2015). Other pathways are likely to be indirect and occur through facilitating behavioural and cognitive processes, for example, through providing opportunities for physical activity (Bowler, Buyung-Ali, Knight, & Pullin, 2010), social interaction (Coley, Sullivan, & Kuo, 1997; Kuo, 2003), positive emotional and/or spiritual experiences (Warber, Irvine, Devine-Wright, & Gaston, 2013), as well as allowing recovery from cognitive fatigue (Kaplan, 1995), reducing anti-social behaviour, particularly in adolescents (Younan et al., 2016) and enhancing perceived community cohesion (Weinstein et al., 2015). Furthermore, the outcomes from such indirect pathways may vary depending on the person experiencing the pathway. An individual's subjective perceptions of the nature they are exposed to may alter the associated health outcome. For example, if an individual perceives a nature space as unsafe or scary then they may experience feelings of anxiety or stress as opposed to wellbeing. These perceptions of nature are likely to vary based on age, gender, cultural background and socio-economic status.

While the majority of literature reports on positive associations between nature exposure and health and wellbeing, more attention needs to be paid to the characteristics of these relationships. A linear assumption underlies most of the literature where an increase in nature exposure is assumed to result

in improved health and wellbeing outcomes. However, this relationship will likely be determined by a number of factors such as the type of pathway being examined, the frequency, duration and type of nature exposure taking place, the type of nature setting in which it occurs and the type of person receiving the exposure. For example, longitudinal research has shown that the association between nature and mental health varies across both the life course and gender with men seeming to derive the greatest benefit of nature exposure during early to mid-adulthood (Astell-Burt, Mitchell, & Hartig, 2014). Similarly, certain pathways will have a more defined dose-response relationship than others as is the case with ultra violet light exposure, where exceeding a certain dose or exposure can lead to adverse health outcomes (Grant & Holick, 2005).

The increasing prevalence of mental illness highlights the need to better understand the complex psychological pathways and mechanisms by which nature can promote a sense of wellbeing. Mental and substance use disorders were the leading cause of years lived with disability (YLDs) worldwide in 2010, accounting for 22.9% of all YLDs (Whiteford et al., 2013). Depression alone accounts for 4.3% of the global burden of disease and is among the largest single causes of disability worldwide (11 % of all YLDs globally), particularly for women (WHO, 2013). In Australia it is estimated that, over a lifetime, nearly half of the adult population will experience mental illness at some point—equating to nearly 7.3 million Australians aged 16 to 85 (ABS, 2008). Occurrence of mental illness also varies across different sub-groups within a population. Using an Australian example again, adult Indigenous Australians are nearly three times as likely as non-Indigenous adults to experience high to very high levels of psychological distress (ABS, 2013).

Despite the pressing need to combat mental illness and the mounting evidence for the link between nature and wellbeing, currently, little is known about how nature promotes psychological wellbeing. Our understanding of the psychological pathways and mechanisms by which nature can influence mental health and wellbeing is strongest in relation to the *recovery* of stress and mental ailments (e.g., Ulrich's 1991 Stress Recovery Theory and Kaplan's 1995 Attention Restoration Theory). In contrast, our understanding of how nature *promotes and sustains* psychological wellbeing is much less developed. This is a missed opportunity particularly since many health plans and policies now include

the aim of delivering health systems that support contributing and flourishing communities with high psychological wellbeing (NMHC, 2014). Developing a comprehensive understanding of the psychological wellbeing promotion potential of nature in its diverse forms is therefore imperative and forms the main focus of this essay.

What do we mean by ‘nature’?

‘Nature’ is a broad and sometimes ambiguous term. It has a wide variety of objective referents, but is experienced subjectively, with some framing it as a social construction (Castree, 2013; Proctor, 1998). Greider and Garkovich (1994, p.1) describe natural landscapes as “symbolic environments created by human acts of conferring meaning to nature and the environment, of giving the environment definition and form from a particular angle of vision and through a special filter of values and beliefs”. Indeed, the meaning and interpretation that people place on nature or natural landscapes can even present contradictions with one study of American adults showing that even people who viewed themselves as part of nature still understood natural landscapes to be those which were free of human interference (Vining, Merrick, & Price, 2008). ‘Nature’ is therefore interpreted in diverse ways and has sparked debate in the literature (Hartig et al., 2014). This essay discusses nature from two perspectives, first by presenting an overview of research examining the benefits of *exposure* to nature and then by introducing the concept of nature *connection*. Nature exposures are diverse, with multiple variables such as setting, duration and subjective perceptions interacting to create the exposure. According to Frumkin (2013, p. 197) it can extend “from flowers (as in horticultural therapy) to healing gardens, from viewing trees to wilderness adventures, from bird-watching to visiting zoos to owning pets”. Furthermore, nature experiences do not occur within isolation, but are situated within the context of the life of the individual undergoing the experience. We need to consider the frequency and duration of nature experiences across the life course and on how these affect the short and long-term outcomes of a nature experience, coupled with considering the potential for positive or negative feedback loops to be instigated, for example, a positive experience in nature may encourage further nature experiences whereas a negative nature exposure may lead to avoidance of a repeat experience. Within 30 years, 70% of people will live in urban areas (Dye, 2008) and it is therefore the everyday urban

nature that will increasingly be where people's nature exposures occur (Dunn, Gavin, Sanchez, & Solomon, 2006). Hence, this essay is focused primarily on the diverse types of nature exposure accessible within an urban landscape and considers both the 'green' and 'blue' space elements of this urban nature.

Urban nature spans a continuum of different levels of human intervention, design and management, for example from gardens to parks to urban forests, and from canals to rivers to coasts. Regardless of the level of human influence, what is (or isn't) considered to be urban nature will depend on how people *perceive* the 'naturalness' of the urban nature, with some people valuing elements of urban nature that others disregard as inferior or even 'inauthentic' compared to that encountered in, for example, protected national parks or wilderness areas (Tuan, 1971). The degree to which such settings are perceived as 'urban nature' may depend on people's personal experiences as well as the prevailing cultural representations of nature that they are regularly exposed to (Castree, 2013). Consideration of such personal and cultural conceptions of nature is critical when seeking to define and understand urban nature and the everyday exposures of urban residents. Nature *connection*, on the other hand, describes the personal mix of feelings, emotions and attitudes that a person has towards nature. We return to the concept of nature connection and elaborate on it in more detail below.

What do we mean by 'psychological wellbeing'?

Despite widespread policy and research interest in understanding and promoting wellbeing, there is little consensus on how to define this concept (Trigwell, Francis, & Bagot, 2014). Two general perspectives tend to be used to describe wellbeing within the literature: hedonism (also termed affective wellbeing) and eudaimonism (also termed psychological wellbeing; McMahan & Estes, 2011; Ryan & Deci, 2001). From the hedonic perspective wellbeing relates to happiness, generally defined as the absence of negative affect and the presence of positive affect. Eudaimonism, on the other hand, focuses on prime psychological functioning, self-realization and living life in a full and purposeful way (Deci & Ryan, 2008). Debate about eudaimonic wellbeing and what exactly it means to have prime psychological functioning has resulted in a number of different conceptualisations. For example, Ryff and Keyes (1995) conceptualize psychological wellbeing as consisting of six facets,

including personal growth, self-acceptance, life purpose, mastery, autonomy and positive relatedness. Ryan and Deci (2000), however, emphasize only competence, autonomy, and relatedness as the important psychological needs, and still others suggest living a purposeful life to be the key factor in psychological wellbeing (Seligman, 2004). Given the growing demand for health plans and policies to deliver thriving and flourishing communities, this essay focuses specifically on eudaimonic wellbeing and the role that urban nature can play in supporting communities with positive psychological functioning. However, it is recognised that a holistic understanding of wellbeing requires attention to the multiple facets of wellbeing, as described above.

This essay explores what is known about the effect of urban nature on psychological (eudaimonic) wellbeing, looking first at *nature exposure* before building the case for investigating the influence of *nature connection* on psychological wellbeing specifically. We discuss how our limited understanding of the mechanisms underpinning the nature connection-eudaimonia relationship may be limiting the optimisation of wellbeing outcomes from nature-based interventions for mental health. We examine two potential mechanisms, namely promoting non-human relatedness and fostering intrinsic value orientations, both of which are rooted within Self Determination Theory. Exploring these mechanisms could help to better theorise the relationship between eudaimonic wellbeing and nature connection. The concluding section explores future research opportunities that could strengthen our understanding of the mechanisms driving the nature connection-eudaimonia relationship which would help reveal the salutary potential (and limits) of urban nature.

2.4 What do we know about the links between eudaimonic wellbeing and nature exposure?

Nature exposure is shown to consistently affect mental health. While nature exposures can have adverse impacts on mental wellbeing through promoting feelings of fear (C. Milligan & Bingley, 2007) and anxiety (Skår, 2010), the majority of research reports positive associations (Mantler & Logan, 2015). However, many of the experimental studies reporting positive mental wellbeing associations are limited by their focus on short-term restorative benefits of single nature exposures (Hartig et al., 2014). Moreover, the nature exposures under examination tend to be somewhat

controlled or artificial forms of nature exposure usually delivered via virtual means (e.g., nature videos, photos; Van den Berg, Koole, & Van der Wulp, 2003) or through facilitated nature exposures (e.g., guided nature walks; (Korpela, Stengård, & Jussila, 2016). Hence, genuine (rather than scenario-based) feelings of risk, safety concerns or discomfort tend to be removed from such exposures. The direction of association might be quite different if the exposure was administered in an autonomous setting, in riskier nature, with people who have little experience or familiarity in negotiating such settings. That said, despite such limitations, the growing evidence for the beneficial effects of nature exposure on psychological wellbeing is promising.

To date there have been relatively few experimental studies that have addressed the question of why nature exposure produces beneficial effects for psychological wellbeing, and even fewer studies have explored the potential mechanisms through which the relationship occurs (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2008). Attention Restoration Theory (Kaplan, 1995) and Stress Recovery Theory (Ulrich et al., 1991) seek to explain the psycho-neuro-endocrine mechanisms through which the restorative and recovery functions of nature exposure occur. Most studies that have explored these theories have tended to concentrate on the effect of nature exposure on short-term physiological and psychological mood states rather than longer-term eudaimonic wellbeing outcomes (Hartig et al., 2014). In addition, Attention Restoration Theory and Stress Recovery Theory both suggest that the benefits of nature exposure are dependent upon the recipient being in various degrees of mental *ill*-health, whether through cognitive fatigue, or one-off/cumulative episodes of stress. The pathways by which people *without* chronic or acute mental ailments derive psychological wellbeing benefits through everyday nature exposure are somewhat under-theorised. This is a pertinent gap in our understanding and inhibits efforts to harness the wellbeing potential of nature exposure by those charged with the promotion of thriving and flourishing communities. In order to address this theoretical lacuna and explore critically the mechanisms underpinning the eudaimonic wellbeing promotion outcomes of nature exposure, we must first consider humankind's relationship with nature. There are various constructs that contribute to our understanding of complex human-nature relationships. These include Biophilia (Wilson, 1984), sense of place (Lewicka, 2011), solastalgia

(Albrecht, 2006; Warsini, Mills, & Usher, 2014), and therapeutic landscapes (Bell, Phoenix, Lovell, & Wheeler, 2015; Gesler, 1992).

The Biophilia Hypothesis

The Biophilia Hypothesis, popularised by Wilson (1984), proposes that humankind, as part of our species' evolutionary heritage, has an innate need to be around other living things. It also suggests that humans are naturally drawn to those places that, in our pre-historic past, have best facilitated survival, in particular, savannah-type landscapes providing shelter and sustenance (Kellert & Wilson, 1995; Wilson, 1984). The Biophilia Hypothesis suggests that the human-nature relationship is driven by biological evolution. While Kellert (2012) has refined this to include nine underpinning biological values, there is limited empirical evidence to support the Biophilia Hypothesis (Joye & De Block, 2011; Joye & Van den Berg, 2011) or to further our understanding of whether *innate* or learned *cultural* mechanisms are likely to underpin nature's psychological wellbeing benefits.

Sense of place

A well-established body of multi-disciplinary research devoted to people-place relationships has emerged which examines why people come to develop a 'sense of place' as settings accrue meaning over time. This is interpreted as a broad construct consisting of three dimensions: (a) *place attachment*, describing an individual's emotional attachment to a setting, linked to feelings of belonging and rootedness; (b) *place identity*, reflecting a cognitive connection to a setting or type of setting that provides opportunities to both express and affirm personally salient values and identities; and (c) *place dependence*, often used to explain a more functional reliance on a specific setting to carry out desired activities and realise the achievement of goals (Kyle, Mowen, & Tarrant, 2004). Despite a growing body of work examining sense of place (or one or more of its constituent dimensions) in the context of everyday green spaces (Arnberger & Eder, 2012; Bernardini & Irvine, 2007; R. L. Ryan, 2005), relatively few studies have examined the complex relationships between sense of place, eudaimonic wellbeing and nature exposure (Scannell, 2013; Scannell & Gifford, 2016).

One as yet under-researched link between urban nature exposure, *place attachment* and eudaimonic wellbeing concerns the potential role of urban nature in promoting feelings of comfort, belonging and community attachment amongst regular users (Arnberger & Eder, 2012; Rishbeth & Powell, 2013). Such feelings may, in turn, nurture a sense of individual stability, familiarity and security; factors noted by Manzo (2008) as ‘critical ingredients’ in psychological wellbeing. Studies examining associations between place attachment and wellbeing suggest that place attachment can affect people’s sense of life purpose through providing a central place of significance through which the rest of the world becomes coherent (Casakin & Kreitler, 2008). Moreover, more recent work is beginning to identify a role for nature in shaping people’s favourite or ‘most attached’ places and the subsequent benefits derived (Scannell, 2013)

There may also be value in examining relationships between urban nature exposure, *place identity* and eudaimonic wellbeing. Place identity is commonly discussed in relation to four principles: distinctiveness (the desire to differentiate oneself from others); self-esteem (an individual’s feeling of self-worth or social value); self-efficacy (a measure of individual capacity or agency); and continuity (the desire to preserve continuity of self-concept over time; Twigger-Ross & Uzzell, 1996). The maintenance of a link with a specific place (e.g., a favourite local urban park) can offer individuals a sense of purpose and continuity to their identity, using those places as ‘referents to past selves and actions’; this is *place referent continuity*. Alternatively, self-identity may also be preserved through *place congruent continuity*; making a conscious effort to seek out places with shared characteristics which seem to represent and allow the expression of personal values, thereby preserving continuity of self as a certain *type* of person. However, to date, limited effort has been made to examine the links between place identity, eudaimonic wellbeing, and nature exposure.

Importantly, studies have also illustrated how place attachment can lead to *negative* impacts on eudaimonic wellbeing. For example, psychological health can be negatively affected when the environment that the person feels an emotional attachment or connection to becomes degraded or lost. Solastalgia describes the distress felt by people who, due to environmental degradation, experience loss of solace and place attachment toward their ‘home’ environments (Albrecht et al., 2007).

Solastalgia is one of the key elements within the environmental distress scale which measures the bio-psycho-social cost of ecosystem disturbance (Higginbotham, Connor, Albrecht, Freeman, & Agho, 2006). Although not explicitly examined in the context of solastalgia, the distinction between place congruent and place referent continuity may be important in shaping such distress. For example, drawing on the findings of a survey with users of a degraded urban park in Michigan, Ryan (2005) identified greater levels of distress and personal feelings of loss amongst neighbours and recreational users who expressed a place-specific attachment to that particular urban park, than amongst park staff and volunteers who expressed a more conceptual attachment to that type of urban nature-based setting and responded by seeking out an alternative urban park in which to channel their volunteering efforts. This may reflect the different types of place bonds formed by these urban park users; engaging in environmental improvement efforts within the park may have enhanced volunteers' self-identity as environmentally conscious individuals (suggesting a role for place identity), whereas neighbours and recreational users may have relied on the park more for its unique views, facilities, and building memories over time (reflecting greater place attachment and place dependence).

Therapeutic landscapes

Closely aligned with the sense of place literature (Eyles & Williams, 2008) is the concept of therapeutic landscapes, used to describe place encounters where “the physical and built environments, social conditions and human perceptions combine to produce an atmosphere which is conducive to healing” (Gesler, 1996, p. 96). Whilst early therapeutic landscape studies focused on ill-health and ‘extraordinary’ places of *healing*, such as pilgrimage sites and spas (Gesler, 1992, 1993, 1996), researchers have increasingly turned their attention to people’s use of everyday settings to promote and maintain a sense of wellbeing on a routine basis. These settings include, for example, public urban parks, community gardens, riverside and coastal settings (Bell et al., 2015; Christine Milligan, Gatrell, & Bingley, 2004; Völker & Kistemann, 2013) and indoor nature exposures (McSweeney, Rainham, Johnson, Sherry, & Singleton, 2014). The concept of therapeutic landscapes therefore seeks to understand how the physical (both natural and built) attributes of an environment, coupled with the more subjective (and inter-subjective) ways in which people relate to an environment (also shaped by

prevailing symbolic and cultural/social interpretations), can combine to determine the degree to which environments are experienced as healing, or health promoting for different people (Gesler, 2003). Despite established understandings of these four dimensions of therapeutic landscapes (natural, built, symbolic and social), the mechanisms by which these four dimensions work in combination to promote health, as well as the contested nature of different ‘therapeutic’ settings amongst different groups and individuals, remains as of yet, somewhat unclear (Bell et al., 2015).

The human-nature relationship has been investigated from many different perspectives. Whilst drawing on contrasting underpinning explanations (ranging from evolutionary to social) the Biophilia Hypothesis, sense of place, solastalgia and therapeutic landscapes concepts deepen our understanding of possible human-nature relationships. These concepts highlight the importance of humankind’s co-evolution with(in) nature, the perceived therapeutic and healing qualities of nature and the positive and negative emotional and/or cognitive connections between a person and a location. These are all valuable considerations when seeking to discern the nature-eudaimonia relationship. However, despite these contributions to our understanding, the field still lacks a comprehensive understanding of the mechanisms through which nature promotes eudaimonic wellbeing, and how this varies for different people and via diverse modes of nature exposure.

2.5 What do we know about the links between eudaimonic wellbeing and nature connection?

While the above-mentioned concepts and fields of research provide diverse insights to the human relationship with nature there still remains a gap in our understanding of nature’s ability to promote eudaimonic wellbeing amongst different individuals. This gap may be addressed by considering an individual’s level of nature *connection*. There is a growing call for researchers, in the nature-health field, to assess what some authors term ‘individual agency’ when investigating how people engage with nature and the health outcomes associated with that nature exposure (Bell, Phoenix, Lovell, & Wheeler, 2014). A key aspect of individual agency is a person’s self-identification with nature or level of nature connection. In its broadest sense, nature connection describes the mix of feelings, attitudes, beliefs and behaviours that people have towards nature. A range of validated scales exist for

measuring an individual's level of nature connection, with the most commonly used scales being the single item 'Inclusion of Nature in Self Scale' (Schultz, 2001), the more recent 'Nature Relatedness Scale' (Nisbet, Zelenski, & Murphy, 2009) and the Mayer and Frantz (2004) 'Connection to Nature Scale', which has also been adapted to measure nature connection among children (Bragg, Wood, Barton, & Pretty, 2013). Nature connection scales tend to measure, to varying degrees, the affective (feelings and attitudes), cognitive (beliefs and knowledge) and behavioural (actions and experience) aspects of the human-nature connection. The affective domain of this relationship is the most commonly assessed and is reported to be measured by all three of the above-mentioned scales, although this is debated in the literature particularly for the 'Connection to Nature Scale' (Perrin & Benassi, 2009). Of the three scales, the 'Nature Relatedness Scale' is the only one designed to measure the behavioural domain of the relationship. Higher levels of nature connection have been associated with greater subjective wellbeing (Nisbet et al., 2011) as well as a range of hedonic measures of wellbeing such as vitality, life satisfaction and positive affect (Capaldi, Dopko, & Zelenski, 2014). While research on nature connection tends to still rely strongly on reported associations with these hedonic measures of wellbeing, there are some promising findings emerging around positive associations between nature connection and eudaimonic measures of wellbeing as measured by the 'Connection to Nature Scale' (Howell, Dopko, Passmore, & Buro, 2011), the 'Nature Relatedness Scale' and the 'Inclusion of Nature in Self Scale' (Zelenski & Nisbet, 2014). In addition, higher immersion in nature, as achieved through viewing nature images with guiding audio, predicted high levels of nature connection, as measured using an adapted version of 'Connection to Nature Scale', which in turn predicted greater intrinsic value orientation which is also linked to eudaimonic wellbeing (Weinstein, Przybylski, & Ryan, 2009).

'Nature Relatedness' and 'Inclusion of Nature in Self' have been shown to correlate with eudaimonic wellbeing indicators, as measured by the Psychological Well-Being Inventory, but not with ill-being indicators, as measured by the Center for Epidemiological Studies Depression Scale and Negative Affect scale, suggesting that nature connection may play a more useful role in *promoting* eudaimonic wellbeing as opposed to restoring people from states of ill-health (Zelenski & Nisbet, 2014).

Furthermore, mediational analyses have indicated that the positive health effects of *exposure* to nature are partially mediated by increases in an individual's level of nature *connection* (Mayer et al., 2008). While the wellbeing promotion potential of nature connection holds promise, it must be noted that the nature connection evidence base tends to rely heavily upon student samples (contributing a third of samples for a recent nature connection meta-analysis) with a strong female bias (65% median in the same meta-analysis; Capaldi et al., 2014). In addition, the nature connection evidence base is derived mainly from westernised cultures with few studies measuring and assessing the role of nature connection among other cultures. The nature connection studies that do look at non-westernised cultures tend to also rely on student samples, for example, measuring nature connection among Hong Kong university students using a variety of scales (Tam, 2013). While there is a wealth of work from Japan exploring health outcomes from forest bathing (or *shinrin-yoku*) there has yet to be an explicit exploration of this within the context of nature connection, despite Craig, Logan, and Prescott (2016) delivering a convincing case for the benefits of integrating the research fields of forest bathing and nature connection.

The growing evidence of nature connection's association with eudaimonic wellbeing and positive health outcomes is coupled with a recent call to action by Craig et al. (2016) for fellow researchers across all disciplines to incorporate validated nature connection scales into diverse research protocols. This would provide critical unifying information from across multiple disciplines and sectors, building the case for the potential importance of nature connection's role in health and wellbeing. However, given that the majority of nature connection scales have been validated within western cultures there may be need for such scales to be tailored to better resonate with the perceptions and understandings of nature connection among people from diverse and varying cultures.

Exploring an individual's nature connection may be central to unlocking our understanding of how urban nature promotes eudaimonic wellbeing. However, despite the growing interest and accumulating research around the concept of nature connection, there remains limited in-depth theoretical work that explores the mechanisms by which a high level of nature connection could promote psychological wellbeing. Moreover, we know little about how this connection manifests

itself in relation to varied nature-based settings, in the context of different modes of nature exposure, or amongst diverse urban population groups. To date research has instead tended to focus more on understanding nature *exposure*. Substantial work has been carried out to discern the mediators and moderators influencing the pathways between direct nature exposure and resulting wellbeing outcomes (de Vries, van Dillen, Groenewegen, & Spreeuwenberg, 2013; Shanahan et al., 2015) but this tends to overlook the different and often highly personal ways in which people conceptualise, value and connect to (or indeed, disconnect from) varied forms of urban nature. Lachowycz and Jones (2013) developed a theoretical framework highlighting the mediators and moderators that drive associations between nature exposure and both physical and psychological health outcomes. The framework proposes three broad groups of mediators (perception of living environment, viewing nature and using nature) and outlines a range of moderators including demographics, living context, nature characteristics and climate. This work has been built on by Markevych et al., (2017) who developed a green space and health pathway framework that is structured around the three functional domains of green space; reducing harm, restoring capacities and building capacities. Although these frameworks are relatively comprehensive, incorporating a number of relevant cultural and socio-economic factors, they do not consider nature connection. Hence, despite the compelling evidence accumulating around nature connection and health, particularly psychological wellbeing, nature connection is still proving elusive when it comes to its incorporation into theory and explanatory frameworks in the nature-health field.

2.6 How a limited understanding of mechanisms impedes cultivation of nature connection

As mentioned above, nature connection is likely to play an important role in promoting eudaimonic wellbeing amongst certain individuals (Capaldi et al., 2014; Capaldi, Passmore, Nisbet, Zelenski, & Dopko, 2015; Nisbet et al., 2011; Zelenski & Nisbet, 2014). Hence, there is growing interest in the cultivation of nature connection amongst diverse urban communities. Research indicates that individuals feel closer and more connected to natural landscapes after contact with such settings (Mayer et al., 2008; Weinstein et al., 2009). This has catalysed calls for nature exposure to be

increased as a cost-effective way to enhance people's nature connection and associated sense of wellbeing (Capaldi et al., 2015; Trigwell et al., 2014). Consequently, a plethora of nature exposure interventions are now common-place in many countries. For example, the Canadian Mental Health Association's Mood Walks initiative, David Suzuki Foundation's 30x30 Nature Challenge, Australian Nature Play programmes and the United Kingdom's Wild Network and 30 Days Wild campaign led by The Wildlife Trusts, to name a few. In addition, nature exposure interventions can be found increasingly in mental health and addiction literature and practice, sometimes under the guise of 'Green Care'. Green Care interventions, such as group nature walks, have been found to be effective treatments for people with significant mental ill-health (Korpela, Stengård, & Jussila, 2016; Marselle, Irvine, & Warber, 2014). Notably, Cutcliffe and Travale (2016) highlight the cultivation of nature connection as critical to the delivery of wellbeing benefits from Green Care.

Despite the growing popularity of these nature exposure interventions, to date only a few have been evaluated to assess their effectiveness for enhancing nature connection. For example, the 30 Days Wild Campaign has been shown to deliver sustained nature connection improvements (Richardson, Cormack, McRobert, & Underhill, 2016). However, the types of nature exposures that occurred during this campaign were not recorded and the authors recognised that those completing all three time points of data collection may have been motivated by a greater nature connection to begin with, therefore potentially clouding our understanding of the effectiveness of such initiatives among general urban communities. Hence, enhancing nature connection and associated wellbeing outcomes through such nature exposure initiatives requires careful consideration of all the factors that constitute the nature exposure including consideration of both the type of nature and type of exposure as well as the individual undergoing the exposure and the mediators and moderators that may be at play; we explore these further in what follows.

The types of experiences that occur during the nature exposure will likely influence the degree to which nature connection and diverse wellbeing outcomes can be realised. Some authors propose that there are certain requirements of the nature exposure in order for nature connection to be cultivated and the associated eudaimonic wellbeing outcomes achieved. For example, mindfulness (awareness of

the present moment and its associated thoughts, emotions and sensations) and the ability to perceive nature's 'beauty', as measured by the engagement with natural beauty scale, appear to be requirements for achieving maximal connection and health benefits associated with nature exposure across western and Asian cultures (Howell et al., 2011; Howell, Passmore, & Buro, 2013; Lin, Tsai, Sullivan, Chang, & Chang, 2014; Richardson & Hallam, 2013; Zhang, Howell, & Iyer, 2014; Zhang, Piff, Iyer, Koleva, & Keltner, 2014). Nature exposure may not fulfil its wellbeing enhancement potential if individuals are distracted from mindful awareness and thereby less able to develop a sense of nature connection (Mantler & Logan, 2015). Conversely, Richardson and Sheffield (2015), propose that intentional, reflective self-attention is critical during a nature exposure, with those who are more reflective and inclined to analyse their 'self' indicating a greater increase in nature connection.

The integral role of the individual within this relationship must also be considered. The success of efforts to promote nature connection through increasing nature exposure will be dependent upon the priorities, perceptions, preferences and experiences of the individual under-going the nature exposure. The exposure will be influenced by the individual's unique identities, their current personal projects, past experiences and situational influences (Patterson, Williams, Watson, & Roggenbuck, 1998); this suggests that people's nature exposures and potential nature connection outcomes are idiosyncratic, dynamic and vary across the life course. Similarly, Rose (2012) describes how people's 'prior familiarity' with a landscape or type of landscape can influence the wellbeing outcomes experienced within that landscape, with more familiar landscape types producing greater wellbeing outcomes. Prior familiarity also affects people's landscape preferences as shown in a Swedish study which demonstrated that adults prefer landscape types experienced during childhood (Adevi & Grahn, 2012). Hence, when designing and delivering urban nature exposures, the nature preferences and previous experiences of local urban residents need to be considered to ensure benefits are delivered and adverse outcomes avoided.

Moderators of the nature connection-eudaimonia relationship have been identified. While the Biophilia Hypothesis (Wilson, 1984) and evolutionary psychology (Barkow, Cosmides, & Tooby, 1995) propose an evolutionary tendency amongst humans to connect with nature, empirical evidence

for such tendencies is limited, and there is therefore a need to better understand the role of developmental experiences and socio-cultural contexts. Cultural differences and prevailing social constructions of nature may play an important role in how people conceptualise their relationship with nature, hence moderating the nature connection-eudaimonia relationship. For example, researchers have observed that some groups (e.g., Menominee Native Americans) are more likely to view themselves as connected to nature compared to other groups (e.g., European Americans), even at relatively early stages in the life course (Bang, Medin, & Atran, 2007; Unsworth et al., 2012). Furthermore, studies have found that connections with the land over many generations render Indigenous peoples particularly sensitive to the psychological wellbeing outcomes from nature connection (Townsend, Henderson-Wilson, Warner, & Weiss, 2015). Therefore, nature connection and subsequent wellbeing outcomes are *moderated* by the diverse conceptualisations of nature connection fostered within varying cultural and social contexts.

In addition to these moderators, ‘purposeful living’ and ‘spirituality’ have been identified as potentially important *mediators* of the nature connection-eudaimonia relationship. Spirituality can be defined as a person’s inner belief system that can serve as a unifying force experienced through one’s connecting and becoming (Burkhardt, 1989). Saroglou, Buxant, and Tilquin (2008) found that spirituality is significantly associated with nature connection. Building on this and drawing on ‘ecological self’ theory, Trigwell et al. (2014) showed that non-religious spirituality emerged as a mediator explaining associations between nature connection and five aspects of eudaimonic wellbeing: autonomy, life purpose, personal growth, self-acceptance and positive relatedness. This extends similar work by Kamitsis and Francis (2013) who also proposed spirituality as a potential mediator explaining how nature connection links to psychological wellbeing, and is complemented by recent work identifying associations between spirituality and nature connection among Pacific Islanders (Nunn et al., 2016). Howell et al. (2011) suggest that another mediator influencing pathways between eudaimonia and nature connection might be purpose in life, again a key dimension of eudaimonic wellbeing. Howell suggests that people who experience a high level of connection to nature gain a sense of meaningful existence, which may in turn boost eudaimonic wellbeing. There is

therefore evidence that the nature connection-eudaimonia relationship can be mediated by spirituality and purposeful existence. However, we lack clear understanding of the intricacies and underpinning mechanisms that drive these relationships. By what mechanism does having a high level of nature connection promote a sense of purpose or enhance spirituality? This gap in our understanding may limit our ability to optimise the wellbeing outcomes from nature connection enhancing initiatives. .

2.7 Identifying nature connection mechanisms

The question of how best to enhance nature connection among urban residents is a difficult one to address. Given the multiple factors at play during a nature exposure, it is not possible to design or prescribe a ‘one-size-fits-all’ urban nature exposure that will effectively increase nature connection and associated wellbeing outcomes among urban residents, particularly when so little is known about the mechanisms by which nature connection enhances psychological wellbeing. We need to focus research effort initially on identifying the full range of contributing mechanisms, before then discerning how the effectiveness of these mechanisms varies across different conceptions of nature, varied modes of nature exposure (including media modes such as film, sounds and images) and the different cultural and social contexts in which the exposure occurs. This fine-grained understanding will inform the design and delivery of urban nature spaces aimed at enhancing nature connection among complex urban populations with diverse preferences and needs.

A key objective of the current essay is therefore to theorise the potential mechanisms underpinning pathways between eudaimonic wellbeing and nature connection and thereby extend the limited research that has been conducted on this issue. Identifying the psychological mechanisms through which eudaimonic wellbeing is associated with nature connection will help to optimise the design and integration of urban green and blue space interventions that enhance nature connection among urban residents, thereby potentially facilitating delivery of maximum wellbeing benefits. Using the theoretical framework of Self Determination Theory (SDT; Ryan & Deci, 2000), two potential mechanisms are presented here. SDT is a macro theory, comprised of six sub-theories, which explains human motivation and personality. SDT concerns people's inherent growth tendencies and innate

psychological needs. The first proposed mechanism, based within the SDT sub-theory of Basic Psychological Needs Theory, concerns the potential for nature connection to satisfy the psychological need for *relatedness*. The second mechanism, based within the SDT sub-theory of Goal Contents Theory, explores how nature connection may foster *an intrinsic value orientation* and associated wellbeing outcomes. We expand on these sub-theories below, and the role they may play in the nature connection-eudaimonia relationship.

Promoting non-human relatedness

Satisfaction of the basic psychological need for *relatedness* may explain the underlying mechanism through which nature connection affects positive psychological wellbeing. According to the Basic Psychological Needs Theory of SDT, relatedness, along with competence and autonomy, are seen as basic psychological needs. Behaviours and contexts that allow for the experience of relatedness, autonomy and competence, support basic psychological needs and thereby enhance an individual's sense of integrity and eudaimonic wellbeing (Ryan & Deci, 2000). The psychological need for relatedness refers to the basic and innate need for all humans to relate and connect to others or to the world around them. To date relatedness has mainly been considered from the perspective of interaction, connection and caring for other people. However, it is recognised that while relatedness needs are often satisfied through interactions with others, they are not necessarily exclusively satisfied in this way (Deci & Ryan, 2000).

Nature connection appears largely distinct from other types of connection or relatedness. Even after controlling for connections that could satisfy relatedness (e.g., family or culture), Zelenski and Nisbet (2014) found that nature connection, as measured by the 'Nature Relatedness Scale', still significantly predicted happiness. This suggests that nature connection may play a unique role in satisfying the basic psychological need for relatedness. Shiota, Keltner, and Mossman (2007) found that participants recalling experiences where they felt nature's 'beauty' gave higher ratings to statements such as "I felt connected with the world around me." Indeed, for some individuals (e.g., those with high levels of stress or more severe disabilities such as autism), social relationships can prove overwhelming, with comfort gained instead from simple relationships with non-human forms of nature (Davidson &

Smith, 2009; Ottosson, 2001; Ottosson & Grahn, 2008). Furthering the case for non-human forms of relatedness is the well-established research demonstrating that bonds between humans and animals, particularly pets, can help fulfil relatedness needs (Podberscek, Paul, & Serpell, 2005). These findings suggest that nature connection may serve as a non-human form of relatedness hence satisfying the basic psychological need for relatedness and potentially explaining how nature connection promotes eudaimonic wellbeing.

Fostering intrinsic value orientations

The Goals Contents Theory of SDT focuses on value-orientations and aspirations and may explain another potential mechanism through which nature connection influences psychological wellbeing. Specifically, intrinsic aspirations involve the pursuit of goals concerning personal growth, intimacy and community, and have been shown to be associated with greater eudaimonic wellbeing (Kasser et al., 2014; Ryan, Huta, & Deci, 2008). Extrinsic aspirations relate to externally valued goods that are not inherently rewarding but are sought to derive positive regard or rewards from others (e.g., money, image, status and fame). Extrinsic aspirations are associated with lower scores for outcomes such as life satisfaction, happiness, vitality, and self-actualization, and higher scores for outcomes such as depression, anxiety, behaviour disorders, and a host of other types of psychopathologies (Kasser, 2003; Kasser & Ryan, 1993). Nature connection is positively associated with a variety of intrinsic aspirations, including humanitarianism (Nisbet, Zelenski, & Murphy, 2009), kindness (Leary, Tipsord, & Tate, 2008), empathic concern (Zhang, Piff, et al., 2014) and altruistic concern (Schultz, 2001). Nature connection has also been linked to behaviours indicative of intrinsic aspiration, for example relational emotions (e.g., love and care; Vining et al., 2008), less selfish consumer decision making (Mayer & Frantz, 2004) and pro-environmental decision making (Vining, 1987). In addition to nature connection, direct exposure to nature is also associated with intrinsic aspirations. After viewing nature images participants reported higher valuing of intrinsic aspirations and lower valuing of extrinsic aspirations, whereas those who viewed images of urban landscapes, which lacked nature, reported increased valuing of extrinsic aspirations and no change of intrinsic aspirations (Weinstein et al., 2009). Similarly, briefly viewing either unspectacular or awe-evoking photographs of nature can

promote people's intrinsic aspirations making them feel more caring, spiritual and connected to others (Joye & Bolderdijk, 2014). Taken together this research suggests that value orientations and aspirations may be implicated in the relationship between eudaimonic wellbeing and nature connection. On this basis we theorise that nature connection may be related to wellbeing because it helps to increase intrinsic value orientations and aspirations. By increasing nature connection, it is plausible that intrinsic aspirations could be promoted and resulting eudaimonic wellbeing benefits delivered. Further research on nature connection should assess people's value-orientations to ascertain whether (and if so, how and why) eudaimonic wellbeing benefits are delivered through the mechanism of nature connection fostering intrinsic values within people.

2.8 Conclusions

Promoting feelings of eudaimonic wellbeing through forging connections to nature has important consequences for psychological health, particularly among urban residents. This essay builds on previous recommendations to consider individual agency within the nature-health research field (Bell et al., 2014), to incorporate nature connection into study protocols (Craig et al., 2016) and to cultivate nature connection among urban communities (Trigwell et al., 2014). It critically examines what is known about the nature connection and eudaimonic wellbeing relationship, exploring the current state of evidence for the potential moderators (e.g., cultural constructions/interpretations of nature) and mediators (e.g., mindfulness, spirituality, purpose in life) that could influence this relationship. In so doing, it identifies pertinent gaps in our understanding of this relationship, namely the need to identify and understand its underpinning mechanisms.

Using Self Determination Theory, we propose two potential mechanisms for further investigation in order to address this gap: satisfaction of the psychological need for relatedness and fostering an intrinsic value orientation. This is not to suggest that these are the only mechanisms that may be at play within the nature connection-eudaimonia relationship, or that their influence will be uniform across different individuals and groups; rather, we have examined the existing literature to identify these two mechanisms as worthy of further investigation. More broadly, this essay seeks to stimulate

and contribute to the ongoing debate, among nature and health researchers, on the wellbeing promotion potential of nature connection, and to encourage researchers to include and test the two mechanisms suggested within their study protocols.

By gaining a deeper understanding of such mechanisms, we can better inform the implementation of targeted policies and interventions designed to enhance psychological wellbeing through the cultivation of nature connection among urban populations. Already there are growing calls within the policy arena for increased access to urban green spaces, as with the Sustainable Development Goal 11.7 (UN, 2015), and for urban green space to be part of children's daily routines (WHO, 2010). Similarly, there are recent moves to explore the health promotion potential of 'green prescriptions' that seek to administer a 'healthy dose of nature' to target adult populations (Shanahan et al., 2016). However, such interventions that aim to improve health and wellbeing through simply increasing the provision of and/or access to urban nature, in isolation of targeted interventions to connect and engage people with the nature space, may not deliver on the intended health outcomes (Hunter et al., 2015). In order for urban nature to deliver on its reported multiple outcomes the connection and relationship occurring between the nature and the person experiencing it needs to be understood and facilitated within the design and delivery of the urban nature. Certain initiatives already have this relationship as their central focus, for example, widespread initiatives to reconnect children to nature (Louv, 2008) and campaigns such as 30 Days Wild (Richardson et al., 2016). However, these initiatives are delivered without an established understanding of the nature connection mechanisms at play. Such understanding could enhance the efficacy of urban nature connection programmes helping to explain how and why different individuals and cultural groups feel able (or otherwise) to connect with diverse forms of nature in their living environments, in what ways, and to what extent (if at all) such experiences enhance feelings of eudaimonic wellbeing. Future research should also explore the role of individual difference factors as influencers on programs aiming to increase wellbeing through nature connection. For example, recent research suggests that agreeableness, conscientiousness and openness to new experiences are the personality traits most strongly linked to environmental engagement, whereas extraversion and neuroticism are less so (Milfont & Sibley, 2012).

Such insights could help unravel the intricacies involved in designing and delivering effective urban nature connection experiences for diverse urban populations. Should satisfaction of the psychological need for relatedness and fostering an intrinsic value orientation be shown to be the key mechanisms through which nature connection promotes eudaimonic wellbeing then this understanding could be used by landscape designers and urban planners to inform how urban green and blue space interventions are designed and implemented. For example, delivering urban nature spaces that allow people the opportunity to contemplate and reflect on their own relationship and connection with nature or that actively promote people's sense of connection with nature through facilitating meaningful nature experiences may promote the feeling of non-human relatedness hence satisfying this basic psychological need. Urban gardening is showing promise as one way to provide meaningful nature experiences among urban residents (Buck, 2016). Similarly, designing urban nature spaces that include quiet areas which, through signs or other visual cues, encourage the visitor to pause and notice their surroundings may help satisfy the need for relatedness. Providing urban nature spaces that enable urban residents to contribute and 'give back' to the community may be a way to promote nature connection and an intrinsic value orientation. Providing conservation and green volunteer opportunities within urban nature spaces may be a possible way to achieve this (Husk, Lovell, Cooper, Stahl-Timmins, & Garside, 2016). Identifying and understanding the mechanism(s) responsible for the wellbeing outcomes from nature connection will enable interventions to be designed in a way that specifically targets and influences the identified mechanism promoting the desired outcome. This will help move the application of nature and health research beyond 'one-size-fits-all' and 'more-is-better' type interventions towards more tailored, targeted and effective solutions.

Understanding the underpinning mechanisms between nature connection and wellbeing can inform efforts to enhance and/or retrofit 'healthy' green infrastructure networks within and between cities, towns and villages, promoting opportunities for residents to develop their nature connection and wellbeing, as well as offering more widely acknowledged sustainable transport and ecological benefits.

2.9 References

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Chapter 3. Methodology

This chapter presents the methodological approach for the thesis. First the paradigmatic positioning of the research is explained before introducing the research questions and an overview of the methodology. The study site is described followed by two sections devoted to each phase of the data collection. These sections provide technical detail, consideration of the strengths and weaknesses of each methodological approach and justification for the methodology.

3.1 Positioning the research

Research is informed and influenced by a philosophical worldview (also known as paradigm or epistemology and ontology). From the onset, a pragmatic philosophical worldview was applied to this research. Instead of focusing on methods, the emphasis has been on the research problem with all available approaches being considered and the most appropriate and feasible methods being chosen to understand the problem. Pragmatism arises out of actions, situations and consequences rather than antecedent conditions (as in postpositivism; Creswell, 1996). Pragmatism is concerned with applications of research and solutions to problems. A pragmatic worldview is not committed to any one system of philosophy and, as such, matches the transdisciplinary field of nature and mental health research. While certain areas in this field are well researched with established theories, for example, direct restoration from stress or fatigue through psycho-neuro-endocrine pathways (Kaplan, 1995; Ulrich et al., 1991), other areas are lacking clear understanding of pathways and underlying theories. Hence a purely postpositivist worldview was not considered appropriate for addressing the questions posed by this research. This research seeks to explore the relationship between nature and psychological wellbeing, an aspect of the research area that is under-researched with an underdeveloped theoretical base.

A multi-phased survey design was considered the most suitable for answering the thesis research questions within the resources and timeframes of the candidature. The survey method provides a structured approach to data collection and analysis and relies upon a particular logic of analysis which is, in essence, that variation in one variable is related to variations in other variables (De Vaus & de

Vaus, 2013). Survey research is commonly regarded as inherently quantitative and positivistic. However, there is debate in the literature about the usefulness of typifying survey research using the quantitative/qualitative distinction which can encourage too narrow a focus on the use of statistical analysis and quantitative measures as opposed to emphasising the underlying research questions (Becker, 1996). Therefore, while the survey methods used in this research may be classified as quantitative it is more useful to focus on the pragmatic worldview which emphasises the research questions and finding solutions to answering these questions. A pragmatic worldview allows for the use of multiple methods and different forms of data collection and analysis. As a result, a pragmatic worldview can often lead to a mixed methods study design. However, as explained below, in the case of this research, the pragmatic worldview led to a multi-phased, survey-based methodology being selected as the most appropriate.

3.2 Research questions and an overview of the methods

The overall aim of this doctoral research was to explore, within an urban context, how people's subjective perception of and relationship with nature relates to their psychological wellbeing and to investigate factors that may be associated with an individual's nature connection. In order to address this aim, three specific research questions were identified to guide the research:

1. **(RQ1)** How do changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing among mid-aged Brisbane urban residents?
2. **(RQ2)** How is nature connection associated with psychological wellbeing among adult Brisbane urban residents?
3. **(RQ3)** What is the relationship between childhood and adult nature experiences and nature connection among adult Brisbane urban residents?

Underpinned by a pragmatic worldview which focuses on these research questions, it was decided that a sequential, multi-phased, survey design would be best suited to exploring these questions. Hence, a two-phased, survey-based data collection approach was designed and is depicted in Figure 3.1. Other forms of data collection were considered, in particular qualitative data collection techniques such as

interviews. However, survey data collection was deemed the most appropriate for numerous reasons; namely, the availability of longitudinal data from a cohort panel study of the target population which was suited to addressing the first research question; the existence of validated scales for measuring nature connection, a construct of interest for both the second and third research questions; and the ability to carry out mediation and moderation analysis which is key to answering the second and third research questions. The two main phases of this research are as follows:

- **Phase 1: Longitudinal survey data** – This phase involved data analysis of longitudinal, multi-level survey data from the HABITAT (How Areas in Brisbane Influence Health and Activity) study. This phase explores the first research question of how changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing.
- **Phase 2: Cross-sectional survey data** – This phase involved designing and administering a survey instrument to a sample of Brisbane urban residents over the age of 18 years who have lived in Brisbane for six months or longer. This phase explores the second and third research questions of how nature connection is related to psychological wellbeing and what factors are associated with nature connection.

An overview of these two phases is provided in Table 3.1. While both phases of data collection use surveys, the methods of survey administration vary, with the longitudinal survey data being collected from a mail questionnaire and the cross-sectional survey data being collected from an email and web-based questionnaire. Further details on each survey data collection phase are provided in Sections 3.4 and 3.5. A literature review preceded the two survey data collection phases and an overall synthesis of the findings from both phases concluded the methodological design. The design follows a sequential approach where the findings of the first phase inform and underpin the second phase.

Table 3.1. The worldview, strategies and methods contributing to the research design

	Worldview	Research Strategy	Research Method	Research Approach	Target Population
Phase 1	Pragmatism	Non-experimental design	Longitudinal survey	Mail-based panel survey	Brisbane urban residents (≥ 40 yr)
Phase 2	Pragmatism	Non-experimental design	Cross-sectional survey	Web-based survey	Brisbane urban residents (≥ 18 yr)

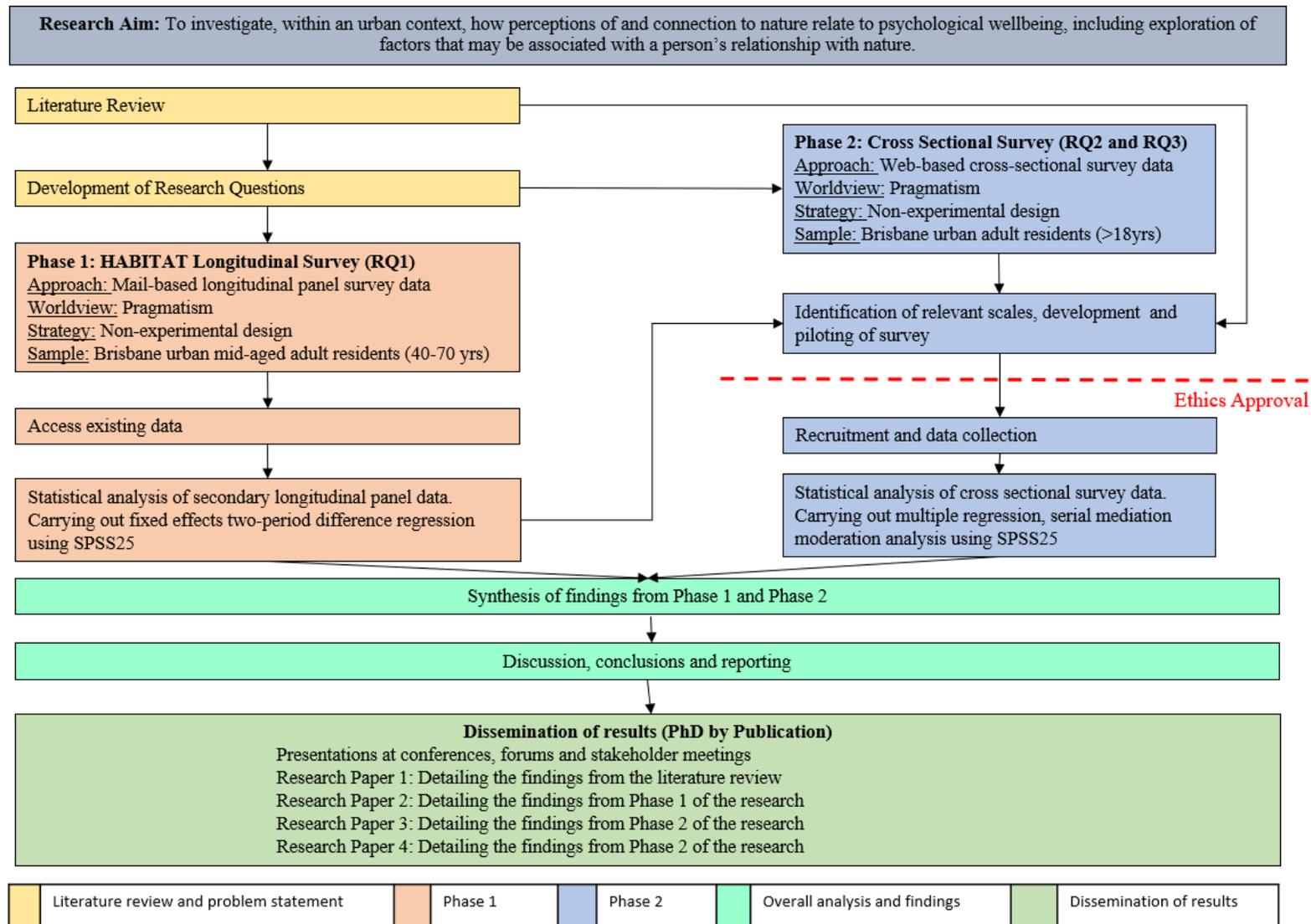


Figure 3.1. A schematic of the methodological approach

3.3 Study site

With a population of over two million, Brisbane is Australia's third largest city. Located on the east coast in the state of Queensland, Brisbane experiences a sub-tropical climate with humid and hot summers coupled with mild winters. With a rapidly growing population, Brisbane is one of Australia's fastest growing cities. Brisbane is governed by a single local government authority which means there are consistent policies across the entire city resulting in a relatively even spread of public green space across social groups (Shanahan, Lin, Gaston, Bush, & Fuller, 2014). The city also has a high overall level of green space (36% tree cover), and the physical provision of public parks is over 200 m² per person, well above the 8 m² per person recommendation provided by UN-Habitat (UN Habitat, 2013). Nature and health research has a strong presence in Brisbane with multiple cross-sectional studies sampling the city's population (Lin et al., 2014; Shanahan et al., 2014) and the HABITAT study, an environment and health longitudinal cohort study, tracking Brisbane residents since 2007 (Burton et al., 2009). This increases the appeal of Brisbane as a study site as it provides a good evidence base from which to further develop and explore relationships as well as the opportunity to gain access to a relevant secondary dataset.

3.4 Phase 1 – Longitudinal survey data

The longitudinal HABITAT (How Areas in Brisbane Influence Health and Activity) dataset was chosen for analysis as it includes data on psychological wellbeing as well as perceptions of the quantity and quality of local urban nature. Hence, it was deemed appropriate for investigating how changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing (RQ1). The HABITAT study is a longitudinal study of Brisbane residents who were aged between 40 – 65 years in 2007. HABITAT is funded by the Australian National Health and Medical Research Committee (ID290521; ID497236) with additional funding and data support provided by Brisbane City Council. The HABITAT study received ethical clearance from The University Human Research Ethics Committee at the Queensland University of Technology (ID3967H). The baseline survey was completed in 2007 with subsequent waves occurring approximately every two years (2009, 2011,

2013, 2016). At the time of this thesis research the 2016 wave was not available for analysis. Although there were four waves of data available in HABITAT, only two waves of data were analysed in this thesis research because the independent and dependent variables selected for investigation were only measured for all study participants in 2009 and 2011.

HABITAT areas and participants were selected using a stratified two stage design. Details on the design, sampling and data collection procedures for the HABITAT dataset have been described elsewhere (Burton et al., 2009). In brief, HABITAT uses a multi-stage probability sampling design to select a stratified random sample ($m = 200$) of Census Collector's Districts (CCD), and from within each CCD, a random sample of people (on average 85 per CCD). The analytical sample used in this research comprised 5,014 individuals. A structured, self-administered mail questionnaire is used to collect data from participants. This thesis research analysed data across two waves from a subset of variables from the full questionnaire. These variables included the independent variable of perceptions of quality and quantity of urban nature, the dependent variable of psychological wellbeing and the following control variables – age, gender, occupation status, education level, neighbourhood disadvantage and household income (questionnaire provided in Appendix 1).

The data were accessed through first discussing the research proposal with the HABITAT Chief Investigator and then, upon receiving feedback from the Chief Investigator, submitting an Expression of Interest (EOI) to the HABITAT project manager. The EOI was submitted with approval to access the HABITAT data being granted in early 2017. Following approval, I signed a Study Confidentiality and Data Use Agreement which resulted in access to a link to download the HABITAT dataset. The process for accessing HABITAT data is outlined in Figure 3.2. Details on the analytical approach are provided in the Chapter 4, which addresses the first research question.

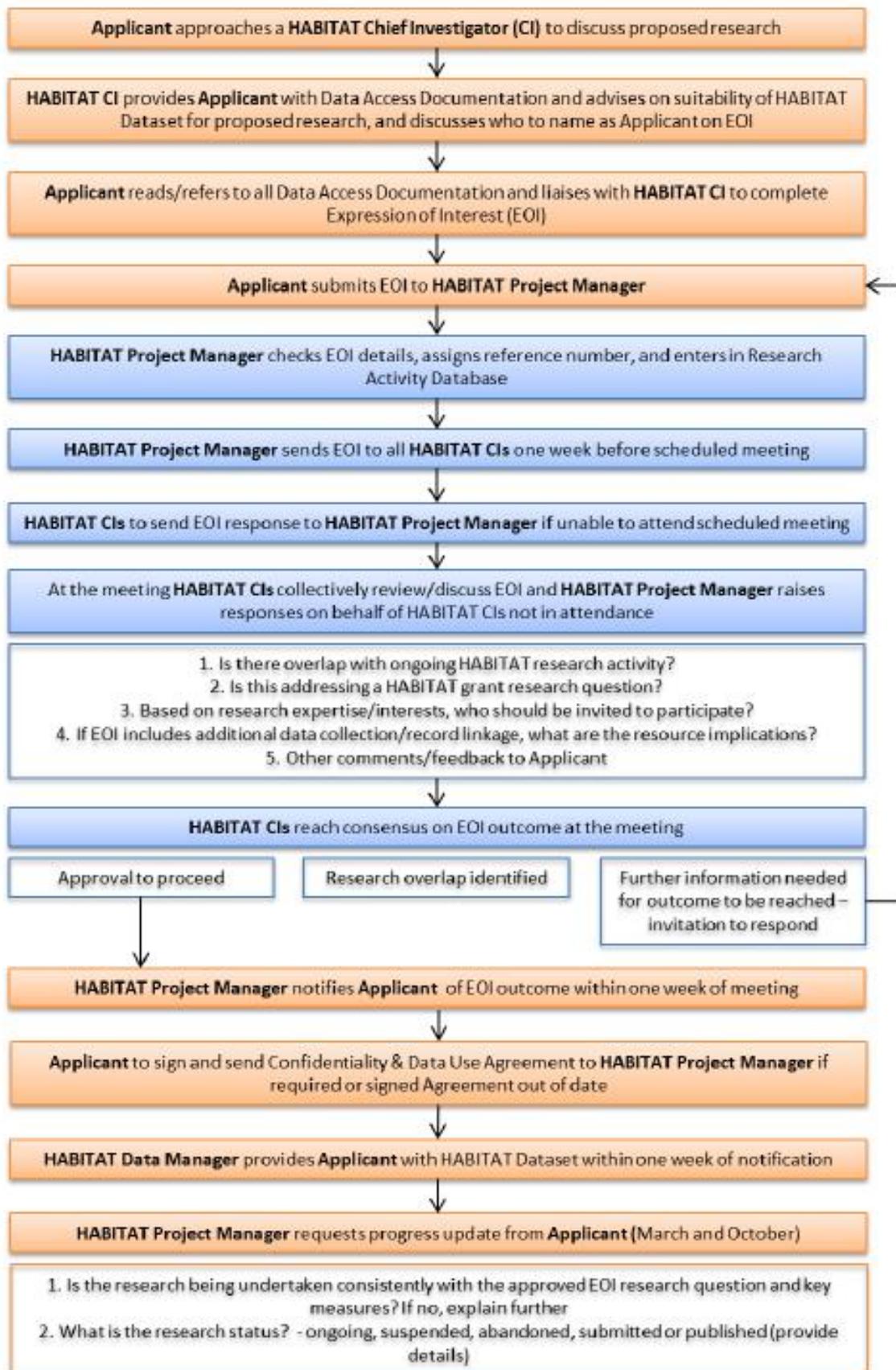


Figure 3.2. HABITAT Study data access process flowchart

3.5 Phase 2 – Cross-sectional survey data

Based on the results from Phase 1, it was decided that people's subjective relationship with nature would be further explored by investigating the role of nature connection. A survey was designed with the aim of investigating how nature connection is associated with psychological wellbeing (RQ2) and exploring factors that predict a person's nature connection (RQ3). A survey instrument was chosen as the data collection method for multiple reasons. A key reason was the existence of numerous validated scales that measure an individual's nature connection that are suited to a survey-based study design. Furthermore, a well-designed and administered survey allows for results from the survey sample to be generalised to the target population which will increase the relevance and application of study findings (Fowler Jr, 2013). An email and web-based self-administered survey was chosen over more traditional survey forms such as postal surveys, face-to-face interviews or telephone interviews. Web-based surveys have grown in popularity among the research community because they hold numerous advantages over more traditional survey data collection methods. Key advantages of web-based surveys include ease of use, less labour and resource intense (no printing, mailing or manual tracking), quicker turn around (immediate survey delivery, quick and easy follow-up and data tracking) and more accurate data collection (web format minimizes entry of erroneous or unacceptable data and automatic data transfer removes data entry errors).

There are multiple stages involved in the design and administration of a web-based survey. The design of the survey questionnaire was driven by the research questions of the thesis and the key constructs of interest contained within these research questions. Through reviewing the relevant literature, indicators of these constructs were identified. These indicators were then considered within the context of the study site and relevant survey questions were drafted. For example, the third research question explores factors that are related to nature connection. The literature suggests that childhood nature experiences may be a key factor that influences nature connection. The construct of interest is therefore childhood nature experiences. The literature was further explored to identify or inform possible indicators for measuring this construct. From the literature I identified the Early Environmental Experiences scale as an indicator of childhood nature experiences (Hinds, 2018). This

scale was developed in England and hence had to be adapted to the Australian context by including reference to Brisbane relevant landscapes (see resulting scale in Appendix 2). This is an example of how the research questions and constructs of interest inform the design of the questionnaire. The questionnaire then went through an iterative process of testing and refining. Draft versions of the survey were reviewed internally among the supervisory team with the final draft version of the survey being reviewed externally by six critical friends who were experienced in the design of web-based, self-administered surveys. Following incorporation of feedback from the critical friends the survey was then piloted among a sample of Gold Coast residents (n = 25). Gold Coast is a coastal city about 100 km south of Brisbane and was chosen as the site of the pilot survey as it experiences a similar climate and urban nature as Brisbane. This pilot sample was recruited through emailing a link to the online survey to individuals from community groups that were randomly selected from the Gold Coast My Community Directory. This pilot helped to further refine the questionnaire ensuring it was succinct and not too arduous or time-consuming for respondents. The final questionnaire is provided in Appendix 2.

During the design stage multiple online survey platforms were tested namely, LimeSurvey, Survey Monkey and Qualtrics with the final survey being administered via the Qualtrics survey platform. Qualtrics was chosen as it is accessible through Griffith University, has 24-hour access to the Qualtrics support team and is the most sophisticated with regards to the branching and question logics that could be specified in the questionnaire.

Once the survey had been designed and built in the online platform, a social research company was engaged to assist with the administration of the online survey. Numerous companies were researched with Pureprofile, Qualtrics, Online Research Unit and Q & A Market Research all providing quotes for the work. Pureprofile were chosen as they are ISO accredited (ISO 26362:2009 Access Panels in Market, Opinion and Social Research and ISO 20252:2012 Market, Opinion and Social Research), were competitively priced and had positive user reviews. Furthermore, Pureprofile have transparent and robust quality control procedures in place to ensure that their panel is comprised of active members with up-to-date demographic data. The sample was recruited through Pureprofile who

emailed the survey link to a subset of their panel members that matched the target population for the research. Respondents who completed the survey in full received minor monetary compensation.

The web-based survey was designed with a number of screening questions embedded in the questionnaire which if answered a certain way would remove respondents who did not meet the selection criteria of the study sample. For example, respondents were removed from the survey if they provided a postcode that was outside of the study site (n = 944), provided a date of birth that was below 18 years old (n = 6) or if they stated that they had been living in Brisbane for less than six months (N = 595). The survey was designed to include multiple quality control screeners. For example, if respondents completed the questionnaire in a third of the median completion time then they were excluded, as this was considered too short a time for a participant to read the questions and provide legitimate responses (n = 28). Similarly, an attention check question was included midway in the questionnaire that stated ‘*You are over halfway there! To ensure that you are still paying attention please click on the answer 'easy'*’. Those that failed to answer ‘easy’ to this question were also excluded (n = 65). Finally, all open-ended question responses were manually screened with respondents that provided nonsensical or computer-generated responses being removed (n = 19). Respondents who started the survey but failed to complete it were also removed (n = 52). Age and gender quotas were also embedded in the survey design to help stratify the sample based on age and gender. Hence, respondents were excluded if they matched the age or gender of a quota that was already full (n = 629). That said, it was difficult to fill the male quota towards the end of the survey and the female quota had to be relaxed hence the slight over representation of females in the final sample (females = 52.5%). Overall, 3,338 participants attempted to answer the survey with 2,338 respondents being excluded based on the reasons outlined above. Table 3.2 provides a breakdown of reasons for the exclusion of the 2,338 respondents.

Table 3.2. Reasons for exclusion of respondents

Reason for exclusion	Number of respondents excluded
Respondent provided a postcode outside of the study area	944
Respondent was living in Brisbane for less than six months	595
Respondent was under 18 years	6

Respondent failed the attention check question	65
Respondent completed survey in too short a time	28
Respondent provided nonsensical responses to open-ended questions	19
Respondent failed to complete the survey	52
Respondent's age or gender quota was full	629
Total respondents excluded	2,338

On 15 May 2017 a soft launch of the survey occurred with 5% of the sample (n = 50). This was to ensure that there were no issues with the survey design and that all question logics and embedded screeners were working correctly. In total the survey was open for a month with the full sample being collected (N = 1000) and the survey closing on 18 June 2017. This time of year was chosen for data collection as it occurs following several public holidays when people are likely to have returned to a typical routine. In addition, in Brisbane, May is a time of year which is conducive to outdoor activity following the end of the high summer temperatures. Data entry is automated and was exported as a SAV File and imported to IBM SPSS V25 software package for analysis. Details on the analytical approaches are provided in Chapter 5 which addresses the second research question and Chapter 6 which addresses the third research question.

Ethical approval for this study was sought and obtained successfully in February 2016 from Griffith University Human Research Ethics Committee (Approval Reference: 2016/085). The cross-sectional survey was conducted in accordance with the National Statement on Ethical Conduct in Human Research. This involved ensuring key steps were carried out during the data collection process such as obtaining informed consent from all survey respondents and allowing them the option to withdraw at any time throughout the survey (consent form is provided in Appendix 3) and maintaining participant privacy throughout the research through following the Griffith University Privacy Plan (<http://www.griffith.edu.au/privacy-plan>) with regards to data collection, storage, analysis and reporting.

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Chapter 4.

The relationship between perceptions of nature and psychological wellbeing

4.1 Overview

This chapter reports results from analysis of the longitudinal HABITAT survey data and addresses the first research question of this thesis ‘How do changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing among mid-aged urban residents?’. This is the first time that the relationship between perceptions of nature and psychological wellbeing has been explored within a longitudinal study design and, as such, this research provides unique insight to the nature and mental health relationship. Results show that changes in perceptions of quality and quantity of urban nature are positively associated with changes in psychological wellbeing. This provides justification for looking beyond objective measures of nature exposure to start exploring and disentangling how people perceive and interpret nature and how these interpretations affect the psychological wellbeing outcomes from nature. Urban nature interventions that seek to promote wellbeing among urban residents need to consider how people perceive and interpret that nature. Failing to do so may lead to misinformed design and delivery of nature-based interventions as well as inaccurate evaluations of their effectiveness. This could undermine movements such as Healthy Cities and Biophilic Cities which seek to use nature-based solutions to promote thriving and flourishing urban communities. Note, this paper spells wellbeing with a hyphen (well-being) as per the journal’s requirements.

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:

Cleary, A., Roiko, A., Burton, N., Fielding, K. S., Murray, Z., Turrell, G. (under review). Changes in perceptions of quality and quantity of urban green space are related to changes in psychological well-being:

Cross-sectional and longitudinal study of mid-aged urban residents.

Submitted to *Health and Place* on 7 August 2018.

STATEMENT OF CONTRIBUTION TO CO-AUTHORED PUBLISHED PAPER

Contributor	Statement of contribution
Cleary, A.	Conceived the study design (80%) Completed analysis (100%) Wrote paper (100%)
Fielding, K.	Edited paper and provided critical feedback (20%)
Murray, Z.	Edited paper and provided critical feedback (20%)
Roiko, A.	Edited paper and provided critical feedback (20%)
Turrell, G.	Conceived the study design (20%) Edited paper and provided critical feedback (20%)
Burton, N.	Edited paper and provided critical feedback (20%)

My specific contributions to the paper involved conceiving of the research idea, identifying and accessing an appropriate secondary dataset, defining the analytical sample and specifying the analytical approach, carrying out the analysis and interpretation of results and writing and revising the manuscript.

Signed:
(Anne Cleary)

Date: 31 August 2018

Countersigned:
(Anne Roiko)

Date: 31 August 2018

4.2 Abstract

We used data from 5,014 mid-aged adults in the HABITAT study, across two waves (2009 and 2011), to explore associations between perceptions of quality and quantity of urban green space and psychological well-being. Linear regression revealed that perceptions of quality and quantity of urban green space were significantly and positively associated with psychological well-being at both time points. A longitudinal, fixed effects, two-period difference regression revealed that within-person change in perceptions of quality and quantity of green space across two years was positively associated with psychological well-being. All associations remained significant after controlling for age, gender, household income, education, occupation and neighbourhood disadvantage. Our findings indicate that psychological well-being is influenced by perceptions of local urban green space. Subjective measures of green space are an important factor that needs to be considered when exploring the relationship between green space and mental health outcomes. These findings are timely given the growing interest in urban green space interventions for combating increasing mental ill-health rates among expanding urban populations.

4.3 Introduction

Presence of nature in our living environment is associated with a range of mental health benefits. High levels of residential green space have been associated with lower rates of mental ill-health indicators, for example, anxiety (Nutsford, Pearson, & Kingham, 2013), stress (Fan, Das, & Chen, 2011), psychological distress (Sturm & Cohen, 2014, Astell-Burt, Feng, & Kolt, 2013), major depressive disorders (Mukherjee et al., 2017; Sarkar, Webster, & Gallacher, 2018), antidepressant prescription rates (Taylor, Wheeler, White, Economou, & Osborne, 2015) and suicide risk (Helbich, de Beurs, Kwan, O'Connor, & Groenewegen, 2018). Residential green space has also been shown to be positively associated with indicators of positive mental health, such as life satisfaction (Fleming, Manning, & Ambrey, 2016), happiness (Van Herzele & de Vries, 2012) and psychological well-being (Sugiyama, Leslie, Giles-Corti, & Owen, 2008; White, Pahl, Wheeler, Depledge, & Fleming, 2017; Wood, Hooper, Foster, & Bull, 2017).

Reviews of studies on the relationship between green space and mental health have identified a common shortcoming of this evidence, namely the preponderance of cross-sectional study designs (Frumkin et al., 2017; Hartig, Mitchell, De Vries, & Frumkin, 2014). Cross-sectional studies are effective at identifying and measuring the strength of associations between green space and mental health, however, such studies lack temporality, which is important for establishing causation. Hence, there have been repeated calls for a greater representation of longitudinal study designs within green space and mental health research (Frumkin et al., 2017; Hartig et al., 2014). A number of studies have used nationally representative, longitudinal surveys, such as the British Household Panel Survey, to investigate how residential green space influences mental health across the life course and by gender (Astell-Burt, Mitchell, & Hartig, 2014) or how moving to greener residential areas affects mental health (Alcock, White, Wheeler, Fleming, & Depledge, 2014). Younan et al. (2016) used a two-wave cohort of adolescents in the USA to show that increased exposure to local urban green space was related to lower aggression. Richardson, Pearce, Shortt, and Mitchell (2017), using longitudinal survey data of urban-dwelling children in Scotland, found that access to green space was related to social and emotional development as measured by the Strengths and Difficulties Questionnaire. Dadvand et al. (2015) carried out repeated assessments of cognitive development among school children (ages 7-10) in Spain and found that increases in urban green space exposure were associated with increased attention and working memory. These longitudinal studies are providing stronger evidence for causal inference about the role green space plays in mental health outcomes.

To date, longitudinal studies investigating the relationship between green space and mental health have tended to use objective indicators of green space exposure. These are often measured on the basis of readily available GIS-based land use variables or satellite-based vegetation indices such as the Building Proximity to Green Spaces Index (Li et al., 2014), Enhanced Vegetation Index (Huete et al., 2002), Leaf Area Index (Hu, Yan, Mu, & Luo, 2014) or the Normalized Difference Vegetation Index (NDVI; Rhew, Vander Stoep, Kearney, Smith, & Dunbar, 2011), with NDVI being commonly used in population level studies. Subjective measures of urban green space have been less researched within longitudinal study designs. A recent systematic review of 68 non-cross-sectional studies on the

relationship between urban green space and health included only three studies that used subjective measures of green space (Kondo, Fluehr, McKeon, & Branas, 2018). These three studies revealed that changes in perceptions of quality and quantity of green space was positively associated with uptake in cycling following a residential relocation (Beenackers et al., 2012), higher subjective scoring of quantity of local green space was associated with increased physical activity among children in the Netherlands (De Vries, Bakker, Van Mechelen, & Hopman-Rock, 2007) and perceiving more nature in neighbourhoods was related with a decrease in depressive symptoms among Dutch urban residents (Gubbels et al., 2016). Interestingly, Gubbels et al. (2016) also collected data on objective measures of changes in green space, but no association was found with depressive symptoms. This suggests that when assessing associations with mental health, subjective measures of green space may provide unique insights that are not captured by objective measures alone.

Findings from other studies also suggest that perceived and objective measures capture different aspects of neighbourhood greenness (Coldwell & Evans, 2018; de Jong, Albin, Skärbäck, Grahn, & Björk, 2012; Leslie, Sugiyama, Ierodionou, & Kremer, 2010). A recent review of 85 studies, found that perceived- and objectively-measured neighbourhood environment are related but distinct constructs that account for unique variance in physical activity (Orstad, McDonough, Stapleton, Altincekic, & Troped, 2017). Some studies comparing the relationship between health outcomes and green space quantity, which tends to be objectively measured, versus green space quality, which tends to be subjectively measured, have reported contrasting results between quantity and quality of green space. For example, a recent longitudinal study of Australian women (N = 3897) found no association between green space quantity and mental health disorders but found a positive relationship with perceived green space quality (Feng & Astell-Burt, 2018). Similar results have been found with a cross-sectional study assessing the relationship between quality and quantity of public open space and psychological distress in western Australia (Francis, Wood, Knuiman, & Giles-Corti, 2012). Parents' and teachers' perceptions of green space have been shown to be associated with children's general health (Feng & Astell-Burt, 2017a, 2017b). Other studies have shown that associations between

wellbeing outcomes and green space quality and quantity become more salient over time, for example as children grow older (Feng & Astell-Burt, 2017c).

Perceptions of green space are therefore distinct, providing unique insight to the green space and health relationship and hence they need further attention within the literature, particularly within longitudinal study designs.

The aim of this study was to address the shortcomings in the green space and mental health evidence base that stem from an over-reliance on cross-sectional study designs and use of objective measures of green space. We used two waves of data from a longitudinal panel survey that has tracked urban residents since 2007, and subjective measures of how participants perceive the quantity and quality of green space in their suburb of residence. There is growing recognition of the role that promotion of mental well-being plays in combating growing mental ill-health trends (Wood et al., 2017). Our study aims to contribute to this evidence base of positive mental health, by using measures of mental well-being as opposed to a measure of mental ill-health. To our knowledge, this is the first study to assess the effects of perceptions of quality and quantity of urban green space on a measure of mental well-being, within a longitudinal study design. As such, we aim to provide a unique contribution to the field of urban green space and mental health research.

4.4 Methods

Sample and procedure

The HABITAT (How Areas in Brisbane Influence HealTh and AcTivity) study is a longitudinal study of Brisbane residents who were aged 38 – 66 years in 2007. HABITAT was designed to explore how environmental factors influence the health of adults as they age. HABITAT used a multi-stage probabilistic sampling design to select a stratified random sample ($m = 200$) of Census Collector's Districts (CCD), and from within each CCD, a random sample of people (on average 85 per CCD). Further details on the design, sampling and data collection procedures for HABITAT have been described elsewhere (Burton et al., 2009). This study uses mail survey data from wave 2 (2009) and wave 3 (2011) of HABITAT, because perceptions of green space and psychological well-being were

both measured across the whole sample in these two waves. This therefore means that the age range of the study sample in 2009 was 40 – 68. The mail survey response rate at baseline was 68.4% (11,035 surveys from 17,000 sent with 16,128 eligible respondents). The response rate was 72.4% in 2009 (7,867/10,866) and 66.8% in 2011 (6,901/10,327). The HABITAT mail survey was granted ethical approval by The University Human Research Ethics Committee at the Queensland University of Technology (ID3967H).

Perceptions of quality and quantity of green space

Perceptions of green space were measured using three items which asked participants about how they perceived the quality and quantity of green space in their suburb of residence. Participants rated their level of agreement (1 = disagree strongly, 5 = agree strongly) with two statements about the quantity of green space, “There is lots of greenery around my suburb (trees, bushes, household gardens)”, “There is tree cover along many of the footpaths in my suburb”, and with one statement about the quality of green space, “There are pleasant natural features in my suburb (e.g., nature reserves, beach, riverfront, bushland)”. We tested the reliability of this three-item perceptions of green space scale at both time points. The Bartlett’s test of sphericity was significant ($p < 0.001$) and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy values were greater than 0.6 at both time points. Hence, factor analysis was deemed appropriate for these three perceptions of green space items. Principal component analysis was performed resulting in the extraction of one component (eigenvalue = 1.63 accounting for 54.2% of variance at time point 1 and eigenvalue = 1.64 accounting for 54.6% of variance for time point 2). At both time points all three items loaded onto this single green space component with all factor loadings ≥ 0.69 . Cronbach alpha values were low but consistent across both time points (0.55 for time point 1 and 0.56 for time point 2). Item deletion did not improve the reliability of the scale. Cronbach alpha values are quite sensitive to the number of items in the scale with low Cronbach alpha values being common among scales that have a small number of items, such as our three-item scale (Cortina, 1993; Pedhazur & Schmelkin, 2013). Hence, we also calculated the mean inter-item correlation which was 0.31 at time point 1 and 0.32 at time point 2. As recommended by Briggs and Cheek (1986), the optimal mean inter-item correlations values range from 0.2 to 0.4.

To assist with the interpretation of the results, a standardised scale score was derived and then re-scored to range from 0 to 15 ($M = 11.16$, $SD = 2.27$ in 2009, $M = 11.16$, $SD = 2.25$ in 2011), with higher scores indicating greater perceived quality and quantity of green space in the suburb of residence.

Psychological well-being

Psychological well-being was measured using the short Warwick and Edinburgh Mental Well-being scale (Stewart-Brown et al., 2009; Tennant et al., 2007). This is a seven-item, positively phrased scale that asks respondents how frequently (1 = none of the time, 5 = all of the time) they have experienced each feeling/occurrence during the past two weeks. While some items within this scale measure hedonic well-being ('I've been feeling relaxed'), the majority of items measure eudaimonic well-being ('I've been thinking clearly'), and hence this scale is recognised as an accurate measure of psychological well-being (Stewart-Brown et al., 2009). The sum of the seven items is transformed using a conversion table, available on the Warwick Medical School website (<https://warwick.ac.uk/fac/med/research/platform/wemwbs/>), to produce the final metric score with values ranging from 7 to 35, where higher results represent better psychological well-being (Cronbach's $\alpha = 0.86$ at both time points, $M = 23.3$, $SD = 3.54$ in 2009, $M = 23.2$, $SD = 3.54$ in 2011).

Confounders

Based on previous research on factors associated with psychological well-being (Dolan, Peasgood, & White, 2008), demographic data on gender, age, education, gross household income, neighbourhood disadvantage, employment status and occupation were treated as potential confounders of the relationship between perceptions of green space and psychological well-being. These variables were treated in a way that is consistent with previous studies using the HABITAT data (Rachele, Ghani, Loh, Brown, & Turrell, 2016; Turrell et al., 2018). Participants reported their age using a date-of-birth format (day/month/year) and data were coded into five-year age-groups ranging from 40 – 44 to 66 – 70 years. In the baseline survey participants reported the highest educational qualification that they had completed. The time-invariant education variable was coded as 'bachelor's degree or higher' (including post graduate diploma, Masters, or doctorate); 'diploma/associate diploma' (associate or

undergraduate); ‘certificate’ (trade or business certificate, or apprenticeship); ‘school’ (no post-school qualifications) or; ‘missing’. Participants were asked to indicate their current employment situation and occupation. For analysis, these two variables were combined and recoded as: ‘manager/professional’, ‘white collar’, ‘blue collar’, ‘retired’, ‘home duties’, ‘unemployed’, ‘permanently unable to work’, ‘other’ and ‘missing’. To measure household income, respondents were asked to estimate the total pre-tax income for their household using a single question comprising 13 income categories that were recoded into eight categories: ‘AUD\$130,000 per annum or more’; ‘\$129,999 – 72,800’; ‘\$72,799 – 52,000’; ‘\$51,999 – 26,000’; ‘\$25,999 – 0’; ‘Don’t know’; ‘Don’t want to answer this’; and ‘Missing’ (i.e. left the income question blank). To measure neighbourhood disadvantage, each of the 200 neighbourhoods was assigned a socioeconomic score using the ABS’ Index of Relative Socioeconomic Disadvantage (IRSD; ABS, 2003). The IRSD reflects each area’s overall level of disadvantage based on 17 socioeconomic attributes, including education, occupation, income, unemployment, and household tenure. For analysis, the 200 neighbourhoods were grouped into quintiles based on their IRSD scores with Q1 denoting the 20% (n = 40) most disadvantaged areas in Brisbane and Q5 the least disadvantaged 20% (n = 40). The survey questionnaire is provided in Appendix 1.

Analysis Strategy

The data were cleaned with cases being excluded if participants moved outside the Brisbane area study site (n = 329), were not the same individual responding at both time points (n = 111), moved address between time point 1 and 2 (n = 257), or had missing data for the dependent or independent variable at either time point (n = 533; Figure 4.1). The final sample for analysis comprised 5,014 participants.

Pearson’s correlations were computed to explore the bivariate relationships between perceptions of green space and psychological well-being at each time point.

For the cross-sectional analysis, multi-level, linear regression analysis was conducted with data from each time point. A multi-level model was used to account for the clustering of participants within neighbourhoods (m = 200). The cross-sectional analysis was carried out to explore the associations

between perceptions of green space and psychological well-being at both time points while controlling for age, gender and markers of socio-economic status (education, household income, occupation, neighbourhood disadvantage).

For the longitudinal analysis, we employed a fixed effects regression, two-period difference model that allowed us to examine whether within-person changes in perceptions of green space predicted within-person changes in psychological well-being. Fixed effects models are a useful exploratory tool when applied to longitudinal data because they control for all unmeasured characteristics of participants that did not change over the time period (Gunasekara, Richardson, Carter, & Blakely, 2013). Following the approach outlined by Allison (2009), we included confounders in the model that may change over time (e.g., age, income, occupation, neighbourhood disadvantage) as well as confounders that don't change over time but may have different effects at different time points (in the case of our study this was education). We also included perceptions of green space at time point 1 in the model to assess whether its effects are stable over time (Allison, 2009). A fixed effect approach was deemed appropriate for this analysis as it has the advantage of removing the effects of time-invariant variables, whether such variables are measured or not (Firebaugh, Warner, & Massoglia, 2013). This is useful in exploratory research, such as this, where all the factors that affect the relationship between perceptions of green space and psychological well-being are not yet known, and it is therefore not possible to create a fully specified model. Hence, we chose a fixed effects approach as it is less vulnerable to omitted-variable bias; however, this approach does not remove the biasing of excluded time-varying confounders or reverse causation.

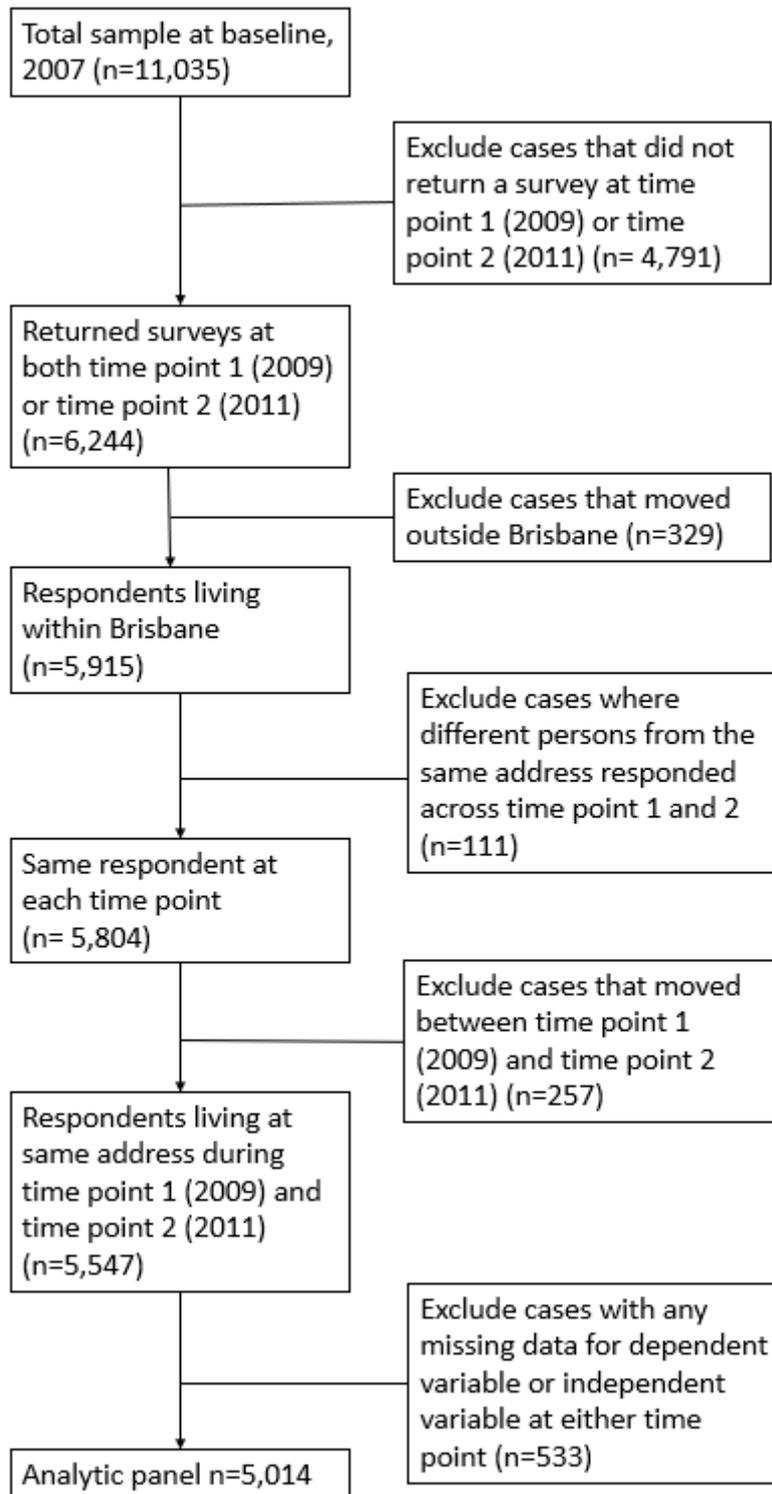


Figure 4.1. Flowchart showing exclusions and inclusions of analytical sample

4.5 Results

Descriptive statistics

The sociodemographic characteristics of the sample are presented in Table 4.1, alongside the mean values of perceptions of green space and psychological well-being.

Bivariate correlations were computed for the dependent variable and independent variable at each time point (Table 4.2). Perceptions of green space were significantly and positively correlated with psychological well-being at both time points. However, while the correlations were highly significant ($p < 0.001$), the effect sizes were small ($r = 0.12$ at time point 1, $r = 0.14$ at time point 2).

Table 4.1. Sociodemographic characteristics of the analytical sample at time point 1 (2009), by mean (SD) perceptions of green space and psychological well-being

N = 5014	n	%	Perceptions of green space	Psychological well-being
Overall	5014	100	11.2 (2.27)	23.3 (3.54)
<i>Gender</i>				
Male	2134	42.6	11.1 (2.22)	23.1 (3.37)
Female	2880	57.4	11.2 (2.31)	23.5 (3.67)
<i>Age (years)</i>				
40-44	573	11.4	11.0 (2.36)	22.8 (3.32)
45-49	1037	20.7	11.1 (2.26)	22.7 (3.33)
50-54	1060	21.1	11.3 (2.22)	23.1 (3.36)
55-59	1024	20.4	11.2 (2.39)	23.4 (3.56)
60-65	1104	22.0	11.2 (2.18)	24.0 (3.85)
66-70	216	4.3	11.1 (2.24)	24.0 (3.45)
<i>Neighbourhood disadvantage</i>				
Q1 (most disadvantaged)	646	12.9	10.2 (2.31)	22.7 (3.75)
Q2	962	19.2	10.5 (2.37)	23.2 (3.70)
Q3	1028	20.5	10.9 (2.15)	23.1 (3.44)
Q4	1093	21.8	11.5 (2.07)	23.4 (3.54)
Q5 (least disadvantaged)	1285	25.6	12.1 (2.05)	23.6 (3.35)
<i>Education (highest level attained)</i>				
Bachelor's degree or higher	1699	33.9	11.3 (2.40)	23.6 (3.40)
Diploma/associate diploma	576	11.5	11.4 (2.12)	23.5 (3.38)
Certificate (trade/business)	853	17.0	11.2 (2.17)	23.2 (3.39)
School	1813	36.2	10.9 (2.23)	22.9 (3.76)
Missing	73	1.5	11.4 (2.25)	23.6 (3.40)
<i>Occupation</i>				
Manager/professional	1631	32.5	11.3 (2.28)	23.5 (3.19)
White collar	1037	20.7	11.2 (2.21)	23.0 (3.46)
Blue collar	610	12.2	10.9 (2.18)	22.9 (3.47)
Retired	642	12.8	11.2 (2.19)	24.1 (3.91)
Home duties	289	5.8	11.0 (2.45)	23.3 (3.70)
Unemployed	74	1.5	10.9 (2.39)	21.9 (3.46)
Permanently unable to work	98	2.0	10.8 (2.05)	20.9 (4.18)
Other	87	1.7	10.8 (2.86)	23.4 (3.85)
Missing	546	10.9	11.1 (2.36)	23.2 (3.72)
<i>Gross Household income (per annum) AUD</i>				
130 000 or more	970	19.3	11.5 (2.24)	23.7 (3.18)
72 800–129 999	1311	26.1	11.2 (2.22)	23.3 (3.23)
52 000–72 799	704	14.0	11.1 (2.25)	23.0 (3.40)
26 000–51 999	885	17.7	11.0 (2.31)	23.1 (3.70)
0–25 999	490	9.8	10.7 (2.30)	22.7 (4.16)
Don't know	99	2.0	11.0 (2.26)	23.3 (3.61)
Don't want to answer question	482	9.6	11.1 (2.33)	23.8 (4.04)
Missing	73	1.5	11.0 (2.26)	23.1 (4.03)

Note: Psychological well-being scale values range from 7-35, Perceptions of green space values range from 0-15

Table 4.2. Bivariate correlations (N = 5,014)

	1.	2.	3.
1. Psychological well-being (T1)			
2. Perceptions of green space (T1)	.116***		
3. Psychological well-being (T2)	.594***	.114***	
4. Perceptions of green space (T2)	.111***	.614***	.137***

Notes: T1 = time point 1 (2009), T2 = time point 2 (2011) *** $p < 0.001$. Two-tailed.

Cross-sectional and longitudinal analyses

At both time points, perceptions of green space were significantly and positively associated with psychological well-being after controlling for age and gender and markers of individual-level socioeconomic position and area-level disadvantage (Table 4.3). Participants who perceived greater quality and quantity of green space in their suburbs were more likely to report higher psychological well-being. The effect sizes were comparable at both time points for the fully adjusted models ($\beta = 0.15$, $p < 0.001$ at time point 1 and $\beta = 0.17$, $p < 0.001$ at time point 2).

For the longitudinal results, the perceptions of green space difference score was a significant predictor of changes in psychological well-being in all three models (Table 4.3). In both Models 2 and 3 baseline perceptions of green space proved to be a non-significant predictor, indicating that the effects of perceptions of green space were stable over time. Within-person changes in perceptions of green space were positively associated with changes in psychological well-being (i.e., perceiving greater quality and quantity of green space in one's suburb of residence was associated with an improvement in psychological well-being and perceiving lesser quality and quantity of green space in the suburb of residence was associated with a decline in psychological well-being). One disadvantage of fixed effects models is that they can produce imprecise estimates in cases where the independent variables vary greatly between individuals but have little variation within individuals. However, the standard error of the perceptions of green space coefficient in the longitudinal model ($SE = 0.02$) is the same as the standard error in the 2009 and 2011 cross-sectional models, which indicates that there is sufficient within-person variation in perceptions of green space across the two time points.

Table 4.3. Modelling the cross-sectional and longitudinal association between perceptions of green space and psychological well-being

	Model 1 ^a			Model 2 ^b			Model 3 ^c		
	β	SE	95%CI	β	SE	95%CI	β	SE	95%CI
N = 5014 individuals									
M = 200 neighbourhoods									
Cross-sectional									
2009 Perceptions of green space	0.18***	0.02	0.14, 0.22	0.17***	0.02	0.13, 0.22	0.15***	0.02	0.10, 0.19
2011 Perceptions of green space	0.22***	0.02	0.17, 0.26	0.21***	0.02	0.17, 0.26	0.17***	0.02	0.13, 0.21
Longitudinal									
Perceptions of green space	0.06*	0.02	0.01, 0.10	0.07**	0.03	0.02, 0.12	0.07**	0.03	0.02, 0.12
Baseline Perceptions of green space[†]				0.02	0.02	-0.02, 0.07	0.02	0.02	-0.02, 0.06

a. Model 1: unadjusted model

b. Model 2: Model 1 plus adjustment for age and sex

c. Model 3: Model 2 plus adjustment for education, occupation, household income and neighbourhood socioeconomic disadvantage

[†] Only included in Model 2 and 3 of the longitudinal analysis

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.6 Discussion

The aim of this study was to further our understanding of the relationship between perceptions of quality and quantity of urban green space and psychological well-being. Consistent with past cross-sectional research, we found significant positive correlations between perceptions of quality and quantity of urban green space and mental health outcomes (de Jong et al., 2012; Sugiyama et al., 2008). This study extends past research by also using longitudinal data to assess how changes in perceptions of urban green space relate to psychological well-being. We found a positive association with participants who perceived an increase in the quality and quantity of green space in their suburb between time point one and two (e.g., over two years) also experiencing an improvement in their psychological well-being and, conversely, participants who perceived a decline in the quality and quantity of green space in their suburb between time point one and two, experienced a decrease in their psychological well-being. This association remained significant after controlling for age, gender, household income, education, occupation and neighbourhood disadvantage as well as all unmeasured time-invariant variables. This suggests that changes in perceptions of local urban green space – whether perceiving greater or lesser quality and quantity of green space – influences psychological well-being. While the bivariate correlations showed that the effect sizes were small, it can be argued that such effects sizes may still have a viable impact given that the costs of green space interventions are relatively low and have the potential to impact on a wide cross-section of the population.

Our findings show that changes in perceptions of green space had a significant effect on well-being, even across a relatively short, two-year period. Brisbane, the setting of this study, is considered to have a high level of urban green space and is Australia's most biodiverse capital city (Garden, McAlpine, & Possingham, 2010). However, a rapidly growing population is resulting in a changing and densifying urban landscape. This may explain why, in our study, perceptions of green space changed across a relatively short timeframe. We recommend investigating the relationship between perceptions of green space and well-being across longer timeframes, among different age groups and across diverse urban environments with varying quality and quantity of green space.

In this study we used a simple three-item, quantitative measure of perceptions of green space that asked participants to rate their level of agreement with statements about the quantity and quality of green space in their suburb of residence. A qualitative line of enquiry would yield a richer and more nuanced understanding of people's perceptions of green space and how this relates to mental well-being. Nevertheless, by using longitudinal data at a population level we can identify patterns across time that may not be possible to detect in small scale qualitative studies, and the three-item scale we used had low participant burden. It would be worthwhile to use more sophisticated measures of perceptions of green space within longitudinal designs. Other studies have developed and tested more advanced measures of perceptions of green space, for example, qualitative interviews across a 10-year period have identified eight perceived characteristics of green space which have been tested for their effect on stress among Swedish populations (Grahn & Stigsdotter, 2010). Similarly, the emerging research field on people's subjective relationship with nature, known as nature connection, provides insight to the subjective sense of our experiential, cognitive and affective relationship with nature (Cleary, Fielding, Bell, Murray, & Roiko, 2017; Ives et al., 2017; Restall & Conrad, 2015; Russell et al., 2013). Nature connection has been shown to be positively associated with psychological well-being (Cervinka, Röderer, & Hefler, 2011; Howell, Dopko, Passmore, & Buro, 2011; Nisbet, Zelenski, & Murphy, 2011), and may be an important factor to consider when exploring the relationship between perceptions of urban green space and psychological well-being.

As our findings suggest, it is important to consider perceptions of green space when assessing the impact of green space on mental health. To date longitudinal research has mostly considered objective measures of green space, however, it may be that psychological well-being has a unique relationship with perceptions of green space, which may differ from objective green space measures. Objectively measuring green space exposure without considering how the individual perceives the green space may not capture the full picture, leading to misinformed design and inaccurate evaluations of urban green space interventions for mental health. These findings are timely given the growing interest in nature-based interventions for addressing rising rates in mental ill-health (WHO, 2017). To our knowledge, this is the first time that a measure of mental well-being, as opposed to mental ill-health

measures or mental disease screening tools such as the General Health Questionnaire, has been used to assess the effects of perceptions of green space within a longitudinal study design. This is an important distinction as combating growing trends in mental ill-health requires an understanding of and focus on promotion of mental well-being, in addition to treatment of mental ill-health. With additional research, these findings may help inform the design and delivery of urban green space interventions for addressing rising rates in mental ill-health among expanding urban populations.

Limitations

As mentioned, this study used a simple three-item measure of perceptions of green space. While all items loaded onto a single factor, the Cronbach alpha values at both time points were low (< 0.6). We recommend that future research further develop subjective measures of green space particularly measures that would be suited to longitudinal study designs. Similarly, there is still much debate in the literature about how best to measure mental well-being (Gilbert, Colley, & Roberts, 2016). Our study uses the globally recognised Warwick and Edinburgh Mental Well-being Scale. However, mental well-being is a multi-dimensional and complex construct and results may vary when using other measures that assess different aspects of this construct. Our study presents findings from a mid-aged urban population living in a westernised, sub-tropical city. As such, the results of this study may not apply to other age groups, or people living in regional areas or other countries.

As mentioned, the fixed effects model approach was considered appropriate for this study which sought to assess within-person changes of green space perceptions across two timepoints. The fixed effect advantage of controlling for all time-invariant confounding, both measured and unmeasured, was beneficial, particularly given the exploratory nature of this study which can be vulnerable to omitted-variable bias. That said, we recognise the well documented limitations of fixed effects models, namely their inability to control for other biases such as reverse causation. The issue of how best to deal with reverse causality using panel data is keenly debated in the literature. While there are emerging approaches for how to address this issue, for example with cross-lagged models, such methods are still open to debate and as such clear guidance is lacking (Leszczensky & Wolbring, 2018). Nevertheless, as an exploratory study, we believe that this research provides a unique

contribution to the study of green space and mental health and makes the case for the further exploration of subjective measures of green space within longitudinal study designs.

4.7 Conclusion

The evidence linking urban green space and mental health is growing and gaining recognition within policies relevant to urban planning and mental health services. The aim of our study was to provide a unique contribution to this evidence base by exploring the relationship between perceptions of urban green space and psychological well-being over time. This is the first study to assess the effects of perceived (vs. objective) urban green space on a measure of mental well-being, within a longitudinal study design. Based on this study's findings we conclude that subjective green space measures should be included in studies regarding the impact of environments on mental health, particularly mental well-being. Equally, consideration of how people perceive the quality and quantity of green space needs to be factored into the monitoring and evaluation of nature-based interventions within mental health care and urban planning. Our findings are timely given the growing interest in urban green space interventions for addressing rising rates in mental ill-health among expanding urban populations.

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Chapter 5.

The relationship between nature connection and psychological wellbeing

5.1 Overview

This chapter reports results from analysis of the cross-sectional survey data of 1,000 Brisbane urban residents and addresses the second research question of this thesis ‘How is nature connection associated with psychological wellbeing?’. A parallel, multiple mediation analysis was carried out to test satisfaction of the basic psychological need for relatedness (our basic human need to feel close to other people and the world around us) and intrinsic values (valuing goals of self-acceptance, community connections and personal growth) as mediators of the relationship between nature connection and psychological wellbeing. Results show that the positive association between nature connection and psychological wellbeing was wholly mediated by satisfaction of the psychological need for relatedness and intrinsic values. This study provides evidence of the mediators of the nature connection-wellbeing relationship and positions the relationship within the well-established Self Determination Theory. Self Determination Theory may provide a useful framework for further exploration of the nature connection-wellbeing relationship as well as help guide the design and delivery of nature connection enhancing initiatives that seek to optimise wellbeing outcomes. Chapter 5 and 6 analyse the same cross-sectional survey data to explore different aspects of nature connection, as such, there is some overlapping content, particularly in the introduction and methods sections.

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:

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STATEMENT OF CONTRIBUTION TO CO-AUTHORED PUBLISHED PAPER

Contributor	Statement of contribution
Cleary, A.	Designed survey (85%) Completed analysis (100%) Wrote paper (100%)
Fielding, K.	Designed survey (5%) Edited paper and provided critical feedback (33%)
Murray, Z.	Designed survey (5%) Edited paper and provided critical feedback (33%)
Roiko, A.	Designed survey (5%) Edited paper and provided critical feedback (33%)

My contribution to the paper involved:

- conceiving of the research idea
- attaining ethics approval
- designing, piloting and launching the cross-sectional survey
- completing the data collection, management and cleaning
- conceiving of the analysis strategy, completing the analysis and interpreting the results
- writing and revising the paper.

Signed:
(Anne Cleary)

Date: 31 August 2018

Countersigned:
(Anne Roiko)

Date: 31 August 2018

5.2 Abstract

The current study aims to further our understanding of reported positive associations between nature connection and psychological wellbeing by exploring and testing potential mediators of this relationship. Drawing on previous research and Self Determination Theory, it was hypothesised that the relationship between nature connection and psychological wellbeing is mediated by satisfaction of the basic psychological need for relatedness (one of the three basic psychological needs that support psychological wellbeing) and through intrinsic values (valuing goals of self-acceptance, community connections and personal growth). The hypothesised mediated relationships were supported in a cross-sectional survey of adult urban residents in Brisbane, Australia (N = 1000). That is, the positive association between nature connection and psychological wellbeing was wholly mediated by satisfaction of the psychological need for relatedness and intrinsic values. These findings demonstrate that Self Determination Theory can provide a theoretical framework for understanding the nature connection-wellbeing relationship. Findings from this study could help to inform the design and delivery of interventions which seek to promote psychological wellbeing through enhancing nature connection.

5.3 Introduction

The concept of nature connection, that is, the subjective sense of the cognitive, affective and experiential relationship that people have with nature, is gaining increasing interest in research and policy arenas. Annual publications about nature connection have quadrupled over the past decade (Ives et al., 2017). In turn, the resulting evidence base on nature connection's associations with enhanced wellbeing (Howell, Dopko, Passmore, & Buro, 2011) and pro-environmental attitudes and behaviours (Nisbet, Zelenski, & Murphy, 2008; Zelenski, Dopko, & Capaldi, 2015) has led to nature connection being recognised explicitly within environmental agendas. This is reflected by nature connection objectives being included in environmental policy documents (HM Government, 2018; Victoria State Government, 2017), and the establishment of numerous environmental initiatives that

aim to foster nature connection among individuals (IUCN, 2017; Richardson, Cormack, McRobert, & Underhill, 2016).

Environmental and conservation agencies are leading the call for the cultivation of nature connection, with ecological outcomes being the primary focus. However, it can be argued that equal attention needs to be given to the positive associations reported between nature connection and wellbeing (Capaldi, Dopko, & Zelenski, 2014; Capaldi, Passmore, Nisbet, Zelenski, & Dopko, 2015; Nisbet, Zelenski, & Murphy, 2011; Zelenski & Nisbet, 2014). Globally, levels of mental ill-health are unprecedented with depression predicted to be the primary contributor to disease burden by 2030 (WHO, 2013). Despite this, the health and wellbeing aspects of nature connection receive considerably less research focus than environmental sustainability and behaviour change outcomes (Ives et al., 2017). This represents a missed opportunity in light of the role that nature connection could play in preventing mental ill-health and promoting wellbeing. The current study aims to address this gap in the literature by seeking to understand the processes that explain the link between nature connection and wellbeing.

The current evidence base linking nature connection with wellbeing has notable gaps. To date, research on this relationship has tended to be drawn from small scale studies sampling atypical populations (e.g., female dominant student samples; Capaldi et al., 2014). This has led to recommendations for larger studies representing general populations (Kamitsis & Francis, 2013). Furthermore, underpinning theory explaining the reported positive associations between higher nature connection and greater psychological wellbeing is lacking. For example, while associations have been identified between nature connection and increased wellbeing (Cervinka, Röderer, & Hefler, 2011; Nisbet et al., 2011) and reduced anxiety (Martyn & Brymer, 2016), such studies fail to explain why these associations have been found, with mediators of such relationships remaining largely unexplored. An improved understanding of how nature connection relates to wellbeing could help refine the design of nature connection enhancing initiatives and optimise wellbeing outcomes.

There is a need to develop a deeper understanding of nature connection's relationship with psychological wellbeing. This requires a focused research effort on identifying and exploring potential

mediators of this relationship. Such an understanding could inform the design and delivery of nature connection interventions that promote wellbeing. Previous work in this area has identified spirituality as a mediator of the relationship between nature connection and wellbeing (Kamitsis & Francis, 2013; Trigwell, Francis, & Bagot, 2014). Spirituality refers to an inner belief system that gives meaning to existence and allows a person to transcend the present context (Burkhardt, 1989). Cross-sectional, mediation analyses revealed spirituality as a significant mediator between nature connection and both affective (known as hedonic; Kamitsis & Francis, 2013), and psychological (known as eudaimonic) forms of wellbeing (Trigwell et al., 2014). The studies focusing on spirituality as a mediator were limited to small, atypical (female and student dominant) samples and lacked adjustment for potentially confounding variables such as gender, age, income and education. While these limitations mean that results cannot be generalised, they do suggest that people experience greater wellbeing through deriving spiritual fulfilment from their nature connection. Kamitsis and Francis (2013) acknowledge that although spirituality was found to mediate the relationship between nature connection and wellbeing, the effects were not large and hence they recommended that additional mediators be explored.

Howell, Passmore, and Buro (2013), using a Canadian, female dominant, student sample, showed that 'meaning in life' mediates the relationship between nature connection and psychological wellbeing. Meaning in life, or life purpose, is considered an important dimension of psychological wellbeing (Seligman, Steen, Park, & Peterson, 2005). To avoid overlap between the mediator and the dependent variable, Howell et al. (2013) removed measures of life purpose from the psychological wellbeing construct used in their study. Nevertheless, investigating a component of the dependent variable as a mediator of the relationship in question makes it difficult to interpret and translate the findings. To our knowledge, there are no other studies that have investigated mediators of the nature connection-wellbeing relationship.

The human relationship with nature is subjective, influenced by cultural differences and prevailing social constructions of nature. Therefore, it is likely that multiple mediators exist, differing in relevance across individuals and population sub-groups. In the present study we seek to expand the

currently limited understanding of the processes that explain the relationship between nature connection and psychological wellbeing through testing two novel mediators. We draw on previous research and the well-established Self Determination Theory (Ryan & Deci, 2000) to identify potential mediators, focusing specifically on the psychological need for relatedness and intrinsic values (Cleary, Fielding, Bell, Murray, & Roiko, 2017). Both are described in further detail below.

Non-human relatedness as a potential mediator of the nature connection–wellbeing relationship

Self Determination Theory is a psychological needs-based motivational theory that describes how people's motivations can either support or undermine basic psychological needs, in turn promoting or inhibiting psychological wellbeing (Deci & Ryan, 2008). Motivation is described as encompassing six types – intrinsic, integrated, identified, introjected, external and amotivation (Deci & Ryan, 1985; Ryan & Deci, 2000). Intrinsic motivations represent the most self-determined or autonomous type of motivation. Integrated, identified, introjected and external motivations are collectively known as extrinsic motivations and describe when people act in order to satisfy an external demand. Finally, amotivation refers to when a person has no intention to act or acts without intent. According to Self Determination Theory, people are optimally motivated and experience wellbeing when they have three basic psychological needs satisfied. These psychological needs include autonomy, competence, and relatedness (Deci & Ryan, 2000; Ryan & Deci, 2000). Autonomy refers to an individual's need to act with a sense of ownership over their behaviour, competence refers to an individual's need to develop new skills and feel a sense of mastery over the environment, and relatedness refers to an individual's need to feel connected to others, loved and cared for by others and to love and care for others.

Basic psychological needs have been the focus of research in numerous domains, such as health care (Ng et al., 2012), education (Vansteenkiste, Lens, & Deci, 2006), organisations and workplaces (Van den Broeck, Ferris, Chang, & Rosen, 2016), and sports and exercise (Edmunds, Ntoumanis, & Duda, 2006). However, to date there has yet to be a comprehensive exploration of psychological needs within the nature connection domain. The well-established evidence base on the positive relationship

between basic psychological needs and wellbeing may provide a potential answer to why nature connection is positively associated with wellbeing. Consistent with Self Determination Theory, in this study we argue that one reason why nature connection is associated with wellbeing is because it satisfies the psychological need for relatedness.

Self Determination Theory does not necessarily define relatedness as only feeling close to other people, however, this tends to be how it is interpreted in the research field. Research to date has only explored relatedness from the perspective of interaction, connection and caring for other people, with no attention given to the role that non-human forms of relatedness may play (e.g., relating to non-human forms such as animals or nature; Cleary et al., 2017). Conceptualising the psychological need for relatedness as feeling close to other people only, and excluding other forms of closeness or connection, limits our understanding of this concept. We reason that feeling a connection to nature, which encompasses the natural world and all the plants and animals that comprise it, could also help to satisfy a person's need for relatedness. Interestingly, research has shown that the relationship between nature connection and wellbeing remains significant even when controlling for other forms of relatedness such as family, friends, culture and home (Zelenski & Nisbet, 2014). This suggests that people's connection with nature is not simply reflective of connection with people, culture or place but rather that nature connection has a unique relationship with wellbeing. Satisfaction of the psychological need for relatedness through non-human forms may help explain this unique relationship. It may be that when people experience higher levels of nature connection, they feel a greater sense of relatedness to the animal and plants in the natural world and this satisfies their basic psychological need for relatedness. In turn, satisfaction of the need for relatedness promotes wellbeing. Therefore, satisfaction of the psychological need for relatedness through nature connection, henceforth termed non-human relatedness, should be explored as a potential mediator of the nature connection-wellbeing relationship.

Intrinsic values as a potential mediator of the nature connection–wellbeing relationship

Based within the Goal Contents sub-theory of Self Determination Theory, and closely linked to motivations and psychological needs, is the concept of values which can also be either intrinsic or

extrinsic (Kasser, 2002). Having a higher intrinsic value orientation, where high importance is placed on aspirations such as self-acceptance, community connection and personal growth, is associated with greater psychological wellbeing (Kasser et al., 2014; Ryan, Huta, & Deci, 2008). In contrast, extrinsic values reflect a desire to obtain praise or reward, or to avoid punishment or criticism. Extrinsic values “do not provide satisfaction in and of themselves, instead, their allure usually lies in the presumed admiration that attends them or in the power and sense of worth that can be derived from attaining them” (Kasser & Ryan, 1996, p. 206). It is not surprising then that placing high importance on extrinsic values such as fame, image and wealth is related to lower levels of wellbeing (Ryan & Deci, 2000).

Cross-sectional studies have shown positive associations between nature connection and intrinsic traits such as altruism, empathetic concern, agreeableness, intrinsic aspirations and biospheric values (Martin & Czellar, 2017; Schultz, 2001; Weinstein, Przybylski, & Ryan, 2009; Zhang, Piff, Iyer, Koleva, & Keltner, 2014). Furthermore, research shows that nature connection is associated with behaviours indicative of intrinsic values, such as less consumerism (Mayer & Frantz, 2004), more pro-environmental behaviour (Guiney & Oberhauser, 2009) and more relational emotions (e.g., love and care; Vining, Merrick, & Price, 2008). In light of the correlations between nature connection and traits and behaviours reflecting intrinsic values, and between intrinsic values and wellbeing, we reason that intrinsic values may be a mediator of the relationship between nature connection and wellbeing. This reasoning is underpinned by the proposition that experiencing a higher level of nature connection could help to foster intrinsic traits, such as empathy and personal growth, which will in turn enhance wellbeing. It is worth noting that the evidence base for the relationship between nature connection and intrinsic values is derived from cross-sectional study designs and as such there is no firm evidence on the direction of the effect. Hence, it may be that intrinsic values promote nature connection and nature connection is the mediator of the relationship between intrinsic values and wellbeing. In the current study we test both potential pathways.

The present study

The present study aims to address the theoretical lacuna in nature connection-wellbeing mediators.

This study uses cross-sectional survey data from a large, representative sample of urban residents in Brisbane, Australia (N = 1000) to investigate non-human relatedness and intrinsic values as potential mediators of the nature connection-wellbeing relationship. Investigation of these mediators aims to help explain how higher levels of nature connection are associated with greater psychological wellbeing. Hence the study hypotheses are as follows:

1. The relationship between wellbeing and nature connection is mediated, either wholly or in part, by non-human relatedness.
2. The relationship between wellbeing and nature connection is mediated, either wholly or in part, by an intrinsic value orientation.

5.4 Methods

Participants and Procedure

Brisbane is Australia's third largest city with a population of almost two million. A questionnaire was designed and administered to a target population of Brisbane adult (over 18 years) residents in May 2017. Recruitment occurred through a social research company who administered the online questionnaire via an email invitation to people who had voluntarily enrolled to be part of the survey database. Respondents who completed the survey received minor monetary compensation. The survey instrument can be viewed in Appendix 2. This research was conducted in accordance with the National Statement on Ethical Conduct in Human Research and received ethics approval from Griffith University Human Research Ethics Committee, project number 2016/085. Informed consent was obtained from all survey respondents.

Measures

Nature connection: The single item Inclusion of Nature in Self scale (Schultz, 2001) was used to measure nature connection. The Inclusion of Nature in Self scale asks respondents to view seven images. Each image contains two circles with one circle representing self and the other circle

representing nature. The two circles increasingly overlap and enlarge across the seven images. The respondent is asked to select the image that best describes their relationship with nature. The resulting scale ranges from 1 – 7 with higher scores indicating a greater connection to nature. This more simple, single-item measure of nature connection was chosen to reduce potential risk of item overlap between the nature connection variable and the non-human relatedness mediator variable.

Non-human relatedness: A scale for measuring non-human relatedness was developed for the purpose of this study. This four-item scale aligns closely with the original relatedness scale (Ryan & Deci, 2000), but has been adapted to measure the extent of satisfaction of the psychological need for relatedness through non-human means (Table 5.1). Items were adapted with references to ‘people’ or ‘social contacts’ being replaced with ‘nature’ such that *‘I get along with people I come into contact with’* is replaced with *‘I respond well to the nature that I come into contact with’*, *‘I pretty much keep to myself and don’t have a lot of social contacts’* is replaced with *‘I pretty much avoid interacting with nature and spend little time in nature’*, *‘I really like the people I interact with’* is replaced with *‘Most of the time, I really like the types of nature I interact with’* and *‘People in my life care about me’* is replaced by *‘I feel comforted by nature’*. Respondents rated their level of agreement with each of the four items (1 = Strongly disagree, 5 = Strongly agree). Negatively-worded items were reverse scored.

Table 5.1. Non-human relatedness scale

Instructions: Please rate the extent to which you agree with each statement. Please click on the answer that indicates how you really feel, rather than how you think “most people” feel.

Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
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1. Most of the time, I really like the types of nature I interact with
 2. I respond well to the nature that I come into contact with
 3. I pretty much avoid interacting with nature and spend little time in nature
 4. I feel comforted by nature
-

Intrinsic values: Intrinsic values were measured using the shortened version (Martos & Kopp, 2012) of the original Aspiration Index (Kasser, Ryan, Zax, & Sameroff, 1995). The Aspiration Index is commonly used to measure personal goals and values and has been applied in a range of countries such as Peru (Guillen-Royo & Kasser, 2015), China (Lekes, Gingras, Philippe, Koestner, & Fang, 2010), America (Sheldon, Corcoran, & Prentice, 2018), Russia (Ryan et al., 1999) and Spain (Romero, Gómez-Fraguela, & Villar, 2012). Intrinsic values are measured by asking participants what level of importance they place on goals of affiliation, self-acceptance and community feeling. The importance of each goal is measured via two items with responses ranging from 1 = not at all important, 5 = very important. The goal of self-acceptance is measured by asking participants '*how important is it for you in your life to grow and learn new things*' and '*to know and accept who I really am*'. The goal of community feeling is measured via the items '*to help others to improve their lives*' and '*to work to make the world a better place*'. The goal of affiliation is measured via the items '*to have deep enduring relationship*' and '*to feel that there are people who really love me, and whom I love*'. The mean of the six items was calculated to give an overall intrinsic values score (Cronbach's $\alpha = .80$). Higher values represent a greater intrinsic value orientation.

Psychological wellbeing: Psychological wellbeing was measured using the short Warwick and Edinburgh Mental Wellbeing scale (Stewart-Brown et al., 2009; Tennant et al., 2007). This seven-item, positively phrased scale asked respondents how frequently (1 = none of the time, 5 = all of the time) they experienced the feelings or thoughts embodied within each statement during the preceding fortnight. While some items measure hedonic wellbeing ('*I've been feeling relaxed*'), the majority of items measure eudaimonic wellbeing ('*I've been thinking clearly*') and hence this scale is recognised as a valid measure of psychological wellbeing (Stewart-Brown et al., 2009). The sum of all items is transformed using a conversion table, available on the Warwick Medical School website, to produce the final metric score where higher values represent greater psychological wellbeing (Cronbach's $\alpha = .88$).

Analysis Strategy

After exploring the demographics of the sample, we explored the bivariate relationships between nature connection, psychological well-being, and the proposed mediators of non-human relatedness and intrinsic values using Pearson correlation.

To test the hypotheses, the indirect effect of nature connection on psychological well-being through both non-human relatedness and intrinsic values was evaluated through a parallel, multiple mediator model using bootstrapping with 10,000 resamples (Model 4 PROCESS software, (Hayes, 2013)). This procedure used an ordinary-least-squares path analysis to estimate the coefficients in the model to determine the direct and indirect effects of nature connection on psychological well-being. Nature connection was entered as the independent variable, psychological well-being was entered as the dependent variable, intrinsic values and non-human relatedness as the mediating variables and age and gender as covariates. Longitudinal research has shown that the associations between nature contact and mental health vary across the life course and by gender (Astell-Burt, Mitchell, & Hartig, 2014). Since a similar relationship may also exist with nature connection, age and gender were controlled for in analyses.

5.5 Results

Assessing the structure of the non-human relatedness scale

To assess whether the non-human relatedness scale consisted of a single factor a principal axis factor analysis was conducted using an oblique rotated solution (direct oblimin). The Bartlett's test of sphericity was significant ($p < .001$) and the Kaiser-Meyer-Olkin measure was 0.78 verifying the sampling adequacy for factor analysis. The factor analysis revealed one factor with an eigenvalue of 2.43, explaining 60.7% of the variance. All items loaded positively on this factor, from .58 to .82 (average factor loading = .69; Table 5.2). The reliability of the scale was satisfactory (Cronbach's $\alpha = .77$). A standardised scale score was derived and then re-scored to range from 1 to 10 to make the results easier to interpret, where higher scores indicate greater average levels of satisfaction of the psychological need for relatedness through non-human means.

Table 5.2. Factor loadings for non-human relatedness items

Scale item	Factor 1
Most of the time, I really like the types of nature I interact with	0.68
I respond well to the nature that I come into contact with	0.82
I pretty much avoid interacting with nature and spend little time in nature (R)	0.58
I feel comforted by nature	0.68

R = reverse scored item

Descriptive statistics

The sociodemographic characteristics of the sample, including mean nature connection and psychological wellbeing values, are presented in Table 5.3. The analytical sample (N = 1000) was similar to the target population with regards to gender (female 52.5%) and age (18-24 years 11%; 25-34 years 18.6%; 35-44 years 19.6%; 45-54 years 17.7%; 55-64 15.6%; Over 65 years 17.5%).

Table 5.3. Sociodemographic characteristics of sample by mean (SD) nature connection and psychological wellbeing

N = 1000	n	%	Nature Connection	Psychological wellbeing
Overall	100	100	3.55 (1.57)	21.86 (3.83)
<i>Gender</i>				
Male	475	47.5	3.45 (1.58)	21.94 (3.64)
Female	525	52.5	3.64 (1.56)	21.78 (3.99)
<i>Gross Household income (per annum)</i>				
AUD				
150 000 or more	145	14.5	3.19 (1.31)	22.49 (3.28)
100 000 – 149 999	174	17.4	3.40 (1.60)	21.91 (3.63)
50 000 – 99 999	281	28.1	3.57 (1.47)	21.95 (3.73)
20 000 – 49 999	192	19.2	3.68 (1.69)	21.59 (4.06)
1 – 19 999	46	4.6	4.24 (1.90)	21.54 (5.29)
Nil or negative income	7	0.7	4.57 (2.07)	18.37 (1.59)
Prefer not to answer	122	12.2	3.71 (1.57)	22.02 (3.66)
Missing	33	3.3	3.33 (1.58)	19.97 (4.28)
<i>Age (years)</i>				
Over 65	175	17.5	3.91 (1.86)	23.48 (3.55)
55-64	156	15.6	3.90 (1.57)	22.42 (3.68)
45-54	177	17.7	3.49 (1.53)	21.77 (4.12)
35-44	196	19.6	3.26 (1.30)	20.92 (3.08)
25-34	186	18.6	3.40 (1.52)	21.47 (3.95)
18-24	110	11.0	3.37 (1.50)	20.14 (4.06)
<i>Speak a language other than English at home</i>				
No	866	86.6	3.56 (1.56)	21.80 (3.70)
Yes	134	13.4	3.51 (1.63)	22.23 (4.57)
<i>Education (highest level attained)</i>				
Post-graduate degree (masters/PhD)	119	11.9	3.66 (1.46)	22.27 (3.73)
University graduate	345	34.5	3.47 (1.53)	21.86 (3.69)
Trade/technical/vocational training	249	24.9	3.63 (1.62)	21.88 (3.80)
Year 12 or equivalent	345	34.5	3.66 (1.64)	21.64 (4.21)
Less than year 12 or equivalent	88	8.8	3.30 (1.59)	21.70 (3.72)

Note: Nature Connection values range from 1-7, Psychological wellbeing values range from 7-35

All data satisfied tests for standard parametric assumptions. Pearson's correlation coefficients between nature connection, psychological wellbeing, and the proposed mediators of non-human relatedness and intrinsic values were statistically significant ($p < .001$), but of varying strength (Table 5.4).

Table 5.4. Pearson's correlation coefficients between nature connection, psychological wellbeing and proposed mediators (N = 1000)

Variables	Mean (SD)	1.	2.	3.
1. Inclusion of Nature in Self	3.55 (1.57)	1		
2. Psychological wellbeing	21.86 (3.83)	.15*	1	
		[0.09, 0.22]		
3. Intrinsic values	0.70 (0.46)	.28*	.21*	1
		[0.22, 0.34]	[0.16, 0.27]	
4. Non-human relatedness	5.10 (1.00)	.46*	.22*	.38*
		[0.40, 0.52]	[0.15, 0.29]	[0.32, 0.44]

Note: * $p < .001$. Two-tailed. 95% bias-corrected confidence intervals reported in brackets.

Mediation analysis

To test the hypotheses, the indirect effect of non-human relatedness and intrinsic values on the relationship between nature connection and psychological wellbeing was evaluated through a parallel, multiple mediator model using bootstrapping with 10,000 resamples (Model 4 PROCESS software, (Hayes, 2013)). This procedure uses an ordinary-least-squares path analysis to estimate the coefficients in the model to determine the direct and indirect effects of nature connection on psychological wellbeing. Nature connection was entered as the independent variable, psychological wellbeing was entered as the dependent variable, intrinsic values and non-human relatedness as the mediating variables and age and gender as confounders. Longitudinal research has shown that the associations between nature contact and mental health vary across the life course and by gender (Astell-Burt, Mitchell, & Hartig, 2014). While this research refers to nature contact, a similar relationship may also exist with nature connection and hence age and gender were controlled for in the analyses. All paths for the full process model are illustrated in Figure 5.1 and their corresponding coefficients are provided in Table 5.5.

The results of the 10,000 bootstrapped samples demonstrated that the total direct effect (c'), which removes the effect of the mediators, was not significant ($b = 0.034$, 95% CI [-0.130, 0.197], $p = .685$). This suggests that the relationship between nature connection and psychological wellbeing is wholly mediated by the two mediators. As predicted, the indirect effect of nature connection on psychological

wellbeing via non-human relatedness was significant ($b = 0.13$, $SE = 0.05$, 95% CI [0.04, 0.24]). This finding suggests that having a higher level of nature connection may satisfy the psychological need for relatedness which in turn promotes positive psychological wellbeing. There was also a significant indirect effect of nature connection on wellbeing through intrinsic values ($b = 0.14$, $SE = 0.03$, 95% CI [0.09, 0.20]). This suggests that feeling connected to nature fosters intrinsic values which promote psychological wellbeing.

Finally, additional mediation analysis was conducted to test the potential for a reverse relationship whereby nature connection mediates the positive relationship between intrinsic values and psychological wellbeing (Figure 5.2). This was conducted because current findings on the positive associations between nature connection and intrinsic values are derived from cross-sectional studies and hence the direction of the effect is uncertain. The results of the mediation model showed that there was a non-significant indirect effect of intrinsic values on psychological wellbeing through nature connection ($b = 0.107$, 95% CI [-0.021, 0.255]). The total direct effect of intrinsic values on wellbeing (c') remained significant ($b = 1.470$, 95% CI [1.073, 1.866], $p = < .001$). This shows that the positive relationship between intrinsic values and psychological wellbeing is not mediated by nature connection, suggesting that nature connection promotes intrinsic values as opposed to intrinsic values promoting nature connection.

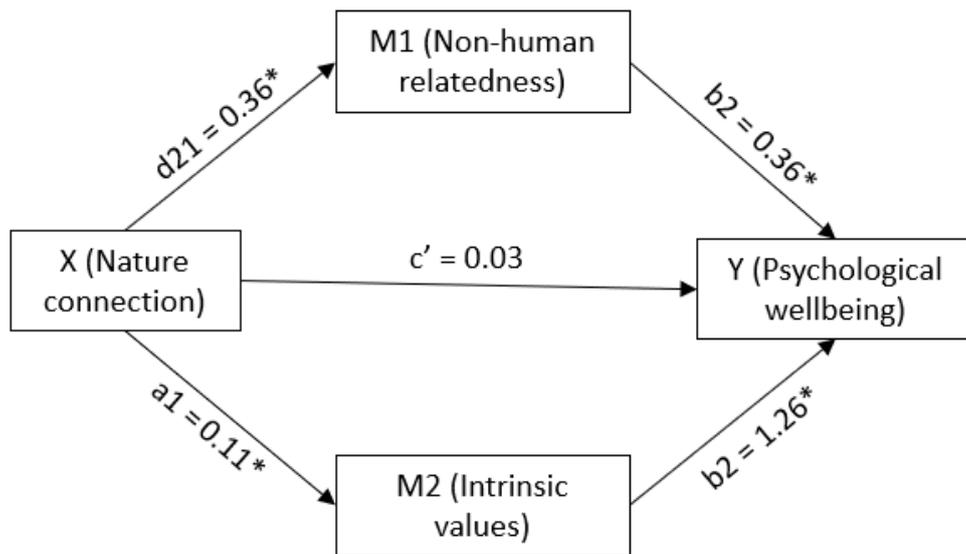


Figure 5.1. Parallel multiple mediator model testing the impact of nature connection on psychological wellbeing through intrinsic values and non-human relatedness while controlling for age and gender. $*p < .001$, $N = 1000$

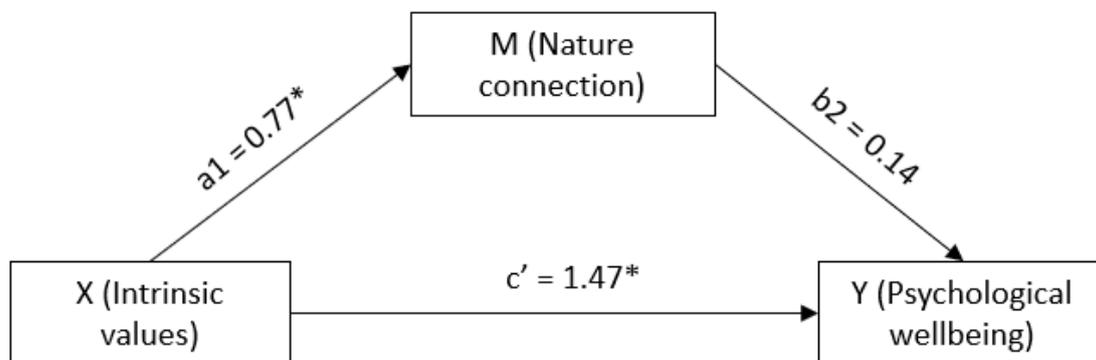


Figure 5.2. Simple mediation model testing the reverse relationship of the impact of intrinsic values on psychological wellbeing through nature connection while controlling for age and gender. $*p < .001$, $N = 1000$

Table 5.5. Regression coefficients, standard errors and model summary information for the parallel multiple mediator model depicted in Figure 5.1.

Antecedent	Consequent									
	M1 (Non-human relatedness)			M2 (Intrinsic values)			Y (Psychological wellbeing)			
	<i>Estimate</i>	<i>SE</i>	<i>p</i>	<i>Estimate</i>	<i>SE</i>	<i>p</i>	<i>Estimate</i>	<i>SE</i>	<i>p</i>	
X (Nature Connection)	<i>a1</i>	0.358 (0.31, 0.40)	0.023 <.001	<i>a2</i>	0.113 (0.09, 0.14)	0.012 <.001	<i>c'</i>	0.034 (-0.13, 0.20)	0.083	.685
M1 (Non-human relatedness)	-	-	-	-	-	-	<i>b2</i>	0.362 (0.15, 0.57)	0.108	.001
M2 (Intrinsic values)	-	-	-	-	-	-	<i>b1</i>	1.26 (0.85, 1.67)	0.211	<.001
Gender	-0.197 (-0.34, -0.05)	0.073	.007	-0.208 (-0.28, -0.14)	0.037	<.001	0.198 (-0.27, 0.67)	0.241	.411	
Age	0.003 (-0.00, 0.01)	0.002	.124	-0.006 (-0.01, -0.00)	0.001	<.001	0.049 (0.04, 0.06)	0.007	<.001	
Constant	<i>M1</i>	6.498 (6.20, 6.79)	0.151 <.001	<i>M2</i>	4.203 (4.05, 4.36)	0.076 <.001	<i>Y</i>	11.327 (9.22, 13.43)	1.072	<.001
	$R^2 = 0.219$ $F[3, 996] = 92.86, p < .001$			$R^2 = 0.143$ $F[3, 996] = 55.25, p < .001$			$R^2 = 0.116$ $F[5, 994] = 26.02, p < .001$			

Note: 95% bias-corrected confidence intervals reported in brackets. (N = 1000)

5.6 Discussion

The aim of the current study was to enhance understanding of the nature connection-wellbeing relationship through exploring potential mediators of the relationship. Consistent with previous findings, the current research revealed a significant and positive correlation between nature connection and wellbeing (Capaldi et al., 2014; Nisbet et al., 2011; Zelenski & Nisbet, 2014), although similar to previous research the effect was relatively small. Importantly, this study extends previous research by providing evidence of mediators of this relationship that are suggested by past research and a well-established theory. Based on the Self Determination Theory sub-theories of basic psychological needs theory and goal contents theory, the present study tested the hypothesis that nature connection may be related to wellbeing because it satisfies the psychological need for relatedness and fosters intrinsic values which in turn promote wellbeing. Survey data from a large sample of Brisbane urban adults supports both of the hypothesised mediation pathways.

Our study sample was recruited from the general population which helps to address criticisms of over representation of female dominant, student samples in this research field and recommendations for samples that better represent the population (Kamitsis & Francis, 2013). Our results show that the relationship between nature connection and wellbeing is mediated by non-human relatedness and intrinsic values which operate as parallel mediators. Because past research demonstrating links between nature connection, intrinsic values and wellbeing has been correlational, there was a possibility that rather than intrinsic values mediating the relationship between nature connection and wellbeing, nature connection may have mediated the relationship between intrinsic values and wellbeing. The latter pathway, however, was not supported. Overall, this study suggests that people who experience greater connection to nature also experience greater wellbeing and this may be because nature connection satisfies the psychological need for relatedness and reinforces intrinsic values.

This study provides a novel perspective by framing the nature connection-wellbeing relationship within the context of well-established Self Determination Theory. This helps with the understanding

and interpretation of the mediators identified in this study. Viewing the nature connection-wellbeing relationship through the lens of Self Determination Theory may provide a workable framework in which to devise nature connection interventions. The application of Self Determination Theory within multiple disciplines has been long-established and wide-ranging (Edmunds et al., 2006; Ng et al., 2012; Van den Broeck et al., 2016; Vansteenkiste et al., 2006). Providing a sound theoretical framework to understand the nature connection-wellbeing relationship may help to better relate the concept of nature connection to diverse disciplines as well as help to inform the design and encourage the uptake of nature connection initiatives.

This study suggests that designing nature connection initiatives that facilitate non-human relatedness and intrinsic values may help optimise the wellbeing outcomes from such efforts. Intrinsic values include altruistic aspirations such as wanting to ‘help others’ and ‘make the world a better place’. Hence, these values may be best expressed by allowing individuals the opportunity for volunteering and participating in the management of their local nature spaces. Not only might this help optimise the psychological wellbeing outcomes from nature connection, but it may also help local authorities resolve resource gaps within urban green space management. Furthermore, fostering intrinsic values through the cultivation of nature connection may also promote the added benefit of encouraging pro-environmental attitudes and behaviour (Ku & Zaroff, 2014). Similarly, given the increasing rates of loneliness and isolation experienced in modern society and resulting negative mental health trends, the use of nature connection interventions to assist people with experiencing satisfaction of the psychological need for relatedness may prove an important tool in combating the growing disease burden of mental ill-health. Encouraging people to connect with nature may be an effective way to satisfy the psychological need for relatedness, particularly where other forms of relatedness are difficult to attain, for example, for individuals with social anxiety or other barriers to forming human connections.

While this study showed that non-human relatedness and intrinsic values mediate the relationship between nature connection and wellbeing, it is worth noting that the effect sizes were small. There is still a need for further exploration of other factors that may mediate the nature connection-wellbeing

relationship. As mentioned, spirituality and meaning in life have also been identified as mediators of the nature connection-wellbeing relationship (Howell et al., 2013; Kamitsis & Francis, 2013; Trigwell et al., 2014). It would be worthwhile to test a full mediation model which assesses spirituality, meaning in life, intrinsic values and non-human relatedness as well as other mediators yet to be identified. Understanding how these various mediators interact and how their effects vary across individuals and groups will help to reveal the full process involved in the relationship between nature connection and wellbeing. The results of this study suggest that Self Determination Theory may be a useful framework in which to position such exploratory research.

One's sense of nature connection is highly subjective, shaped by diverse factors such as current and past nature experience, prevailing symbolic and cultural/social interpretations and personal preferences. Therefore, different types of nature may be more or less relatable for different types of people and these nature connections may vary across the life course. Such factors will have to be taken into consideration when designing nature connection interventions that seek to promote wellbeing through facilitating the mediators explored in the study. It will be necessary to understand the social fabric of the target community and work in close collaboration to identify and co-create solutions that will foster intrinsic values and enhance satisfaction of the psychological need for relatedness through nature connection.

Limitations

The methodological shortcomings of cross-sectional designs are well recognised, namely in their inability to reveal direction of effect or to establish causality. This study sought to optimise the use of cross-sectional data by aiming to reveal mediators of reported relationships. While mediation analyses are commonly performed with cross-sectional data we recognise the inherent shortcomings and potential for bias. Partial mediation analyses of cross-sectional data can result in bias where the existence of a substantial indirect effect is implied even when the true longitudinal indirect effect is zero (Maxwell, Cole, & Mitchell, 2011). That said, cross-sectional mediation analysis may still be of value as long as the analysis is supported by “relevant theory and previous empirical findings on components of the assumed process in question” (Markevych et al., 2017, p. 310). The mediators

tested in this study were identified based on the well-established Self Determination Theory, as well as evidence showing the links between nature connection and intrinsic values (Weinstein et al., 2009) and the psychological need for relatedness (Zelenski & Nisbet, 2014). That said, using cross-sectional ‘snap shot’ data to assess the relationships between constructs such as intrinsic values and non-human relatedness which are likely to be founded on deeper, and more long-term aspects of human nature may not adequately capture to whole story. A follow-up randomised experimental study designed to manipulate the mediators identified in this study would be an appropriate next step to confirm true mediation (MacKinnon, Krull, & Lockwood, 2000). However, manipulation of variables such as non-human relatedness or intrinsic values may prove difficult within an experimental design. Pursuing a qualitative or mixed methods line of enquiry for future research may therefore be most appropriate and useful. Finally, while we attempted to develop a simple four item scale for measuring the level of satisfaction of the psychological need of relatedness through nature, this is a new scale that warrants further testing and validation.

5.7 Conclusions

This study furthered our understanding of the nature connection-wellbeing relationship by exploring and testing potential mediators. Building on existing evidence and drawing on the Self Determination Theory sub-theories of basic psychological needs theory and goal contents theory, it was hypothesised that the relationship between nature connection and wellbeing would be mediated by through satisfaction of the basic psychological need for relatedness (our basic human need to feel close to other people and the world around us) and intrinsic values (valuing goals of self-acceptance, community connections and personal growth). The proposed mediated relationships were tested using a cross-sectional survey of adult urban residents in Brisbane, Australia (N = 1000). Results showed that the positive association between nature connection and psychological wellbeing was mediated by intrinsic values and satisfaction of the psychological need for relatedness, which operate as parallel mediators. Our research demonstrates that Self Determination Theory can provide valuable insight to the mediators of the nature connection-wellbeing relationship and may serve as a relevant and useful underpinning theoretical framework. With additional research, findings from this study may help

inform the design and delivery of interventions which seek to promote psychological wellbeing through enhancing nature connection.

5.8 References

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Chapter 6.

The relationship between nature experiences and nature connection

6.1 Overview

This chapter reports results from analysis of the cross-sectional survey data and addresses the third research question of this thesis ‘What is the relationship between childhood and adult nature experiences and nature connection?’. A multiple regression and moderation analysis were completed to explore how retrospectively reported childhood and current adult urban nature experiences relate to nature connection. Both childhood and duration of adult nature experiences were shown to be positively associated with nature connection. Furthermore, the positive relationship between duration of adult nature experiences and nature connection was not moderated by childhood nature experiences suggesting that nature connection can be developed in later life through experiencing nature as an adult. The findings of this chapter may help address the numerous policy and planning documents which include objectives around nature connection enhancement. Through exploring factors that may be associated with nature connection this research aims to help inform the design and delivery of nature connection enhancing objectives and initiatives.

Chapter 5 and 6 analyse the same cross-sectional survey data to explore different aspects of nature connection, as such, there is some overlapping content, particularly in the introduction and methods sections. Note, this paper was accepted for publication in a journal that uses American English, and as such the spelling of certain words is different from the rest of the thesis.

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:

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STATEMENT OF CONTRIBUTION TO CO-AUTHORED PUBLISHED PAPER

Contributor	Statement of contribution
Cleary, A.	Designed survey (85%) Completed analysis (100%) Wrote paper (100%)
Fielding, K.	Designed survey (5%) Edited paper and provided critical feedback (33%)
Murray, Z.	Designed survey (5%) Edited paper and provided critical feedback (33%)
Roiko, A.	Designed survey (5%) Edited paper and provided critical feedback (33%)

My contribution to the paper involved:

- conceiving of the research idea
- attaining ethics approval
- designing, piloting and launching the cross-sectional survey
- completing the data collection, management and cleaning
- conceiving of the analysis strategy, completing the analysis and interpreting the results
- writing and revising the paper.

Signed:
(Anne Cleary)

Date: 31 August 2018

Countersigned:
(Anne Roiko)

Date: 31 August 2018

6.2 Abstract

Fostering nature connection may promote psychological wellbeing and enhance pro-environmental attitudes. However, there is limited understanding of what factors influence a person's nature connection. Using survey responses from 1000 residents of a large Australian city, we describe the relationship between nature connection and nature experiences at different stages in life, that is, past nature experiences that occurred during childhood and current, everyday nature experiences. Both past childhood nature experiences and duration of current nature experiences significantly predicted nature connection. The positive relationship between duration of current nature experiences and nature connection was not significantly moderated by past childhood nature experiences. Hence, current nature experiences are associated with higher levels of nature connection, even among those lacking childhood nature experiences. This research empirically demonstrates the positive relationship between nature connection and nature experiences and suggests that it may be equally important to promote nature experiences at any life-stage if increasing nature connection is the goal.

6.3 Introduction

The study of the human-nature relationship seeks to reveal how people identify themselves with nature and how people form relationships with nature (Restall & Conrad, 2015). The human-nature relationship has been explored from a variety of perspectives, such as the Biophilia Hypothesis (Wilson, 1984), therapeutic landscapes (Bell, Foley, Houghton, Maddrell, & Williams, 2018; Gesler, 1992, 1993) and place attachment (Scannell & Gifford, 2016), and has been labelled many things within the literature, for example, love and care for nature (Perkins, 2010), inclusion of nature in self (Schultz, 2001), connectivity with nature (Dutcher, Finley, Luloff, & Johnson, 2007), nature relatedness (Nisbet, Zelenski, & Murphy, 2008) and emotional affinity towards nature (Kals, Schumacher, & Montada, 1999). Collectively, this body of work can be referred to as *nature connection*, with the multiple perspectives each providing a unique contribution to our understanding of nature connection.

Nature connection refers to individuals' subjective sense of their relationship with nature and encompasses the affective, cognitive and experiential aspects of that relationship (Cleary, Fielding, Bell, Murray, & Roiko, 2017; Mayer & Frantz, 2004). The concept of nature connection seems to be receiving increasing interest within multiple disciplines (e.g., psychology, sociology, environmental management, public health, tourism, geography, education and urban planning). This may be in part owing to the relatively recent emergence of numerous established scales that measure nature connection. The most commonly used nature connection measures tend to be the single item 'Inclusion of Nature in Self Scale' (Schultz, 2001), the 'Nature Relatedness Scale' (Nisbet et al., 2008), and the 'Connection to Nature Scale' developed by Mayer and Frantz (2004; for a review, see Restall and Conrad (2015)).

Consistent with the conceptualization of nature connection, scales measuring this construct tend to measure, to varying degrees, the cognitive, behavioral and the affective aspects of the human-nature connection. There is debate in the literature about what components each of these nature connection scales measure (Perrin & Benassi, 2009; Tam, 2013). In general, the affective domain of nature connection is the most commonly assessed domain by these scales, an example item being '*I feel very connected to all living things and the earth*'. The 'Nature Relatedness Scale' is one of the few scales designed to also measure the behavioral domain of the relationship with scale items such as '*My ideal vacation spot would be a remote, wilderness area*' and '*I take notice of wildlife wherever I am*'.

There has been a rapid rise in nature connection related publications over the past 10 years (Ives et al., 2017). The resulting evidence base identifies the associations between higher levels of nature connection and a range of positive mental health outcomes such as increased psychological well-being (Capaldi, Passmore, Nisbet, Zelenski, & Dopko, 2015; Nisbet, Zelenski, & Murphy, 2011) and reduced anxiety (Martyn & Brymer, 2016), as well as numerous pro-environmental outcomes such as increased environmental concern (Nisbet & Gick, 2008), development of biospheric values (Martin & Czellar, 2017), and willingness to engage in pro-social and sustainable behaviors (Dutcher et al., 2007; Zelenski, Dopko, & Capaldi, 2015). These reported associations make nature connection a construct of relevance and interest to both public health and environment sectors. As a result, objectives related to enhancing nature connection are starting to appear within various plans and

policies, particularly environmental policies (HM Government, 2018; Victoria State Government, 2017), coupled with the recent establishment of numerous nature connection enhancing initiatives (e.g., IUCN's 'Nature for All' program, The Wildlife Trusts '30 Days Wild' campaign).

Nature connection enhancing initiatives are often delivered with urban residents as the target audience. Given that urban environments contain fewer opportunities for nature experiences, city dwellers are considered at risk with regard to low nature connection and suffering from a nature disconnect (Frumkin et al., 2017). This phenomenon has also been termed the 'extinction of experience' or a 'nature deficit' within the literature and is seen as a key threat to both human and environmental health (Soga & Gaston, 2016). Given estimates that 66% of the earth's residents will be living in urban areas by 2050 (UNESA, 2014), there is a pressing need to better understand how urban residents connect to nature. Such an understanding could help to inform the design and delivery of urban environments and experiences that foster nature connection and hence promote both well-being and environmental outcomes.

Despite the increased research focus on nature connection, there is still limited understanding of what factors enhance and maintain a person's nature connection. To date only a small number of studies have explored potential pathways that may promote nature connection. For example, Ernst and Theimer (2011) investigated the effect of participation in seven varied forms of environmental education on students' levels of nature connection in America. Participation in two of the seven types of environmental education was shown to significantly enhance levels of nature connection. It is worth noting that both of the successful environmental education programs, field trips and summer camp, occurred in outdoor nature settings. This finding is consistent with previous environmental education research where experience of natural areas has been identified as an important precursor to environmental commitment (Chawla, 1998; Tanner, 1980). Contact with nature or nature experiences have been shown to predict nature connection (Lin, Fuller, Bush, Gaston, & Shanahan, 2014; Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2008; Wolsko & Lindberg, 2013). Nature experiences can be considered either as those that have occurred in the distant past, for example during childhood, or those that have occurred in the recent past and hence better reflect an individual's current nature experiences. In addition to the role that nature experiences may play in fostering nature connection,

they also have the added benefit of promoting multiple positive health effects (Frumkin et al., 2017) and equity outcomes through their potential to be universally accessible. Nature experiences and their relationship with nature connection therefore warrant further investigation. Hence, this paper focuses on the roles that recent adult urban nature experiences and past childhood nature experiences may play in predicting current nature connection levels. The existing evidence on the links between nature connection and both adult and childhood nature experiences are discussed in detail below.

Nature Connection and Adult Nature Experiences

Frequent and direct experience of nature is suggested in the literature as a potential pathway to developing a person's connection with nature (Restall & Conrad, 2015) and a small number of studies have explored this pathway. For example, an American study surveyed visitors ($N = 372$, female = 58.1%) to six different locations chosen to represent varying degrees of 'natural' and urban settings. The Implicit Association Test was used to assess nature connection. By recording reaction time, this test measures people's automatic associations between pairs of concepts presented on a computer screen. The study revealed positive associations between implicitly measured nature connection and nature experiences such as time spent on hiking trails and beaches whereas there was no significant relationship with time in less 'natural' settings such as golf courses, gyms and libraries (Schultz & Tabanico, 2007). A UK study used the biological values concept as a framework for identifying types of nature experiences that may be related to nature connection (Lumber, Richardson, & Sheffield, 2017). Biological values were developed by Kellert (2012) to underpin the Biophilia Hypothesis (Wilson, 1984). Using a sample with almost 70% females ($N = 321$), the study found that nature connection was predicted by nature experiences structured around five of the nine biological values, namely: naturalistic (contact), aesthetic (beauty), humanistic (emotion), symbolic (meaning) and moralistic (compassion). Similarly, another study of adults and university students living in a small city in America ($N = 410$, female = 60.7%), used a shortened version of the Connectedness to Nature Scale by Mayer and Frantz (2004), to assess the effect of various outdoor recreation activities on nature connection. Participation in what were considered to be 'appreciative' outdoor recreation activities (e.g., sailing, jogging, dog-walking, cross-country skiing) were significantly associated with

higher levels of nature connection whereas participation in motorized outdoor recreation (e.g., jet skiing, off road vehicle driving) were not (Wolsko & Lindberg, 2013). A study of American students ($N = 76$, female = 67%) showed that students who walked through a nature reserve reported a stronger nature connection in comparison to students who walked through an urban environment (Mayer et al., 2008).

The Monitoring Engagement with the Natural Environment survey collects cross-sectional, nationwide data on how English adults (> 16 years) engage with the natural environment. Analysis of a non-representative, subset of this sample ($n = 4,515$, female = 52.2%), showed that visits to coastal and rural environments were associated with greater recalled nature connection as compared to visits to urban green space (Wyles et al., 2017). Furthermore, visits to sites that were designated as protected areas also had stronger associations with recalled nature connection as opposed to sites that held no such designated status. This finding suggests that both type and quality of the nature experience are associated with nature connection.

While the above studies provide interesting insight into the types of nature experiences that relate to nature connection, it can be argued that for the average city dweller activities such as sailing, hiking and visits to national parks may not be easily accessible, particularly on a frequent or daily basis. We therefore need to understand nature connection within an urban context, in particular, teasing apart the relationship between nature connection and local, routine urban nature experiences or what some authors term everyday nature or nearby nature (Bell, Westley, Lovell, & Wheeler, 2017; Nisbet & Zelenski, 2011).

I know of only two studies that have investigated this relationship. A study of adults (18-70 years) living in Brisbane, Australia ($N = 1479$, female = 50%) showed that both frequency and duration of visits to urban parks were significantly associated with nature connection, as measured by the Nature Relatedness Scale (Lin et al., 2014). A study of visitors to urban parks in Bogotá, Colombia ($N = 300$, female = 50.3%, mean age 43.47, $SD = 18.73$) found that nature connection, as measured by the Connectedness to Nature Scale, was higher among visitors to larger urban parks as opposed to smaller district parks (Scopelliti et al., 2016). However, both studies looked at the associations between nature connection and a very defined form of urban nature experience, that of a visit to a public urban park.

Of the few studies that have adopted a broad definition of urban nature none have specifically assessed the effects of exposure to diverse forms of urban nature on nature connection.

Nature Connection and Childhood Nature Experiences

Childhood nature experiences have also been hypothesized as an important influencing factor on the development of an individual's relationship with nature (Chawla, 2009; Cheng & Monroe, 2012). Qualitative data from interviews with adult environmentalists from America and Scandinavia highlighted childhood nature experiences as the foundation of current relationships with nature (Chawla, 1999). However, most studies in this field tend to focus on adult environmental attitudes as the outcome variable, as opposed to nature connection (Chawla & Derr, 2012; Evans, Otto, & Kaiser, 2018; Wells & Lekies, 2017). For example, in America, Wells and Lekies (2006) sampled adult urban residents ($N = 2004$, female = 56%, mean age 45, $SD = 15.98$) to investigate the relationship between childhood nature experiences and adult environmental attitudes and behaviors. They revealed that pro-environmental attitudes and behaviors among their adult sample were more strongly predicted by retrospectively reported wild (e.g., camping, forest hikes) as opposed to domesticated (e.g., gardening) childhood nature experiences. While there are some overlaps between nature connection and environmental attitudes or values, nature connection “differs theoretically and operationally from other explanations of environmental values” (Dutcher et al., 2007, p. 1). Hence, reported effects of childhood nature experiences on environmental values cannot be generalized directly to nature connection outcomes.

Only a small number of studies have investigated the relationship between retrospectively reported childhood nature experiences and current nature connection levels. A survey of environmental volunteers in America ($N = 145$, female = 65%, mean age 51) found that almost all volunteers reported a moderate to high level of nature connection, as measured via a single survey item, and most of them reported first becoming interested in nature during their childhood years (less than 10 years old; Guiney & Oberhauser, 2009). A Canadian study of university students ($N = 308$, female = 79%) showed that nature connection correlated positively and significantly with self-recalled positive childhood nature experiences (Windhorst & Williams, 2015). Adults from America ($N = 185$, female

= 63.8%, mean age = 33.4, $SD = 13.2$) who reported more frequent childhood nature contact scored significantly higher nature connection than those who reported less childhood nature contact (Tam, 2013).

Very few studies have directly measured nature connection among children. For example, a cross-sectional study of 30 grade school children (10 – 12 years) in America revealed negative associations between nature connection, as measured via the Implicit Association Test, and the hours that children reported playing indoors, watching television and playing video games (Bruni & Schultz, 2010).

There seem to be equally few studies that have measured nature connection among adolescents directly, for example, a study of high school students in Europe ($N = 403$, female = 59.3%, aged 15 to 19) showed that nature connection was significantly associated with nature contact (Müller, Kals, & Pansa, 2009). That said, Bragg, Wood, Barton, and Pretty (2013) have recently developed a methodology for measuring nature connection among children in the UK and hence this approach may become more common in future studies.

Overall, the evidence base on childhood nature experiences and nature connection is meagre and dominated by cross-sectional study designs that tend to use small samples with majority female and student participants. While the current evidence base highlights the potential importance of childhood nature experiences on nature connection, there is a need for further investigation of this relationship, particularly among general populations.

Nature Experiences at Different Stages in Life

Very few studies have assessed the association of both childhood and adult nature experiences simultaneously on current nature connection levels. This inhibits our understanding of how nature connection may be shaped across the life course. One of the few studies to assess childhood and adult nature experiences simultaneously, revealed moderate, positive associations between nature connection and both adult and childhood nature exposures (Pensini, Horn, & Caltabiano, 2016). The study used a small German student sample ($N = 141$, female = 64.5%) that was not representative of the general population. While the results cannot be generalized, they do provide some insight into the role of nature experiences at different stages in life.

Similarly, a cross-sectional study of French adults ($N = 4639$) showed that adult nature experiences are predicted by childhood nature experience and nature connection, as measured via an adapted Inclusion of Nature in Self Scale (Colléony, Prévot, Saint Jalme, & Clayton, 2017). However, childhood nature experiences in the study were measured via a single item survey question asking respondents to state whether they grew up in a large, medium or small city, village or hamlet. This is an unrefined measure of childhood nature experiences that assumes that living in smaller urban areas results in more nature experiences and hence fails to capture any information on the quantity or quality of these childhood nature experiences. Similarly, such a simple proxy of childhood nature experiences also fails to account for the role of family values towards nature, which has been suggested as an important influencing factor (Chawla, 1999; Windhorst & Williams, 2015). Currently, there is little known about how occurrence of nature experiences at different stages in life is related to an individual's current nature connection. As described above, childhood nature experiences have been shown to be associated with adult nature connection. However, it may be that certain adults can come to develop a relationship with nature through current nature experiences, even when previous childhood nature experiences are lacking. For example, qualitative, map-aided interviews with English adults highlighted the importance of 'biographic time' in how people value and use nature spaces (Bell, Wheeler, & Phoenix, 2016). Biographic time refers to how one's sense of self can be shaped by lifetime experiences. While numerous interviewees highlighted the importance of childhood nature experiences in shaping their current relationship with nature, others spoke of how their relationship with nature was formed later in life, triggered by life events such as relocating to areas with more accessible nature, relationship changes or parenthood. The relationship between first-time adult nature experiences and nature connection is under-explored. Much remains unknown as to what are the optimal stages in life for nature experiences to occur in order for a nature connection to be formed. Such clarity would help inform the design and delivery of urban environments that promote nature connection outcomes among urban residents.

The Current Study

Cultivation of nature connection among urban residents requires an understanding of how past nature experiences and current contact with nature in urban environments are associated with an individual's nature connection. The current evidence base identifies positive associations between nature connection and adult and childhood nature experiences, but several gaps remain. The aim of the present study is to address these noted limitations, first, by assessing both adult and childhood nature experiences simultaneously as potential predictors of nature connection among a large representative urban sample. This may shed light on whether childhood nature experiences are a prerequisite to adult nature connection or whether nature connection can be cultivated through adult nature experiences alone. Second, adult nature experiences are measured within the context of everyday, accessible urban nature experiences (as opposed to visits to national parks) and are not restricted by a narrow definition of urban nature (e.g., visits to urban parks) but include contact with all types of nature within an urban environment (e.g., street trees, pocket parks) and consider both private and public forms of urban nature. For the purposes of this study urban nature is considered to be all the plants and wildlife living in the urban environment. Urban nature includes both blue and green spaces, private and public spaces, and can vary in its degree of 'naturalness', from more natural or wild spaces, such as urban forests and coastlines, to more managed and designed forms, such as urban parks and canals. Third, this study uses a comprehensive measure of childhood nature experiences that looks beyond simple location of the childhood home (rural vs. urban) to include measures of family nature values, as well as access to nature in the home and school settings. Finally, these relationships are assessed while controlling for key factors that have been shown to be associated with nature connection such as gender, age, feelings of financial security and spirituality (Trigwell, Francis, & Bagot, 2014). Hence, this study explores the following research questions:

Research Question 1. What is the association between level of participation in childhood nature experiences and current adult nature connection?

Research Question 2. What is the association between occurrence of adult routine urban nature experiences *at home* and current adult nature connection?

Research Question 3. What is the association between occurrence of adult routine urban nature experiences *in the city* and current adult nature connection?

Research Question 4. To what extent is the relationship between adult nature experiences and current adult nature connection moderated by childhood nature experiences?

6.4 Methods

Participants and Procedure

Located on the east coast, and with a population of over 2 million, Brisbane is Australia's third largest city. Brisbane has a sub-tropical climate and is Australia's most biologically diverse capital city.

While considered to have a relatively high amount of urban nature, a rapidly growing population places increasing pressure on these existing nature spaces (Garden, McAlpine, & Possingham, 2010).

A survey of adult urban residents living in Brisbane, Australia (aged 18-90) was administered online via a social research company to suitable potential respondents in May 2017 ($N = 1000$). This time of year was chosen for data collection as it occurs following several public holidays when people are likely to have returned to a typical routine. In addition, in Brisbane, May is a time of year that is conducive to outdoor activity following the end of the high summer temperatures.

A definition of urban nature was provided at the start of the survey and read as follows: '*All cities contain nature. Parks, street trees, riverside walkways, creeks, bushland reserves, sports fields and even home gardens are all part of what makes up nature in Brisbane City. Urban nature includes all the plants and wildlife that live in the city*'. This definition was provided to ensure that all respondents had a shared understanding of urban nature that was beyond urban parks and not exclusive to public forms of green or blue space.

Over half the sample identified as female (52.5%), which reflects the population (female 50.7%). Data were collected only from residents over 18 years old and an even spread of ages was obtained (18-24 years 11%; 25-34 years 18.6%; 35-44 years 19.6%; 45-54 years 17.7%; 55-64 15.6%; Over 65 years 17.5%; Table 6.1). Respondents who completed the survey in full received minor monetary compensation. This research was conducted in accordance with the National Statement on Ethical

Conduct in Human Research and received ethics approval from Griffith University Human Research Ethics Committee [project number 2016/085]. Informed consent was obtained from all survey respondents.

Table 6.1. Means for the independent variable of nature connection

Variable	Level	n	%	<u>2011 Brisbane SUA (%)</u>	Nature Connection	
					Mean	SD
Gender	Male	475	47.5	49.3	3.31	0.68
	Female	525	52.5	50.7	3.45	0.71
Age (years)	18-24	110	11	~9.5	3.29	0.64
	25-34	186	18.6	15	3.37	0.76
	35-44	196	19.6	14.8	3.31	0.67
	45-54	177	17.7	13.1	3.40	0.69
	55-64	156	15.6	10.7	3.48	0.64
	Over 65	175	17.5	11.6	3.41	0.72

SUA = Significant Urban Area

Constructs and Measures

Early environmental experiences: The Early Environmental Experiences scale was used to measure childhood nature experiences (Hinds, 2018). The wording of the original scale was adapted to make it more relevant to the Australian context (e.g., inclusion of Australian relevant landscapes such as creeks and bushland). Respondents read four statements and rated how true each statement was with regard to their own childhood (*1 = very untrue, 5 = very true*). The scale includes items relating to family nature values (*‘When I was younger my parents were interested in nature and the outdoors’*), access to nature as a child (*‘I had access to a garden when I was young, My early school/s had green play areas’*) and time spent in nature as a child (*‘I remember playing outdoors [e.g., at the beach or creeks, in the bush, fields or forests] while I was growing up’*). The mean of all items provides a score representing childhood nature experiences where a higher score indicates greater levels of childhood nature experience.

Childhood home setting: As an additional measure of childhood nature experiences, we followed the approach used by Weinstein et al. (2015) and collected data on the childhood home setting by asking respondents *‘Thinking back to when you were growing up, do you consider that you grew up in an area that was...’* with response options of *‘1 = mostly surrounded by a high density of buildings (e.g., large cities, city centre)’*, *‘2 = mostly surrounded by medium to low density of buildings (e.g., smaller*

towns, city suburbs)’ and ‘3 = mostly surrounded by nature areas (*farmlands, coastlines, forests, mountains, bush*)’. This categorical variable was dummy coded to form two predictor variables for an urban and rural childhood setting with the ‘medium to low density’ category, which had the highest frequency, as the comparison group.

Adult nature experiences at home: Participants were asked about their everyday urban nature experiences within two settings; their home and their city. Four single-item variables were used to measure various aspects of home nature experiences. These included duration of contact with home outdoor areas, level of greenness of home outdoor areas, greenness of views from the home and, level of satisfaction with nature around the home. First respondents were asked whether they had access to a privately owned outdoor space (e.g., backyard, balcony, garden, veranda). Those who did ($n = 951$), then reported, using a weekly timescale, the typical duration of time spent in their private outdoor area (*‘During a typical week how much time would you spend in this private outdoor area’* paired with the following responses *‘No time’*, *‘Less than 30 minutes a week’*, *‘30 minutes to 4 hours a week’*, *‘Over 4 hours and less than 10 hours a week’*, *‘Over 10 hours and less than 25 hours a week’*, *‘Over 25 hours a week [approx. three hours a day]’*). Three additional single-item variables measured the quality of home outdoor/nature experiences. Firstly, respondents reported the level of greenness of the private outdoor area (*‘What approximate percentage of this private outdoor area is covered with plants? [e.g., grass, trees, shrubs, potted plants]’* paired with the following responses *‘0% (no plants)’*, *‘1% to 20%’*, *‘21% to 40%’*, *‘41% to 60%’*, *‘61% to 80%’*, *‘81% to 100%’*). Those who did not have access to a private outdoor area ($n = 49$) were automatically scored as spending zero time there and as having zero greenery. Secondly, respondents were asked to report on the views from their homes ($1 = \text{very urban}$, $5 = \text{very natural}$). The final variable, which measured satisfaction with home nature experiences, asked respondents to rate their satisfaction with nature within 20 m of their home ($1 = \text{extremely dissatisfied}$, $7 = \text{extremely satisfied}$) with people who reported having no nature near their home ($n = 15$) being excluded from the analysis of this variable.

Adult nature experiences within the city: Three single-item variables were used to measure various aspects of adult nature experiences within the city: duration of contact with city nature, level of satisfaction with city nature, and accessibility of city nature. The first variable, duration of adult

nature experiences within the city setting, was assessed by asking respondents to report the duration of contact with nature they experience during a typical week (*'During a typical week how much time do you approximately spend in contact with nature'* paired with the following responses *'No time'*, *'Less than 30 minutes a week'*, *'30 minutes to 4 hours a week'*, *'Over 4 hours and less than 10 hours a week'*, *'Over 10 hours and less than 25 hours a week'*, *'Over 25 hours a week [approx. three hours a day]'*). The second variable, which measured satisfaction with city nature experiences, asked respondents to rate their level of satisfaction, using a seven-point scale, with nature in their suburb (*1 = extremely dissatisfied, 7 = extremely satisfied*). The third variable, which measured accessibility of city nature experiences, asked respondents to rate how easy or difficult it is to access nature in their suburb (*1 = Extremely difficult, 7 = Extremely easy*).

Nature connection: The dependent variable of nature connection was measured using the shortened six-item Nature Relatedness scale (Nisbet & Zelenski, 2013). This scale measures the affective (*'I feel very connected to all living things and the earth'*) and experiential (*'I take notice of wildlife wherever I am'*) aspects of an individual's nature connection. Respondents used a five-point Likert scale to rate their level of agreement (*1 = strongly disagree, 5 = strongly agree*) with each of the six statements. The average of all items was used as the measure of nature connection with higher scores reflecting a greater level of nature connection.

Adult nature experiences - type of activity: To give insight into the type of activity that occurs most often during contact with nature, respondents were asked to rank up to three main activities that occur during the time they spend in contact with nature. Respondents were provided with a list of 10 activity types alongside an 'Other' option. The activity types included 'work', 'transport', 'health and fitness', 'rest and relaxation', 'social interaction', 'chores', 'education', 'spiritual/cultural', 'animal interactions', and 'hobbies'. Full descriptions of each activity type can be found in Appendix 2. Note that this question was included to provide contextual information but is not included in the regression analyses.

Control variables: Typical control variables such as age, gender and feelings of financial security were collected. In addition, some research has identified associations between spirituality and nature connection (Kamitsis & Francis, 2013; Trigwell et al., 2014). Hence, to account for the potential

effect of spirituality, survey respondents were asked whether they regularly attended a place of worship (0 = No, 1 = Yes). The full survey questionnaire can be found in Appendix 2.

Analysis Strategy

Descriptive statistics of the data provided an overview of the sample and informed the analytical approach. This involved computing Pearson's correlations to explore the bivariate relationships between nature connection and the various predictor variables measuring childhood and adult nature experiences. This helped to determine suitable variables for inclusion in the regression analysis, which was conducted to assess the strength of associations between nature connection and childhood and adult nature experiences while controlling for potential confounding variables (RQ1, RQ2 and RQ3). The last research question sought to explore whether the relationship between adult nature experiences and current nature connection is moderated by childhood nature experience. To address this question nature connection was regressed on predictor variables of adult nature experience and childhood nature experience with the interaction term of these two predictor variables included in the model (RQ4).

Standard parametric assumptions were tested and satisfied. However, it is worth noting that some of the independent variables were negatively skewed. For example, the satisfaction scores for both nature around the home, $D(1000) = 0.267, p < .001$, and nature in the suburb, $D(1000) = 0.288, p < .001$, displayed a negative skew with most respondents reporting that they were moderately or extremely satisfied with nature in their suburb or around their home. Given that parametric tests are robust to deviations from Gaussian distributions when the sample sizes are large (Motulsky, 2013), it was deemed that the validity of the statistical inferences would not be compromised. Further, bootstrapping was used where appropriate to counter such normality breaches. Factor analysis was completed on all multi-item variables to explore the structure and reliability of these scales for this study. All statistical analysis was completed in 2017 using IBM SPSS Statistics 25.

6.5 Results

Factor Analyses of Scales

To explore the structure and reliability of the Nature Relatedness scale and the Early Environmental Experiences scale we performed principal axis factor analyses. For the Nature Relatedness Scale, we used an orthogonal rotated solution (varimax) that revealed one factor with an eigenvalue of 3.31 that accounted for 55.1% of the variance. All items loaded positively on this factor, with loadings ranging from .45 to .88 (average factor loading = .67; Table 6.2). The reliability of this six-item scale was satisfactory (Cronbach's $\alpha = .83$)

For the Early Environmental Experiences scale we again used an orthogonal rotated solution (varimax) that revealed one factor with an eigenvalue of 2.19 that accounted for 54.8% of the variance. All items loaded positively on this factor, with loadings ranging from .51 to .72 (average factor loading = .63; Table 6.3). The reliability of this four-item scale was satisfactory (Cronbach's $\alpha = .71$).

Table 6.2. Factor loadings for Nature Relatedness scale

Scale item	Factor 1
My ideal holiday spot would be a remote, wilderness area	0.45
I always think about how my actions affect the environment	0.57
My connection to nature and the environment is a part of my spirituality	0.71
I take notice of wildlife wherever I am	0.61
My relationship to nature is an important part of who I am	0.88
I feel very connected to all living things and the earth.	0.81

Table 6.3. Factor loadings for Early Environmental Experiences scale

Scale item	Factor 1
When I was younger my parents were interested in nature and the outdoors (e.g., going on camping trips, gardening, bush walks, beach trips)	0.51
I remember playing outdoors (e.g., at the beach or creeks, in the bush, fields or forests) while I was growing up	0.69
I had access to a garden when I was young	0.72
My early school(s) had green play areas	0.60

Descriptive Statistics

Analysis of the ranking of the types of activities that participants reported engaging in during nature contact revealed that ‘rest and relaxation’ received the most rankings in total, whereas ‘physical activity’ received the highest number of first place rankings (Figure 6.1). Pearson’s correlation coefficients between the dependent variable of nature connection and the independent variables measuring childhood nature experiences and adult nature experiences in both home and city settings are shown in Table 6.4. Neither accessibility to nor satisfaction with nature within the city showed a significant correlation with nature connection ($r(985) = .04, p = .176$ and $r(985) = .06, p = .080$ respectively). Similarly, views from the home setting were not significantly correlated with nature connection ($r(985) = .06, p = .080$). Hence, these three proposed predictor variables were not included within the subsequent regression analysis. All other predictor variables were significantly correlated with nature connection, although the strength of these associations were weak. Duration of adult nature experiences in the city had the strongest correlation with nature connection ($r(985) = .28, p < .001$), followed by the Early Environmental Experiences scale ($r(985) = .19, p < .001$) and duration of nature experiences at home ($r(985) = .19, p < .001$).

Figure 6.1. Ranking results for the three main purposes for participants' contact with nature

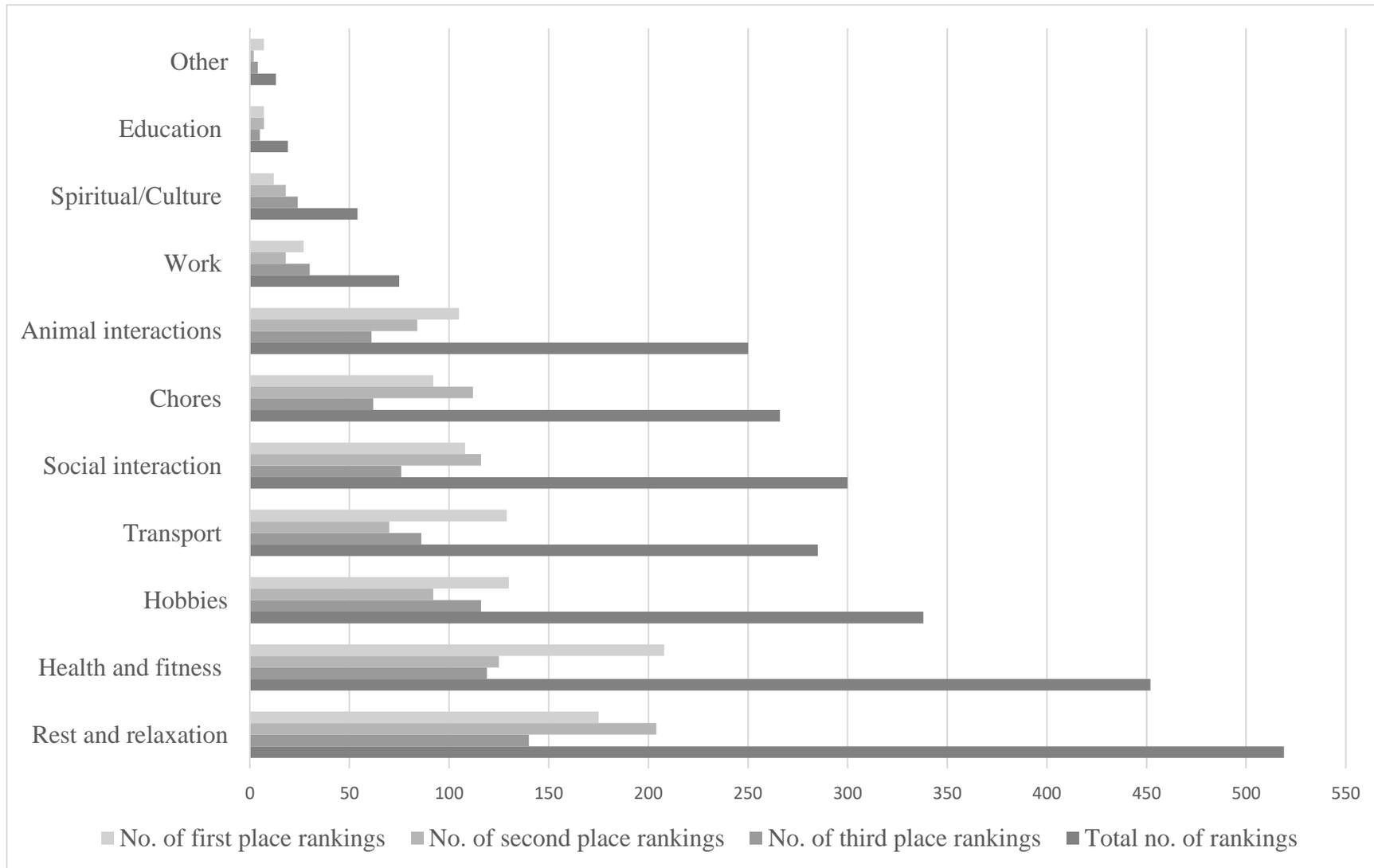


Table 6.4. Pearson's correlations between nature connection and variables measuring different aspects of childhood and adult nature experiences ($N = 985$)

	M	SD	1	2	3	4	5	6	7	8	9	10
1. Nature Connection	3.39	0.69	1									
2. Adult Nature Experience Home - Nature contact duration	2.97	1.06	.187***	1								
			[.116, .253]									
3. Adult Nature Experience Home - Level of greenness	3.23	1.52	.102**	.356***	1							
			[.041, .156]	[.295, .416]								
4. Adult Nature Experience Home - Home views	2.55	0.87	.056	.112***	.181***	1						
			[-.011, .121]	[.050, .178]	[.121, .238]							
5. Adult Nature Experience Home - Satisfaction with nature	5.56	1.34	.070*	.159***	.092**	.255***	1					
			[.002, .135]	[.093, .226]	[.024, .157]	[.163, .288]						
6. Adult Nature Experience City - Nature contact duration	3.19	1.06	.281***	.474***	.225***	.210***	.178***	1				
			[.214, .343]	[.405, .541]	[.161, .291]	[.151, .275]	[.105, .250]					
7. Adult Nature Experience City - Satisfaction with nature	5.83	1.26	.056	.077*	.046	.206***	.595***	.154***	1			
			[-.016, .122]	[.009, .146]	[-.017, .113]	[.136, .277]	[.524, .660]	[.082, .227]				
8. Adult Nature Experience City - Accessibility	6.04	1.16	.042	.144***	.138***	.288***	.471***	.255***	.626***	1		
			[-.032, .116]	[.082, .210]	[.064, .200]	[.223, .351]	[.406, .535]	[.185, .323]	[.567, .683]			
9. Childhood Nature Experience Early Environmental Experiences	3.99	0.73	.188***	.082*	.040	.012	.072*	.191***	.123***	.156***	1	
			[.118, .256]	[.017, .151]	[-.033, .112]	[-.055, .074]	[.011, .135]	[.127, .259]	[.061, .183]	[.092, .219]		
10. Childhood Nature Experience Home setting: low to medium urban vs. high urban	0.09	0.28	-.046	-.111**	-.016	-.053	.043	-.091**	.011	-.027	-.319***	1
			[-.113, .017]	[-.170, - .046]	[-.080, .052]	[-.118, .015]	[-.007, .092]	[-.156, - .023]	[-.048, .066]	[-.084, .031]	[-.388, - .247]	
11. Childhood Nature Experience Home setting: low to medium urban vs natural surrounds	0.29	0.45	.078*	.122***	.003	.012	.020	.104**	.047	.053	.304***	-.196***
			[.010, .140]	[.062, .179]	[-.059, .072]	[-.059, .080]	[-.040, .083]	[.038, .171]	[-.016, .104]	[-.011, .115]	[.256, .354]	[-.223, - .175]

* $p < .05$, ** $p < .01$., *** $p < .001$ Two-tailed. BCa bootstrap 95% CIs reported in brackets.

Regression Analysis

The results of the regression analysis are presented in Table 6.5. The first step included the control variables of gender, age, feelings of financial security and spirituality ($R^2 = .033$, $F[4, 980] = 8.30$, $p < .001$). The second step included three separate variables measuring various aspects of adult nature experiences at home, namely, weekly duration of contact with home nature, level of greenness of home nature, and satisfaction with nature around the home (RQ2; $\Delta R^2 = .037$, $F[7, 977] = 10.39$, $p < .001$). The third step included one variable measuring adult nature experiences in the city, namely, weekly duration of adult nature experiences in the city (RQ3; $\Delta R^2 = .043$, $F[8, 976] = 15.50$, $p < .001$). Other variables measuring adult nature experiences in the city, such as accessibility of and satisfaction with city nature, were not included in the regression models as the correlation analyses showed that these variables did not significantly correlate with nature connection. The fourth and final step included three separate variables measuring childhood nature experiences. These variables were the Early Environmental Experiences scale and two dummy coded variables for childhood home setting (i.e., natural surrounds and high urban; RQ1; $\Delta R^2 = .018$, $F[11, 973] = 13.30$, $p < .001$). The strength of the evidence base on associations between adult nature experiences and nature connection is comparable to the evidence base on associations between childhood nature experiences and nature connection. Hence, sequencing of steps within the model was based first on the number of variables per step followed by strength of correlations between the independent variables and nature connection (Table 6.4). Hierarchical regression was chosen to help differentiate between the effect of childhood versus adult nature experiences and city based versus home based adult nature experiences. While there was minimum change in the significance and effects of variables across the four models it was revealed that the inclusion of duration of adult nature experiences in the city contributed the greatest improvement to model fit ($\Delta R^2 = .043$ for Step 3). Only duration of time spent in contact with nature, both at home and at the city level, as well as the Early Environmental Experiences scale emerged as significant predictors of nature connection. The final model accounted for approximately 12% of the variation in nature connection levels (Adjusted $R^2 = .121$). The Durbin-Watson value was 1.90 indicating that multicollinearity was not an issue.

Moderation Analysis

The final research question (RQ4) sought to explore whether the relationship between adult nature experiences and current nature connection is moderated by childhood nature experience. The Early Environmental Experiences scale was significantly, although weakly, correlated with duration of adult nature experiences in both home ($r(985) = .08, p < .05$) and city settings ($r(985) = .19, p < .001$; Table 3), which would suggest that childhood nature experiences may play a moderating role. To investigate this potential moderating role, nature connection was regressed on mean centered predictor variables of duration of adult nature experience in the city and the Early Environmental Experiences scale. The predictor variable of duration of adult nature experience in the city was chosen for this analysis as it had the strongest effect size of all the adult nature experience variables ($b = 0.14, 95\%$ Confidence Intervals 0.09, 0.18). The interaction term of these two predictor variables was included to assess whether the positive association between high nature connection and high duration of adult nature experience is moderated by the level of nature experienced during childhood. This interaction was investigated while controlling for age, gender, spirituality and financial security. The interaction effect proved non-significant, $b = 0.02, 95\%$ CI [-0.04, 0.06], $t = 0.585, p = .559$, indicating that the relationship between duration of adult nature experiences and nature connection is not moderated by childhood nature experiences (Table 6.6).

Table 6.5. Linear model predictors of nature connection with confidence intervals in brackets and standard errors ($N = 985$)

Independent Variables	Step 1				Step 2				Step 3				Step 4			
	<i>b</i>	<i>SE B</i>	β	<i>p</i>	<i>b</i>	<i>SE B</i>	β	<i>p</i>	<i>b</i>	<i>SE B</i>	β	<i>p</i>	<i>b</i>	<i>SE B</i>	β	<i>p</i>
Constant	3.57	0.10		<.001	3.22	0.13		<.001	3.00	0.13		<.001	2.49	0.17		<.001
Gender	(3.39, 3.76) -0.16 (-0.25, -0.07)	0.05	-.12	<.001	(2.97, 3.47) -0.16 (-0.24, -0.07)	0.04	-.12	<.001	(2.75, 3.25) -0.16 (-0.25, -0.08)	0.04	-.12	<.001	(2.15, 2.83) -0.15 (-0.24, -0.07)	0.04	-	<.001
Age	0.01 (0.00, 0.01)	0.00	.11	<.001	0.00 (0.00, 0.01)	0.00	.06	.058	0.00 (0.00, 0.01)	0.00	.07	.040	0.00 (0.00, 0.01)	0.00	.08	.014
Financial Security	-0.06 (-0.11, -0.02)	0.02	-.10	.003	-0.07 (-0.12, -0.04)	0.02	-.11	<.001	-0.07 (-0.11, -0.03)	0.02	-.10	.001	-0.07 (-0.10, -0.03)	0.02	-	.001
Spirituality	0.15 (0.04, 0.27)	0.06	.08	.013	0.15 (0.03, 0.26)	0.06	.08	.012	0.14 (0.03, 0.25)	0.06	.08	.014	0.14 (0.03, 0.24)	0.06	.07	.016
Adult Nature Experience Home - Nature contact duration					0.11 (0.06, 0.14)	0.02	.18	<.001	0.04 (0.00, 0.09)	0.02	.07	.051	0.05 (0.00, 0.09)	0.02	.07	.046
Adult Nature Experience Home - Level of greenness					0.01 (-0.02, 0.03)	0.02	.03	.356	0.01 (-0.02, 0.04)	0.02	.02	.632	0.01 (-0.02, 0.04)	0.02	.02	.651
Adult Nature Experience Home - Satisfaction with nature					0.02 (-0.01, 0.05)	0.02	.04	.252	0.01 (-0.03, 0.04)	0.02	.01	.743	0.00 (-0.03, 0.03)	0.02	.00	.995
Adult Nature Experience City – Nature contact duration									0.15 (0.11, 0.20)	0.02	.24	<.001	0.14 (0.09, 0.18)	0.02	.21	<.001
Childhood Nature Experience - Early Environmental Experiences													0.14 (0.07, 0.20)	0.03	.15	<.001
Childhood Nature Experience - Home setting: low to medium urban vs natural surrounds													0.00 (-0.10, 0.09)	0.05	.00	.978
Childhood Nature Experience - Home setting: low to medium urban vs. high urban													0.08 (-0.07, 0.24)	0.08	.04	.278
	$R^2 = .033$ $F[4, 980] = 8.30, p < .001$				$\Delta R^2 = .037$ $F[7, 977] = 10.39, p < .001$				$\Delta R^2 = .043$ $F[8, 976] = 15.50, p < .001$				$\Delta R^2 = .018$ $F[11, 973] = 13.30, p < .001$			

NOTE: Adjusted R^2 for final model = .121

Table 6.6. Linear model of predictors of nature connection including interaction ($N = 1000$)

	<i>b</i>	<i>SE B</i>	<i>t</i>	<i>p</i>
Constant	3.44 [3.26, 3.62]	0.09	36.629	< .001
Gender	0.00 [0.00, .01]	0.00	2.681	.007
Age (mean centered)	-0.15 [-0.24, -0.07]	0.04	-3.545	< .001
Financial Security (mean centered)	-0.06 [-0.10, -0.02]	0.02	-3.191	.001
Spirituality	0.14 [0.03, 0.25]	0.06	2.472	.014
Early Environmental Experiences (mean centered)	0.16 [0.12, 0.20]	0.02	7.928	< .001
Duration of adult nature experience (mean centered)	0.12 [0.07, 0.18]	0.03	4.222	< .001
Early Environmental Experiences x Duration of adult nature experience	0.02 [-0.04, 0.06]	0.03	0.585	.559

Note: Adjusted $R^2 = .11$

6.6 Discussion

The aim of this study was to investigate potential predictors of nature connection through testing the effect of nature experiences; both past experiences that occurred during childhood and urban nature experiences that occur during a routine week within home and city settings. Consistent with past research we found that both adult and childhood nature experiences have a positive relationship, of comparable strength, with current nature connection levels (Cheng & Monroe, 2012; Lin et al., 2014; Restall & Conrad, 2015; Windhorst & Williams, 2015). Given the cross-sectional study design, it is not possible to determine the direction of this effect and while we suggest that spending time in nature may enhance nature connection, it may also be the case that having a high level of nature connection encourages people to spend time in nature. Furthermore, while childhood and adult nature experiences were shown to be significant predictors of nature connection, they only explain a relatively small proportion of the overall variability in nature connection. Given the subjectivity of one's relationship with nature, influenced by cultural differences and prevailing social constructions of nature, it is likely that there are many other factors that may influence this complex construct. Nevertheless, deepening our understanding of the role that childhood and adult urban nature experiences play in shaping nature connection may help inform the design and delivery of nature connection enhancing experiences within our cities.

The current study extends past research by assessing childhood and adult nature experiences simultaneously and testing the moderating effect that childhood nature experiences may play on the relationship between adult urban nature experiences and nature connection. The results of our survey with a large sample of adults living in Brisbane revealed that childhood nature experience was not a significant moderator of the positive relationship between duration of adult urban nature experiences in the city and nature connection. This finding suggests that people can develop their relationship with nature throughout various stages in life and that childhood nature experiences are not necessarily a prerequisite to adult nature connection. However, the Early Environmental Experiences scale used in this study was based on adults retrospectively reporting on their childhood nature experiences. Such measures are prone to recall bias. This may have led to participants answering more positively about their childhood nature experiences, which may explain the somewhat high average for childhood nature experiences among this study sample ($M = 3.99$, $SD = .73$, $Min = 1$, $Max = 5$). The limitation of recall bias needs to be considered when interpreting the results.

Currently, there is substantial focus on connecting children with nature as evidenced by the establishment of initiatives such as Forest Schools and Nature Play Programs. The aim of such programs is to increase childhood nature experiences through outdoor learning or unstructured outdoor play. This focus on children's nature connection is driven by concern over 'nature deficit disorder' which is believed to be a critical problem facing modern children who are growing up in the age of technology and within urban environments with predominantly indoor lifestyles (Louv, 2008). Such efforts serve an important role, particularly for children living in urban environments with reduced opportunities for nature experiences. However, the findings from this study suggest that equal attention needs to be given to promoting adult nature experiences and fostering adult nature connection.

Nature connection initiatives should consider the opportunity to engage adults with nature, particularly those who may not have prior familiarity with nature. The design of such adult nature initiatives will need to be tailored to suit the age, ability and cultural and social context of the target adult population, especially given that certain urban adult groups may face more barriers to engaging with nature than others. For example, numerous studies show that people who infrequently engage

with nature are more likely to be female, older, in poor health, of lower socioeconomic status and of ethnic minority status (Boyd, White, Bell, & Burt, 2018; Lin et al., 2014; Roe, Aspinall, & Ward Thompson, 2016). Encouragingly, in Europe multiple organizations are now working closely with diverse ethnic and refugee groups living in cities, to co-create activities that support first, second and third generation migrants to access and connect with urban nature in new, and often unfamiliar, settings (Rishbeth, Blachnicka Ciacek, Bynon, & Stapf, 2017). Similarly, a number of nature connection initiatives already tailor their activities to accommodate diverse ages and abilities. For example, community greening and gardening initiatives, such as those run by Thrive or Green Gyms by The Conservation Volunteers, provide age and ability appropriate nature connection activities. Dementia Adventure, a nature-based program in the UK, provides activities that connect people living with dementia to nature (Morgan, 2018). Tailored and co-created nature connection activities such as these, may be an effective way of connecting diverse urban adult populations with nature.

Our findings show that duration of adult nature experiences, both those that occur at home and those within the wider city environment, are significant predictors of nature connection. This supports previous findings that suggest that people's nature connection may be developed through frequent and direct contact with nature (Lin et al., 2014; Restall & Conrad, 2015; Russell et al., 2013; Scopelliti et al., 2016). The majority of respondents in our study reported that rest and relaxation was one of the main purposes for spending time in contact with nature. This may explain why our results show that duration of nature experience is associated with nature connection. It may be that spending time in nature for rest and relaxation allows for appreciative and mindful nature experiences, which have been shown to be associated with nature connection (Howell, Dopko, Passmore, & Buro, 2011; Wolsko & Lindberg, 2013).

I used a rather simple ranking survey question as an attempt to provide insight into how people in our sample spent time in nature. Future research could investigate what type of nature (e.g., private vs. public nature) supports different types of activities. For example, home nature may support social activities or activities for rest and relaxation, whereas public nature may be more suited for physical activity or for travelling from one location to another. These different types of activities experienced in different types of urban nature may have varying relationships with nature connection and should

be investigated. We recommend study designs and indicators that can tease apart how different types of urban nature experiences relate to nature connection. Such study designs could use qualitative methods, such as time-use diaries, map-aided interviews and emplaced interviews – those conducted within the place under study - or smartphone technologies and specific apps that collect real time data on how people experience urban nature. The latter may be a particularly effective method for collecting data from young adults and adolescents (Bakolis et al., 2018; MacKerron & Mourato, 2013). Such approaches may help reveal how people interact with different types of urban nature and how these various types of experiences relate to nature connection.

In addition to duration of contact, we also tested other variables that measured different aspects of adult urban nature experiences, for example, satisfaction with nature or level of greenness. However, only duration of contact proved to be a significant predictor of nature connection. This suggests that, with regards to our study sample, initiatives that seek to enhance nature connection should focus on increasing people's duration of time in contact with nature whereas focus on other aspects, for example enhancing people's satisfaction with nature, may not prove as effective. Urban greening initiatives should therefore consider, at the core of their design, the human experience of that nature space, seeking to optimize contact with and ultimately connection to nature. That said, it is recognized that Brisbane, the setting of this study, is considered to have a high level of urban nature (Shanahan et al., 2016), and that the satisfaction with and accessibility of nature at the city level were both rated highly by most of this study's participants. It would therefore be interesting to see how these results would compare with a city that has greater variability in residents' reported accessibility, quality and satisfaction with urban nature. In settings with lower access to, quality of and satisfaction with urban nature it may be that simply increasing duration of exposure to existing urban nature may not prove effective at enhancing nature connection. Indeed, encouraging people to spend time in nature that they perceive as low quality or are dissatisfied with may even have an adverse effect on nature connection levels, whereby people experience fear or discomfort in the setting (Skår, 2010), or even a sense of solastalgia in cases where the degradation of a familiar space leads to distress and loss of place attachment (Albrecht et al., 2007). It is therefore important to consider how urban nature spaces are

perceived and understood by local residents, prior to implementing nature connection enhancing initiatives.

This study adopted a broad definition of urban nature that included ‘*all the plants and wildlife that live in the city*’. Our findings show that contact with this everyday or nearby nature has a positive relationship with nature connection. Dunn, Gavin, Sanchez, and Solomon (2006) previously wrote of the dependency of global conservation upon urban people’s ability to experience urban nature. This study extends this thought to the dependency of humankind’s very connection to nature upon urban people’s ability to experience urban nature. Hence, we need to adopt a broad perspective and think ‘beyond the park’ when it comes to designing initiatives that engage urban residents with nature in their city. Such thinking is starting to be reflected in the literature with studies now exploring how urban residents use and engage with a variety of urban nature types, such as wild spaces (Threlfall & Kendal, 2017), urban forests (de Oliveira et al., 2013), blue spaces (Gascon, Zijlema, Vert, White, & Nieuwenhuijsen, 2017) and community and private gardens (Farahani, Maller, & Phelan, 2018; Guitart, Pickering, & Byrne, 2012). All aspects of nature within the city should be considered as a potential opportunity for people to experience nature and develop their nature connection.

Incorporation of such thinking across the multiple disciplines and sectors working within the space of urban nature and green infrastructure could help promote co-benefits where enhanced nature connection is delivered alongside the objectives of sustainable and liveable cities.

Finally, although growing at a rapid pace, the nature connection research field is still considered to be in its infancy with much still to be explored about this complex construct. The majority of studies on nature connection and the development of scales to measure nature connection have been derived mainly from westernized cultures. Future work should seek to explore how people from diverse cultures perceive and understand their relationship with nature. Such work may require the adaptation of current nature connection measures to be relevant to the cultural context of the target population. Other valuable suggestions have also been made within the literature about how to move the nature connection research field forward, for example through building a spatial understanding of nature connection (Klanięcki, Leventon, & Abson, 2018).

Fostering nature connection may promote the important dual outcomes of improved psychological well-being and enhanced pro-environmental attitudes and behaviors. Nature connection enhancing initiatives may particularly be of benefit among urban residents who are thought to be at risk from a 'nature disconnect'. With additional research, findings from this study may inform the creation of urban environments that enable people to experience nature and grow their nature connection, in turn promoting the dual outcomes of improved psychological well-being and enhanced pro-environmental attitudes and behaviors. Furthermore, enhancing nature connection through increased nature exposure will also support more widely acknowledged health and well-being benefits from nature contact (Hartig, Mitchell, De Vries, & Frumkin, 2014), complementing existing healthy city agendas.

Limitations

While causality cannot be inferred from correlation analysis of cross-sectional data, we have attempted to shed light on the underlying causal processes by investigating the moderating effect of childhood nature experiences on the relationship between adult nature experiences and nature connection. However, use of cross-sectional data in this way has been received with caution in the literature (Markevych et al., 2017). That said, such analysis may still be of value as long as the analysis is supported by 'relevant theory and previous empirical findings on components of the assumed process in question' (p. 310; Markevych et al., 2017), which is the case in this study. Further investigations on this topic should employ longitudinal study designs that track individuals over their life course assessing how changing nature experiences affect their nature connection levels. Given the subjectivity of one's nature connection, such a design should ideally be coupled with a qualitative line of inquiry to better understand how certain types of nature experiences influence nature connection in comparison to others. The explanatory power of our models was quite low, suggesting that there may be a number of other factors associated with nature connection. Nature connection is still an emerging research field with much still to learn about the factors that shape an individual's nature connection. In addition, this study used a number of variables that were single item measures (e.g., satisfaction with nature). Such measures were chosen in order to produce a survey questionnaire that was of a reasonable length. However, we recognize that single item measures are vulnerable to mono-operation

bias that can undermine construct validity. Similarly, the Early Environmental Experiences scale is based on participants retrospectively reporting on their childhood nature experiences. Such measures are prone to recall bias. This research field would benefit from succinct and validated measures that assess constructs such as perceived quality of urban nature experiences. Finally, this study attempted to tease apart the effects of contact with public forms of urban nature in comparison with private forms of urban nature (e.g., privately owned outdoor spaces). This, however, fails to account for communal nature spaces that people living in apartment or housing complexes may have access to. That said, given that less than 5% of the sample had no access to a private outdoor space it is unlikely that communal nature spaces would have significantly affected the results of this study. Nevertheless, such forms of urban nature should be considered in future studies. Similarly, the effects of indoor nature (e.g., potted plants, green walls) on nature connection were not accounted for in this study.

6.7 Conclusions

Nature connection holds promise for its potential to enhance well-being and promote pro-environmental attitudes and behaviors among adult urban residents. Using online survey responses from 1000 residents of a large metropolitan city in Australia, we showed that past childhood and duration of current urban nature experiences at home and in the city were likely to have a significant influence on how connected these adults feel to nature. We also showed that the positive relationship between duration of current adult urban nature experiences and nature connection was not significantly moderated by past childhood nature experiences. This finding suggests that people lacking experience of nature during childhood can still come to have a high sense of nature connection through experiencing nature as an adult. These findings are timely given the growing number of nature connection objectives starting to appear in planning and policy documents. This research empirically demonstrates the positive relationship between nature experiences and nature connection and suggests that it may be equally important to promote nature experiences at any stage in life if the goal is to increase connection with nature. Furthermore, our findings suggest spending time in contact with everyday or nearby urban nature, both at home and in the city, may be a key tool for connecting urban residents with nature.

6.8 References

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Chapter 7. Discussion

7.1 Overview

The overall aim of the thesis was to investigate, within an urban context, how perceptions of and connection to nature relate to psychological wellbeing, including exploration of factors that may be associated with a person's relationship with nature. The evidence base on the relationship between nature exposure and mental health is substantial, with a strong focus on objective measures of nature exposure (e.g., GIS-based land use variables or satellite-based vegetation indices such as the Normalized Difference Vegetation Index) and indicators of mental ill-health (e.g., stress levels, anxiety, depressive disorders). To further our understanding of the relationship between nature and mental health, this thesis looks beyond objective measures of nature exposure to assess how an individual's subjective perceptions of and relationship with nature relates to their psychological wellbeing. This thesis also takes a departure from focusing on clinical measures of mental *ill-health* to assess mental *wellbeing*, as measured via the short Warwick-Edinburgh Mental Well-Being scale. Finally, to assist with the practical application of the research, this thesis explores factors that may relate to an individual's relationship with nature within an urban context. Through exploring factors that may be associated with nature connection this research aims to inform the design and delivery of nature connection enhancing objectives and initiatives. As such, this thesis makes a unique and important contribution to our understanding of the relationship between nature and mental health. However, it must be noted that Brisbane, the urban setting within Queensland, Australia in which these human-nature relationships were explored, experiences a sub-tropical climate which promotes an outdoor lifestyle in all seasons. Similarly, the urban footprint of Brisbane city possesses a relatively high number of nature spaces. These unique features of the study setting, together with attributes of the sample population, may have influenced the research findings. As a consequence, the inferences drawn about the three research questions cannot be generalized beyond the target population of adult Brisbane urban residents.

In Chapters 1 and 2, I reviewed the current literature on the relationship between nature and mental health highlighting the gaps in our understanding, namely the role that perceptions of and connection to nature play in mental wellbeing and our lack of understanding of what factors shape an individual's nature connection. In Chapter 3, I outlined the methodological approach chosen to answer the research questions identified from the literature review. Chapter 4, 5 and 6 each addressed a research question and presented the empirical findings from the study designed to answer each research question; How do changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing? (Research Question 1 and Chapter 4); How is nature connection associated with psychological wellbeing? (Research Question 2 and Chapter 5); What is the relationship between childhood and adult nature experiences and nature connection? (Research Question 3 and Chapter 6).

The purpose of this final chapter is to provide a critical discussion and summary of the findings presented within the three empirical chapters. In the following sections, I first present the main findings from the three empirical studies and discuss answers to the research question addressed in each chapter. I then discuss the conceptual and practical implications of the present research and outline opportunities to build on these insights in future studies. Lastly, I present a summary of the main conclusions.

7.2 Main findings

This research used a multi-phased, sequential, survey-based design to explore how perceptions of and connection to nature relate to psychological wellbeing, including exploration of factors that may be associated with a person's relationship with nature. Using longitudinal, mail-based survey data I explored the first research question of this thesis - How do changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing? This research question emerged from the review of the nature and mental health literature which highlighted the preponderance of cross-sectional study designs investigating how objective measures of nature relate to measures of mental ill-health. To move the field forward I used longitudinal data

from 5,014 mid-aged Brisbane urban residents to assess how changes in perceptions of quality and quantity of nature relate to mental wellbeing over time – which, to the best of my knowledge, is the first time this relationship has been investigated within a longitudinal study design. Results of the longitudinal, fixed effects, two-period difference regression showed that within-person changes in perceptions of urban nature were positively associated with changes in psychological wellbeing. This means that perceiving greater quality and quantity of urban nature in one's suburb of residence was associated with an improvement in psychological wellbeing and perceiving lesser quality and quantity of urban nature in the suburb of residence was associated with a decline in psychological wellbeing.

This positive relationship between perceptions of quality and quantity of urban nature and psychological wellbeing provided justification for further exploration of people's subjective relationship with nature and how this relates to wellbeing and hence shaped the second research question of this thesis - How is nature connection associated with psychological wellbeing? To answer this question, I designed and administered a cross-sectional, web-based survey of 1,000 adult Brisbane urban residents. Mediators were identified based on previous research and on Self Determination Theory. Through a parallel, multiple mediator model, I tested the indirect effect of non-human relatedness and intrinsic values on the relationship between nature connection and psychological wellbeing. The results show that the relationship between nature connection and wellbeing is mediated by non-human relatedness and intrinsic values, which operate as parallel mediators, whereby nature connection satisfies non-human relatedness and fosters intrinsic values which promote psychological wellbeing. These findings shed light on how nature connection may promote wellbeing and could help inform the design of and enhance the wellbeing outcomes from nature connection promoting initiatives. In addition, these findings provide evidence of nature connection's positive relationship with psychological wellbeing and provide support for the cultivation of nature connection among urban residents for wellbeing promotion.

Building on this finding the third and final research question of this thesis sought to understand the relationship between childhood and adult nature experiences and nature connection. I used data from the same cross-sectional web-based survey of 1,000 Brisbane urban residents to answer this question. Multiple regression analysis showed that both adult and childhood nature experiences have a positive relationship, of comparable strength, with current nature connection levels. To further unpack the role of childhood and adult nature experiences I carried out a moderation analysis which revealed that childhood nature experience was not a significant moderator of the positive relationship between duration of adult nature experiences and nature connection. This suggests that adults can come to develop a connection to nature through experiencing nature as an adult, even when childhood nature experiences are minimal. Hence, nature experiences should be encouraged at all life stages if enhanced nature connection is the goal.

By exploring how perceptions of and connection to nature relate to psychological wellbeing, and through investigating factors that relate to an individual's nature connection, this research sought to fill a key gap in the nature and mental health literature. Analysis of cross-sectional and longitudinal survey data resulted in four main findings from this thesis, namely:

1. Perceptions of quality and quantity of urban nature influence psychological wellbeing.
2. The association between nature connection and psychological wellbeing is mediated by non-human relatedness and intrinsic values.
3. Childhood nature experiences and duration of adult nature experiences are associated with nature connection.
4. The positive relationship between duration of adult nature experiences and nature connection is not moderated by childhood nature experiences.

These findings make a unique and valuable contribution to the growing literature on nature and mental health. The implications of these findings are discussed in the following sections, first from a theoretical perspective and then from a practical perspective.

7.3 Theoretical implications

This section discusses the specific conceptual and theoretical contributions of this doctoral research project. In Chapters 1 and 2, I identified several gaps in current understanding of the links between nature and psychological wellbeing. These included:

- lack of exploration of the temporal relationship between perceptions of quality and quantity of nature and measures of mental wellbeing.
- minimal theoretical underpinning or understanding of mechanisms involved in the positive relationship between nature connection and psychological wellbeing.
- limited knowledge of how nature connection is cultivated and what role childhood and adult nature experiences play in shaping nature connection.

The research questions and methodology of this thesis were designed around addressing these key knowledge gaps. Here, I draw on the findings and analysis presented in Chapters 4-6 to highlight four key conceptual contributions that have emerged from this research. These are:

- the recognition that subjective measures of the quality and quantity of nature need to be included in future studies exploring the relationship between nature and mental wellbeing including better representation within longitudinal study designs;
- the positioning of the nature connection and psychological wellbeing relationship within a well-established theoretical framework revealing the mediators of this relationship;
- the understanding that both childhood and adult urban nature experiences are related to nature connection, and;
- that people can come to develop a sense of nature connection through later life nature experiences and in the absence of childhood nature experiences.

Each of these four theoretical contributions are discussed in further detail below.

Subjective measures of nature need to be included in future studies

This is the first time that the relationship between perceptions of quality and quantity of urban nature and psychological wellbeing has been explored within a longitudinal study design. The findings show that changes in perceptions of quality and quantity of urban nature have a positive relationship with changes in psychological wellbeing. Such findings strengthen the case for the inclusion of subjective measures of nature in future studies on the relationship between nature and mental health, particularly within longitudinal study designs. Previous research exploring people's level of optimism and outlook on life has shown that an individual's perception of a given situation, which can differ greatly from the actual situation, can have a substantial effect on mental wellbeing (Conversano et al., 2010; Korn et al., 2014). This may also be the case within the context of urban nature. A key theoretical implication of this thesis is the recognition of subjective measures of nature as a key to deepening our understanding of the nature and wellbeing relationship.

Although this research used a simple three-item scale for measuring perceptions of urban nature, it did assess aspects of both the perceived quantity and quality of urban nature. Objective measures of green space, such as vegetation indices, are commonly criticised as they assess the overall level of vegetation only and do not assess the quality of urban nature (Markevych et al., 2017). For example, an objective vegetation index may rate an inaccessible, abandoned lot overgrown with vegetation with the same value as a well-serviced, widely used urban park. There are objective measures of nature quality, for example, biodiversity measures such as species richness and abundance which have been shown to have a positive relationship with mental health (Cox et al., 2016).

However, objective measures of nature quality may not match subjective measures of nature quality. For example, a study measuring perceived and actual species richness of urban plants, birds and butterflies found no association between perceived and actual species richness and found that while wellbeing was positively related to the participants' perceived species richness of all three taxa, the same relationship was not found with objective measures of species richness (Dallimer et al., 2012). This follows findings from other studies which have

investigated objective and subjective measures of urban nature simultaneously and found that these two measures differ (Coldwell & Evans, 2018) or that subjective measures reveal unique associations with mental health indicators not accounted for with objective measures (Gubbels et al., 2016). This means that not only do we need to assess the quantity and quality of nature in our cities, but we also need to comprehend how urban residents perceive the quality and quantity of urban nature, particularly if the goal is to understand the wellbeing outcomes from urban nature.

There is still meagre understanding of how an individual's subjective perceptions and interpretations of nature relate to wellbeing. While this thesis attempted to address this gap, it can be argued that the three-item scale used to measure perceptions of nature is an oversimplification that doesn't capture the nuanced ways in which different people perceive and interpret the diverse types, qualities and quantities of urban nature. In addition, there is still little known about how perceptions of nature may vary among individuals or by gender, across age groups, socio-economic status, diverse cultural and social contexts and across the life course. Some studies have shown cultural differences in how people perceive nature and conceptualise their relationship with nature (Atran, Medin, & Ross, 2005; Bang, Medin, & Atran, 2007; Unsworth et al., 2012), for example indigenous people (e.g., Native Americans) have been shown to be more likely to view themselves as connected to nature compared to other groups (e.g., European Americans), even at relatively early stages in the life course (Unsworth et al., 2012). Further exploration is needed on how different conceptualisations of nature affect the wellbeing outcomes from exposure to diverse types of nature. Understanding how different people perceive different types of nature would aid the optimisation of wellbeing outcomes from urban nature interventions among diverse urban populations.

The therapeutic landscapes research field has arguably made the greatest strides in furthering our understanding of the more subjective ways in which people might interpret and use healing spaces (Cattell, Dines, Gesler, & Curtis, 2008). Efforts have been made to understand how therapeutic landscapes work to maintain and promote wellbeing for different individuals and

groups at different times (Bell, Wheeler, & Phoenix, 2016; Finlay, Franke, McKay, & Sims-Gould, 2015). Therapeutic landscapes aren't exclusively focused on nature spaces, but there have been recent calls in the literature for therapeutic landscapes to move beyond its origins in health geography to contribute towards wider interdisciplinary discussions and debates around health promoting nature spaces (Bell et al., 2018). This may benefit the nature and health research field, helping to further the case for the consideration of subjective perceptions and interpretations of nature as an important part of understanding the relationship between nature and wellbeing.

Similarly, better integrating the sense of place scholarship within the nature and wellbeing research field may also help build our understanding on how people perceive and form subjective connections with urban nature. Again, while sense of place research isn't exclusive to nature spaces it does provide insight to how people form an emotional attachment to a setting (place attachment), how places may support and affirm personally salient values and identities (place identity) and how places support autonomy and personal goals (place dependence; Kyle, Mowen, & Tarrant, 2004). Recent work in the sense of place literature has contemplated how place attachment may change over the life course and the role that fast (sensory or immediately perceived meanings) and slow (accrued meaning over time) attachments may play in the formation of sense of place (Raymond, Kytä, & Stedman, 2017). This is an important consideration particularly within urban contexts that can experience changing landscapes and transient populations.

Exploring how subjective interpretations of nature relate to wellbeing requires a transdisciplinary approach that utilises a myriad of approaches, for example, combining psychological measures with in-depth narrative methods. Such mixed method approaches may be aided by the increasing availability of technologies such as personal GPS and accelerometers as well as improved access to digital spatial data and longitudinal datasets. This may help disentangle how people's perceptions of and subjective relationship with nature varies across

individuals and groups and also how within-person changes in perceptions of nature vary across the life course.

In summary, the findings of this thesis show that when an individual perceives greater quantity and quality of nature in their suburb of residence or reports a greater connection to nature that they report better psychological wellbeing. Understanding how people connect with nature, how they perceive the quality and quantity of urban nature, and how changes in these connections and perceptions relate to psychological wellbeing is critical to understanding the relationship between nature and mental health.

Positioning of the nature connection and psychological wellbeing relationship within a well-established theoretical framework

In Chapter 1 and 2, I identified that a key gap in the literature on nature and wellbeing is a lack of understanding of the mechanisms involved in the positive relationship between nature connection and psychological wellbeing. The relationship between nature exposure and measures of mental ill-health is better understood with theories such as Attention Restoration Theory (Kaplan, 1995) and Stress Reduction Theory (Ulrich et al., 1991) providing the theoretical underpinning for why contact with nature is associated with restored cognitive function and reduced stress levels. The fascination aspect of Attention Restoration Theory does tap into more of the positive spectrum of mental health but within the context of fascination serving as a source of captivation for people's indirect attention source allowing people's depleted direct attention source to recover. While this does provide valuable insight, it falls short of explaining the sense of meaning, joy and wellbeing that people can experience in nature. As highlighted by the literature review (Chapter 2), there is a lack of theory explaining why feeling connected to nature boosts psychological wellbeing. In response, I identified Self Determination Theory as an appropriate theoretical framework in which to position the nature connection and psychological wellbeing relationship and from which to identify potential mediators of this relationship.

Based on the Self Determination Theory sub-theories of basic psychological needs theory and goal contents theory, I identified non-human relatedness and intrinsic values as potential mediators and designed and administered a cross-sectional survey to test any mediating role of these variables. As shown in Chapter 5, the relationship between nature connection and wellbeing is mediated by non-human relatedness and intrinsic values. Analyses conducted in Chapter 5 did not support the alternative hypothesis that nature connection may mediate the relationship between intrinsic values and wellbeing. Previous research has shown that nature connection is associated with intrinsic values, but there was no firm evidence of the direction of the effect. By testing the reverse relationship, this research helps shed some light on the direction of the relationship, suggesting that nature connection fosters intrinsic values.

Over time Self Determination Theory has expanded with both theoretical developments and empirical findings leading to the use of this theory to examine a plethora of processes and phenomena integral to personality growth, effective functioning and wellbeing. Self Determination Theory has been used to explore wellbeing within numerous domains, such as health care (Ng et al., 2012), education (Vansteenkiste, Lens, & Deci, 2006), organisations and workplaces (Van den Broeck, Ferris, Chang, & Rosen, 2016), and sports and exercise (Edmunds, Ntoumanis, & Duda, 2006). This thesis makes a unique theoretical contribution through using Self Determination Theory to explore the relationship between nature connection and wellbeing, which to date has not been done comprehensively within the literature.

As the research field around nature connection continues to grow it is important that the research is supported by an appropriate theoretical framework. This research suggests that Self Determination Theory may be such a framework, although this is not to say that other theoretical frameworks could not also be useful. Using Self Determination Theory may help with identifying and understanding the processes involved in the complex construct of nature connection. Providing the underpinning of a sound theoretical framework lays the groundwork to better relate the concept of nature connection to diverse disciplines as well as help to inform the design and encourage the uptake of nature connection initiatives.

It is worth noting that given the cross-sectional nature of the data there are limitations to the conclusions that can be drawn and while I suggest that nature connection promotes wellbeing, as is consistent with past research, it is also possible that wellbeing promotes nature connection. The nature connection evidence base would benefit from moving beyond correlational findings to establishing causality between nature connection and wellbeing and exploring how this relationship changes over time. As such it is important that nature connection nature measures are included within longitudinal study designs that track individuals across the life course.

Childhood and adult urban nature experiences are related to nature connection

The relationship between nature experiences and nature connection has been investigated previously (Lin et al., 2014; Müller, Kals, & Pansa, 2009; Schultz & Tabanico, 2007). This thesis provides a unique contribution to this evidence base through exploring adult nature experiences within the context of everyday, urban nature experiences and by using a comprehensive measure of childhood nature experiences. Previous research exploring the relationship between urban nature experiences and nature connection have investigated a narrow scope of urban nature experiences, namely visits to urban parks (Lin et al., 2014; Scopelliti et al., 2016). This thesis used a broad definition of urban nature experiences that included ‘all the plants and animals that live in the city’. This provides us with a more holistic understanding of how diverse types of urban nature experiences relate to nature connection. Similarly, I used the Early Environmental Experiences scale which provides a more holistic measure of childhood nature experiences, assessing aspects such as family values towards nature, access to nature in home and school settings and memories of playing in nature. This provides a more comprehensive understanding of childhood nature experiences in comparison to more simple measures used in previous studies (Weinstein et al., 2015, Colléony et al., 2017)

Given that the majority of the earth’s residents now live in urban areas, the exploration of nature experiences within an urban context is an important contribution of this research. It is within these urban environments that most people are likely to regularly experience nature. Hence, it is important to understand how these types of everyday urban nature experiences relate to nature

connection. This research showed that duration of contact with everyday urban nature is positively associated with nature connection. This is an important finding that provides a counter perspective to the current focus on ‘natural’ or ‘wild’ nature experiences as an important pathway to nature connection (Schultz & Tabanico, 2007; Wolsko & Lindberg, 2013; Wyles et al., 2017). These more ‘natural’ nature experiences may have a stronger association with nature connection in comparison with urban or more modified nature experiences (Wells & Lekies, 2006). That said, everyday urban nature experiences have the potential to be universally accessible, which will have advantages for equity outcomes and addressing health inequality issues. It is unlikely that more ‘wild’ nature experiences, which may require travel to a destination, specialised equipment (e.g., hiking boots) or a certain level of physical fitness, will be accessible to everyone. In addition, it is unlikely that such ‘wild’ nature experiences would be able to occur on a frequent basis for urban residents. Moreover, there is little known about the long-term effects of one-off ‘wild’ nature experiences. It would be interesting to know how experiencing urban nature more frequently compares with experiencing ‘wild’ nature less frequently; it may be that more frequent, ‘less natural’ nature doses are more beneficial for nature connection in the long-term. This is an aspect of the nature experience and nature connection relationship that requires urgent attention, particularly with the emergence of nature connection enhancing objectives which seek to connect urban residents to nature (Victoria State Government, 2017)

This thesis also explored other aspects of urban nature experiences such as satisfaction with urban nature, accessibility of urban nature, and level of greenness of home outdoor spaces – but these aspects were not significantly associated with nature connection. That said, the majority of this research’s participants reported high scores for their satisfaction with and perceived accessibility of nature. It would therefore be interesting to explore these variables of nature quality within a city that has greater variability in residents’ perceived quality of urban nature. In settings with lower access to, quality of and satisfaction with urban nature it may be that simply increasing duration of exposure to existing urban nature may not prove effective at enhancing

nature connection. It is therefore important that variables that measure the quality of urban nature experiences are explored across diverse cultures and settings in order to help tease apart how the type, quality and quantity of the urban nature experiences relate to nature connection. This is a key gap in the understanding of how nature experiences relate to nature connection. This PhD research program attempted to address this gap and has provided evidence for the role of routine urban nature experiences in shaping nature connection.

Developing a sense of nature connection through later life nature experiences

Numerous studies have assessed how childhood or current nature experiences relate to nature connection. This thesis provides a unique contribution to this evidence base by assessing, among a large urban sample, both adult and childhood nature experiences simultaneously, which has been rarely done in the literature. This is a useful distinction with important theoretical implications as it allows us to explore how nature connection is related to nature experiences that occur at different stages in life.

The development of personality and sense of self across the life course has been long researched, ignited by Erik Erikson's seminal work on identity and the life cycle (Erikson, 1959). Erikson's theory describes eight distinct stages of psychosocial development where basic virtues or characteristics of personality develop during each stage. It is proposed that one's identity or sense of self develops during the adolescent life stage (ages 12 – 18). Nature connection is essentially the study of how people identify themselves with nature and how people form relationships with nature. It may therefore be reasoned that adolescence would be an important life stage for developing an identity or sense of self that encompasses nature. This may explain why there is currently such a strong focus on getting children and young people outdoors experiencing and connecting with nature (Louv, 2008). There are numerous networks and initiatives that aim to create a 'movement to connect children to nature' (The Children and Nature Network), 'rewild childhoods' (The Wild Network), or 'make nature play a part of normal childhoods' (The Nature Play Program). These initiatives aim to address 'nature deficit

disorder' which Louv (2008) warns may lead to adverse outcomes for the health and wellbeing of future adults and result in adults who will not care for or value nature.

The results of the current research show that the positive relationship between current nature connection and current everyday nature experiences was not moderated by the level of childhood nature contact experienced by an individual. This suggests that even when an individual has minimal nature experiences during their childhood they can still develop their nature connection through experiencing nature as an adult. While Erikson's theory highlights the importance of adolescence for forming one's identity and sense of self, it is also recognised that identity development is a cyclical process with identity re-formulation occurring throughout adulthood and later life stages (Marcia, 2002). This may help explain how the participants of this thesis research who experienced nature in adulthood came to have a high sense of nature connection, even when possessing minimal childhood nature experiences. It may be that through experiencing nature as an adult, individuals can re-formulate their identity to encompass nature. This aligns with previous findings from qualitative research by Bell et al. (2016) which highlighted how people's relationship with nature could be formed later in life, triggered by life events such as relocating to areas with more accessible nature, relationship changes or parenthood.

This research sheds light on the relationship between nature experiences and nature connection at different life stages. However, given that these findings are derived from analyses of cross-sectional data, there are limitations to the conclusions that can be drawn. A more in-depth exploration of nature experiences and nature connection across the life course is required.

Studies that track individuals over time assessing levels of nature connection at various life stages, using GPS to assess duration and frequency of nature contact, coupled with interviews to explore how individuals engage with and interpret nature would help to disentangle the relationship between nature experiences and nature connection across the life course. Such an understanding would greatly aid the design and delivery of nature-based interventions that aim to enhance nature connection and promote wellbeing among urban residents. Nevertheless, this

research's findings do show that both childhood and adult urban nature experiences are associated with nature connection and provide justification for further exploration of this relationship across the life course. As the findings suggest, experiencing nature later in life may help nature deprived adults to re-formulate their identity to encompass a sense of nature connection.

Summary

Overall this thesis has contributed to the nature and mental health research field through providing evidence of the positive associations between people's perceptions of and connection to nature and their psychological wellbeing, and through providing evidence on the positive relationship between nature experience and nature connection. This provides justification for looking beyond objective measures of nature exposure to start exploring and disentangling how people perceive and interpret nature and how these interpretations affect the psychological wellbeing outcomes from nature. Similarly, this thesis encourages further investigation of the relationship between nature experiences and nature connection across the life course, as well as the further exploration of other factors that may influence a person's nature connection. Much remains to be explored in this space with key gaps in our understanding of what influences an individual's nature connection, how perceptions and interpretations of nature vary across individuals and groups, across the life course and across diverse types, quantities and qualities of nature. Nevertheless, the findings of this thesis provide a useful basis for future exploration of people's subjective relationship with nature, the factors that shape it and the wellbeing outcomes that derive from it.

7.4 Practical implications

In this section I summarise the main practical contributions of this thesis. This thesis research presents findings from an urban population living in a westernised, sub-tropical city. As such, the results of this research may not apply to other cultural and social contexts, or people living in regional areas or other countries - which limits opportunities to make widespread design

recommendations based on the findings from this thesis. Nevertheless, five broad practical insights were identified which will be of interest to urban planning and mental health sectors, particularly for those trying to promote mental health through nature-based interventions.

Include subjective measures of nature exposure when assessing the effectiveness of nature-based interventions for mental health.

As global trends in mental ill-health continue to grow the use of non-drug, non-health-service interventions have been proposed as a cost-effective way for people to manage chronic illness and improve their health and wellbeing as well as to facilitate general wellbeing promotion (Husk, Blockley, et al., 2016). Such interventions have been described as non-medical referral, community referral or social prescribing and tend to involve accessing activities run by the third sector or community agencies. Outdoor and nature-based activities, such as walking groups, care farming, conservation volunteering or gardening and therapeutic horticulture, are a common type of activity used as part of social prescriptions (Husk, Lovell, Cooper, Stahl-Timmins, & Garside, 2016; Husk, Lovell, & Garside, 2017). Nature-based interventions are considered to be a relatively cost-effective approach to building resilience and promoting mental wellbeing, particularly among urban communities or people from lower socio-economic status backgrounds (Bragg & Atkins, 2016). However, reviews of the evidence base for the effectiveness of such interventions highlight the need for more robust research to understand exactly how and why nature-based interventions may benefit mental health, and to assess whether they could be used as an effective health promotion tool (Husk, Lovell, et al., 2016; Lovell, Husk, Cooper, Stahl-Timmins, & Garside, 2015).

Based on the results of this thesis I recommend the use of subjective measures of nature as a key component to building this much needed understanding of how and why nature-based interventions may benefit mental health. Analysis of longitudinal data showed that changes in perceptions of quality and quantity of urban nature had a positive relationship with psychological wellbeing. Similarly, analysis of the cross-sectional data showed that those who reported a higher connection to nature were more likely to report better psychological

wellbeing. These findings build the case for the inclusion of subjective measures of perceptions of and connection to nature in the evaluations of nature-based interventions for mental health. Failing to include these subjective measures may led to misinformed design and delivery of nature-based interventions as well as inaccurate evaluations of their effectiveness. Only using objective measures of the nature exposure will not account for how people perceive and relate to that nature and the affect that this may have on the wellbeing outcomes from the nature-based intervention.

Facilitate everyday urban nature experiences among city dwellers for nature connection enhancement.

There is growing interest in connecting people with nature in a bid to foster pro-environmental behaviour and promote wellbeing. Nature connection objectives are starting to appear in numerous plans and policies. For example, the United Kingdom's recent 25 Year Plan for the Environment identifies connecting people with the environment to improve health and wellbeing as one of its six key areas (HM Government, 2018). Similarly, the Australian state of Victoria's Biodiversity 2037 Plan aims to connect all Victorians to nature as one of its two overarching objectives (Victoria State Government, 2017). Despite the growing support for the cultivation of nature connection, little is known about what factors foster nature connection. The results of this research suggest that duration of contact with urban nature is a predictor of nature connection. This means that people who spend more time in contact with urban nature as part of their typical routine are also more likely to have higher levels of nature connection. However, these findings are based on analyse of cross-sectional data and as such it is not possible to determine the direction of this effect. Nevertheless, positive findings of the relationship between urban nature experiences and nature connection are important, particularly given growing urban populations where people's regular nature experiences are likely to occur within urban environments.

In the current research, the majority of respondents reported that rest and relaxation was one of the main purposes for spending time in contact with nature, suggesting that this type of

engagement with nature may be particularly beneficial for promoting nature connection. If enhancing nature connection among urban populations is the goal, then urban planners should consider designing nature spaces within city environments that provide opportunity for rest and relaxation. It may be useful to apply the concept of restorative landscapes when considering how to design nature spaces that encourage rest and relaxation. According to the Attention Restoration Theory, restorative landscapes encompass characteristics that are important for the recovery or recharging of depleted cognitive resources (Kaplan, 1995). The four restorative characteristics of an environment are fascination (an environment that can engross one's attention), being away (an environment that allows one to 'escape'), extent (an environment with sufficient scope to engage the mind) and compatibility (an environment that matches one's purpose and intent). Natural environments have been shown to contain these restorative characteristics (Ohly et al., 2016). The rhythms, sounds and patterns of nature allow for the effortless captivation of attention (fascination), quiet green and blue spaces provide a stark contrast to crowded and noisy grey, concrete urban spaces (being away), diverse and open nature spaces supply sufficient content that can engage the mind (extent) and can promote individual agency and autonomy (compatibility). Therefore, providing nature spaces that promote rest and relaxation may be achieved by introducing quiet spaces within an urban nature space and minimising noise pollution within the space allowing for the rhythms, sounds and patterns of nature to be appreciated and encouraging people to escape the busy city environment.

Providing seating and resting places that encourage visitors to stop and rest or providing information signs inviting people to pause and reflect within the nature space may also help promote rest and relaxation. Similarly, organising activities within the nature space that promote rest and relaxation could also help cultivate nature connection for city dwellers. For example, guided meditation or mindfulness based cognitive therapy sessions within parks and green spaces may encourage people to spend time in nature for rest and relaxation and hence potentially enhance their nature connection.

The findings of this thesis show that people tend to spend time in urban nature for the purpose of rest and relaxation, which is similar to previous findings (Chiesura, 2004). However, it is important to be careful not to over-generalise this finding to other contexts and to always consult and collaborate with urban residents to understand how they use and engage with urban nature and how this relates to their nature connection. Co-creating urban nature spaces and initiatives with community groups is important for ensuring that urban nature spaces are used in a way that optimises nature connection and wellbeing outcomes.

Encourage nature experiences during childhood to promote nature connection.

The results of this research show that retrospectively reported childhood nature experiences are related to nature connection. This means that people who have higher levels of nature contact during childhood are more likely to have higher levels of nature connection as an adult. This finding provides support for the already well-established initiatives that aim to increase nature experiences and nature connection among children, for example, Nature Play programs and Forest Schools. Through promoting outdoor learning or unstructured outdoor play, such programs increase children's exposure to nature and as a result aim to increase nature connection among children. In this thesis I used the Early Environmental Experiences scale which includes aspects such as family values towards nature, access to nature spaces at home and at school and memories of playing in nature. I also used a simple measure of childhood nature experiences – location of childhood home. However, location of childhood home was not a significant predictor of nature connection. This suggests that initiatives that seek to promote nature connection among children should consider the roles of family values towards nature, access to nature at home and at school and facilitating memorable nature experiences. This could be achieved by designing initiatives that engage all family members and that facilitate intergenerational learning or by working with schools and charity organisations, such as Edible Playgrounds, to ensure there is accessible nature in schools. Similarly, developing teachers' capacity to deliver outdoor nature activities and embedding nature activities as part of the education curriculum could help promote childhood nature experiences at school. Finally, urban

planning and urban greening initiatives should ensure universal access to nature spaces across the urban landscape with all urban residents having equal opportunity to access quality nature, hence ensuring children have access to nature from their home.

Nature connection enhancing initiatives should target all age-groups.

As mentioned in the previous section, on-ground nature connection enhancing initiatives tend to target children. This focus on children's nature connection is driven by concern over 'nature deficit disorder' which is believed to be a critical problem facing modern children who are growing up in the age of technology and within urban environments with predominantly indoor lifestyles (Louv, 2008). Such efforts serve an important role, particularly for children living in urban environments with reduced opportunities for nature experiences. However, the results of this thesis show that the positive relationship between duration of adult nature experiences and nature connection is not moderated by childhood nature experiences. This suggests that people can develop their nature connection through experiencing nature later in life – even when prior childhood nature experiences are minimal. Therefore, a key practical implication of this thesis is that nature connection enhancing initiatives should aim to increase nature experiences for individuals from all age-groups, particularly those who may not have prior familiarity with nature. The design of such adult nature connection initiatives will need to be tailored to suit the age, ability, and cultural and social context of the target adult population. For example, initiatives that aim to increase nature experiences among adolescents may consider providing amenities such as skate ramps, walking trails, sports fields and social areas such as BBQ and seating facilities (Edwards, Hooper, Knuiman, Foster, & Giles-Corti, 2015). Whereas initiatives that aim to promote nature experiences among older age groups may look at providing accessible walking trails that accommodate all abilities and are interspersed with frequent rest stops, adequate lighting and toilet facilities. It is also worth noting that certain urban groups may face more barriers to engaging with nature than others. For example, numerous studies show that people who infrequently engage with nature are more likely to be female, older, in poor health, of lower socioeconomic status and of ethnic minority status (Boyd, White, Bell, & Burt,

2018; Lin et al., 2014; Roe, Aspinall, & Ward Thompson, 2016). Again, initiatives will have to be tailored to target these harder to reach groups. For example, there are numerous case studies of co-created activities that support first, second and third generation migrants to access and connect with urban nature in new, and often unfamiliar, settings (Rishbeth, Blachnicka Ciacek, Bynon, & Stapf, 2017). A challenge of tailoring nature experiences for diverse urban populations is that limited urban nature results in multiple user groups with varying needs utilising the same nature space, which may lead to conflicts of interest among different groups. Co-creating urban nature spaces and initiatives with community groups is a key way to manage the expectations of and potential conflict among diverse user groups (WHO, 2017).

Facilitate the mediators of the relationship between nature connection and psychological wellbeing.

Previous research has shown positive associations between nature connection and mental wellbeing outcomes (Cervinka et al., 2011; Nisbet et al., 2011). This has led to growing interest in nature connection as a tool for promoting wellbeing (HM Government, 2018). However, little is known about the mechanisms through which nature connection affects wellbeing or how to optimise the wellbeing outcomes from nature connection. This research showed that the relationship between nature connection and wellbeing is mediated by non-human relatedness and intrinsic values. This is important information for guiding the design and delivery of nature connection initiatives that aim to promote wellbeing outcomes. Designing nature connection initiatives that facilitate intrinsic values and non-human relatedness may help optimise the wellbeing outcomes from such efforts. Intrinsic values include altruistic aspirations such as wanting to ‘help others’ and ‘make the world a better place’. Hence, these values may be best expressed by allowing individuals the opportunity for volunteering and participating in the management of their local nature spaces. Not only might this help optimise the psychological wellbeing outcomes from nature connection, but it may also promote social cohesion and help local authorities resolve resource gaps within urban green space management. It is more difficult to provide guidance on the design of nature spaces or delivery of initiatives that

facilitate the mediator of non-human relatedness. It is likely that the optimal way for a person to relate to nature will vary depending on their age and gender, their cultural and social context and their past experiences and relationship with nature. It is important in this circumstance to work with the target population using qualitative techniques to understand how different people relate to different types of urban nature. Through this understanding it will be possible to co-create nature experiences that facilitate non-human relatedness hence optimising the wellbeing outcomes from nature connection.

7.5 Strengths, weaknesses and future research

This thesis research used longitudinal and cross-sectional data from a multi-phased, survey-based methodology to explore the research questions of this thesis. Data collection through self-administered mail- and web-based surveys has numerous advantages such as being relatively cost effective, quick and allowing automated data entry which results in accurate data collection. However, there were also numerous methodological challenges encountered with this study design. In this section I highlight these challenges and also identify opportunities for future research to build on the insights from this thesis.

Within the longitudinal survey data, I assessed participants' perceptions of the quality and quantity of nature in their local suburb. This measure of perceptions of nature was a simple three-item scale and while all items loaded onto a single factor, the Cronbach alpha values at both time points were low (< 0.6). Although this thesis research highlights the importance of considering how people perceive the quality and quantity of urban nature when assessing wellbeing outcomes, it can be argued that more in-depth and sophisticated measures of perceptions of nature should be used. I recommend that future research further develop subjective measures of both the quality and quantity urban nature, particularly measures that would be suited to longitudinal study designs. The results of the cross-sectional data analyses revealed a positive relationship between nature connection and psychological wellbeing. Therefore, in addition to including perceptions of quality and quantity of nature within

longitudinal study designs, I also recommend that measures of nature connection are included. This will help reveal how changes in people's subjective relationship with nature relates to psychological wellbeing.

The methodological shortcomings of cross-sectional designs are well recognised, namely in their inability to reveal direction of effect or to establish causality. This thesis research sought to optimise the use of cross-sectional data by aiming to reveal mediators and moderators of reported relationships. While mediation and moderation analyses are commonly performed with cross-sectional data, I recognise the inherent shortcomings and potential for bias of this type of analysis. Partial mediation analyses of cross-sectional data can result in bias where the existence of a substantial indirect effect is implied even when the true longitudinal indirect effect is zero (Maxwell, Cole, & Mitchell, 2011). That said, cross-sectional mediation and moderation analysis are considered to be of value as long as the analysis is supported by "relevant theory and previous empirical findings on components of the assumed process in question" (Markevych et al., 2017, p. 310), which is the case in this research. With regards to further testing mediators of the relationship between nature connection and wellbeing, a follow-up randomised experimental study designed to manipulate the mediators would be considered an appropriate next step to further establish true mediation (MacKinnon, Krull, & Lockwood, 2000). However, manipulation of variables such as non-human relatedness or intrinsic values may prove difficult within an experimental design. Therefore, I recommend pursuing a qualitative line of enquiry that provides a deeper exploration of how nature connection satisfies people's need for relatedness and fosters intrinsic values and how these relationships vary across individuals and groups.

With regards to furthering our understanding of how nature experiences are related to nature connection at different life stages, I recommend that future studies pursue longitudinal study designs that track individuals over their life course assessing how changing nature experiences affect their nature connection levels. Longitudinal studies that track individuals across the life course should include measures of people's perceptions of nature and their nature connection.

Such a study design should also include a narrative approach where participants are interviewed at various time points to help gain a richer understanding of how people conceptualise nature, form connections with nature and how this relates to their wellbeing. Furthermore, future research should capitalise on the increasing accessibility of smart phone and GPS technologies which will enable participants to provide real time data on their interactions with nature, their subjective experience of these interactions and their wellbeing outcomes.

This research field is still in its infancy with much still to learn about the factors that influence an individual's perception of and connection to nature and how these relate to psychological wellbeing. This thesis has shown that people's perceptions of and connection to nature are related to their psychological wellbeing and it also attempted to unpack what types of nature experiences affect nature connection through showing that childhood and adult urban nature experiences are related to nature connection. To build on these findings and move the field forward, future studies should consider longitudinal, mixed method approaches that aim to establish causality between nature connection and wellbeing and, through collecting qualitative data, establish a deeper understanding of how an individual's nature connection is shaped across the life course and among diverse individuals and groups.

7.6 Conclusions

The overall aim of the thesis was to investigate, within an urban context, how perceptions of and connection to nature relate to psychological wellbeing, including exploration of factors that may be associated with a person's relationship with nature. A multi-phased, survey-based methodology, that uses both longitudinal and cross-sectional survey data, was used to explore these relationships. More specifically, this thesis sought to address three research questions:

1. How do changes in perceptions of the quantity and quality of urban nature relate to psychological wellbeing?
2. How is nature connection associated with psychological wellbeing?

3. What is the relationship between childhood and adult nature experiences and nature connection?

In exploring these questions, this thesis made a number of theoretical contributions (see section 7.3), practical contributions (see section 7.4) and recommendations for future research (see section 7.5). Overall, there are four main conclusions that can be drawn from this body of work:

Conclusion 1. Perceptions of quality and quantity nature influence psychological wellbeing.

Conclusion 2. The association between nature connection and psychological wellbeing can be mediated by non-human relatedness and intrinsic values.

Conclusion 3. Childhood nature experiences and duration of adult nature experiences are associated with nature connection.

Conclusion 4. The positive relationship between duration of adult nature experiences and nature connection is not moderated by childhood nature experiences.

This thesis has helped build our understanding of how perceptions of and connection to nature relate to psychological wellbeing and of the factors that are associated with an individual's relationship with nature. As such, this thesis makes a unique contribution to the field of nature and mental health research.

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Appendix 1: Longitudinal Survey Questionnaire

The following statements are about your suburb's **surroundings**. How much do you agree or disagree with each statement?

Please tick the box that best applies to your suburb.

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
There is lots of greenery around my suburb (trees, bushes, household gardens)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
There is tree cover along many of the footpaths in my suburb	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
There are pleasant natural features in my suburb (e.g. nature reserves, beach, riverfront, bushland)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Below are some statements about feelings and thoughts. Please tick the box that **BEST** describes your experience of each over the **LAST TWO (2) WEEKS**.

Please tick one box for each item.

	None of the time	Rarely	Some of the time	Often	All of the time
I've been feeling optimistic about the future	<input type="checkbox"/>				
I've been feeling useful	<input type="checkbox"/>				
I've been feeling relaxed	<input type="checkbox"/>				
I've been dealing with problems well	<input type="checkbox"/>				
I've been thinking clearly	<input type="checkbox"/>				
I've been feeling close to other people	<input type="checkbox"/>				
I've been able to make up my own mind about things	<input type="checkbox"/>				

What is your date of birth (e.g. 23/5/1951)

Day	Month	Year
<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

Are you:

Please tick one.

Male	Female
<input type="checkbox"/>	<input type="checkbox"/>

Which **ONE** of the following best describes your current employment situation?

Please tick **ONE** number only.

Full time paid work in a job, business or profession	<input type="checkbox"/>	1
Part time paid work in a job, business or profession	<input type="checkbox"/>	2
Casual paid work in a job, business or profession	<input type="checkbox"/>	3
Work without pay in a family or other business	<input type="checkbox"/>	4
Home duties not looking for work	<input type="checkbox"/>	5
Unemployed looking for work	<input type="checkbox"/>	6
Retired	<input type="checkbox"/>	7
Permanently unable to work	<input type="checkbox"/>	8
Student	<input type="checkbox"/>	9
Other (please specify)	<input type="text"/>	10

What is your current occupation? (If you have more than one job, we are interested in your main job.)

Please give full title (for example: Childcare Aide, Maths Teacher, Pastrycook, Commercial Airline Pilot, Apprentice Toolmaker, etc). For **Public Servants**, state official designation and occupation. For **armed services personnel**, state rank and occupation.

Full title of Occupation:

Please add up the amount of **BEFORE-TAX** income received by **ALL** members of your household, and tick the box that comes closest to this number. Please indicate income either per year, per fortnight, or per week.

Tick one box only.

Per year	OR	Per fortnight	OR	Per week
<input type="checkbox"/> Less than \$15,599		<input type="checkbox"/> Less than \$600		<input type="checkbox"/> Less than \$300
<input type="checkbox"/> \$15,600-20,799		<input type="checkbox"/> \$600-799		<input type="checkbox"/> \$300-399
<input type="checkbox"/> \$20,800-25,999		<input type="checkbox"/> \$800-999		<input type="checkbox"/> \$400-499
<input type="checkbox"/> \$26,000-31,199		<input type="checkbox"/> \$1,000-1,199		<input type="checkbox"/> \$500-599
<input type="checkbox"/> \$31,200-36,399		<input type="checkbox"/> \$1,200-1,399		<input type="checkbox"/> \$600-699
<input type="checkbox"/> \$36,400-41,599		<input type="checkbox"/> \$1,400-1,599		<input type="checkbox"/> \$700-799
<input type="checkbox"/> \$41,600-51,999		<input type="checkbox"/> \$1,600-1,999		<input type="checkbox"/> \$800-999
<input type="checkbox"/> \$52,000-72,799		<input type="checkbox"/> \$2,000-2,799		<input type="checkbox"/> \$1,000-1,399
<input type="checkbox"/> \$72,800-93,599		<input type="checkbox"/> \$2,800-3,599		<input type="checkbox"/> \$1,400-1,799
<input type="checkbox"/> \$93,600-129,999		<input type="checkbox"/> \$3,600-4,999		<input type="checkbox"/> \$1,800-2,499
<input type="checkbox"/> \$130,000 or more		<input type="checkbox"/> \$5,000 or more		<input type="checkbox"/> \$2,500 or more
<input type="checkbox"/> Don't know				
<input type="checkbox"/> Don't want to answer this				

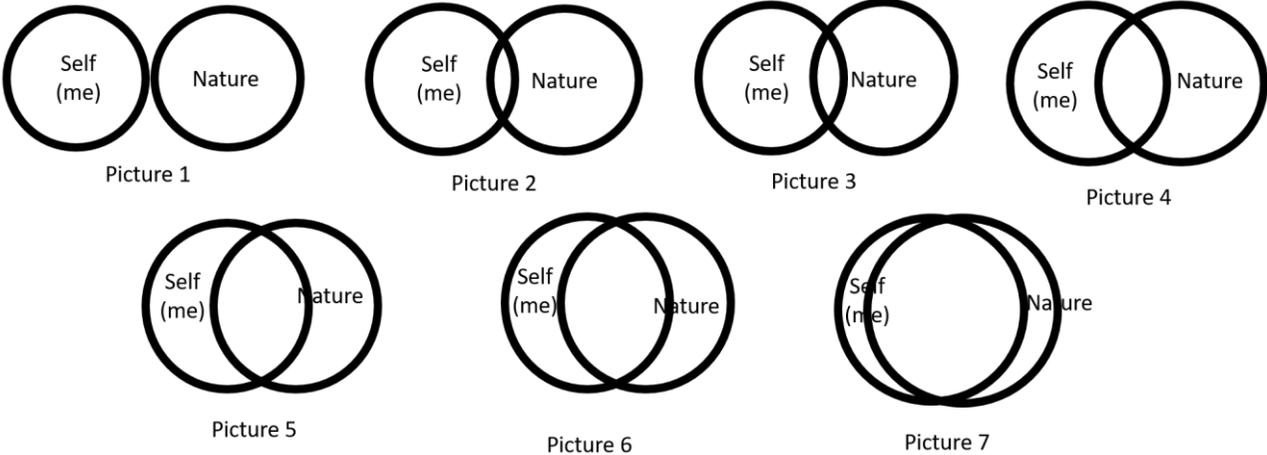
What is the **highest** educational qualification you have completed?

Tick ONE only.

Year 9 or less	<input type="checkbox"/>	1	
Year 10 (Junior/4th form)	<input type="checkbox"/>	2	
Year 11 (Senior/5th form)	<input type="checkbox"/>	3	
Year 12 (Senior/6th form)	<input type="checkbox"/>	4	
Certificate (trade or business)	<input type="checkbox"/>	5	
Diploma or Associate Degree	<input type="checkbox"/>	6	
Bachelor Degree (Pass or Honours)	<input type="checkbox"/>	7	
Graduate Diploma or Graduate Certificate	<input type="checkbox"/>	8	
Postgraduate degree (Masters degree or Doctorate)	<input type="checkbox"/>	9	
Other (please describe)	<input type="text"/>	<input type="checkbox"/>	10

Appendix 2: Cross-sectional Survey Questionnaire

Construct	Variable	Items					
Urban Nature	Definition	All cities contain nature. Parks, street trees, riverside walkways, creeks, bushland reserves, sports fields and even home gardens are all part of what makes up nature in Brisbane. Urban nature includes all the plants and wildlife that live in the city. These next two sections contain questions about how you interact with urban nature.					
Nature connection	Nature Relatedness Six Item Scale	<p><i>Instructions:</i> Please rate the extent to which you agree with each statement. Please click on the answer that indicates how you really feel, rather than how you think “most people” feel.</p> <table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 20%;">Strongly disagree (1)</td> <td style="width: 20%;">Disagree (2)</td> <td style="width: 20%;">Neither agree nor disagree (3)</td> <td style="width: 20%;">Agree (4)</td> <td style="width: 20%;">Strongly agree (5)</td> </tr> </table> <ol style="list-style-type: none"> 1. My ideal holiday spot would be a remote, wilderness area 2. I always think about how my actions affect the environment 3. My connection to nature and the environment is a part of my spirituality 4. I take notice of wildlife wherever I am 5. My relationship to nature is an important part of who I am 6. I feel very connected to all living things and the earth. 	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)			
Nature connection	Inclusion of Nature in Self Scale	<p><i>Instructions:</i> How interconnected are you with nature? Please view the following seven images and select the image that best describes your relationship with nature.</p>					

		 <p>Picture 1 Picture 2 Picture 3 Picture 4</p> <p>Picture 5 Picture 6 Picture 7</p>
<p>Adult Nature Experience Home</p>	<p>Access to a private outdoor area</p>	<p><i>Instructions:</i> Does your home have a private outdoor area (e.g., backyard, balcony, garden, veranda)?</p> <ul style="list-style-type: none"> • Yes (2) • No (1)

<p>Adult Nature Experience Home</p>	<p>Duration of nature contact at home</p>	<p><i>Instructions:</i> During a typical seven day week how much time would spend in this private outdoor area?</p> <ul style="list-style-type: none"> • No time (1) • Less than 30 minutes a week (2) • 30 minutes to 4 hours a week (3) • Over 4 hours and less than 10 hours a week (4) • Over 10 hours and less 25 hours a week (5) • Over 25 hours a week (approx. three hours a day) (6)
<p>Adult Nature Experience Home</p>	<p>Level of greenness at home</p>	<p><i>Instructions:</i> What approximate percentage (%) of this private outdoor area is covered with plants? (e.g., grass, trees, shrubs, potted plants)</p> <ul style="list-style-type: none"> • 0% (no plants; 1) • 1% to 20% (2) • 21% to 40% (3) • 41% to 60% (4) • 61% to 80% (5) • 81% to 100% (6)

<p>Adult Nature Experience Home</p>	<p>Home views</p>	<p><i>Instructions:</i> Are the views from your home mainly:</p> <ul style="list-style-type: none"> • Very urban (1) • Urban (2) • Mix of urban and natural (3) • Natural (4) • Very natural (5)
<p>Adult Nature Experience Home</p>	<p>Satisfaction of nature at home</p>	<p><i>Instructions:</i> How satisfied are you with the nature (e.g., trees, parks, vegetation) around your home (i.e. within 20 meters of your home)?</p> <ul style="list-style-type: none"> • Extremely satisfied (7) • Moderately satisfied (6) • Slightly satisfied (5) • Neither satisfied nor dissatisfied (4) • Slightly dissatisfied (3) • Moderately dissatisfied (2) • Extremely dissatisfied (1) • There is no nature within 20 m of my home (99)

<p>Adult Nature Experience City</p>	<p>Duration of nature contact in the city</p>	<p><i>Instructions:</i> During a typical seven day week, how much do you come into contact with nature?</p> <ul style="list-style-type: none"> • No time (1) • Less than 30 minutes a week (2) • Over 30 minutes and less than 4 hours a week (3) • Over 4 hours and less than 10 hours a week (4) • Over 10 hours and less than 25 hours a week (5) • Over 25 hours a week (approx. three hours a day) (6)
<p>Adult Nature Experience City</p>	<p>Satisfaction of nature in the city</p>	<p><i>Instructions:</i> How satisfied are you with the nature (e.g., trees, parks, vegetation) in your suburb?</p> <ul style="list-style-type: none"> • Extremely satisfied (7) • Moderately satisfied (6) • Slightly satisfied (5) • Neither satisfied nor dissatisfied (4) • Slightly dissatisfied (3) • Moderately dissatisfied (2) • Extremely dissatisfied (1) • There is no nature in my suburb (99)

<p>Adult Nature Experience City</p>	<p>Accessibility</p>	<p><i>Instructions:</i> In your opinion, how easy or difficult is it to come into contact with the nature in your suburb?</p> <ul style="list-style-type: none"> • Extremely easy (8) • Moderately easy (7) • Slightly easy (6) • Neither easy nor difficult (5) • Slightly difficult (4) • Moderately difficult (3) • Extremely difficult (2) • It is not possible (1) • There is no nature in my suburb (99)
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<p>Adult Nature Experience</p> <p>Activity Type</p>	<p>Activity type during nature contact</p>	<p><i>Instructions:</i> Thinking about the amount of time you come into contact with nature, as answered above, please rank up to three main purposes for the majority of this time spent in contact with nature?</p> <ul style="list-style-type: none"> • Work - spending time in nature is part of my working day • Transport - travel through nature to get from one destination to another • Health and fitness - spending time in nature to exercise/play sports and look after my physical health • Rest and relaxation - spending time in nature to 'switch off' and escape daily pressures • Social interaction - spending time in nature to meet with other people (e.g., family, friends, teammates) • Chores - spending time in nature as part of domestic responsibilities • Education - spending time in nature for educational purposes • Spiritual/Culture - spending time in nature is part of my spirituality and/or culture • Animal interactions - spending time in nature to walk dogs, ride horses, feed ducks etc • Hobbies - spending time in nature to carry out activities I find fun and/or interesting (e.g., gardening, art, craft, photography, golf) • Other 					
<p>Childhood Nature Experience</p>	<p>Early Environment Experience Scale</p>	<p><i>Instructions:</i> Thinking back to when you were growing up, how true for you are each of following statements:</p> <table border="1"> <tr> <td>Very untrue (1)</td> <td>Untrue (2)</td> <td>Neither true nor untrue (3)</td> <td>True (4)</td> <td>Very true (5)</td> </tr> </table> <p>1. When I was younger my parents were interested in nature and the outdoors (e.g., going on camping trips, gardening, bush walks, beach trips)</p>	Very untrue (1)	Untrue (2)	Neither true nor untrue (3)	True (4)	Very true (5)
Very untrue (1)	Untrue (2)	Neither true nor untrue (3)	True (4)	Very true (5)			

		<p>2. I remember playing outdoors (e.g., at the beach or creeks, in the bush, fields or forests) while I was growing up</p> <p>3. I had access to a garden when I was young</p> <p>4. My early school(s) had green play areas</p>					
Childhood Nature Experience	Home setting of childhood	<p><i>Instructions:</i> Thinking back to when you were growing up, do you consider that you grew up in an area that was:</p> <ul style="list-style-type: none"> • mostly surrounded by a high density of buildings (e.g., large cities, city centre) • mostly surrounded by medium to low density of buildings (e.g., smaller towns, city suburbs) • mostly surrounded by nature areas (farmlands, forests, mountains, bush, undeveloped coastlines) 					
Non-Human Relatedness	Relatedness through Nature Connection Scale	<p><i>Instructions:</i> Please rate the extent to which you agree with each statement. Please click on the answer that indicates how you really feel, rather than how you think “most people” feel.</p> <table border="1" style="width: 100%; text-align: center;"> <tr> <td>Strongly disagree (1)</td> <td>Disagree (2)</td> <td>Neither agree nor disagree (3)</td> <td>Agree (4)</td> <td>Strongly agree (5)</td> </tr> </table> <ul style="list-style-type: none"> • Most of the time, I really like the types of nature I interact with • I respond well to the nature that I come into contact with • I pretty much avoid interacting with nature and spend little time in nature • I feel comforted by nature 	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)			

		<p><i>Scoring Information:</i> Reverse score the negatively worded items. Once you have reverse scored the relevant items, the non-human relatedness score is then calculated by averaging the scores of all eight items.</p>					
Intrinsic values	Shortened Aspiration Index	<p><i>Instructions:</i> How important is it for you in your life:</p> <table border="1"> <tr> <td>Not at all important (1)</td> <td>A little bit important (2)</td> <td>So/so (3)</td> <td>Pretty important (4)</td> <td>Very important (5)</td> </tr> </table> <p><u>Affiliation (meaningful relationships)</u></p> <ol style="list-style-type: none"> To have deep enduring relationships. To feel that there are people who really love me, and whom I love. <p><u>Self-Acceptance (personal growth)</u></p> <ol style="list-style-type: none"> To grow and learn new things. To know and accept who I really am. <p><u>Community Feeling</u></p> <ol style="list-style-type: none"> To help others improve their lives. To work to make the world a better place. 	Not at all important (1)	A little bit important (2)	So/so (3)	Pretty important (4)	Very important (5)
Not at all important (1)	A little bit important (2)	So/so (3)	Pretty important (4)	Very important (5)			
Psychological wellbeing	Shortened Warwick-Edinburgh Mental Wellbeing Scale	<p><i>Instructions:</i> Below are some statements about feelings and thoughts. Please tick the box that best describes your experience of each over the last 2 weeks:</p> <table border="1"> <tr> <td>None of the time (1)</td> <td>Rarely (2)</td> <td>Some of the time (3)</td> <td>Often (4)</td> <td>All of the time (5)</td> </tr> </table> <ol style="list-style-type: none"> I've been feeling optimistic about the future I've been feeling useful I've been feeling relaxed I've been dealing with problems well 	None of the time (1)	Rarely (2)	Some of the time (3)	Often (4)	All of the time (5)
None of the time (1)	Rarely (2)	Some of the time (3)	Often (4)	All of the time (5)			

		<p>9. I've been thinking clearly</p> <p>10. I've been feeling close to other people</p> <p>11. I've been able to make up my own mind about things</p>
Control Variable: Demographics	Age	<i>Instructions:</i> In what year were you born? (drop down list of years 1900 – 2010)
Control Variable: Demographics	Gender	Gender: I identify as Male (2), Female (1), Other (3)
Control Variable: Demographics	Financial security	<p><i>Instructions:</i> How financially secure do you feel?</p> <ul style="list-style-type: none"> • I feel very financially secure (5) • I feel financially secure (4) • I feel neither financially secure nor insecure (3) • I do not feel financially secure (2) • I really do not feel financially secure (1)
Control Variable: Religion	Annual participation	<p><i>Instructions:</i> During the last 12 months have you, at least once a week for most weeks, attended a religious service/event at a place of worship (e.g., church, mosque, temple).</p> <p>0 = No, 1 = Yes</p>

Appendix 3: Cross-sectional Survey Informed Consent Form

Who is conducting the research?

This study is being conducted by investigators from Griffith University and the University of Queensland as part of a research project funded through a Griffith University PhD scholarship. The research forms part of a PhD being completed by Ms Anne Cleary under the supervision of Associate Professor Anne Roiko, Associate Professor Kelly Fielding and Dr Zoe Murray. Any matter or concern regarding the research can be raised with the Chief Investigator, whose contact details are provided below.

- Chief Investigator Associate Professor Anne Roiko School of Medicine Griffith University Ph: + 61 7 5552 7870 Email: a.roiko@griffith.edu.au
- Student Investigator Ms Anne Cleary School of Medicine Griffith University Ph: + 61 4 2278 4441 Email: anne.cleary@griffithuni.edu.au
- Investigator Associate Professor Kelly Fielding School of Communication and Arts The University of Queensland Ph: + 61 7 3365 1125 Email: k.fielding@uq.edu.au
- Investigator Dr Zoe Murray School of Medicine Griffith University Ph: + 61 7 5552 7878 Email: z.murray@griffith.edu.au

Why is the research being conducted?

This research examines the wellbeing of urban residents and the environmental and social factors that may affect this wellbeing.

What you will be asked to do?

You will be asked to complete a short questionnaire. The questionnaire contains questions on how you spend your time currently, how you spent your time as a child and questions about your values and attitudes towards the environment. In addition, some demographic characteristics (e.g., age, gender) will also be asked. The questionnaire will take approximately 15 minutes to complete.

The basis by which participants will be selected or screened

Participants over 18 years living within Brisbane area for six months or more will be sought for participation. People living outside of Brisbane area will be excluded from analysis.

The expected benefits of the research

The findings of this study are expected to contribute to scientific knowledge regarding the wellbeing of urban residents. This will help inform urban planning as well as health plans and policies which could aid in the provision of healthy urban environments.

Are there any risks to me if I participate?

The research team does not believe there are any foreseeable risks associated with participation. Some questions ask about how you are feeling right now. Although we don't foresee that they will cause any distress, if these questions do raise issues, you might wish to contact a telephone counsellor at Lifeline on 13 11 14. Access to psychological services is also available by contacting your GP for a Medicare referral to a psychologist.

Your confidentiality

No personally identifying information will be collected unless you choose to volunteer to participate in the next stage of the research in which case you will have to provide your contact

details. Numerical codes will be used to anonymise data and only group findings will be used for reporting of the results.

Your participation is voluntary

Please note that participation in this research project is voluntary and that you may withdraw at any time without explanation or penalty. Refusal to participate will not involve any penalty or loss of benefits to which you might otherwise be entitled. However, please note that once you submit the questionnaire, you will not be able to withdraw participation because all submitted questionnaires are de-identified.

Privacy statement

The conduct of this research may involve the collection, access and/or use of your identified personal information. The information collected is confidential and will not be disclosed to third parties without your consent, except to meet government, legal or other regulatory authority requirements. A de-identified copy of this data may be used for other research purposes. However, your anonymity will always be safeguarded. For further information consult the University's Privacy Plan at <http://www.griffith.edu.au/privacy-plan> or telephone (07) 3735 4375.

Questions / further information

Any matter or concern regarding the research can be raised with the Chief Investigator using the contact details provided above.

The ethical conduct of this research

Griffith University conducts research in accordance with the National Statement on Ethical Conduct in Human Research. This research has received ethics approval from the Griffith University Human Research Ethics Committee (GU Ref No: 2016/085). If potential participants have any concerns or complaints about the ethical conduct of the research project they should contact the Manager, Research Ethics, on 07 3735 4375 (or research-ethics@griffith.edu.au).

Data storage and deletion

As required by Griffith University, all research data (survey responses and analysis) will be retained in a locked cabinet and/or a password protected electronic file at Griffith University for a period of five years before being destroyed.

Feedback to you

Feedback can be provided at the end of the research to inform you of the results obtained. If you would like a summary of results, please contact the Student Investigator.

Thank you for your assistance with this research project.

By clicking on the [NEXT] button below, I confirm that I have read and understood the information about this study and in particular that:

- I understand that my participation in the study will entail completing questions about my urban lifestyle, how I spend my time and my attitudes and values towards the environment
- I have had any questions answered to my satisfaction
- I understand that there may be no direct benefit to me from my participation in this research
- I understand that my participation in this research is voluntary
- I understand that if I have any additional questions I can contact the research team
- I understand that I am free to withdraw at any time, without comment or penalty
- I agree to participate in this research project and give my consent freely.

- I understand that the project will be carried out as described above. I can contact the Manager, Research Ethics, at Griffith University Human Research Ethics Committee on 07 3735 4375 (or research-ethics@griffith.edu.au) if I have any concerns about the ethical conduct of the project.