



Variation in experiences of nature across gradients of tree cover in compact and sprawling cities



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HIGHLIGHTS

- We examine how nature experiences and attitudes vary with neighbourhood tree cover.
- Public and private green space use was higher in greener neighbourhoods.
- City resident's orientation towards nature was higher in greener neighbourhoods.
- We found highly similar patterns for both sprawling and compact city designs.
- Maintaining nature close to home is vital for providing daily experiences of nature.

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ABSTRACT

Urban environments are expanding globally, and by 2050 nearly 70% of the world's population will live in towns and cities, where opportunities to experience nature are more limited than in rural areas. This transition could have important implications for health and wellbeing given the diversity of benefits that nature delivers. Despite these issues, there is a lack of information on whether or how the experience of nature changes as green space becomes less available. We explore this question for residents of two case study cities of varying urban designs, sprawling (Brisbane, Australia) and compact (three English towns, U.K.). Second, we examine how people's feelings of connection to nature (measured using the Nature Relatedness scale) vary across this same gradient of nature availability. Despite climatic and cultural differences we found substantial similarities between the two locations. Lower levels of neighbourhood tree cover were associated with a reduced frequency of visits to private and public green spaces, and a similar pattern was found for the duration of time spent in private and public green spaces for Brisbane. Residents of both urban areas showed similar levels of nature relatedness, and there was a weak but positive association between tree cover and Nature Relatedness. These results suggest that regardless of the style of urban design, maintaining the availability of nature close to home is a critical step to protect people's experiences of nature and their desire to seek out those experiences.

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1. Introduction

With nearly 70% of the global population predicted to live in cities by 2050 (United Nations, 2014), there is growing concern that

urbanisation is driving a broad-scale 'extinction of experience' with the natural world, ultimately resulting in a disconnection between people and nature (Miller, 2005; Pyle, 1978; Soga & Gaston, 2016). This trend is particularly important given the growing body of evidence demonstrating the link between interactions with nature and positive physical, psychological and social wellbeing outcomes (Hartig, Mitchell, de Vries, & Frumkin, 2014; Keniger, Gaston, Irvine, & Fuller, 2013; Shanahan, Lin, Bush et al., 2015). The extinction of experience has two fundamental components; a physical decline in the quantity or quality of nature in cities (i.e. the 'intensity' of nature experiences; Shanahan, Fuller, Bush, Lin, & Gaston, 2015a), and changes in human behaviour associated with urban life-styles

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(including reduced frequency and duration of nature experiences; Lin, Fuller, Bush, Gaston, & Shanahan, 2014; Miller, 2005; Shanahan, Fuller et al., 2015).

The physical impact of urbanisation on biodiversity has received considerable attention from urban ecologists, with studies documenting significant variation in species richness and abundance across different urban forms, but with a general decrease relative to natural habitat (e.g. Catterall, 2009; McKinney, 2002). Furthermore, whether a city has a sprawling or compact design is also known to influence the availability of nature around people's homes (Soga, Yamaura, Koike, & Gaston, 2014), as sprawling designs generally ensure ready access to relatively large private gardens, while in contrast compact city designs can reduce wider biodiversity loss and deliver greater accessibility to public green spaces (Sushinsky, Rhodes, Possingham, Gill, & Fuller, 2013). However, few studies have explored the behavioural component of the extinction of experience of nature; specifically, how does the frequency or duration of experiences with nature vary with variation in availability of nature? Does this differ for cities with sprawling and compact designs?

The behavioural component of the extinction of experience of nature is likely to be driven by many complex and interacting factors. For example, urban residents spend greater periods of time indoors or engaged in recreational activities that are not nature-based (Juster, Ono, & Stafford, 2004; Sigman, 2012). Furthermore, variation in the availability of nature within cities could conceivably affect people's ability and inclination to engage with it. For example, people may more actively seek out nature (both within public and private spaces) as it becomes less available in their day-to-day living environment, perhaps motivated by the potential wellbeing benefits (Home, Hunziker, & Bauer, 2012). However, other research suggests that patterns of green space use simply reflect its availability (Gong, Gallacher, Palmer, & Fone, 2014; Kaczynski et al., 2014), with some influence of interacting factors such as gender, age or socio-economic advantage (Jones, Hillsdon, & Coombes, 2009; McCormack, Rock, Toohey, & Hignell, 2010). As such, characteristics of urban form, such as whether a city is sprawling or compact could influence nature interactions (Gaston, Warren, Thompson, & Smith, 2005; Lin et al., in preparation). Exploration of these potential patterns warrants considerable attention. Whether or not people alter their behaviour to compensate for a lower availability of nature in their living environment will have important implications for how cities are designed to accommodate the rapidly growing urban population.

Ultimately, variation in exposure to nature may not only affect urban residents' wellbeing, but also their attitudes and behaviours towards nature itself (Miller, 2005; Pyle, 1978; Soga & Gaston, 2016). There is some evidence, for example, that experiences with nature as a child correlate with environmental activism or environmental career pathways in adult life (e.g. Wells & Lekies, 2006), and wilderness experiences appear to influence a person's world-view (Kaplan & Kaplan, 1989). This has potential implications for the support of nature conservation by urban residents (Miller, 2005; Pyle, 1978); how can people value what they do not experience or understand? However, a key unresolved issue is whether the availability of nature in the local environment is associated with people's orientation towards nature.

This study explores whether the availability of nature is related to nature experience and orientation towards nature for urban residents. Specifically, we first examine the association between urban residents' frequency and duration of nature interactions across a gradient of percentage neighbourhood tree cover. Second, we scrutinise whether people's levels of connection to nature (measured using the Nature Relatedness scale) vary across that same gradient. We address these questions for two case-study locations of contrasting urban design; specifically Brisbane, Australia, with

sprawling urban development around a central business district, and the 'Cranfield Triangle', U.K., which is a cluster of three compact urban centres.

2. Materials and methods

2.1. Study locations

This study was undertaken in Brisbane, Australia (27°27'S 153°01'E, population 1.1 million people), and the Cranfield Triangle, United Kingdom (52°07'N, 0°61'W, Milton Keynes, Luton and Bedford, population c.524 000 people; Fig. 1). Brisbane is a subtropical sprawling city with considerable amounts of public green space distributed rather evenly both spatially and socio-economically (Shanahan, Lin, Gaston, Bush, & Fuller, 2014), and a population density of approximately 1200 people per km². The urban centres of the Cranfield Triangle are located in a temperate region with compact urban form and a denser population (around 3100 people per km²), surrounded by open countryside. There are climatic differences between the locations; in the survey period the Cranfield Triangle had a maximum temperature of 18.7 °C and minimum 9.0 °C with 39.6 mm rainfall, and the Brisbane maximum was 34.4 °C, minimum 14.1 °C, with 116.8 mm rainfall (Bureau of Meteorology, 2015). Properties in the Cranfield Triangle have a lower average residential plot size (278 m² vs 769 m² in Brisbane). Both locations are primarily English speaking, but there are likely to be a range of cultural differences between the sites.

2.2. Population surveys

We conducted an urban lifestyle survey during late spring on 1538 respondents in Brisbane and 519 respondents in the Cranfield Triangle (Brisbane, November 2012; Cranfield Triangle, May 2014), approximately 0.1% of the population for both locations. The survey was delivered online over a two-week period through market research companies (Brisbane, Q&A Market Research Ltd.; UK, Shape the Future Ltd.) to a subset of adults (18 years +) enrolled in their survey databases. We collected several socio-demographic and personal circumstance variables that could influence exposure to nature including age, gender, the primary language spoken at home (an indicator of ethnicity), personal annual income and highest formal qualification (Table S1 shows the classifications within these groups for analysis purposes, and Appendix B in Supplementary material includes the full survey). The demographic and socio-economic survey group was comparable for the two locations (Table S2). Participants were requested to provide their address, or their approximate address if they preferred for privacy reasons.

Survey respondents provided a measure of their orientation to nature using the Nature Relatedness scale (Nisbet, Zelenski, & Murphy, 2009). The scale has been shown to correlate with environmental attitudes, and also differentiates between groups of nature enthusiasts and those who do not engage in nature experiences (Nisbet et al., 2009). Respondents rated a set of 21 statements using a five-point Likert scale ranging from one (disagree strongly) to five (agree strongly), and these responses were aggregated according to Nisbet et al. (2009). Collectively the components of the scale measure the affective, cognitive, and experiential relationship with the natural world, with a higher score indicating a stronger orientation towards nature. We also separated the nature relatedness scale into three established components (Nisbet et al., 2009): NR-Self, which can be thought of as the ecological self, or how strongly people identify with the natural environment; NR-Perspective, which is an indication of how a person's personal relationship with the environment is manifested through attitude and behaviour; and

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