
# Exploring the role of beliefs on green exercise behaviours and outcomes

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## Dedication

I dedicate my thesis to England, my home for the first 30 years of my life

Now is my time to move on and start a new adventure

## Acknowledgements

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Rose, your love and support has allowed me the opportunity to follow my dream – I hope to spend the rest of my life making it up to you.

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## List of papers

This thesis comprises the following original papers

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2. Flowers, E. P., Freeman, P. & Gladwell, V. F. (2017). The development of three questionnaires to assess beliefs about green exercise. *International Journal of Environmental Research and Public Health. 14(*10), 1172.

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## List of abbreviations

**ANOVA** – Analysis of variance

**ART** – Attention Restoration Theory

**BMI** – Body mass index

**CFI** – Comparative fit index

**CI** – Confidence interval

**GIS** – Geographical information system

**IPAQ-SF** – International physical activity questionnaire (short form)

***M*** – Mean

**MENE** – Monitor of Engagement with the Natural Environment

**METs** – Multiples of resting metabolic rate

***N*** – Number

**NRS-14** – Nature Relatedness Scale

**OR** – Odds ratio

**PBC** – Perceived behavioural control

**PET** – Psycho-Evolutionary Stress Reduction Theory

**POMS** – Profile of Mood States

**RMSEA** – Root mean square error of approximation

**RPE** – Rating of perceived exertion

***SD*** – Standard deviation

**SES** – Rosenberg Self-esteem Scale

**TLI** – Tucker-Lewis index

**TPB** – Theory of Planned Behaviour

## Abstract

Undertaking physical activity in the presence of a natural environment (termed green exercise) is good for health and wellbeing. Nevertheless, we need to understand more about what motivates people to perform green exercise. The literature suggests that beliefs may play a role in physical activity behaviours and outcomes. To expand on this, the aim of this thesis was to explore the role of beliefs on green exercise behaviours and outcomes. Specifically, the following research questions guided the experimental chapters: Do beliefs predict visiting local green space? Can beliefs be modified to encourage more green exercise, and improve outcomes?

Chapter 2 found that subjective measures were stronger predictors of green exercise than quantity of local green space, showing initial support for subjective measures playing a role in green exercise behaviours. To explore this further, questionnaires to assess beliefs were developed (Chapter 3) and tested (Chapter 4). This was important because previous research has not explored what people think about green exercise. The evidence showed that beliefs about green exercise appear to predict intentions to perform green exercise and visit frequency to local green space.

Chapter 5 used indoor vs outdoor methodology to assess the impact of a promotional video (attitude modification intervention) on the psychological outcomes of green exercise. This was important because assessment and/or modification of attitudes in a green exercise environment had not been previously examined. Chapter 6 used a promotional video in a four-week green exercise intervention. Overall, the evidence was mixed, however, there was some indication of expectancy effects.

Regular green exercise can help with health and well-being. Evidence provided in this thesis highlights the importance of subjective measures (such as perceptions, beliefs, and intentions) on green exercise behaviours and acute psychological benefits.

# Chapter 1

# Introduction

### *Physical activity and health*

Regular physical activity is an essential component of good health; it can help prevent illness and facilitate positive wellbeing. By definition, physical activity is "any bodily movement produced by skeletal muscles that results in energy expenditure" (p. 126; Caspersen, Powell, & Christenson, 1985), and it encompasses daily routines (such as occupational and household tasks), as well as more structured activities (such as sport, exercise, and conditioning). Throughout this thesis, individual physical activity levels will be referred to as (in)sufficient according to the guidelines set by the UK government (National Health Service, 2015). For adults aged 19-64 years old, the UK government recommends a combination of aerobic and strengthening activities (National Health Service, 2015). Aerobic activities can be identified by increases in heart rate, sweating, and breathing rate, whilst strengthening exercise involves using large muscles groups to repeatedly push or pull against a resistance. For aerobic activity, adults should do at least 150 minutes per week of moderate-intensity activities (such as brisk walking, water aerobics, or rollerblading), or 75 minutes of vigorous activities (such as jogging, football, or hockey), or any combination of the two. As an example, this can be achieved through five 30-minute bouts of moderate-intensity activity. For strengthening exercises, adults should do activities such as sit-ups or heavy digging in the garden, to the point in which it becomes a struggle.

Overall, the benefits of meeting physical activity recommendations, and thus living an active lifestyle, are immeasurable. For example, regular physical activity can help reduce excessive weight, caused by adiposity (or fatty tissue as it is more commonly known), which can have a detrimental effect on the human body. Adiposity plays a role in one of the most commonly used indicators of health: body mass index (BMI). BMI is calculated using measures of height and weight and is universally expressed in units of $kg/m^2$. According to the World Health Organisation (2017), obesity (BMI of $30kg/m^2$ or higher) is a major risk factor in noncommunicable diseases

such as cardiovascular disease (the leading cause of death in 2012), muscular skeletal disorders such as osteoarthritis, and some cancers (such as breast, prostrate, kidney etc). Furthermore, obesity is associated with an increased risk of developing insulin resistance and type 2 diabetes (S. E. Kahn, Hull, & Utzschneider, 2006). Being physically active also has a positive effect on many other indicators of health such as blood pressure (Whelton, Chin, Xin, & He, 2002), bone density (Kohrt, Bloomfield, Little, Nelson, & Yingling, 2004), and respiratory function (Cheng et al., 2003). Therefore, meeting the physical activity recommendations and maintaining a healthy BMI can help maintain good health and prevent serious ill health.

Unfortunately, not everyone participates in regular moderate or vigorous physical activity. According to the most recent statistics, only 63% of men and 59% of women meet the physical activity guidelines in the England (Sport England, 2017). Furthermore, around 26% – or 11.3 million – do fewer than 30 minutes of activity per week (Sport England, 2017). This is partly responsible for increases in obesity prevalence; obesity levels have increased from 15% in 1993 to 27% in 2015 (NHS Digital, 2017). Worryingly, the increase in obesity is not only apparent in adults; 20% of year 6 children (10-11 years old) are now categorised as obese (NHS Digital, 2017). Partly due to inactive lifestyles and rising obesity, noncommunicable diseases are also increasing the UK. Since 1996, the number of people diagnosed with diabetes has more than doubled from 1.3 million to almost 3.5 million (Diabetes UK, 2016), and nearly 90% of these diagnoses are for type 2 diabetes, which obesity and increased waist circumference are major risk factors. Additionally, over 42 thousand people die prematurely (under 75) through cardiovascular disease, which is associated with lifestyle choices such as smoking and obesity (British Heart Foundation, 2018). Furthermore, 30% of adults in the UK suffer from high blood pressure, which increases the risk of developing heart disease and stroke up to three times (British Heart Foundation, 2018). Besides the health implications, there is also a large impact on

the economy; recent estimates suggest the financial burden of physical activity in the UK is a staggering £1.9b per annum (Ding et al., 2016).

### *Physical activity and psychological wellbeing*

Regular physical activity is associated with better psychological wellbeing; regular exercisers consistently report better mood states (McDonald & Hodgdon, 1991), improved self-esteem (Spence, McGannon, & Poon, 2005), and reduced anxiety (Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991) compared with inactive people. Furthermore, exercise can be an effective treatment for depression; a comprehensive review indicates that exercise has a moderate effect on depression (ES = -0.62) compared to no treatment (Cooney et al., 2013). Beside the benefits of regular exercise, acute bouts of exercise also appear to have short and often significant effects on psychological wellbeing. For example, after aerobic exercise, individuals tend to report higher levels of positive-activated affect for at least 30 minutes (Reed & Ones, 2006). The mechanisms for the effects of physical activity on psychological wellbeing remain unclear, however, a number of possible mechanisms have been proposed: increases in self-esteem through mastering new tasks (Fox, 2000), increases in endorphins following exercise (Boecker & Dishman, 2013); social interaction (Smith & Christakis, 2008), and expectancy (Desharnais, Jobin, Cote, Levesque, & Godin, 1993).

In the UK, common mental disorders such as depression, anxiety, and insomnia are also more prevalent now than they were in the early 90's. The Adult Psychiatric Morbidity Survey is conducted every seven years to provide data on the prevalence of both treated and untreated psychiatric disorder in the English adult population (aged 16 and over). Overall, severe symptoms of common mental disorders have slowly increased from 6.9% in 1993 to 9.3% in 2014 (National Health Service Digital, 2016), although mild symptoms have remained steady. Severe

symptoms are classified as likely to warrant intervention such as medication or psychological therapy. One possible explanation for this is the association between physical inactivity and poor mental health; six out of seven observational studies show a positive association between physical inactivity (i.e. sitting) and depression (Teychenne, Ball, & Salmon, 2008) and the association also appears to apply to children and adolescents (Biddle & Asare, 2011).

### *Physical activity governance*

With rising levels of inactivity, obesity and mental disorders, it is vital that governing bodies and policy makers invest in promoting physical activity. Launched in 2010, The Toronto Charter for Physical Activity is a global call for action to create opportunities and policies that encourage people to be more active. The Charter is accompanied by a document that lists 'seven investments that work' (see Figure 1.1). The seven investments are based upon a plethora of evidence and are designed to operate in unison to provide a strategy for increasing worldwide physical activity levels. This thesis includes some discussion of the third and fifth strategies; 'urban design regulations and infrastructure that provide for equitable and safe access for recreational physical activity, and recreational and transport related walking and cycling across the life course' and 'public education, including mass media to raise awareness and change social norms on physical activity', respectively.

Noncommunicable disease prevention: Investments that Work for Physical Activity

1. *'Whole-of-school' programs*
2. *Transport policies and systems that prioritise walking, cycling and public transport*
3. *Urban design regulations and infrastructure that provide for equitable and safe access for recreational physical activity, and recreational and transport-related walking and cycling across the life course*
4. *Physical activity and NCD prevention integrated into primary health care systems*
5. *Public education, including mass media to raise awareness and change social norms on physical activity*
6. *Community-wide programs involving multiple settings and sectors and that mobilize and integrate community engagement and resources*
7. *Sports systems and programs that promote 'sport for all' and encourage participation across the life span.*

**Figure 1.1** Noncommunicable disease prevention: Investments that Work for Physical Activity

Locally, the UK government has recently updated its policy for embedding physical activity into daily life; the 'Everybody active, every day: an evidence based approach to physical activity' is a document produced to help policy makers encourage people to be physically active (Public Health England, 2014). The framework is shaped around four key areas for action: active society, moving professionals, moving at scale, and active environments. Each area focuses on one part of society that can be utilise to encourage more physical activity across the population: active society relates to changing attitudes to physical activity; moving professionals relates to the role of public-facing professionals in creating change; active environments relates land use such as green spaces and playgrounds; moving at scale relates to the need for long-term and large-scale behaviour changes. The third area, active environments,

introduces one of the underlying premises of this thesis; green spaces encourage people to be physically active!

### *Physical activity, health, and natural environment*

The size and distribution of the world's population is changing. For the first time in human history, more people live in urban than rural areas. Globally, 54% of people live in urban areas, compared with just 34% in 1960 (World Health Organisation, 2015b). Furthermore, the global urban population is expected to grow by 1.84% per year between 2015 and 2020. Unsurprisingly, urbanisation is more prevalent in developed countries where most jobs are in towns and cities. For example, in England and Wales, 81.5% live in urban areas (Office for National Statistics, 2013). One drawback of this is a reduced exposure to natural environments, which may have a negative effect on health and wellbeing (Maas et al., 2009).

Worldwide, governing bodies are now starting to acknowledge the benefits of local green spaces on health and wellbeing. In Europe, the World Health Organisation has produced a report titled 'Urban green spaces and health: a review of the evidence' (World Health Organisation Europe, 2016). It summarises the beneficial effects of urban green space, such as improved mental health and reduced obesity. Farther afield, national organisation such as Healthy Parks, Healthy People (Australia), and City Parks Alliance (America) now play a role in highlighting the importance of green space for health and wellbeing. The movement appears to be gaining momentum and for the first time the America College of Sports Medicine has produced 'Go Green with Outdoor Activity', a set of guidelines designed to help fitness professionals evaluate outdoor spaces and develop workouts that are enjoyable and adaptable for individuals with varying fitness levels (K. Brown & Stanforth, 2017). Within the document they refer to outdoor exercise as green exercise.

Throughout this thesis, the relationship between local green space, physical activity and health will be explored further. Currently, there is no universally accepted definition of local green space. For example, green space in urban areas have been described as city's green lungs by providing breathing space to escape modern stresses (Dunnett, Swanwick, & Woolley, 2002), pleasant areas that support the identity of towns and cities (Baycan-Levent & Nijkamp, 2004), and "formal and informal landscape and townscape" (Greater London Authority, 2003 p. 26). In the UK, The Planning Policy Guidance (PPG17) categorises urban green spaces into various types such as parks and public spaces, sports facilities, play areas, civic spaces etc. One issue to consider is the concept of naturalness and how it relates to local green space. For example, how natural is the manicured lawns, flower beds, and water fountains within a new housing development? Does this represent a natural environment? Is it accessible for all or a shared space for some?

Natural England has clear definitions for both accessible green space and natural green space. Accessible green space is 'places that are accessible for the general public to use free of charge and with limited restrictions', whereas natural green spaces are 'places where human control and activities are not intensive so that the feeling of naturalness is allowed to predominate' (Natural England, 2010; p. 8). According to these definitions, the housing development example would probably meet the criteria for accessible green space because it is most likely maintained and accessible for the public. Clearly, there is overlapping characteristics amongst the terms previously described in the literature. For the purposes of this thesis, the term local green space will be adopted throughout to encompass accessible green spaces that are both intertwined within urban towns and cities (regardless of degree of naturalness) and natural environments that make up rural areas.

Researchers usually adopt one of two approaches for assessing the relationship between local green space, physical activity and health. They either use

national surveys and correlate responses against land use databases (Ambrey, 2016; Astell-Burt, Feng, & Kolt, 2014; Mytton, Townsend, Rutter, & Foster, 2012; Vienneau et al., 2017; Villeneuve, Jerrett, Su, Weichenthal, & Sandler, 2017; Witten, Hiscock, Pearce, & Blakely, 2008), or they focus on individual towns/cities/parks (Bai, Wilhelm Stanis, Kaczynski, & Besenyi, 2013; Hobbs et al., 2017; Triguero-Mas, Donaire-Gonzalez, et al., 2017; Van Hecke et al., 2016; Veitch et al., 2015). Overall, the evidence suggests that a positive relationship exists between local green space and both physical activity levels, and health (Calogiuri & Chroni, 2014; Lachowycz & Jones, 2011; Mackenbach et al., 2014; Moran et al., 2014; van den Berg, Maas, Verheij, & Groenewegen, 2010). For example, de Vries, Verheij, Groenewegen, and Spreeuwenberg (2003) found that Dutch people (*N* = 10179) were more likely to report good health if they lived in greener areas, and the impact of 10% more green space with 1km of one's home is positively associated with 15 indicators of health such as coronary heart disease, diabetes, and depression (Maas et al., 2009). A similar study found that Australia residents (*N* = 267,072) have a lower risk of developing type 2 diabetes if they live in green areas (Astell-Burt et al., 2014).

Assessing how, when and why people visit local green spaces is crucial to help understand the effect it may have on physical activity levels, health and wellbeing. The Monitor of Engagement with the Natural Environment (MENE) is a quarterly report funded by Natural England that is used to collect information regarding how people use the natural environment in the UK (such as duration, motivations, barriers to visiting etc). At the time of writing, the most recent report includes data collected between December 2015 and February 2016 (Natural England, 2016b). The findings suggest that parks within towns/cities were the most common location for visits (over 28%) and walking with a dog was the most common activity (over 48%). Furthermore, 34% of people reported visiting a local green space at least once in the past seven days, which was a slight decrease from the year before (38%). Scientific research has

also been collected independently and on behalf on Natural England. For national studies, the evidence is mixed. Across England, the odds of achieving physical activity guidelines was 1.27 higher for people in the greenest areas compared to those living in the least green areas (Mytton et al., 2012). Furthermore, increased local green space was associated with significantly lower levels of type 2 diabetes and body mass index (Bodicoat et al., 2014). However, the relationship was not apparent in Scotland; the availability of local green space was not associated with physical activity levels, nor green space activities (Ord, Mitchell, & Pearce, 2013).

### *Green exercise*

Gaining synergistic benefits from exercising outdoors is not an entirely new concept. Anecdotal evidence from over one hundred years ago shows the extraordinary lengths that one gentlemen went to, to bring green exercise into the comfort of his home. Figure 1.2 is an image taken from an 1897 edition of a magazine called 'The Rambler'. The article titled 'The cycle in the house: Curious domestic uses of the bicycle', features one scene painter's quest to escape the 'monotonous sameness' he experienced whilst cycling indoors. He built a contraption to mimic the experience of cycling outdoors using painted canvas, rollers, and fans, all connected via series of cables and pulleys. As he pedalled the painted scenes moved alongside and the fans blew wind upon him. His motivation for this was quite simple; he wanted to continue cycling throughout winter without being subjected to poor weather conditions.

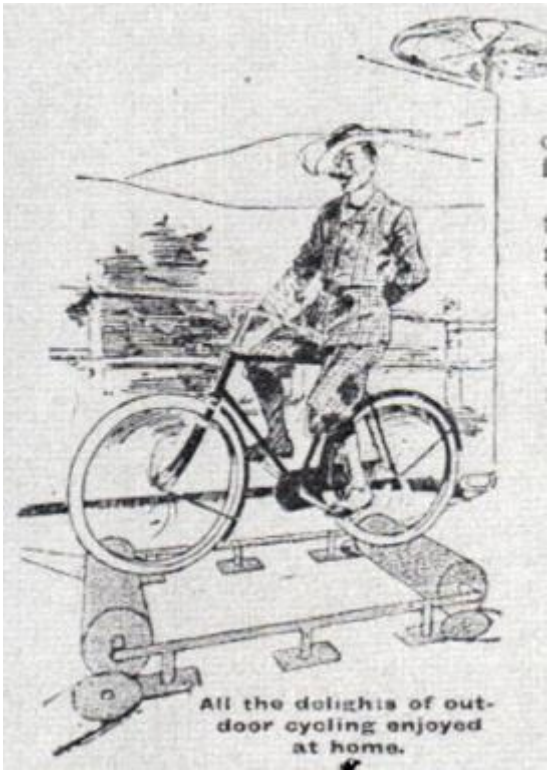



**Figure 1.2** Illustration of an early indoor green exercise device

*"Cycling at home is tame, for one misses the continual change of scenery, which is perhaps the most enjoyable effects attending a spin in the open, and the pleasurable sensation of flying through space derived from the rush of the cooling breeze against one's face. And yet our weather is such that for at least one quarter of the year we must cycle at home, or not at all."* The Rambler, 1897

Green exercise is the term for physical activity that takes place in natural environments such as local green spaces, parks, forests etc (Pretty, Peacock, Sellens, & Griffin, 2005). The term is accepted in the literature, although definitions do vary. Examples of definitions include 'any informal physical activity that takes place outdoors: from gardening, cycling and walking in urban green areas, to kite flying and conservation projects in the countryside' (Natural England, 2011b); "… exercise

performed in (relatively) natural environments such as parks" (Mackay & Neill, 2010, p. 238); and "consisting of activity in green places" (Barton & Pretty, 2010, p. 3947). For the purposes of this thesis, green exercise refers to physical activity performed in the presence of a real or simulated natural environment. The term was introduced by Pretty et al. (2005) to combine the synergistic benefits of physical activity and exposure to nature. Green exercise has now developed into a specific research area and, as of June 2017, the original article had been cited nearly 700 times. The term has now been adopted by groups within the UK (such as Natural England and the Physical Activity and Health Alliance). Two areas of enquiry have emerged a) the additional benefits of green exercise compared with urban/indoor physical activity, and b) the relationship between environmental factors (such as access to local green space), green exercise, and health (as previously discussed).

Pretty et al, (2003) conceptualised three levels of engagement to acknowledge that individuals can experience nature in a variety of ways. The three levels are (1) viewing nature, (2) functional engagement, (3) and active participation. Whilst each level can be beneficial, active participation is the optimal for facilitating synergistic benefits. The first level, viewing nature, is the most passive of activities, burns the least calories, and requires the least effort. Sitting on a park bench and enjoying the sounds, sights, and smells of a natural environment is an examples of viewing nature that most people can relate to. Empirical evidence indicates that viewing nature can help reduce heart rate during stressful situations (D. K. Brown, Barton, & Gladwell, 2013; P. H. Kahn et al., 2008; Ulrich et al., 1991) and facilitate feelings of restoration (Nordh, Hartig, Hagerhall, & Fry, 2009; Tsunetsugu et al., 2013; Van den Berg, Jorgensen, & Wilson, 2014). Results from observational studies in the America imply that more than half of local green space visitors engage in sedentary behaviours (Besenyi, Kaczynski, Wilhelm Stanis, & Vaughan, 2013; Cohen et al., 2010; Floyd, Spengler, Maddock, Gobster, & Suau, 2008). Furthermore, in Australia, 38% of

people that visited metropolitan parks were observed in moderate and vigorous intensity physical activity, compared with 62% of people that were sedentary once they arrived (Veitch et al., 2015). Whilst this may contradict the previously mentioned link between green space and health, it is reasonable to assume that the most visits to green space will require some form of physical activity, be it walking to a bench to sit and read, carrying a picnic basket, standing to take photos of wildlife etc. Therefore, the act of visiting green space to be sedentary may incidentally involve physical activity.

Functional engagement involves incidentally viewing nature whilst participating in another primary activity. As an example, walking through a park because it is the shortest route to your destination would be considered functional engagement; functional because it provides a route from A to B, and engagement because nature provides the background scenery. As mentioned previously, the most recent MENE report indicates that walking with a dog is the most common activity in the UK (Natural England, 2017). This could be considered functional engagement if the motivation behind the activity was to provide exercise for the dog. It is important to note that the motivation behind the activity is fundamental in differentiating it between functional engagement and active participation.

Walking through a park, if the park was not the quickest route, but was chosen because it allowed an experience of nature along the journey, is a form of active participation. Active participation can be defined by the motives involved in the decision to purposefully visit local green space to engage in some form of physical activity. It differs from functional engagement in that the experience of nature becomes part of the primary reason for the behaviour. The experience of nature is still apparent in both behaviours – as is the possibility of experiencing associated outcomes such as feelings of enjoyment, tranquillity, and intention to repeat the behaviour.

The motivation to do green exercise has not been widely researched (Irvine, Warber, Devine-Wright, & Gaston, 2013; Refshauge, Stigsdotter, & Cosco, 2012), however, research has been carried out to identify if the environment where someone exercises has additional benefits. Most of the evidence for the psychological benefits of green exercise has come from experimental research examining active participation (Bowler, Buyung-Ali, Knight, & Pullin, 2010; Thompson Coon et al., 2011). Often comparisons have been made between performing the same exercise in indoor versus outdoor environments (Hug, Hartig, Hansmann, Seeland, & Hornung, 2009; Kerr et al., 2006; Rogerson, Gladwell, Gallagher, & Barton, 2016; Thompson Coon et al., 2011) and in urban versus rural outdoor environments (Bodin & Hartig, 2003; Bowler et al., 2010; D. K. Brown, Barton, Pretty, & Gladwell, 2014; Gidlow, Jones, et al., 2016). Recent systematic reviews have suggested that green exercise elicits psychological benefits over and above that of urban/indoor exercise (Mitchell, 2013; Thompson Coon et al., 2011). In a comprehensive review, Thompson Coon et al. (2011) found strong evidence for the short-term effects of exercise environment on mental wellbeing. They reviewed 11 studies that featured comparisons between walking/running indoors and the equivalent physical activity in an outdoor environment. Most of the studies ($N$ = 7) featured short-term walking interventions and found that walking outdoors had a more positive effect on at least one dimension of mood compared with walking indoors. Furthermore, positive feelings of enjoyment, tranquillity and intent to repeat the experience were associated with walking outdoors. Interestingly, the authors found less evidence for the additional psychological benefits associated with running outdoor vs running indoors. In two of the three studies reviewed, there were no alterations in the effects of running environment on mood or emotion (Kerr et al., 2006; McMurray, Berry, Vann, Hardy, & Sheps, 1987).

The psychological benefits of green exercise are commonly recorded using measurements of self-esteem and mood. Self-reported questionnaires such as the

Rosenberg Self-Esteem Scale (SES; Rosenberg, 1965b) and Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971) are often administered before and after an acute bout of physical activity to assess psychological changes against a baseline. Where self-esteem has been monitored, improvements have been attributed to green exercise. For example, engaging in both real (Barton, Griffin, & Pretty, 2012; Barton, Hine, & Pretty, 2009; Morita et al., 2007; Pretty et al., 2007) and imitation natural environments (Pretty et al., 2005) can elicit additional benefits of self-esteem over and above that or urban exercise. Mood also improves with acute bouts of green exercise. For example, when cycling indoors, participants (*N* = 14) reported better change in mood when exposed to imagery of green nature compared to grey or red images (Akers et al., 2012). Although the majority of the research features an adult sample, the effect is also found amongst young adults (Barton & Pretty, 2010) and adolescents (Wood, Angus, Pretty, Sandercock, & Barton, 2013).

One advantageous feature of green exercise is that benefits can occur relatively quickly. In a multi-study analysis Barton and Pretty (2010), analysed data from 10 UK studies (*N* = 1,252) and found that as little as 5 min of green exercise was enough to elicit positive effects on mood and self-esteem. Also, in a more recent study, cycling indoors at a moderate-intensity for five minutes whilst viewing green natural images significantly improved mood compared with viewing grey images (Akers et al., 2012). Furthermore, Shanahan et al. (2016) found that people who visited green space for 30 minutes or more per week were less likely to have depression and high blood pressure. Overall, the findings suggest that short but frequent bouts of green exercise can be particularly beneficial for good health. Although five minutes of green exercise will not make a large contribution to overall physical activity levels, it does support the idea that short but frequent bouts of exercise may be a sustainable method of meet physical activity guidelines. For

example, five bouts of moderate intensity physical activity lasting 30 minutes or more is sufficient to meet physical activity guidelines.

### *Theories linking nature, health, and wellbeing*

In the literature, there are many models, theories, and approaches that attempt to explain relationships between natural environments, physical activity, health and wellbeing. These can be categorised into two distinct areas of exploration (a) the restorative effects of nature, and (b) the links between nature environment and physical activity. Chronologically, the former came a lot earlier. The most common theories concerning the restorative effects of nature all came in the 1980s: the Psycho-Evolutionary Stress Reduction Theory (PET; Ulrich, 1984), the Biophilia Hypothesis (Wilson, 1984), and the Attention Restoration Theory (ART; R. Kaplan & Kaplan, 1989).

Proposed by Ulrich, the PET suggests that restoration, obtained through spending time in nature, occurs via a reduction in stress (Ulrich et al., 1991). Prolonged stress is detrimental to health and wellbeing; stress can be defined as any uncomfortable "emotional experience accompanied by predictable biochemical, physiological and behavioural changes" (Baum, 1990). It occurs from an imbalance between capability and demand. The premise of the PET is that viewing natural scenery triggers positive emotional reactions that immediately reduce stress. Furthermore, it argues that humans are biologically adapted to nature and that artificial environments such as buildings and roads induce stress. This theory is supported by previously mentioned dose-response relationship, whereby relatively short time periods are sufficient to elicit significant psychological improvements (Barton & Pretty, 2010)

Similarly, the ART proposes that viewing scenes of nature can provide opportunities for restoration (R. Kaplan & Kaplan, 1989). Unlike the emotional

responses argued by Ulrich, the ART is a purely cognitive approach. It suggests that artificial stimuli from modern life (such as computer screens, mobile phones, and built environments) require more cognitive capacity to navigate, and therefore draws upon our limited capacity for directed attention. In contrast, we effortlessly attend to natural environments, therefore allowing our capacity for attention to replenish. This is supported by a recent study that found that viewing scenes of nature during moderate-intensity exercise facilitated significant improvements in directed attention to compared to urban scenes (Rogerson & Barton, 2015). Underpinning both the ART and PET is the notion that human's acute wellbeing prospers when in natural environments.

Unlike the ART and PET, the underlying premise of the biophilia hypothesis is that humans are innately attracted to nature. It argues that through thousands of years of evolution, humans have survived and thrived in nature, and that those innate connections still exist in modern society. In support of this theory, one review suggests that humans are aesthetically attracted to nature environments (Joye, 2007), although this is has been disputed (Dopko, Zelenski, & Nisbet, 2014). However, whilst the biophilia hypothesis does have research support (Kellert & Wilson, 1993), it does not explain why many do not seek natural environments on a regular basis. Recently, other explanations have been proposed.

Some researchers have explained the relationship between natural environments and physical activity using pre-existing psychological theories. For example, Brymer et al, explored the benefits of green exercise with an ecological dynamics analysis (Brymer, Davids, & Mallabon, 2014; Yeh et al., 2016). Ecological dynamics is a framework based upon concepts from dynamical systems theory and ecological psychology (Araujo & Davids, 2011) and is based upon the idea that behaviours are shaped by individual-environment interactions. In this regard, affordances (behavioural opportunities) in the environment can be exploited or

neglected by the individual through choice. The authors illustrate a poignant example of natural environments being rich with affordances; they describe a picturesque scene in the Lake District, UK; the tarn affords the opportunity to swim, the grass affords the opportunity to run, and the pikes in the background afford the opportunity to climb. They go on to suggest that researchers should focus on the affordances (and perceptions of affordances) in the natural environment, and individuals' preferences for green spaces.

The final approach to green exercise research – and most pertinent for this thesis – was conducted by researchers in Norway (Calogiuri & Chroni, 2014). The team performed a systematic review on the impact of the natural environment on the promotion of active living. In essence, the authors mapped a vast body of research (most of which was conducted in the last 15 years) onto a well-established psychological model: the Theory of Planned Behaviour (TPB; Ajzen, 1991). The TPB is an extension of the Theory of Reasoned Action (Ajzen & Fishbein, 1980), and postulates that behavioural intentions determine volitional behaviour. Thus, increases in intentions are accompanied by a greater chance of performing the behaviour. Three factors give rise to intentions: attitudes (positive or negative evaluations of the behaviour), subjective norms (perceived social pressure to perform the behaviour), and perceived behavioural control (evaluation of opportunities and barriers to perform the behaviour). Attitudes, subjective norms, and perceived behaviour control are all derived from corresponding beliefs and evaluations of those beliefs, and therefore reflect underlying cognitions. The TPB is one of the most commonly used theories for exploring physical activity behaviours, and is supported by a vast body of research (Downs & Hausenblas, 2005b; Hagger, Chatzisarantis, & Biddle, 2002). The TPB will be extensively used throughout the thesis and will specifically guide the development of questionnaires in chapter 3.

The review conducted by (Calogiuri & Chroni, 2014), consists of over 1.3 million participants across 90 papers. For the purposes of the review, the authors divided independent variables into four constructs: behavioural beliefs; normative and control beliefs; intention; and behaviour. According to the review, research that explores the psychological benefits of green exercise including stress relief (Bodin & Hartig, 2003), instrumental beliefs such as expected health benefits of green exercise (Bai et al., 2013), and feelings about nature (D. H. Anderson, Stanis, Sonya, Schneider, & Leahy, 2008) can be mapped onto the behavioural beliefs construct of the TPB (attitudes). Research exploring social support (Stigsdotter et al., 2010), personal barriers, and environmental barriers can all be mapped onto normative and control beliefs (i.e. subjective norms and perceived behavioural control, respectively). In keeping with the TPB, research relating to intentions and motives to visit natural environments (Rhodes, Brown, & McIntyre, 2006) were mapped on behavioural intentions, and nature based physical activity (i.e. green exercise) was mapped on the behaviour construct of the TPB.

Overall, the authors provided a compelling argument that green exercise behaviours can be mapped onto the TPB. They proposed that the motivational processes underlying the relationship between natural environments and physical activity behaviours can be categorised into two distinct pathways (Figure 1.3); contribution of natural environments to ‘active living’ and ‘active use’ of the natural environment. They proposed that attitudes serve as a key differentiator between the pathways. For the ‘active living’ pathway, attitudes to physical activity, coupled with instrumental beliefs regarding the expected health and aesthetic benefits give rise to neighbourhood physical activity. In contrast, attitudes to outdoor recreation, coupled with feelings about nature give rise to participation in natural environment-based recreations. Interesting, these pathways are not dissimilar from the levels of engagement proposed by Pretty et al. (2003), and previously discussed (Page 24).

Pretty et al. (2003) suggested that the motivation to perform green exercise was a means to distinguish between 'functional engagement' and 'active participation'. The 'active use' pathway and the 'active participation' level of engagement are both driven by a desire to spend time in natural environments and enjoy the associated benefits. In contrast 'the active living' pathway and 'functional' level of engagement both refer to the use of natural environment for alternate activities such as travel and physical activity.

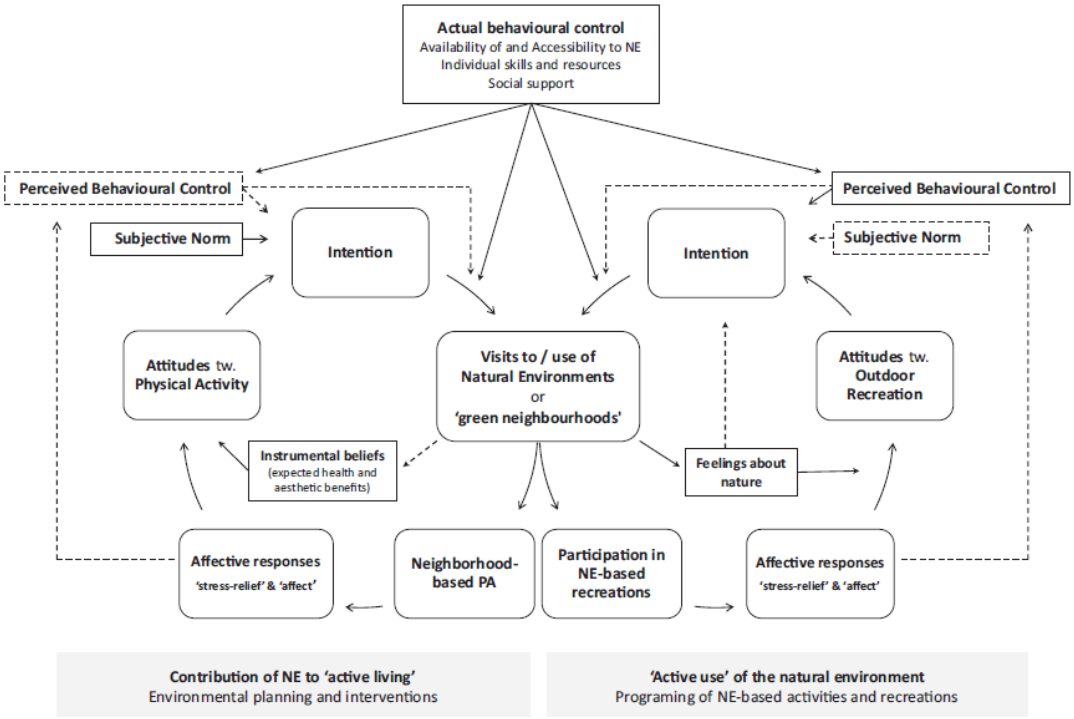



**Figure 1.3** Proposed schematic model of motivational processes underlying the relationship between natural environments and physical activity behaviours (Calogiuri & Chroni, 2014).

In addition to proposing the motivational pathways for green exercise, Calogiuri and Chroni (2014) also made recommendations for researchers and policy makers. They suggested that the TPB provides a model to assess to how individual's feelings

can influence the relationship between natural environments and physical activity. As such, salient beliefs that have room for improvement can be targeted as predictors of intentions and behaviours. Furthermore, they highlighted potential interventions for targeting green exercise. Examples include *social campaigns* to increase of awareness of the health and wellbeing benefits of physical activity, and *information* from reputable sources such as schools and doctors about the benefits of spending time in nature.

### *Conclusion*

In the UK, people are sitting more and moving less. One explanation for this is an increase in sedentary – and often computer based – job types. Subsequently, the amount of people who meet the recommended guidelines for weekly physical activity has reduced. This is having a detrimental effect on physical health and psychological wellbeing; both obesity and common mental disorders have increased over the past 20 years amongst UK adults.

The government acknowledges the problem and wants to encourage recreational physical activity to try and improve health and wellbeing and thus reduce the economic burden. In this effort, they created a framework for encouraging physical activity. Within the document they acknowledge environment has an important role to play in physical activity because it affords people the opportunity to be active. This is supported by a body of evidence that suggests there is a positive relationship between amount of local green space, physical activity levels and health.

In metropolitan areas, parks and fields are often the largest open areas for pedestrians to move freely, therefore allowing for a variety of different physical activities. In this regard, local green spaces are an asset of local communities and people should be encouraged to visit regularly for green exercise. The overall aim of

this thesis is to rigorously explore the impact of beliefs about green exercise on green exercise behaviours and outcomes. To address the overall aim, five studies were conducted. The aim of study one was to investigate if perceptions about local green space relate to visit frequency and/or physical activity levels. The aims of the second and third studies were to create questionnaires that capture beliefs about green exercise and intention to perform green exercise and assess to see if they predicted visit frequency to local green space. The aim of the fourth study was to investigate whether beliefs about green exercise relate to the acute psychological benefits of green exercise. The fifth and final study was conducted to see if beliefs about green exercise and intentions to perform green exercise relate to amount of weekly green exercise.

**Table 1.1** Mapping identified gaps in the literature onto chapter aims

| Ch | Gaps in the literature to be addressed | Aims |
|---|---|---|
| 2 | • It is not known how perceptions of local green space compare to quantity of local green space in relation to encourage visits | • To investigate which perceptual and objective indices of local green space predict visit frequency to local green space<br>• To explore the relationship between visiting local green space and physical activity levels |
| 3 | • No questionnaire exists to assess how people feel about green exercise | • To capture salient beliefs about green exercise<br>• To develop and provide initial evidence of validity for questionnaires to assess belief about green exercise and intentions to perform green exercise |
| 4 | • It is not known if beliefs about green exercise, and subsequent intentions to perform green exercise relate to visit frequency to local green space | • To explore whether beliefs about green exercise predict visit frequency intention to perform green exercise<br>• To explore whether intention to perform green exercise predicts visit frequency to green space more than nature relatedness and/or perceptions of local green space |
| 5 | • No study has explored if beliefs about green exercise play a role in the acute psychological benefits of green exercise | • To assess the effectiveness of a promotional video to enhance the psychological benefits of green exercise<br>• To explore if a promotional video has any immediate effects on attitudes to green exercise |
| 6 | • It is not known if a promotional video about green exercise can increase positive beliefs about green exercise and increase green exercise behaviours amongst the general population | • To assess the effectiveness of a promotional video to encourage people to do more green exercise<br>• To explore if a promotional video has an immediate effect on attitudes, or a lasting effect on beliefs and intentions towards green exercise. |

# Chapter 2

# A cross-sectional study examining predictors of visit frequency to local green space and the impact this has on physical activity levels.

A version of this chapter has been published as a research article. The reference for this is:

Flowers, E. P., Freeman, P., & Gladwell, V. F. (2016). A cross-sectional study examining predictors of visit frequency to local green space and the impact this has on physical activity levels. *BMC Public Health*, 16(1).

### *Introduction*

Physical activity is a well-known contributor to good health (Bouchard, Blair, & Haskell, 2006). Current guidelines for aerobic activity recommend that adults should spend at least 150 minutes per week in moderately intensive physical activity or 75 minutes of vigorous physical activity (or any combination of the two) (National Health Service, 2015; US Department of Health and Human Services, 2015). In the most recent Health Survey for England, unfortunately, only 67% of men and 55% woman met the recommended guidelines (Health Survey for England, 2013). This is replicated to a lesser extent throughout the whole world, with 20% of men and 27% of women considered not to meeting the guidelines (World Health Organisation, 2016). Therefore, increasing levels of physical activity is a major priority in Public Health, particularly in Westernised countries (World Health Organisation, 2015a).

An increasing number of studies have investigated the impact of the natural environment on physical activity behaviours and health. Systematic reviews have found that there is a positive correlation between the availability of local green space and physical activity levels (Kaczynski & Henderson, 2007; Lee & Maheswaran, 2011; Moran et al., 2014). The mechanisms for this, however, remain unclear.

Recently, a schematic model of the motivational processes underlying the relationship between natural environments and physical activity was proposed (Calogiuri & Chroni, 2014). In a compelling argument, the authors suggested two distinct motivational pathways for visiting local green space: firstly, the active use of natural environment and secondly as a contributor to active living. Consistent with these pathways, this study explores how feelings about nature influence visits to local green space (active use) and the subsequent relationship this has on physical activity (active living). Specifically, we examine the influence of both objective and subjective measures of the local environment on visit frequency to local green space and the likelihood of meeting physical activity guidelines. We also explore the influence of visit frequency to local green space on physical activity levels.

The literature in this area has predominately focused on two examples of green spaces, namely natural environments and urban green spaces, or a combination of the two (Natural England, 2010). Natural environments are those that occur naturally on earth. They differ from urban green spaces in that they have had minimum human input in their design, creation, and maintenance (Natural England, 2010). Both are used as locations for recreational activities in modern society. For the purposes of this study, local green space is a combination of urban green space and natural environments near the home.

Many recreational activities that take place in local green space involve some form of physical activity such as walking, jogging, and play (D'Haese et al., 2015; Edwards & Tsouros, 2006; Giles-Corti et al., 2005). Even less intense activities like photography, reading, and fishing often require individuals to walk to desired locations. Thus, visit frequency to local green space may be positively associated with overall physical activity levels and subsequently the likelihood of meeting physical activity guidelines.

A recent review of the impact of local green space on physical activity found that there is a huge variety of research methods employed within the field, including objective and subjective measures of local green space (Calogiuri & Chroni, 2014). Studies using objective measures have predominately focused on specific locations and used a Geographical Information System to assess local green space (Coutts, Chapin, Horner, & Taylor, 2013; Khalil, 2014; Shanahan, Lin, Gaston, Bush, & Fuller, 2014). Using geographical information systems, researchers can analyse geographical data and categorise into various land uses (domestic buildings, roads, green space etc.). Conversely, subjective measures embrace self-report questionnaires to provide vital insight into individuals' perceptions of local green space. Requiring fewer resources, subjective measures enable investigation of some variables over much larger geographic areas (Bai et al., 2013; Hillsdon, Jones, & Coombes, 2011). Interestingly, when both objective and subjective measures have

been used to determine quantity of local green space in the same geographical area contemporaneously, discrepancies have been found between perceptions of park proximity and actual distance to park (Lackey & Kaczynski, 2009) as well as perceived versus actual quantity (Leslie, Sugiyama, Ierodiaconou, & Kremer, 2010).

To date, only a small number of studies have investigated the relationships between objectively measured local green space, physical activity, and health on a national scale (Maas et al., 2009; Mytton et al., 2012; Ord et al., 2013; Witten et al., 2008). These studies have found mixed results. For example, in the Netherlands, the quantity of local green space within a one km radius of home address was associated with 15 indicators of wellbeing (Maas et al., 2009). In contrast, neighbourhood park access was not associated with BMI in New Zealand, although beach access was related to BMI (Ord et al., 2013).

Furthermore, two studies in the UK have also produced mixed results. In England, individuals who lived in the greenest quintile of England were 1.27 times (95% CI, 1.13 to 1.44) more likely to meet physical activity guidelines than individuals in the least green quintile (Mytton et al., 2012). In contrast, no association was found between local green space and meeting physical activity guidelines in Scotland (Ord et al., 2013).

A systematic review (Calogiuri & Chroni, 2014) suggested that perceptions or subjective measures of local green space access are stronger predictors of physical activity than environmental barriers such as actual proximity (e.g., (Bai et al., 2013; McGinn, Evenson, Herring, & Huston, 2007)). For example, perceived access to local green space has linked with physical activity levels in Canada (Lackey & Kaczynski, 2009) and Australia (Veitch et al., 2015). In the UK, a few localised studies have investigated the relationship between perceptions of local green space and green space usage (e.g., (Hillsdon et al., 2011; Kirri, Gardiner, & Huang, 2014)). Results from Oxford and Bristol found that most people were satisfied with accessibility to local

green space. In Bristol, however, despite good perceived access, only 31% of participants visited local green space on a weekly basis. This suggests that other factors are likely to play a crucial role in the actual use of local green space and in turn physical activity levels.

Beyond the role of perceived access, it is important to consider the perceived quality of local green space. Commonly reported as 'satisfaction with neighbourhood parks', evidence suggests perceived quality of local green space is positively related to physical activity (Bai et al., 2013; Van Cauwenberg et al., 2015). This further highlights the potential importance of perceptions of local green space for physical activity.

In addition to perceptions of quality and access, individuals' self-reported relationship with nature may be a crucial determinant of whether they engage in physical activity in local green space (termed Green Exercise). Evidence from recent studies suggests that nature relatedness (individual levels of connectedness with the natural world) plays an important role in engagement with nature and subsequent benefits (Lin, Fuller, Bush, Gaston, & Shanahan, 2014; Zhang, Howell, & Iyer, 2014). Indeed, nature relatedness has been shown to predict travel distance to parks (Lin et al., 2014), time spent in gardens (Lin et al., 2014), and psychological well-being (Zelenski & Nisbet, 2012). In their schematic model, Calogiuri *et al.* (Calogiuri & Chroni, 2014) proposed that feelings about nature influence intentions to visiting local green space.

In summary, there are many factors that influence the relationship between local green space and physical activity, including actual visits to the local green space. Objective (GIS measured quantity of local green space) and subjective (perceived access and quality) have been shown to predict visit frequency to local green space and overall physical activity. It is vital, however, to take a more nuanced approach to understand the role of perceptions in the relationship between local green space and

physical activity. No study has investigated which perceptions of local green space have greatest impact on visit frequency to local green space and subsequent physical activity. The aims of the study, therefore, were to examine: 1) which objective and perceptual indices of local green space predict visit frequency to local green space? 2) which objective and perceptual indices of local green space predict whether participants meet physical activity guidelines? and 3) if visit frequency to local green space predicts whether participants meet physical activity guidelines? It was hypothesised that perceived access and quality of local green space and nature relatedness would be stronger predictors of visit frequency to local green space and physical activity than objectively measured local green space. It was also hypothesised that the likelihood of meeting physical activity guidelines will increase in a dose-response pattern with visit frequency to local green space.

### *Method*

The data used in the present study were extrapolated from a larger research project examining the effects of the environment and exercise on psychological health. Part of the project was conducted using an online questionnaire administered to participants in the 150,000-person Harris Poll panel of Great Britain. The research was approved by the University of Essex Research Ethics Committee and participants provided informed consent. Participants were selected at random from the base sample and invited by email to take part in the survey ($N$ = 22,950). Data from the responding sample were collected over a two-week period in late September 2011. Data collection was closed after two weeks as it reached the requested number of respondents.

**Participants**

This process yielded a sample of 2079 working age adults. In the current study, data were available for 1988 working age adults (997 males) ranging from 22 to 65 years (*M* = 43.19, *SD* = 11.46), which is the higher than the UK median of 39 years (Office of National Statistics, 2011). Only employed individuals were selected for this research to control for the impact of active commuting on visiting local green space and physical activity levels; 69.8% were in full-time employment, 18.1% were in part-time employment, and 12.2% were self-employed.

**Weather**

The UK Meteorological Office (Met Office, 2014) reported that in July and August 2011, mean temperatures were 0.5ºC to 1.0ºC below average across most of the UK. In contrast, during September, 2011 – during data collection – the mean temperatures were around 1.1 ºC above average, making it the sixth warmest September in 100 years. Throughout September, most of England experienced below average rainfall; some parts of Northern England and Scotland, however, received over 50% more rainfall than average (Met Office, 2014).

**Measures**

Self-reported health was assessed with a single item which asked “How would you rate your health in the last month?” Participants responded on a Likert scale from “1 = Terrible” to “7 Excellent”. This was included as a covariate in all statistical analyses alongside age and gender.

Objective representation of the local environment was given as % of local green space available near home. This was calculated to ward level (primary unit of electoral geography), using participants’ home postcodes and Geoconvert (an online

geography matching and conversion tool) (Office of National Statistics, 2001). For % of local green space, ward coded data were then entered into a database, available from CRESH.org.uk, which has previously been described (Richardson & Mitchell, 2010). In brief, the database used general land use across England, supplemented with a second database covering Scotland, Northern Ireland, and Wales and the coordination of information placed on the environment database (European Environment Agency, 2000). The database provided specific % of local green space, including all vegetated areas larger than 5 $m^2$ in area (excluding domestic gardens) for each ward in the UK. Green spaces included ranged from transport verges (narrow strip of land between carriageway and road boundary) and neighbourhood greens, to parks, playing fields and woodlands.

Perceived access to local green space was assessed by asking participants "How easy is it to get to the green space local to your home?" Participants responded from 1 = "Very difficult" to 7 = "Very easy". Perceived quality of local green space was assessed with a single item that asked "How would you rate the quality of your local accessible green spaces that are close to your home?" Participants responded from 1 = "Terrible" to 7 = "Excellent".

Nature relatedness was assessed using two sections of the Nature Relatedness Scale (Nisbet, Zelenski, & Murphy, 2008). The self and experience factors were extrapolated to form the NRS-14. The self and experience factor were used to reflect both how strongly people identify with the natural environment and the attraction people have to nature. The perspective factor of the scale was excluded as we were not interested in global issues such as conservation and species survival rates. Participants were asked to report how they felt about 14 phrases that described their relationship with nature. Examples items included, "Even in the middle of the city, I notice nature around me", and "I am not separate from nature, but part of nature". Participants responded using a Likert scale format ranging from 1 = "disagree strongly"

to 5 = “agree strongly”. Where appropriate, responses were reversed so that higher scores indicated a greater nature relatedness. Nature relatedness was recorded as a mean of 14 items.

Visit frequency to local green space was assessed by asking participants “How often do you visit the green space closest to your home?” This was rated from 1 = “Every day” to 7 = “Never visit my local green space or any other green spaces”. This score was then reversed scored so that a higher frequency of visits was represented by a higher numerical value. Participants also indicated via multiple choice selection how they usually travelled to local green space, and how long it usually took them.

Self-reported physical activity levels were recorded using a short-form version of the International Physical Activity Questionnaire (IPAQ-SF; Booth et al., 2003). Participants were required to indicate how many days they undertook physical activity for more than 10 minutes. Subdomains were vigorous, moderate and walking. Furthermore, participants reported how many hours and minutes they usually spent on these activities on one of those days. Additionally, participants reported how many hours and minutes they would usually spend sitting on a week day.

**Data Analyses**

Raw data were converted into weekly physical activity levels using IPAQ-SF scoring guidelines (The IPAQ Group, 2005). The raw data were calculated into a weekly score described as multiples of the resting metabolic rate (METs). As recommended by IPAQ scoring guidelines, some of the raw data was truncated to reduce potential outliers. Above 180 minutes in all categories is considered to be unlikely, suggesting participants’ misinterpreted the question. In accordance with guidelines (The IPAQ Group), therefore, all moderate minutes that were between 180 and 299 were reduced to 180; those above 299 were divided by 7. Also, vigorous

minutes over 180 were divided by 7 and walking minutes over 180 were reduced to 180. For the data analysis, participants were dichotomised according to whether they achieved at least 600 MET.min per week or not. Those participants who achieved below 600 MET.min per week in total were classified as not meeting the current minimum requirements for a healthy lifestyle (in accordance with (Department of Health, 2011)) and in the low category using IPAQ scoring guidelines (The IPAQ Group, 2005).

A number of variables were included in the study as covariates: age, subjective health, gender, road coverage, environmental deprivation, and active travel to both work and local green space. Environmental Deprivation (at ward level) was obtained from a database that is available on CRESH.org (Richardson, Mitchell, Shortt, Pearce, & Dawson, 2010). In summary, ward level measurements were calculated for a variety of environmental dimensions that impact upon health (air pollution, climate, UV radiation, industrial facilities, and green space). Each ward was given a score from -2 to +3, with +3 indicating most deprived environments. For this study, scores of environmental deprivation were reversed so that the most deprived areas had the lowest score.

Road Coverage was calculated by cross referencing ward codes against general land use database (Office of the Deputy Prime Minister, 2001) across England[i] to give the amount of road coverage in each ward. This was converted to a percentage of the total land area in each ward. For both environmental deprivation and road coverage, participants' home post codes were converted to wards using Geoconvert.

Active travel to work was assessed by asking participants "How do you usually travel to work? Tick all that apply". Any participant who ticked walk or cycle were classified as active commuters. Active travel to local green space was assessed by asking participants "How do you usually travel to your local green space? Tick all that

apply" Any participants who ticked walk or cycle were classified as active travellers to local green space.

All data analysis was carried out using IBM SPSS Statistics 20. Three regression models were run. First, an ordinal regression model was run to determine whether objective (% local green space) and subjective (perceived access, perceived quality, and nature relatedness) measures predicted frequency of visits to local green space. Additional demographic, objective, and subjective variables were included as covariates in the model (see Table 2.2).

Second, a binary logistic regression was run to determine whether objective (% local green space) and subjective (perceived access, perceived quality, and nature relatedness) measures predicted the likelihood of meeting current UK physical activity guidelines. Additional demographic, objective, and subjective variables were included as covariates in the model (see Table 2.3).

Finally, another binary logistic regression was run to determine if visit frequency to local green space predicted the likelihood of meeting current UK physical activity guidelines. Age, gender and health were included as covariates in the third model. Nagelkerke $R^2$ tests were run to assess how much of the variance in the outcomes could be accounted for by the models. Statistical significance was accepted at $p< 0.05$ throughout the analyses.

### *Results*

The 1379 urban wards represented in the study had a mean green space coverage of 52.7% (95% CI, 51.5 to 53.9). This is nearly 10% lower than the UK national average of 62.6%. Furthermore, the wards had a mean road coverage of 10.1% (95% CI, 3.7% to 16.6%) and a mean environmental deprivation score of 0.46 (95% CI, -0.47 to 1.38)

Overall, participants responded favourably towards perceived access (*M* = 6.15, *SD* = 1.14) and perceived quality (*M* = 5.41, *SD* = 1.23) of local green space; 90.1% of participants reported at least 'somewhat easy' access to local green space and 76.1% of participants reported perceived quality of local green space as at least 'good'. Participants reported a mean nature relatedness score of 3.29 (*SD* = 0.73). This is comparable to nature relatedness scores reported in previous literature (Martyn & Brymer, 2014; Nisbet & Zelenski, 2013).

In this study, engagement with the natural environment is indicated by visit frequency to local green space. In total, 67.7% of participants reported visiting local green space at least a 'few times a month'. Active travel to local green space was reported by 85.6% of participants and the vast majority reported travel duration to local green space of less than 20 minutes (86.5%). Additionally, 18.4% of participants reported actively commuting to their place of work.

In total, 75.5% of participants (77.7% of men and 73.2% of women) reported meeting the current UK physical activity guidelines of at least 600 MET.min per week (Department of Health, 2011). This is higher than national averages (66% of men and 56% of women; (Health Survey for England, 2013)). Subsequently, 24.5% of participants did not complete enough MET.min per week to sustain a healthy lifestyle. Participants obtained the most amount of MET.min through walking (*M* = 54.7%).

**What predicts visit frequency to local green space?**

An ordinal regression was run to predict visit frequency to local green space based on perceptions and objective measures of local green space (Table 2.1). A Nagelkerke $R^2$ of 0.226 indicates that the model explained 22.6% of the variation in visit frequency. After controlling for covariates, nature relatedness was the strongest predictor of visit frequency to local green space. An increase in nature relatedness

was associated with an increase in the odds of visiting local green space more frequently (OR = 2.234, 95% CI, 1.937 to 2.581). Perceived quality of local green space also significantly predicted visit frequency (OR = 1.537, 95% CI, 1.388 to 1.704), but perceived access did not.

**Table 2.1** Odds ratios of visit frequency to local green space

| | | [a]OR | [b]95% CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| **Covariates** | Age | 0.994 | 0.985 | 1.002 |
| | Health | 1.071 | 0.985 | 1.165 |
| | Gender | 1.003 | 0.832 | 1.210 |
| | % of Road Coverage | 1.011 | 0.976 | 1.047 |
| | Environmental Deprivation | 1.082 | 0.970 | 1.206 |
| | Active Travel to Work | 1.125 | 0.915 | 1.384 |
| **Objective** | % of Local Green Space | 1.006 | 0.998 | 1.015 |
| **Subjective** | Perceived Access | 1.106 | 0.994 | 1.230 |
| | Perceived Quality | 1.537* | 1.388 | 1.704 |
| | Nature Relatedness | 2.234* | 1.937 | 2.581 |

*Note*. $R^2$=.226 (Cox and Snell), .226 (Nagelkerke). Model $\chi^2$ (10) = 348.022, p<0.01.
[a]Odds Ratios, [b]95% Confidence Intervals, * indicates significance at p<0.01.

**What predicts whether participants meet physical activity guidelines?**

A binary logistic regression was run to determine which variables predicted the likelihood of meeting physical activity guidelines (see Table 2.2); the model explained 13.1% of the variance (Nagelkerke $R^2$ = 0.131). After controlling for covariates, nature relatedness was the only significant predictor of meeting physical activity guidelines (OR = 1.268, 95% CI, 1.128 to 1.424). Neither perceptions of local green space (Access and Quality) nor objectively measured green space were significant predictors. Of the covariates, subjective health and active travel to both work and local green space were significant.

**Table 2.2** Odds ratios of meeting physical activity guidelines

| | | [a]OR | [b]95% CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| **Covariates** | *Age* | 0.994 | 0.982 | 1.006 |
| | *Health* | 1.268* | 1.128 | 1.424 |
| | *Gender* | 0.779 | 0.601 | 1.010 |
| | *% of Road Coverage* | 1.017 | 0.969 | 1.067 |
| | *Environmental Deprivation* | 0.997 | 0.859 | 1.158 |
| | *Active Travel to Work* | 1.971* | 1.441 | 2.695 |
| | *Active Travel to Local Green Space* | 1.600* | 1.076 | 2.378 |
| **Objective** | *% of Local Green Space* | 0.994 | 0.982 | 1.006 |
| **Subjective** | *Perceived Access* | 0.993 | 0.856 | 1.151 |
| | *Perceived Quality* | 1.042 | 0.908 | 1.197 |
| | *Nature Relatedness* | 1.268* | 1.128 | 1.424 |

*Note.* $R^2$=.089 (Cox and Snell), .131 (Nagelkerke). Model $\chi^2$ (11) = 125.680, p<0.01.
[a]Odds Ratios, [b]95% Confidence Intervals, * indicates significance at p<0.01.

**Does visit frequency to local green space predict whether participants meet physical activity guidelines?**

A binary logistic regression was run to predict the likelihood of meeting physical activity guidelines based upon visit frequency to local green space. The model explained 16.8% of the variation in whether participants met physical activity guidelines (Nagelkerke $R^2$ = 0.168). As illustrated by Figure 2.1, as visit frequency to local green space increased so did the likelihood of achieving physical activity guidelines (compared to never going).

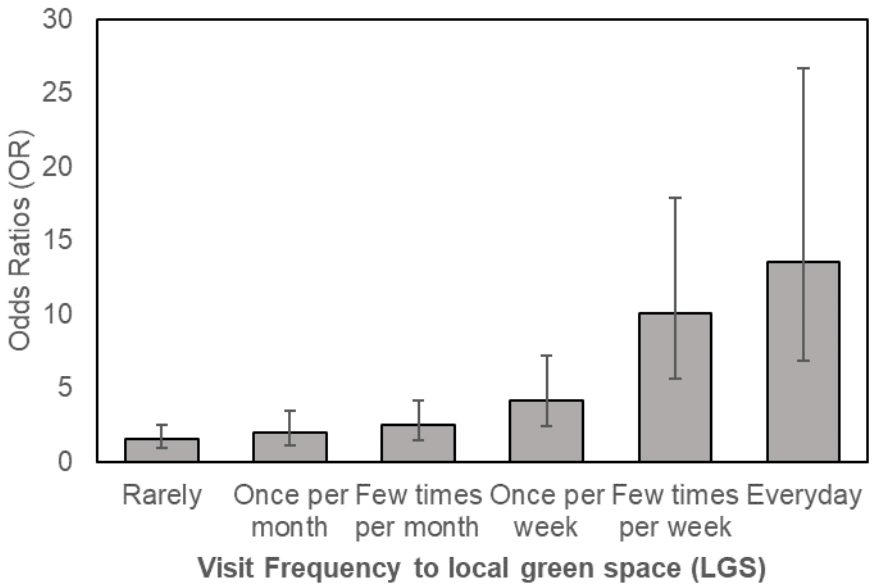



**Figure 2.1** The odds ratios (OR) and 95 % Confidence Intervals of meeting physical activity guidelines (600 MET.min per week), compared with never going to local green space.

### *Discussion*

This study found that as the number of visits to local green space increased so did the odds ratio of meeting physical activity guidelines. The findings also highlight the importance of nature relatedness, which was the strongest predictor of both visit frequency to local green space and meeting physical activity guidelines. In contrast, objectively measured quantity of local green space was not a significant predictor of visit frequency to local green space or meeting physical activity guidelines. Furthermore, perceived quality and perceived access did not significantly predict the likelihood of meeting physical activity guidelines, but perceived quality of local green space did significantly predict visit frequency.

The current research was the first nationwide study to examine the relationship between local green space, visits to local green space, and physical activity in the UK. Previous studies (see Calogiuri & Chroni, 2014 for a review) have often investigated visits to all natural or green spaces regardless of proximity to home. This study specifically asked respondents about local green space closest to home. Local green

spaces are places that are close to homes and therefore should be accessible for the majority irrespective of whether the household owns a car.

Furthermore, the current study was the first study to assess nature relatedness, perceptions of local green space, and objectively measured local green space as predictors of visit frequency to local green space and physical activity levels. Not only does this expand upon the existing literature regarding objectively measured local green space and physical activity, the findings highlight the importance of subjective variables relating to local green space.

Within this study we examined the influence of subjective measures associated with local green space on green space usage. Consistent with previous research (Lin et al., 2014) we found that nature relatedness was positively associated with visit frequency to local green space. In fact, over and above a variety of independent variables and covariates, nature relatedness was the strongest predictor of visit frequency to local green space. In doing so, our evidence supports the schematic model proposed by Calogiuri *et al.* (2014), in which feelings about nature are related to intentions to visit local green space. It also supports the notion that visit frequency to local green space moderates the relationship between nature relatedness and psychological well-being (as highlighted by Zhang et al., 2014). Green exercise research suggests that physical activity in local green space can have a positive effect on many indices associated with psychological well-being (Barton & Pretty, 2010). Therefore, visiting local green space to be physically active (i.e. to do green exercise) is likely to increase psychological well-being and further investigation is warranted to assess what role nature relatedness has on this relationship.

The current findings suggest that perceptions of local green space may impact upon behaviour more than quantity of local green space. In addition to the influence of nature relatedness, perceived quality also significantly predicted visit frequency to local green space but objectively measured quantity of local green space did not. With

regards to perceived quality of local green space, previous research may give an indication of how this could be enhanced, with perceived attractiveness, perceived availability of features (Kaczynski et al., 2014) and park characteristics (Ries et al., 2009) all suggested to play an important role in the relationship between local green space and physical activity.

Neither perceived access nor perceived quality of local green space significantly predicted whether participants met physical activity guidelines. One possible explanation for this is the high percentage (75.5%) of participants who met physical activity guidelines (14.5% higher than the national average in England). In fact, males were 11.7% and females were 17.2% higher than the national average. This is most likely due to the sample being exclusively employed people. Current evidence suggests that those in formal employment were more likely to know the current recommendations for physical activity in the UK, and be physically active (Farrell, Hollingsworth, Propper, & Shields, 2014).

One of the main strengths of this study is the inclusion of both subjective and objective measures of local green space. Most previous studies in this area compared quantity of local green space (described as objectively measured quantity or perceived access) with physical activity. Our study added more robustness to this relationship with additional subjective measures. We expanded the limited research on nature relatedness and have shown its importance in the relationship between local green space and physical activity.

Against these contributions, some limitations should be noted. First, due to the correlational nature of the study, causality cannot be inferred in the observed relationships. Second, the study used a self-reported measure of physical activity. Although the IPAQ is well used in the literature, people often over-estimate physical activity levels (Rzewnicki, 2003). Furthermore, this study did not explore physical activity in detail. Had we also explored ‘green exercise’, as opposed to just overall

physical activity levels, we may have been able to provide stronger explanations for the results. Further investigation of green exercise, distinct from physical activity, is warranted to provide better understanding of the mechanisms between local green space, physical activity and health.

One further limitation is the double inclusion of objectively measured local green space: the environmental deprivation score - that was used as a covariate - was calculated in part using objectively measured local green space. This was deemed necessary as it included a variety of additional factors such as climate, and pollution etc.[ii]. Although efforts were made to account for environmental factors, the level of detail required to accurately portray the favourableness of home location for green exercise was beyond the reach of this study. For example, street lighting and pedestrian pathways that link housing areas to local green space may influence visit frequency.

As mentioned previously, the inclusion of only employed individuals does limit the ability to generalise the findings other populations e.g. unemployed, retired. Likewise, whilst active commuters were controlled for in statistical analysis, this analysis did not explore visiting green space during work hours, and the subsequent impact this may have had on physical activity levels. Additionally, we did not account for variations in employment type. Further work is needed to explore how the complexities of working life (location, activity levels, environment etc.) influence the relationships we found.

Results from this study show that on average participants had less local green space than the national average at ward level. Even though the percentage of employed people is about the same for rural and urban areas in England, the vast majority of people in England live in urban areas (81.5% of people in 2011). We suggest that the inclusion of only employed participants skewed the results towards more urbanised wards. It is therefore likely that the majority of participants reported

visits to urban green space rather than natural environments, although we do not have the data to confirm this.

### *Conclusion*

This is the first nationwide study to explore the relationship between local green space and physical activity. We found that visit frequency to local green space is associated with the likelihood of meeting overall physical activity guidelines, although we did not measure activity performed at local green spaces. Furthermore, subjective measures of local green space, and particularly nature relatedness, appear to be more important than objectively measured quantity of local green space for predicting both visit frequency to local green space and physical activity levels. As physical activity is known to have many positive health benefits, visiting local green space for green exercise could have a significant impact on Public Health.

# Chapter 3

# The Development of three questionnaires to assess beliefs about green exercise

A version of this chapter has been published as a research article. The reference for this is:

Flowers, E. P., Freeman, P, & Gladwell, V. F. (2017). The development of three questionnaires to assess beliefs about green exercise. International Journal of Environmental Research and Public Health. 14(10), 1172.

**Table 3.1** Thesis Map outlining chapter aims and key findings

| Ch | Aims | Key findings |
|---|---|---|
| 2 | • To investigate which perceptual and objective indices of local green space predict visit frequency to local green space<br>• To explore the relationship between visiting local green space and physical activity levels | • Perceived quality of local green space predicts visit frequency to local green space, whereas perceived access and amount of local green space did not.<br>• As visit frequency to local green space increases, so does the likelihood of meeting physical activity recommendations. |
| 3 | • To capture salient beliefs about green exercise<br>• To develop and provide initial evidence of validity for questionnaires to assess belief about green exercise and intentions to perform green exercise | |
| 4 | • To explore whether beliefs about green exercise predict visit frequency intention to perform green exercise<br>• To explore whether intention to perform green exercise predicts visit frequency to green space more than nature relatedness and/or perceptions of local green space | |
| 5 | • To assess the effectiveness of a promotional video to enhance the psychological benefits of green exercise<br>• To explore if a promotional video has any immediate effects on attitudes to green exercise | |
| 6 | • To assess the effectiveness of a promotional video to encourage people to do more green exercise<br>• To explore if a promotional video has an immediate effect on attitudes, or a lasting effect on beliefs and intentions towards green exercise. | |

### *Introduction*

Worldwide figures suggest that around 20% of males and 27% of females are insufficiently active (World Health Organisation, 2016). This is a concern for both public health and the economy, with conservative estimates suggesting that the global economic cost of inactivity is US$53.8b annually (Ding et al., 2016). Recently described as a "miracle cure" (Academy of Medical Royal Colleges, 2015), regular physical activity is well known to improve health (National Health Service, 2015) and prevent ill health (Haskell et al., 2007). Given the importance of physical activity, a wealth of literature has sought to identify the determinants of exercise behaviour, with individuals' beliefs and attitudes found to play a key role (Downs & Hausenblas, 2005b; Hagger, Chatzisarantis, & Biddle, 2002). Beliefs and attitudes have subsequently been targeted in physical activity interventions with positive effects observed on exercise behaviour and in turn physical and mental health (Darker, French, Eves, & Sniehotta, 2010; Parrott, Tennant, Olejnik, & Poudevigne, 2008). Beyond the overall value of exercise, however, physical activity that is performed in the natural environment (termed green exercise) may have enhanced health benefits (Calogiuri, Patil, & Aamodt, 2016; Fromel et al., 2017; Pretty, Griffin, & Sellens, 2003). To better understand the role of green exercise for health and well-being and to contribute to the development of green exercise interventions, therefore, it is vital to elucidate individuals' beliefs about green exercise. This current paper contributes to these issues by developing and providing initial evidence for the psychometric properties of three questionnaires that assess beliefs about green exercise.

Despite the promising evidence for the benefits of green exercise, little is known about how individuals' thoughts and feelings about green exercise influence participation and subsequent outcomes. This is surprising given the myriad of studies that have demonstrated the importance of understanding the beliefs about physical activity more generally (Downs & Hausenblas, 2005b; Hagger et al., 2002). A small

number of studies, however, have shown that perceptions of local green space may predict visit frequency more than quantity and proximity (Chapter 2; Bai et al., 2013; Lackey & Kaczynski, 2009; Leslie et al., 2010). Additionally, the New Ecological Paradigm (Dunlap & Van Liere, 1978) and Nature Relatedness Scale (Nisbet et al., 2008) are tools that have been developed to measure how people feel towards nature, but these have rarely been applied in the context of physical activity. Nevertheless, one recent study found that nature relatedness was a strong predictor of visit frequency to local green space (Chapter 2). An exploration of green exercise beliefs is needed to better understand how to augment engagement with green exercise behaviours.

The theory of planned behaviour (TPB) is an important framework that has been used to advance understanding of how cognitions influence physical activity behaviours generally (Hagger et al., 2002; Plotnikoff et al., 2011; Wankel & Mummery, 1993). Derived from the theory of reasoned action (Ajzen & Fishbein, 1980), the TPB assumes that intention to perform a behaviour is best predicted when individuals evaluate the behaviour positively (attitudes), believe peers will support the behaviour (subjective norm), and perceive the behaviour to be within their capabilities (perceived behavioural control; PBC). TPB factors can be assessed directly (e.g., by asking people to report attitudes, norms, and PBC) or indirectly (e.g., by asking people about specific behavioural beliefs and combining the scores with a paired evaluation of the belief) (see Figure 3.1). As such, indirect behavioural, normative, and control beliefs combine with evaluations of those beliefs to predict the respective direct measures of attitudes, subjective norms, and PBC. Not only does this enable correlational analyses to establish convergent validity, but also serves to capture the different underlying cognitive processes of each measure (Francis, Johnston, Eccles, Grimshaw, & Kaner, 2004). Despite concerns about the intention–behaviour gap, the TPB (Ajzen & Driver, 1991) has been the most successful approach in exercise psychology for predicting

participation from beliefs (Biddle, Mutrie, & Gorely, 2015). One meta-analysis revealed that nearly half of variance in physical activity intentions, and over a quarter of variance in physical activity behaviours could be explained by beliefs (Hagger et al., 2002).

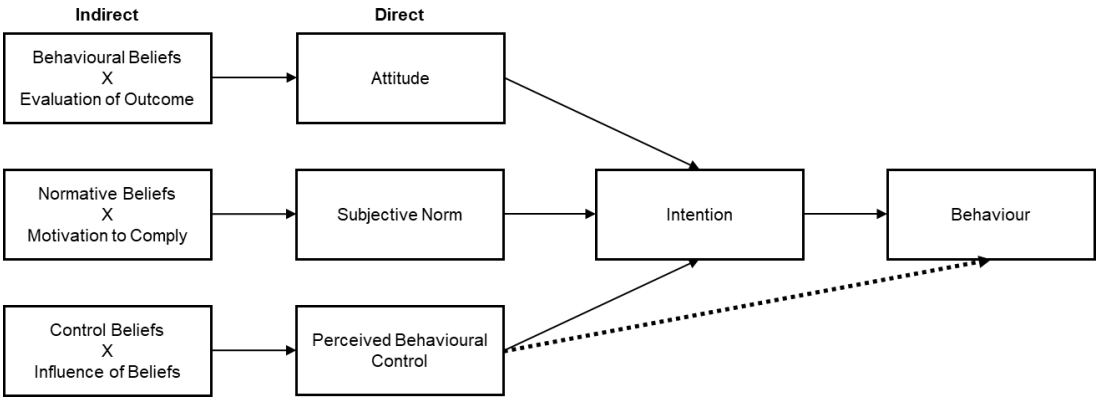



**Figure 3.1** The theory of the planned behaviour (adapted from Ajzen, 2006).

As a form of physical activity, some authors have hypothesised that green exercise can be modelled using the TPB (Calogiuri & Chroni, 2014; Nelson, Wright, Lowry, & Mutrie, 2008). Using a systematic review, Calogiuri and Chroni (2014) integrated the green exercise literature with the TPB to propose a schematic model of motivational processes underlying the relationship between natural environments and physical activity behaviours. The evidence collected supports using the TPB framework to explore the green exercise phenomenon. Moreover, empirical evidence—collected using ad hoc TPB questionnaires—has shown that beliefs may predict behaviours such as park visitation (Shrestha & Burns, 2009), participation in outdoor recreation programs (Kouthouris & Spontis, 2005), outdoor walking (Rhodes et al., 2006), and outdoor pool use (Middlestadt, Anderson, & Ramos, 2015). Although

these studies have enriched understanding into the role of beliefs on specific green exercise behaviours, the need to create measurement tools for individual studies does not encourage a proliferation of research into green exercise beliefs, and also impairs the ability to synthesise evidence across studies. A valid measure of beliefs about green exercise is necessary to deepen our understanding of the relationship between green exercise and health, understand variations in green exercise beliefs, and develop interventions to increases green exercise.

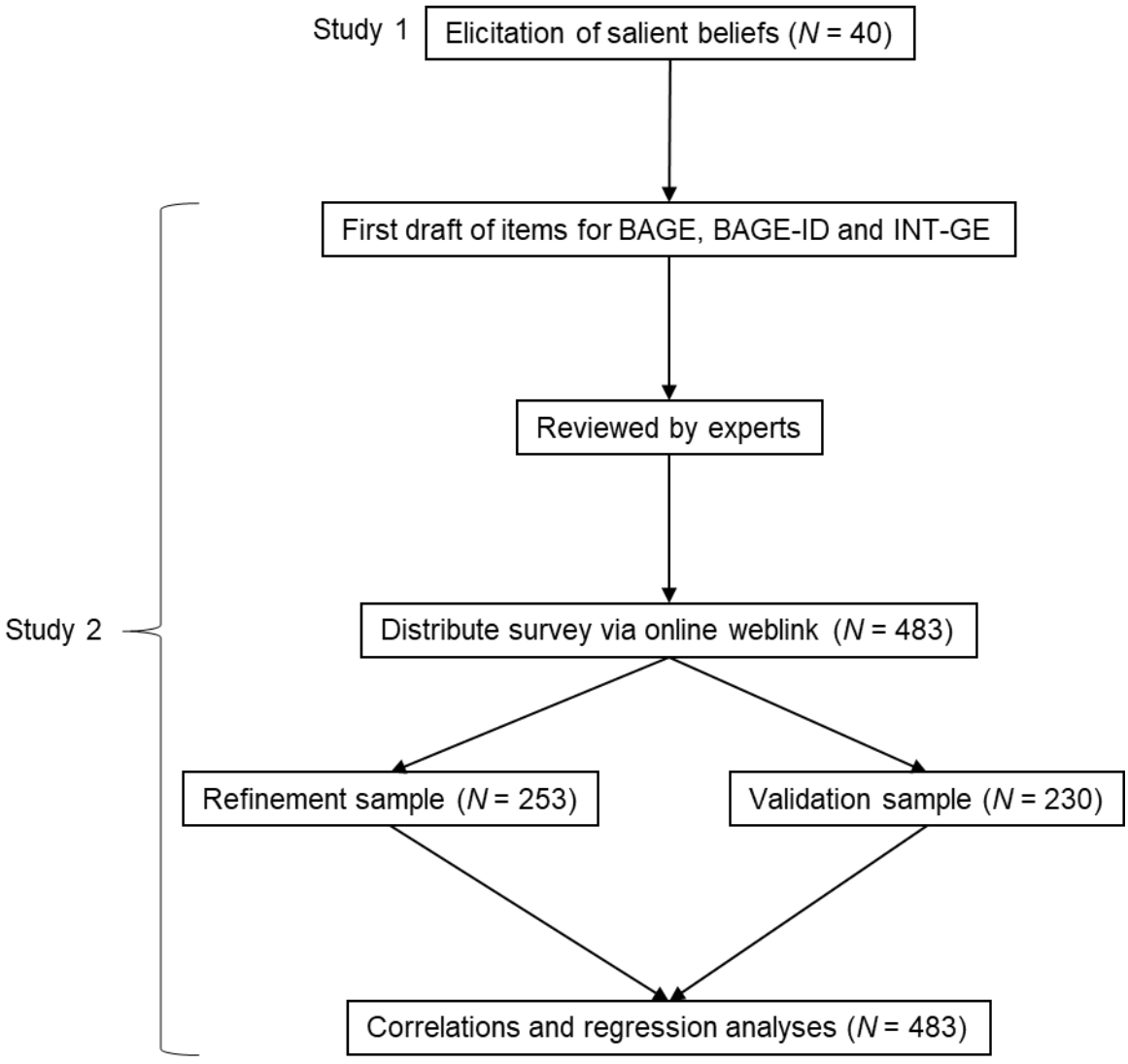



**Figure 3.2** Phases in the construction of the questionnaires.

## *Study 1*

Before creating a TPB questionnaire, an elicitation study is recommended to capture the salient beliefs that individuals hold toward a given behaviour (Ajzen & Driver, 1991; Ajzen & Fishbein, 1980; Oluka, Nie, & Sun, 2014). Authors suggest that a minimum sample of 25 participants is required to sufficiently ascertain a representation of salient belief amongst a population (Francis, Eccles, et al., 2004; Godin & Kok, 1996). Content analysis of responses to carefully worded open-ended questions provides the beliefs that underlie the indirect psychological factors of TPB (Francis, Eccles, et al., 2004). However, within the physical activity domain, elicitation studies are not routinely used in TPB research (Downs & Hausenblas, 2005a; Hagger et al., 2002). Indeed, out of 150 TPB studies exploring physical activity, only 47 included a prior elicitation of beliefs (Downs & Hausenblas, 2005a). The purpose of Study 1 was to elicit the salient beliefs individuals hold about green exercise.

### Method

#### *Participants*

The sample comprised 40 adults (22 women, 18 men, mean age 27.1 ± 10.5 years, age range 18–59 years). Participants were undergraduate students (50%), employed (35%), self-employed (7.5%), or other (7.5%).

#### *Measures*

In accordance with recommendations (Ajzen, 2006), questions were specifically worded to elicit beliefs about the (dis)advantages of green exercise and whether it is liked or disliked (behavioural beliefs), who would (dis)approve of green exercise (normative beliefs), and factors that facilitate or impede green exercise

behaviours (control beliefs). The questions were preceded by the following statement: “Some people like to spend free-time in local green spaces such as parks, woodlands and sports fields. When people do exercise at these places, we like to call it green exercise. We want to find out what people think about green exercise”. Example questions include: “What do you think are the disadvantages of doing green exercise as part of your weekly physical activity” and “What do you think would make it easy for you to do green exercise as part of your weekly physical activity?”. Each question was followed by five blank lines to allow for multiple responses.

### *Procedure*

The research was conducted in December 2015 following ethical approval from the University of Essex, Ethical Committee (15/BS/403/EF). All participants provided informed consent. A hard copy of the questionnaire was completed by 20 undergraduate students using convenience sampling at University of Essex, Colchester Campus. To reduce order effects, three versions of the questionnaire were created each with a different order of questions. An online version—with randomised question order—was also created using Qualtrics Software (Provo, UT, USA). This was distributed as a short web-link via various social media platforms, such as LinkedIn and Twitter. Data collection was closed once 20 participants had completed the online version and 20 had completed the hard copy version.

### *Analyses*

The lead author conducted line-by-line content analyses to find emerging themes from the responses. Next, all salient beliefs were categorised into the themes and corroborated with a second author. Following recommendations (Francis, Eccles,

et al., 2004), the advantages and disadvantages responses were coupled with the likes and dislikes responses respectively.

## Results

Beliefs pertaining to the advantages and likeable features of green exercise were the most commonly reported (*N* = 198, see Table 3.2). In contrast, only 11 responses were given around whether people would disapprove of them doing green exercise. Within the themes, poor weather was the most commonly cited disadvantage/dislikeable feature of green exercise (*N* = 61; 46%). However, climatic conditions were also reported 19 times as a facilitating factor of green exercise.

Overall, the most prevalent responses which reflected behavioural beliefs were poor weather (*N* = 61), fresh air (*N* = 32) and positive affect (*N* = 31). The most prevalent responses which reflected normative beliefs were family (*N* = 19), friends (*N* = 15), and health professionals approving of green exercise (*N* = 10). Finally, the most prevalent responses relating to control beliefs were weather (*N* = 20), free time (*N* = 20), and access (*N* = 16). There were no discernible differences in the beliefs elicited from the student and general population samples.

**Table 3.2** Descriptive Statistics for the Salient Beliefs Elicited in Study 1

| | **Total Beliefs** | *M (SD)* | | **Total Beliefs** | *M (SD)* | | **Total Beliefs** | *M (SD)* |
|---|---|---|---|---|---|---|---|---|
| **Advantages & Likes** | 198 | 4.9 (2.18) | **Disadvantages & Dislikes** | 133 | 3.4 (2.11) | **Approve** | 63 | 1.6 (1.00) |
| Fresh Air | 32 (16%) | | Poor weather | 61 (46%) | | Family | 19 (30%) | |
| Positive Affect | 31 (16%) | | Lack of equipment/facilities | 17 (13%) | | Friends | 15 (24%) | |
| Health and Fitness | 29 (15%) | | Safety concerns | 15 (11%) | | Health Professionals | 10 (16%) | |
| Change of Scenery | 23 (12%) | | Time consuming | 11 (10%) | | Sports clubs/Trainers | 5 (8%) | |
| Social | 20 (10%) | | Lack of available green space | 10 (7%) | | Environmental Groups | 5 (8%) | |
| Openness/Freedom | 13 (7%) | | Pollution Levels | 6 (4%) | | Other | 5 (8%) | |
| Costs/Resources | 13 (7%) | | Lack of privacy | 5 (4%) | | Employers/Colleagues | 4 (6%) | |
| Nature/Environment | 10 (5%) | | Can't find people to do it with | 3 (2%) | | | | |
| Type of activity | 8 (4%) | | Lack of motivation | 3 (2%) | | | | |
| Access/Availability | 8 (4%) | | Other | 3 (2%) | | | | |
| Other | 6 (3%) | | | | | | | |
| Weather/Climate | 5 (3%) | | | | | | | |
| **Disapprove** | 11 | 0.30 (0.45) | **Easy** | 65 | 1.6 (1.19) | **Difficult** | 68 | 1.7 (1.22) |
| Gym Users | 5 (42%) | | Access/Availability | 16 (24%) | | Weather | 20 (29%) | |
| Other | 4 (33%) | | Weather | 14 (21%) | | Time | 20 (29%) | |
| Gym Companies | 3 (25%) | | Facilities/Equipment | 11 (17%) | | Access/Availability | 10 (15%) | |
| | | | Free time | 9 (14%) | | Facilities/Equipment | 8 (12%) | |
| | | | Other | 6 (9%) | | Activity Groups | 5 (7%) | |
| | | | Transport | 5 (8%) | | Lack of motivation | 3 (4%) | |
| | | | Organised Activity | 5 (8%) | | Other | 2 (3%) | |

*Note*. *M (SD)* = Mean (standard deviation) of beliefs elicited per person. Advantages & Likes = features of green exercise that are perceived favourably. Disadvantages & Dislikes = features of green exercise that are perceived unfavourably. Approve = individuals who would approve of green exercise. Disapprove = individuals who would disapprove of green exercise. Easy = features that would make green exercise easy to do. Difficult = features that would make green exercise difficult to do.

## *Study 2*

The beliefs elicited in Study 1 provided the foundation for the indirect questionnaire in Study 2. According to Oluka et al. (2014), this is an essential criterion in developing TPB questionnaires. Three separate questionnaires were developed to assess attitudes, subjective norms, and PBC both indirectly and directly, along with intention to perform green exercise: the Indirect Beliefs about Green Exercise Questionnaire (BAGE-ID), the Beliefs about Green Exercise Questionnaire (BAGE), and the Intention to Perform Green Exercise Questionnaire (INT-G).

### Method

#### *Initial Scale Construction*

Adhering to TPB principles, themes from the elicitation study were used to inform the development of the items for the BAGE-ID (Oluka et al., 2014). As per recommendations (Francis, Eccles, et al., 2004), over 75% of salient beliefs elicited were covered in the questionnaire items. The responses from each elicitation question corresponded directly to a particular TPB factor in the BAGE-ID: responses from the (dis)advantages/(dis)likes questions provided the themes for the behavioural belief items, (dis)approve questions related to normative beliefs, and easy/difficult questions related to control beliefs. Furthermore, each factor in the BAGE-ID contained particular question types: behavioural beliefs consisted of both instrumental and experiential evaluations of green exercise; normative beliefs consisted of injunctive and descriptive evaluations of norms; and control beliefs consisted of self-efficacy and controllability items. As per the guidelines (Francis, Eccles, et al., 2004), each belief item was paired with an evaluation item that reflected the same theme.

The BAGE and INT-GE were developed using TPB measurement guidelines (Ajzen, 2006; Francis, Eccles, et al., 2004). Items in the BAGE were worded to reflect direct beliefs about attitudes, subjective norms, and PBC towards green exercise.

Items in the INT-GE were based on pre-existing phrases from (Francis, Eccles, et al., 2004). At least five items (or pairs of items in the BAGE-ID to reflect beliefs and the evaluations of those beliefs) were created by the lead author for each TPB factor. All items were reviewed for wording and relevance by three authors who have previously published peer-reviewed green exercise research. After some minor alterations, the questionnaires were completed by two non-academic professionals who provided external feedback; no further modifications were made. The BAGE-ID, BAGE, and INT-GE consisted of 32 (16 pairs), 16, and 5 items respectively.

*Indirect beliefs about green exercise (BAGE-ID)*

The 32 items in the BAGE-ID operated in pairs. In the indirect measure of attitudes, six behavioural beliefs (responded to on a 1 to 7 scale) were multiplied with six evaluations of outcomes (responded to on a −3 to +3 scale). Therefore, each pair of items produced a single datum from −21 to +21. For example, the response to "when I do Green Exercise, I feel better about myself afterwards (1) Strongly Agree to (7) Strongly Disagree" was multiplied by the response to "feeling better about myself after Green Exercise is… (−3) Extremely Undesirable to (+3) Extremely Desirable". For the indirect measure of subjective norm, five normative beliefs (−3 to +3) were multiplied with motivation to comply (1 to 7). For example, "My friends think I should do Green Exercise (−3) Strongly Disagree to (+3) Strongly Agree" was paired with 'My friends approving of me doing Green Exercise is… (1) Not at all Important to (7) Extremely Important'. For the indirect measure of PBC, five control beliefs (1 to 7) were multiplied with perceived power of beliefs (−3 to +3). For example, "The amount of green space in my local area influences my decision to do Green Exercise (1) Strongly Agree to (7) Strongly Disagree" was paired with "Having more local green space would make me more likely to do Green Exercise (−3) Very Unlikely to (+3) Very Likely".

*Direct beliefs about green exercise (BAGE)*

Each of the 16 items in the BAGE had a response scale of 1 to 7. The attitudes factor consisted of six items assessed on a bipolar scale of adjectives. An example item and response scale were: "Doing Green Exercise as part of my weekly physical activity is… (1) Pleasant to (7) Unpleasant". The subjective norms factor included five items that were all scaled from (1) Strongly Disagree to (7) Strongly Agree. For example, "People often ask me to do Green Exercise with them…". The PBC factor also had five items; four items were scaled from (1) Strongly Agree to (7) Strongly Disagree, and one item was scaled from (1) Very Difficult to (7) Very Easy. For example, "I am confident I could do Green Exercise if I wanted to… (1) Strongly Disagree to (7) Strongly Agree".

*Intentions (INT-GE)*

The INT-GE consisted of five items measured on a 7-point scale; four items were scaled from (1) Strongly Agree to (7) Strongly Disagree, and one item was scaled from (1) Very Unlikely to (7) Very Likely. An example item was "I want to do Green Exercise at least once per week for the next four weeks… (1) Strongly Disagree to (7) Strongly Agree".

*Participants*

The total sample comprised 483 adults (306 women, $M_{age}$ 45, SD 16 years, age range 18–83 years). The majority of the participants were employed (60.5%), with the remaining participants being retired (18.6%), self-employed (8.1%), students (6.8%), or other (6.0%). Additionally, the majority of participants reported their ethnicity as white (95.4%). Over half of participants (52%) reported a household

income less than £49,999, 38% reported over £50,000, and 10% reported not knowing or did not wish to say.

For the analyses, the participants were randomly divided into two samples: a refinement sample ($N$ = 253) and a validation sample ($N$ = 230). There was a significant difference in the age for the refinement ($M$ = 48.6 ± 16.5 years) and validation ($M$ = 41.9 ± 14.9 years) groups, $t$ (479) = 4.62, $p < 0.01$. There was no significant difference in gender split ($\chi^2$ (1) = 2.13, $p > 0.05$) or income ($\chi^2$ (7) = 4.85, $p > 0.05$).

*Procedure*

The research was conducted between February and June 2016 following ethical approval from the University of Essex, Ethical Committee (16/BS/420/EF). All participants provided informed consent. An online survey was created using Qualtrics Software (Provo, UT, USA). The survey was primarily distributed as a short web-link via email to contacts on social media via the lead researchers personal accounts, and internet messaging services to professional networks. It was also marketed via two specialist participant recruitment websites: callforparticipants.com and findparticipants.com. On the first, it was placed as a static advert, and on the second it was distributed to 219 individuals who had registered to receive such surveys. Participants provided demographic information before completing all items from BAGE-ID, BAGE, and INT-GE questionnaires. All items within the three questionnaires were randomised to reduce order effects.

*Analyses*

Initially, data from the refinement and validation samples was screened for non-normality, missing data, and outliers. Screening revealed multivariate non-normality and less than 1% missing data. Missing data was imputed using the

regression method available on IBM SPSS 23 (Chicago, IL, USA) and constrained to match questionnaire item response options (i.e., 1 to 7/−3 to +3 in whole numbers). Where appropriate, items were recoded so that higher numbers reflected stronger agreement with the item. Paired items in the BAGE-ID were multiplied.

Confirmatory factor analyses with maximum likelihood estimation were then performed on IBM AMOS 23 (Chicago, IL, USA) to assess the factorial validity of the BAGE-ID, BAGE, and INT-GE in turn. Initially, analyses were conducted on the refinement sample. A three-stage sequential model testing approach was adopted separately with the BAGE-ID and BAGE in the refinement sample (Joreskog, 1993), whereas a single stage was used for the INT-GE. First, to assess convergent validity, single-factor models of attitudes, subjective norms and PBC were run individually. Overall model fit and individual item indices (described below) were checked and where necessary items were deleted and the models re-examined.

Second, each subscale within a questionnaire was paired in turn with all subscales in that questionnaire and two-factor models were tested. This allowed identification of ambiguous items. Overall fit indices of each model were considered along with modification indices which indicated whether the fit could be improve if items were freed to cross-load on another subscale. Third, all subscales within a questionnaire were included in a three-factor model and model fit and individual item indices were examined. The final models for the BAGE-ID, BAGE, and INT-GE identified using the refinement sample were then re-tested in the validation sample in turn.

Overall model fit was assessed using numerous indices. Following recommendations (Enders, 2002), Bollen–Stine bootstrapping was used to account for non-normality, thus producing a Bollen-Stine chi-squared score ($BS\chi^2$) for overall model fit. Additionally, the comparative fit index (CFI), Tucker–Lewis index (TLI), and

root mean square error of approximation (RMSEA) were also used to examine model fit from three different classes (Hu & Bentler, 1999; Joreskog, 1993).

Consistent with recommendations (Hu & Bentler, 1999; Jackson, Gillaspy Jr, & Purc-Stephenson, 2009), scores above 0.95 for the CFI and TLI, and scores below 0.6 for the RMSEA were considered as indicators of good model fit, although these were not applied as "golden rules" (Marsh, Hau, & Wen, 2004). Beyond overall model fit, examination of modification indices, factor loadings, and standardised residuals were screened to help identify poorly fitting items and guide model improvement. Following suggestions (Jöreskog & Sörbom, 1996; Stevens, 2009), modification indices above 7, standardised residuals greater than an absolute value of 2, and factor loadings below 0.40 were considered a concern.

Beyond examining the factorial validity of the BAGE-ID, BAGE, and INT-GE, additional analyses were conducted to further assess the psychometric properties of the instruments. First, to account for greater reliability of items with higher weights, composite reliability was calculated using a formula adapted from Fornell and Larcker (1981). Scores above 0.60 were considered acceptable. Using the entire sample ($N$ = 483), parallel-form reliability was assessed by using Pearson's correlation analyses to explore if beliefs obtained indirectly (BAGE-ID) correlated with direct measures of attitudes, subjective norms, and PBC (BAGE). A forced entry regression analysis was also conducted to assess whether the three factors from the BAGE-ID predicted intention (INT-GE). The process was repeated for the BAGE. Statistical significance was accepted at $p < 0.05$ in the correlation and regression analyses.

## Results and Discussion

*Validation of the instruments with the refinement sample*

*BAGE-ID*

The fit statistics and factor loadings at the single-factor stage for the initial BAGE-ID are shown in Table 3.3. Mixed results were found. All the BS$\chi^2$ to degrees of freedom ratios were below 2, CFI values were 0.91–0.98, TLI values were 0.82–0.97, and RMSEA values were 0.06–0.09. For the indirect measure of attitudes, all items had reasonable factor loadings (>0.54) and were subsequently retained at this stage. For the indirect measure of subjective norms, the item relating to current or potential employers had a low factor loading (0.15) and was removed. This may be due to a disparity between the employment rate of the sample (68.1%) and the general population (74.5%; Office for National Statistics, 2017). The health professionals item also had a low factor loading but was retained at this stage as the overall model fit was good following deletion of the employer item (CFI = 1.00, TLI = 0.99, and RMSEA = 0.03). For the indirect measure of PBC, items relating to the weather and free time were removed due to low factor loadings (.15 and −0.08, respectively). As with attitudes and subjective norms, once the items with the lowest factor loadings were removed, the overall model fit improved. Therefore, the individual factors were deemed to have sufficient convergent validity to progress to the paired-factor stage.

At the paired-factor stage, the factors were paired into three models (Attitudes × Subjective Norms, Attitudes × PBC, and Subjective Norms × PBC). All of the paired-factor models had good model fits (Table 3.4). The BS$\chi^2$ to degrees of freedom ratios were below 2, CFI values were 0.93–0.98, TLI values were 0.90–0.97, and RMSEA values were 0.04–0.09. As the overall fits were good and no items had particularly poor factor loadings, the factors progressed onto the final model. This included a combination of all three factors: indirect measures of attitudes, subjective norms, and PBC. The full three-factor model had a good model fit (BS$\chi^2$/df = 1.10, CFI = 0.97 TLI

= 0.96, and RMSEA = 0.05), and all factor loadings were above 0.40 (see Table 3.5). Further, the attitudes factor had good composite reliability (ρc = 0.83), whereas subjective norms and PBC had reasonable composite reliability (both ρc = 0.63).

**Table 3.3** Fit Statistics and Factor Loadings of Single-Factor Models of the Indirect Beliefs about Green Exercise (BAGE-ID)

| Factor and Items | Factor Loadings | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|---|
| Indirect measure of Attitudes | | 10.84 | 9 | .13 | .98 | .97 | .06 |
| When I do Green Exercise, I feel like I am getting fresh air | .55 | | | | | | |
| When I do Green Exercise, I feel better about myself afterwards | .85 | | | | | | |
| Green Exercise is good for my health | .60 | | | | | | |
| Green Exercise is good for my fitness | .60 | | | | | | |
| Doing Green Exercise helps me feel positive about myself | .82 | | | | | | |
| Green Exercise is enjoyable | .60 | | | | | | |
| Indirect measure of Subjective Norms | | 6.23 | 5 | .05 | .94 | .89 | .08 |
| Health professionals would (……...) of me doing Green Exercise | .31 | | | | | | |
| My friends think I should do Green Exercise | .64 | | | | | | |
| My family think I should do Green Exercise | .83 | | | | | | |
| My peers do Green Exercise | .48 | | | | | | |
| Current or potential employers would approve of me doing Green Exercise | .15 | | | | | | |
| Indirect measure of Perceived Behavioural Control | | 6.73 | 5 | .06 | .91 | .82 | .88 |
| The weather influences my decision to do Green Exercise | .02 | | | | | | |
| The amount of free time I have influences my decision to do Green Exercise | -.08 | | | | | | |
| The amount of green space in my local area influences my decision to do Green Exercise | .70 | | | | | | |
| The facilities at my local green space influence my decision to do Green Exercise | .67 | | | | | | |
| Safety at my local green space influences my decision to do Green Exercise | .48 | | | | | | |

*Note.* *N* = 253. BS$\chi^2$ = Bollen-Stine chi-squared. CFI = comparative fit index. TLI = Tucker-Lewis Index. RMSEA = root mean square error of approximation. All items were scored from *Strongly Disagree* to *Strongly Agree*.

**Table 3.4**

*Fit Statistics for Two-Factor and Three-Factor Model of the Indirect Beliefs about Green Exercise (BAGE-ID)*

| Factor | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|
| Attitudes x Subjective Norms | 28.83 | 26 | .03 | .96 | .95 | .06 |
| Attitudes x Perceived Behavioural Control | 32.60 | 26 | .00 | .93 | .90 | .09 |
| Subjective Norms x Perceived Behavioural Control | 7.55 | 8 | .15 | .98 | .97 | .04 |
| Three-factors | 44.91 | 41 | .09 | .97 | .96 | .05 |

*Note.* $N$ = 253. BS$\chi^2$ = Bollen-Stine chi-squared. CFI = comparative fit index. TLI = Tucker-Lewis Index. RMSEA = root mean square error of approximation.

**Table 3.5** Descriptive Statistics, Measurement Error Variances, Factor Loadings and Composite Reliabilities for the Indirect Beliefs about Green Exercise (BAGE-ID)

| | Refinement Group (*N* = 253) | | | | Validation Group (*N* = 230) | | | |
|---|---|---|---|---|---|---|---|---|
| | Var(e) | Factor Loadings | | | Var(e) | Factor Loadings | | |
| Items | | ATT | SUB | PBC | | ATT | SUB | PBC |
| When I do Green Exercise, I feel like I am getting fresh air | .61 | .63 | | | .72 | .53 | | |
| When I do Green Exercise, I feel better about myself afterwards | .37 | .79 | | | .24 | .87 | | |
| Green Exercise is good for my fitness | .47 | .72 | | | .69 | .56 | | |
| Doing Green Exercise helps me feel positive about myself | .49 | .72 | | | .31 | .83 | | |
| Green Exercise is enjoyable | .58 | .65 | | | .65 | .59 | | |
| My friends think I should do Green Exercise | .43 | | .75 | | .61 | | .62 | |
| My family think I should do Green Exercise | .63 | | .61 | | .25 | | .87 | |
| My peers do Green Exercise | .82 | | .43 | | .79 | | .46 | |
| The amount of green space in my local area influences my decision to do Green Exercise | .56 | | | .66 | .56 | | | .66 |
| The facilities at my local green space influence my decision to do Green Exercise | .73 | | | .52 | .50 | | | .71 |
| Safety at my local green space influences my decision to do Green Exercise | .61 | | | .62 | .77 | | | .48 |
| Mean response within factors (standard deviation) | | 15.65 (4.66) | 2.89 (3.92) | 2.31 (4.39) | | 14.28 (5.10) | 2.62 (3.87) | 3.31 (3.76) |
| Composite Reliability | | .83 | .63 | .63 | | .81 | .70 | .65 |

*Note.* ATT = Attitudes. SUB = Subjective Norms. PBC = Perceived Behavioural Control. Var(e) = Measurement Error Variance. All items were scored from *Strongly Disagree* to *Strongly Agree*.

*BAGE*

The fit statistics and factor loadings at the single-factor stage for the initial BAGE are shown in Table 3.6. Mixed results were found. All the BS$\chi^2$ to degrees of freedom ratios were below 2, CFI values were 0.89–0.95, TLI values were 0.77–0.90, and RMSEA values were 0.06–0.14. For attitudes and subjective norms, the individual item with the lowest factor loadings was removed. For attitudes, even though the factor loading of the item relating to green exercise being (un)healthy was reasonable (0.54), as the modification indices (>22) revealed that the chi-squared statistic would improve if the item was removed. The overall model fit subsequently improved. For subjective norms, the item relating to social pressure to do green exercise had the lowest factor loading (0.17) and was subsequently removed. After the removal of the items, the subsequent model fits of the attitudes and subjective norms factors were good (CFI = 0.98–1.00, TLI = 0.96–1.05, and RMSEA = 0.00–0.08).

The PBC factor was more problematic as three items had poor factor loadings (<0.40). The individual item ("whether I do Green Exercise or not is entirely up to me") with the lowest factor loading was removed in the first instance, which resulted in a good model fit (CFI = 0.98, TLI = 0.94, and RMSEA = 0.04). Two additional items remained a concern, as both "the decision to do Green Exercise is beyond my control" and "I choose when and where I do Green Exercise" had low factor loadings (0.30 and 0.35, respectively). Given the good overall model fit and similar factor loadings, both items were retained at this stage pending further examination at the paired-factor and three-factor stages.

The fit statistics at the two-factor stage are shown in Table 3.7. All three paired-factor models had good fits: the BS$\chi^2$ to degrees of freedom ratios were below 2, CFI values were 0.95–0.98, TLI values were 0.92–0.97, and RMSEA values were 0.03–0.05. The factors were therefore progressed to the final three-factor model.

As shown in Table 3.8, the problematic items in the PBC factor still had poor factor loadings (both 0.27). Further inspection revealed that all modification indices were below 7 and standardised residuals were below 2, and that the full three-factor model had a good model fit (BS$\chi^2$/df = 1.05, CFI = 0.98, TLI = 0.97 and RMSEA = 0.03), so the items were retained for further examination in the validation sample. This kept the minimum number of items within each TPB factor to three, consistent with the three-indicator rule described by Blunch (2012). The attitudes factor had good reliability ($\rho c$ = 0.82), whereas subjective norms and PBC had reasonable reliability ($\rho c$ = 0.54 and 0.44, respectively).

**Table 3.6** Fit Statistics and Factor Loadings of Single-Factor Models of the Beliefs about Green Exercise (BAGE)

| Factor and Items | Factor Loadings | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|---|
| Attitudes | | 17.34 | 9 | .02 | .91 | .85 | .14 |
| Doing Green Exercise as part of my weekly physical activity is… | | | | | | | |
| (*Healthy* to *Unhealthy*) | .54 | | | | | | |
| (*Bad* to *Good*) | .62 | | | | | | |
| (*Pleasant* to *Unpleasant*) | .76 | | | | | | |
| (*Boring* to *Fun*) | .63 | | | | | | |
| (*Enjoyable* to *Unenjoyable*) | .69 | | | | | | |
| (*Beneficial* to *Harmful*) | .73 | | | | | | |
| Subjective Norms | | 5.58 | 5 | .15 | .95 | .90 | .06 |
| Most people who are important to me believe I should do Green Exercise | .44 | | | | | | |
| People often ask me to do Green Exercise with them | .57 | | | | | | |
| It is expected of me to do Green Exercise | .36 | | | | | | |
| I feel under social pressure to do Green Exercise | .17 | | | | | | |
| People that are similar to me do Green Exercise | .56 | | | | | | |
| Perceived Behavioural Control | | 4.61 | 5 | .07 | .89 | .77 | .06 |
| I am confident I could do Green Exercise if I wanted to | .56 | | | | | | |
| The decision to do Green Exercise is beyond my control | .30 | | | | | | |
| Doing Green Exercise is… (*Very Difficult* to Very Easy) | .44 | | | | | | |
| Whether I do Green Exercise or not is entirely up to me | .21 | | | | | | |
| I choose when and where I do Green Exercise | .35 | | | | | | |

*Note.* $N$ = 253. BS$\chi^2$ = Bollen-Stine chi-squared. CFI = comparative fit index. TLI = Tucker-Lewis Index. RMSEA = root mean square error of approximation. All items were scored from *Strongly Disagree* to *Strongly Agree,* unless stated otherwise.

**Table 3.7** Fit Statistics for Two-Factor and Three-Factor Model of the Beliefs about Green Exercise (BAGE)

| Factor | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|
| Attitudes x Subjective Norms | 22.72 | 19 | .20 | .98 | .97 | .05 |
| Attitudes x Perceived Behavioural Control | 27.52 | 26 | .31 | .99 | .99 | .03 |
| Subjective Norms x Perceived Behavioural Control | 13.40 | 13 | .14 | .95 | .92 | .04 |
| Three-factors | 53.35 | 51 | .02 | .98 | .97 | .03 |

*Note.* $N$ = 253. BS$\chi^2$ = Bollen-Stine chi-squared. CFI = comparative fit index. TLI = Tucker-Lewis Index. RMSEA = root mean square error of approximation.

**Table 3.8** Descriptive Statistics, Measure Error Variances, Factor Loadings and Composite Reliabilities for the Beliefs about Green Exercise (BAGE)

| | Refinement Group (*N* = 253) | | | | Validation Group (*N* = 230) | | | |
|---|---|---|---|---|---|---|---|---|
| | Var(e) | Factor Loadings | | | Var(e) | Factor Loadings | | |
| Items | | ATT | SUB | PBC | | ATT | SUB | PBC |
| Doing Green Exercise as part of my weekly physical activity is… | | | | | | | | |
| (*Bad* to *Good*) | .62 | .62 | | | .39 | .78 | | |
| (*Pleasant* to *Unpleasant*) | .42 | .76 | | | .34 | .81 | | |
| (*Boring* to *Fun*) | .55 | .67 | | | .39 | .78 | | |
| (*Enjoyable* to *Unenjoyable*) | .48 | .72 | | | .42 | .76 | | |
| (*Beneficial* to *Harmful*) | .56 | .66 | | | .52 | .69 | | |
| Most people who are important to me believe I should do Green Exercise | .80 | | .45 | | .83 | | .41 | |
| People often ask me to do Green Exercise with them | .59 | | .64 | | .48 | | .72 | |
| People that are similar to me do Green Exercise | .76 | | .49 | | .60 | | .63 | |
| I am confident I could do Green Exercise if I wanted to | .80 | | | .45 | .67 | | | .57 |
| The decision to do Green Exercise is beyond my control | .93 | | | .27 | .83 | | | .41 |
| Doing Green Exercise is… (*Very Difficult* to *Very Easy*) | .63 | | | .61 | .64 | | | .60 |
| I choose when and where I do Green Exercise | .93 | | | .27 | .80 | | | .44 |
| Mean response within factors (standard deviation) | | 6.41 (.74) | 4.35 (.99) | 5.97 (.73) | | 6.11 (.94) | 4.31 (.99) | 5.63 (.86) |
| Composite Reliability | | .82 | .54 | .44 | | .88 | .62 | .58 |

*Note.* ATT = Attitudes. SUB = Subjective Norms. PBC = Perceived Behavioural Control. Var(e) = Measurement Error Variance. All response scales ranged from *Strongly Disagree* to *Strongly Agree,* unless stated otherwise

*INT-GE*

The fit statistics and factor loadings of the INT-GE are shown in Table 3.9. The model fit was excellent. The BS$\chi^2$ to degrees of freedom ratio was below 2, the CFI was 1.00, the TLI was 1.01, and the RMSEA was 0.00. The composite reliability was good (ρc = 0.89).

*Analysis of the validation sample*

The factor structure of the BAGE-ID, BAGE, and INT-GE were further explored in the validation sample. All models had a good fit (BS$\chi^2$/df = 0.66–1.15, CFI = 0.95–1.00, TLI = 0.91–1.01, and RMSEA = 0.00–0.07). All items in the BAGE-ID, BAGE, and INT-GE had factor loadings above 0.40 (see Tables 3.5, 3.8 and 3.9). The factor loadings of the two problematic direct PBC items from the refinement sample were both higher (0.41 and 0.44) and significant in the validation sample, suggesting that the items should be retained. For the BAGE-ID, each indirect factor had good composite reliability (attitudes ρc = 0.81, subjective norms ρc = 0.70, and PBC ρc = 0.65). Reasonable results were found in the BAGE (attitudes ρc = 0.88, subjective norms ρc = 0.62, and PBC ρc = 0.58). Composite reliability for the INT-GE was good (ρc = 0.86). Overall, the analyses conducted on the validation sample provide additional evidence of the psychometric properties of the BAGE-ID, BAGE, and INT-GE, and the findings suggest that the factor structures and other indices are relatively consistent across the two samples.

**Table 3.9**

*Fit Statistics and Factor Loadings of the Intentions to Perform Green Exercise (INT-GE)*

| Factor and Items | Factor Loadings | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|---|
| Intention | | 5.79 | 5 | .66 | 1.00 | 1.01 | .00 |
| I expect to do Green Exercise | .71 | | | | | | |
| I want to do Green Exercise | .70 | | | | | | |
| The likelihood of me doing Green Exercise is…(*Very Unlikely* to *Very Likely*) | .87 | | | | | | |
| I plan to do Green Exercise | .81 | | | | | | |
| I intend to do Green Exercise | .84 | | | | | | |

*Note.* *N* = 253. BS$\chi^2$ = Bollen-Stine chi-squared. CFI = comparative fit index. TLI = Tucker-Lewis Index. RMSEA = root mean square error of approximation. All items were scored from *Strongly Disagree* to *Strongly Agree*, unless stated otherwise

*Correlation and regression analysis of the full sample*

To provide evidence for parallel-form reliability and the theoretical predictions of the TPB, correlations between the respective subscales of the BAGE-ID and BAGE were examined in the full sample ($N$ = 483). The measures of attitudes ($r$ = 0.71, $p$ < 0.01) and subjective norms ($r$ = 0.61, $p$ < 0.01) were significantly correlated, but the measures of PBC were not ($r$ = −0.01, $p$ > 0.05). This may partly be due to the lower factor loadings found within PBC factor of the BAGE in the refinement sample. Further exploration may be warranted to see if the wording of those items could be improved.

Consistent with the predictions of the TPB, linear regressions were run to explore whether attitudes, subjective norms, and PBC predict intention to perform green exercise. First, after controlling for age and gender, the three indirect factors (behavioural, normative, and control beliefs) significantly predicted intention to perform green exercise, $r^2$ = 0.34, $F$(3, 475) = 74.18, $p$ < 0.01. All three factors made unique significant contributions: behavioural beliefs ($b$ = 0.12, $p$ < 0.01, $sr^2$ = 0.23), normative beliefs ($b$ = 0.04, $p$ < 0.01, $sr^2$ = 0.02), and control beliefs ($b$ = 0.03, $p$ < 0.05, $sr^2$ = 0.01).

Similarly, the direct factors (attitudes, subjective norms, and PBC) significantly predicted intention to perform green exercise, $r^2$ = 0.51, $F$(3, 475) = 153.34, $p$ < 0.01. All three factors made unique significant contributions: attitudes ($b$ = 0.70, $p$ < 0.01, $sr^2$ = 0.24), subjective norms ($b$ = 0.28, $p$ < 0.01, $sr^2$ = 0.08), and PBC ($b$ = 0.30, $p$ < 0.01, $sr^2$ = 0.06). These results provide initial evidence that the factors in the questionnaires are broadly related in a manner consistent with TPB.

## *General Discussion*

The aim of the current study was to develop and provide initial evidence of the validity of three questionnaires that assess individuals' beliefs about green exercise. Using the TPB as a theoretical framework and drawing upon established guidelines

(Francis, Eccles, et al., 2004; Oluka et al., 2014), tools were developed to assess direct and indirect measures of attitudes, subjective norms and PBC, and intention to perform green exercise. Evidence was provided for the factorial validity, composite reliability, and parallel-form reliability for each of the three questionnaires. Consistent with previous studies (Calogiuri & Chroni, 2014; Kouthouris & Spontis, 2005; Middlestadt et al., 2015; Rhodes et al., 2006; Shrestha & Burns, 2009), our findings support the theoretical structure of the TPB in relation to performing physical activity. To date though, no other instruments exist that focus explicitly on beliefs about green exercise. As such, the current findings offer a novel suite of measurement instruments that could be used to provide important insight into the role of individuals' beliefs in green exercise, thereby contributing to the development of theory and effective interventions.

For content validity, salient beliefs were established through an elicitation study (Study 1). Although valuable for development of TPB questionnaires (Ajzen, 2006; Oluka et al., 2014), this step is often overlooked within physical activity research (Downs & Hausenblas, 2005a). The salient beliefs captured in the elicitation study informed the development of the BAGE-ID and provide confidence that the items reflect the key cognitions about green exercise in the general population. Consistent with previous research, the advantages and likeable features of green exercise were the most prevalent (Darker, French, Longdon, Morris, & Eves, 2007; Sutton et al., 2003). Interestingly, however, weather—as a disadvantage or dislikeable feature of green exercise—was the most reported salient belief. This may be because the temperate oceanic climate of the UK is not conducive to green exercise throughout the year. Similarly, previous research has found that climatic conditions have an important impact on physical activity levels across different populations (Remmers et al., 2017; Tucker & Gilliland, 2007; Witham et al., 2014).

Evidence was provided for the factorial validity of the three measures across two samples (refinement and validation). Specifically, following modifications in the refinement sample, the BAGE-ID, BAGE, and INT-GE had good model fits and all factors loadings were significant in both the refinement and validation samples. Of note, however, is that the item relating to weather in the BAGE-ID was removed during the modification process. Although weather was identified as dislikeable feature of green exercise in Study 1, climatic conditions were also listed as a facilitating factor. These contrasting views may partly explain why the factor loading of weather on PBC was not as strong as other items in Study 2. To improve the questionnaires, items relating to both favourable and unfavourable weather conditions separately may provide a better insight to the impact of climatic conditions on green exercise beliefs/behaviours. Instead—and congruent with previous research (Chapter 2; Bai et al., 2013; Kaczynski et al., 2014)—items relating to the size, facilities, and safety of local green space may be more reflective of PBC. Overall though, the confirmatory factor analyses indicated that the refined questionnaires had a good factorial validity and model fits were comparable to other questionnaires based on the TPB (Fen & Sabaruddin, 2009; González, López, Marcos, & Rodríguez-Marín, 2013).

The current findings provide support for using the TPB as a model to explore green exercise, and the proposed relationships between indirect and direct measures of attitudes and subjective norms. Similarly, previous research has successfully employed the TPB to explore the relationship between physical activity and nature (Calogiuri & Chroni, 2014; Nelson et al., 2008). Consistent with Calogiuri and Chroni (2014), we found evidence that the motivational processes associated with green exercise can be modelled from beliefs to intentions. Indeed, previous research has demonstrated that TPB factors can predict intention to engage in outdoor recreation programmes (Kouthouris & Spontis, 2005) and to visit state parks (Shrestha & Burns, 2009). The current findings extend the literature by demonstrating that both indirect

and direct measures of attitudes, subjective norms, and PBC do predict intention to perform green exercise. Beyond the empirical support for the TPB, these findings could underpin the development of evidence-based interventions to promote intention to perform green exercise.

Previous research has made an important contribution in demonstrating that green exercise has important psychological and health benefits (Gladwell, Brown, Wood, Sandercock, & Barton, 2013; Thompson Coon et al., 2011), and that individuals' beliefs can facilitate the benefits of physical activity (Darker, French, Eves, & Sniehotta, 2010; Parrott, Tennant, Olejnik, & Poudevigne, 2008). The questionnaires developed in this study complement this research and provide tools to explore the role of beliefs in green exercise behaviours and outcomes. The consistent use of the three questionnaires will facilitate attempts to synthesise research findings and enable researchers to address theoretically interesting questions, such as which beliefs are the most salient predictors of green exercise behaviours and under what conditions? In total, the questionnaires contain 39 items, all written in the English language with scaled multiple-choice responses, and can be completed in less than 15 min. As such, researchers and health professionals could utilise the tools to assess beliefs in a variety of settings, including field studies, laboratory-based experiments, and applied interventions.

Whilst the questionnaires are complete and ready to use, they could still be refined further. For example, if after a number of trials, it became apparent that some items lacked reliability or validity, they could be edited or removed. Similarly, additional items could be added if further testing revealed that the questionnaires did not sufficiently capture beliefs or intentions about green exercise. As part of this refinement process, researchers may also consider adapting the questionnaires to suit different groups within the population (such as children, or those who don't speak English as a first language). Continuous re-evaluation of the questionnaires as they

currently are, and after refinement will help provide more evidence of reliability and validity.

Key strengths of the present research were the use of an elicitation study, the development of questionnaires that assess both indirect and direct measures of attitudes, subjective norms and PBC about green exercise, and the ability to replicate the observed factor structures in two samples. According to the assessment criteria for TPB questionnaire development (Oluka et al., 2014), such steps would enable the current study to achieve Grade A. Despite these strengths, some limitations should be noted. With regards to methodology, the randomisation of participants to the refinement and validation samples in Study 2 led to significant between-group differences for age and gender. In the future, it might be useful to consider stratified random sampling to control for demographics prior to doing confirmatory factor analyses. The correlational nature of Study 2 also limits the ability to infer causality in the relationships between indirect, direct, and intention measures. Further, although the findings demonstrate that beliefs predict the intention to perform green exercise, the relationship with subsequent behaviour was not explored. Future research should therefore explore whether intentions play a role in the relationship between beliefs and green exercise behaviour.

### *Conclusion*

The current article reported the development of three instruments that have great relevance for green exercise research. Although further research is warranted on different samples and using different research designs, the current studies have provided promising initial evidence of the validity and reliability of all three instruments to assess thoughts towards green exercise. For the first time, researchers and health professionals now have the tools to assess the role of beliefs on green exercise behaviours and associated outcomes. Although the questionnaires are presented

separately, researchers are encouraged to select the one(s) most relevant for their research. Hopefully, the instruments will contribute to a better understanding of individuals' beliefs about green exercise, and how these influence behaviour, and ultimately to the development of behaviour change interventions designed to promote the use of local green space and facilitate the psychological and physical outcomes of green exercise.

# Chapter 4

# Exploring the role of beliefs on visit frequency to local green space

This chapter has been written as a standalone paper although it has not yet been submitted to a scientific journal

**Table 4.1** Thesis Map outlining chapter aims and key findings

| Ch | Aims | Key findings |
|---|---|---|
| 2 | • To investigate which perceptual and objective indices of local green space predict visit frequency to local green space<br>• To explore the relationship between visiting local green space and physical activity levels | • Perceived quality of local green space predicts visit frequency to local green space, whereas perceived access and amount of local green space did not.<br>• As visit frequency to local green space increases, so does the likelihood of meeting physical activity recommendations. |
| 3 | • To capture salient beliefs about green exercise<br>• To develop and provide initial evidence of validity for questionnaires to assess belief about green exercise and intentions to perform green exercise | • Following systematic guidelines, questionnaires were created to assess indirect and direct beliefs about green exercise, and intention to perform green exercise<br>• Initial evidence for factorial validity, composite reliability and parallel-form reliability. |
| 4 | • To explore whether beliefs about green exercise predict visit frequency intention to perform green exercise<br>• To explore whether intention to perform green exercise predicts visit frequency to green space more than nature relatedness and/or perceptions of local green space | |
| 5 | • To assess the effectiveness of a promotional video to enhance the psychological benefits of green exercise<br>• To explore if a promotional video has any immediate effects on attitudes to green exercise | |
| 6 | • To assess the effectiveness of a promotional video to encourage people to do more green exercise<br>• To explore if a promotional video has an immediate effect on attitudes, or a lasting effect on beliefs and intentions towards green exercise. | |

### *Introduction*

Regular physical activity is beneficial for health and wellbeing. In the UK, however, 33% of males and 45% of females fail to meet recommended physical activity levels (150+ minutes of weekly moderate-intensity activity or equivalent; Health Survey for England, 2013). Consequently, inactivity is a problem for public health, and researchers have extensively explored the antecedents and barriers to exercise. One promising avenue of research is the relationships between accessible natural environments, physical activity and health (Calogiuri & Chroni, 2014; de Vries et al., 2003; van den Bosch & Ode Sang, 2017). An emerging body of evidence indicates that subjective measures such as perceptions and nature relatedness may play a role in the likelihood of visiting local green space; an environment conducive of physical activity (Chapter 2; Kaczynski et al., 2014; Park, 2016; Wang, Brown, Liu, & Mateo-Babiano, 2015). The current study explores this notion further by assessing the role of beliefs and intentions on visiting local green space.

Being physically active at green space is commonly known as green exercise; it has been shown to elicit greater psychological outcomes compared to indoor or urban environments (Barton & Pretty, 2010; Gladwell et al., 2013; Thompson Coon et al., 2011). For example, walking in green space has been shown to be more effective for reducing anxiety (Mackay & Neill, 2010; MIND, 2007), stress (Bowler et al., 2010; Gidlow, Jones, et al., 2016; Triguero-Mas, Gidlow, et al., 2017), and frustration (Aspinall, Mavros, Coyne, & Roe, 2015) compared to walking in urban areas. Further, individuals often report green exercise to be easier (Akers et al., 2012) and more likely to encourage future physical activity (Focht, 2013).

Having accessible and useable local green space is an important factor in green exercise behaviours. For example, research from high-income countries shows that having accessible green space may be associated with physical activity behaviours (Kaczynski & Henderson, 2007; Mytton et al., 2012), although this is not

always the case (Chapter; Maas, Verheij, Spreeuwenberg, & Groenewegen, 2008). In England, cross-sectional research (*N* = 31,409) found the odds of achieving the recommended amount of physical activity was 1.27 higher (95% CI, 1.13–1.44) for people living in the greenest quintile compared to those living in the least green quintile. Moreover, another cross-sectional study in the England (*N* = 165,424) found clear evidence for better green space access being associated with higher levels of recreational walking (Lachowycz & Jones, 2014). Specifically, those in the greenest quintile reported between 13% and 18% more days of recreational walking compared to the least green quintile.

Subjective variables such as nature relatedness (Chapter 2) and perceptions of green space (i.e. access, features, quality) may play a particularly important role in whether or not people choose to visit it (Bai et al., 2013; Ries et al., 2009; Veitch, Salmon, et al., 2016). For example, a recent cross-sectional study found that perceived quality of local green space, and nature relatedness were the strongest predictors of visiting frequency to local green space, and overall physical activity levels (Chapter 2). Importantly, the study also found that visiting local green space at least once per week increased the likelihood of meeting recommended physical activity levels by four times compared to never going. This highlights the importance of exploring subjective measures in the relationship between local green space, physical activity and health. This is also supported by a systematic review and proposed schematic model of motivational processes underlying the relationship between natural environments and physical activity behaviours (Calogiuri & Chroni, 2014). The model, based upon the theory of planned behaviour (TPB; Ajzen, 1991), suggests that one function of local green space is to provide an opportunity for active living (e.g. an open space for sport or a route to walk/run/cycle).

The TPB proposes that three components of beliefs (attitudes, subjective norms, and perceived behavioural control) all play unique roles in predicting intention

to perform a behaviour, which in turn predicts behaviour. Therefore, increases in positive beliefs should increase the likelihood of performing a behaviour. The TPB is a commonly used model for exploring physical activity behaviours (Downs & Hausenblas, 2005b; Hagger et al., 2002). One meta-analysis found that nearly half of variance in physical activity intentions, and over a quarter of variance in physical activity behaviours, was explained by beliefs (Hagger et al., 2002). Additionally, some studies have explored the TPB as a model for green exercise (Calogiuri & Chroni, 2014; Nelson et al., 2008). Calogiuri and Chroni (2014) conducted a systematic review of the impact of natural environment on the promotion of active living and mapped it onto the TPB. The authors proposed that beliefs (e.g. perceived access to local green space, feelings about nature, anticipated benefits) and intentions play a role in visiting the natural environments for active living. Therefore, the evidence supports the notion that beliefs (attitudes, subjective norms, perceived behavioural control) play a role in motivating people to participate in green exercise behaviours.

In summary, there are many factors that influence green exercise participation, including the local environment, perceptions, and nature relatedness. It is, however, crucial to gain a deeper understanding of individuals' motives to visit local green space. The aim of this study was to explore whether beliefs about green exercise (attitudes, subjective norms, perceived behavioural control) predict intentions to perform green exercise over and above perceptions of local green space, quantity of local green space, and nature relatedness, and whether those intentions subsequently predict visiting local green space. We hypothesised that: (a) beliefs about green exercise will predict intention to perform green exercise, and (b) intention to perform green exercise will predict visiting local green space.

## *Method*

### Participants

The sample was a subset of the participants from a previous study (Chapter 3). Participants were included because they completed all the additional measures needed to assess the aims of this study. The current sample comprised 338 adults (223 women, 115 men, $M_{age}$ = 46 years, *SD* = 15.47, age range 18-83 years). Most of the participants were employed (63.5%), with the remaining participants being retired (17.5%), self-employed (8.3%), students (4.5%), or other (6.2%). Additionally, most participants reported their ethnicity as white (95.5%). Over half of participants (54.5%) reported a household income of less than £49,999, 35.5% reported over £50,000, and 10% reported not knowing or did not wish to say.

### Subjective Measures

*Perceptions of local green space.*

Consistent with previous research (Chapter 2), perceived access to local green space was assessed by asking participants "How easy is it to get to the green space local to your home?" Participants responded from 1 = "Very difficult" to 7 = "Very easy". Perceived quality of local green space was assessed with a single item that asked "How would you rate the quality of your local accessible green spaces that are close to your home?" Participants responded from 1 = "Terrible" to 7 = "Excellent".

*Nature Relatedness.*

Nature relatedness has previously been shown to predict visit frequency to local green space and the odds of meeting physical activity guidelines (Chapter 2). Nature relatedness was assessed using two sections of the Nature Relatedness Scale (Nisbet et al., 2008): the self and experience factors. The self and experience factors

were used to reflect both how strongly people identify with the natural environment and the attraction people have to nature. The perspective factor of the Nature Relatedness Scale was excluded as we were not interested in global issues such as conservation and species survival rates. Participants were asked to report how they felt about 14 phrases that described their relationship with nature. Examples items included “Even in the middle of the city, I notice nature around me” and “I am not separate from nature, but part of nature”. Participants responded from 1 = “disagree strongly” to 5 = “agree strongly”. Where appropriate, responses were reversed so that higher scores indicated a greater nature relatedness. Nature relatedness was recorded as the mean of 14 items.

*Visit frequency to local green space.*

Visit frequency to local green space was assessed by asking participants “How often do you visit the green space closest to your home?” Participants responded from 1 = “Every day” to 7 = “Never visit my local green space or any other green spaces”. Scores were recorded into a binary form so that visiting local green space at least once per week was positive (1), compared with not visiting local green space at least once per week (0). A previous study has shown that visiting local green space at least once per week increased the likelihood of meeting physical activity guidelines by four times compared to never going (Chapter 2).

***Beliefs about Green Exercise**.*

The Beliefs about Green Exercise Questionnaire (BAGE; Chapter 3) was developed to assess how people feel regarding physical activity in the presence of natural environments. The questionnaire consists of 12 items; five to assess attitudes, three to assess subjective norms, and four to assess perceived behavioural control.

To our knowledge, this is the only validated questionnaire that assesses beliefs about green exercise. When tested on an adult sample (*N* = 230; Chapter 3) the overall model fit of the BAGE was good (e.g., BS$\chi^2$ = 53.35, CFI = .98).

***Intention to perform Green Exercise***

The Intentions to Perform Green Exercise (INT-GE; Chapter 3) was developed to assess the likelihood of individuals being physically active in the presence of natural environments. The questionnaire contains 5 items that relate to the likelihood of doing green exercise at least once per week for the next four weeks. When tested on an adult sample (*N* = 253, Chapter 3), the overall model fit was good (e.g., BS$\chi^2$ = 5.79, CFI = 1.00).

In keeping with previous research (Chapter 3), items in the BAGE and INT-GE were combined, randomised and preceded with the following statement 'Green Exercise is physical activity that takes place in the presence of nature (e.g. parks, woodlands, sports fields etc.)'. Items were rated on a scale from 1 to 7 and some are reverse scored so that higher scores reflect more positive beliefs about green exercise. Scores of the four constructs (attitudes, subjective norms, perceived behavioural control, and intentions) are represented as means.

**Objective measures of the local environment.**

*Quantity of local green space.*

Objective representation of the local environment was given as the percentage of roads, paths, water, and green space available near home. This was calculated to ward level (primary unit of electoral geography), using participants' home postcodes and Geoconvert (an online geography matching and conversion tool) (UK Data Service: Census Support, 2017). Ward coded data were cross-referenced against a

land use database to give percentages for each postcode in the UK (DATA.gov.uk, 2010). Similar methods to quantify the local environment have been successfully used before (Chapter 2).

*Environmental deprivation.*

Environmental deprivation at ward level was obtained from a database available on CRESH.org (Richardson et al., 2010). In summary, an index score from -2 to +3 was calculated using environmental dimensions that impact upon health (air pollution, climate, UV radiation, industrial facilities and green space). This variable has previously been used in similar cross-sectional research (Chapter 2).

**Procedure**

The research was conducted in conjunction with another study (Chapter 3) between February and June 2016 following ethical approval from the University of Essex, Ethical Committee. All participants provided informed consent. An online survey was created using Qualtrics Software (Provo, Utah). The survey was primarily distributed as a short web-link via email, social media, and internet messaging services. It was also marketed via two specialist participant recruitment websites: callforparticipants.com and findparticipants.com. On the first it was placed as a static advert, and on the second it was distributed to 219 individuals who had registered to receive such surveys. Participants provided demographic information before completing all subjective measures.

**Data Analysis**

Four regression models were run. First a forced entry multiple linear regression was run to assess whether beliefs about green exercise (attitudes,

subjective norms, and perceived behavioural control) predict intention to perform green exercise. Second, a forced entry multiple linear regression was run to assess whether local green space (objective and subjective measures), beliefs about green exercise (attitudes, subjective norms, and perceived behavioural control), and nature relatedness predict intention to perform green exercise. Additional demographic and objective measures of the local environment (% of water, paths and roads) were included as covariates.

Third, a forced entry multiple binary logistic regression was run to assess whether beliefs about green exercise (attitudes, subjective norms, and perceived behavioural control), and intention to perform green exercise predict visiting local green space at least once per week. Lastly, a forced entry multiple binary logistic regression was run to assess whether local green space (objective and subjective measures), beliefs about green exercise (attitudes, subjective norms, perceived behavioural control), nature relatedness, and intention to perform green exercise predict visiting local green space at least once per week. Additional demographic and objective measures of the local environment were included as covariates (see Table 4.2). A Nagelkerke $R^2$ test was run to assess how much of the variance in the outcome was accounted for by the model. Significance was accepted at $p < .05$ throughout and analyses were all conducted using IBM SPSS 23 (Armonk, NY, USA).

### *Results*

The 270 urban wards represented in this study had a mean green space coverage of 52.8% (*SD* = 13.07); this is nearly 10% lower than the UK national average of 62.6%. However, participants responded favourable to perceived access (*M* = 5.01, *SD* = 1.17) and perceived quality (*M* = 4.58, *SD* = 1.13) of local green space. Overall, participants held high positive beliefs about green exercise (attitudes, *M* = 6.35, *SD* = 0.78; subjective norms, *M* = 4.48, *SD* = 1.02; perceived behavioural control, *M* = 5.86,

*SD* = 0.81). In this study, engagement with the natural environment is indicated by visit frequency to local green space. In total, 80.8% (*N* = 273), reported visiting local green space at least once per week.

**Table 4.2** Means (*M*) and standard deviations (*SD*) of the objective and subjective variables.

| | *M* | *SD* |
|---|---|---|
| **Objective** | | |
| *Age (yrs.)* | 46 | 15.46 |
| *Gardens (%)* | 20.81 | 13.07 |
| *Road (%)* | 9.37 | 6.04 |
| *Path (%)* | 0.66 | 0.63 |
| *Water (%)* | 2.89 | 8.67 |
| *Green Space (%)* | 52.83 | 25.88 |
| **Subjective** | | |
| *Perceived Access* | 5.01 | 1.17 |
| *Perceived Quality* | 4.58 | 1.13 |
| *Environmental Deprivation* | 0.26 | 0.88 |
| *Attitudes* | 6.35 | 0.78 |
| *Subjective Norms* | 4.48 | 1.02 |
| *Perceived Behavioural Control* | 5.86 | 0.81 |
| *Intentions* | 6.05 | 1.10 |
| *Nature Relatedness* | 3.72 | 0.67 |

A multiple linear regression was run to predict intention to perform green exercise based on beliefs about green exercise. The model explained 49.2% of the variance in intentions to perform green exercise ($r^2$ = .492, $F_{3, 334}$ = 109.89, $p$ < .001). Attitudes ($b$ = .70, $p$ < .001, $sr^2$ = .03), subjective norms ($b$ = .20, $p$ < .001, $sr^2$ = .05), and perceived behavioural control ($b$ = .27, $p$ < .001, $sr^2$ = .06), all made significant unique contributions in predicting intentions.

A multiple linear regression was run to predict intention to perform green exercise based on measures of the local environment and beliefs (Table 4.3). The

model explained 52.4% of the variance in intentions to perform green exercise ($r^2$ = .524, $F_{14, 323}$ = 27.49, $p$ = .00). Age ($b$ = .01, $p$ = .04, $sr^2$ = .01), environmental deprivation ($b$ = -.13, $p$ = .02, $sr^2$ = .02), attitudes ($b$ = .63, $p$ = .00, $sr^2$ = .21), subjective norms ($b$ = .19, $p$ = .00, $sr^2$ = .05), perceived behavioural control ($b$ = .26, $p$ = .00, $sr^2$ = .05), and nature relatedness ($b$ = .24, $p$ = .00, $sr^2$ = .03) all made significant unique contributions in predicting intentions. Intentions were higher for older participants, at lower levels of environmental deprivation, and at higher levels of attitudes, subjective norms, perceived behavioural control and nature relatedness.

**Table 4.3** Demographic objective and subjective predictors of intention to perform green exercise

| | *B* | *SE B* | β | *t* | *p* | *sr2* |
|---|---|---|---|---|---|---|
| **Objective Measures** | | | | | | |
| *Age* | 0.01 | 0.00 | 0.09 | 2.08 | 0.04 | 0.01 |
| *Gender* | -0.12 | 0.09 | -0.05 | -1.32 | 0.19 | 0.01 |
| *Gardens* | 0.00 | 0.01 | 0.04 | 0.57 | 0.57 | 0.00 |
| *Road* | 0.00 | 0.02 | 0.00 | 0.00 | 1.00 | 0.00 |
| *Path* | 0.16 | 0.09 | 0.09 | 1.81 | 0.07 | 0.01 |
| *Water* | 0.00 | 0.01 | 0.01 | 0.19 | 0.85 | 0.00 |
| *Green Space* | 0.00 | 0.01 | 0.08 | 0.55 | 0.58 | 0.00 |
| **Subjective Measures** | | | | | | |
| *Perceived Access* | 0.06 | 0.04 | 0.06 | 1.52 | 0.13 | 0.01 |
| *Perceived Quality* | 0.02 | 0.04 | 0.02 | 0.58 | 0.56 | 0.00 |
| *Environmental Deprivation* | -0.13 | 0.06 | -0.10 | -2.35 | 0.02 | 0.02 |
| *Attitudes* | 0.63 | 0.07 | 0.44 | 9.23 | 0.00 | 0.21 |
| *Subjective Norms* | 0.19 | 0.05 | 0.17 | 4.12 | 0.00 | 0.05 |
| *Perceived Behavioural Control* | 0.26 | 0.06 | 0.19 | 4.22 | 0.00 | 0.05 |
| *Nature Relatedness* | 0.24 | 0.07 | 0.14 | 3.34 | 0.00 | 0.03 |

*Note.* $r^2$ = .524, $F(14, 323)$ = 27.49, p = .00

A binary logistic regression was run to determine whether beliefs and/or intentions about green exercise predict visiting local green space at least once per week; the model explained 32.5% of the variance (Nagelkerke $r^2$ = .325). Subjective norms (OR = 1.47, 95% CI, 1.01 to 2.13), perceived behavioural control (OR = 1.66,

95% CI, 1.08 to 2.56), and intentions (OR = 1.83, 95% CI, 1.29 to 2.62), all made significant unique contributions in predicting visiting local green space.

A binary logistic regression was run to determine which variables predicted the likelihood of visiting local green space once per week (Table 4.4; the model explained 39.5% of the variance (Nagelkerke $r^2$ = .395). Perceived quality (OR = 1.51, 95% CI, 1.10 to 2.07), subjective norms (OR = 1.63, 95% CI, 1.08 to 2.45), intentions (OR = 1.68, 95% CI, 1.14 to 2.47), and nature relatedness (OR = 1.96, 95% CI, 1.10 to 3.50) all made significant unique contributions in predicting visiting local green space. The likelihood of visiting local green space at least once per week was higher at higher levels of perceived quality, subjective norms, intentions, and nature relatedness.

**Table 4.4** Odds ratios of visiting local green space at least once per week

| | | 95% CI | |
|---|---|---|---|
| | OR | Lower | Upper |
| **Objective Measures** | | | |
| *Age* | 0.99 | 0.97 | 1.02 |
| *Gender* | 1.77 | 0.84 | 3.72 |
| *Gardens* | 1.01 | 0.96 | 1.05 |
| *Road* | 1.03 | 0.88 | 1.21 |
| *Path* | 1.58 | 0.77 | 3.23 |
| *Water* | 0.99 | 0.95 | 1.04 |
| *Green Space* | 1.02 | 0.98 | 1.07 |
| **Subjective Measures** | | | |
| *Perceived Access* | 1.04 | 0.78 | 1.39 |
| *Perceived Quality* | *1.51 | 1.10 | 2.07 |
| *Environmental Deprivation* | 1.18 | 0.75 | 1.86 |
| *Attitudes* | 1.01 | 0.60 | 1.72 |
| *Subjective Norms* | *1.63 | 1.08 | 2.45 |
| *Perceived Behavioural Control* | 1.41 | 0.88 | 2.27 |
| *Intentions* | **1.68 | 1.14 | 2.47 |
| *Nature Relatedness* | *1.96 | 1.10 | 3.50 |

*Note*. $r^2$ = .247 (Cox and Snell), .395 (Nagelkerke). Model $\chi^2$ (15) = 95.854, $p < .00$. * $p < .05$, ** $p < .01$. OR = odds ratio. 95% CI = confidence intervals.

### *Discussion*

As many individuals fail to meet recommended physical activity guidelines – and suffer related health consequences – it is imperative for policy makers to understand the motives and barriers to exercise. This study explored the role of beliefs on visiting local green space (one aspect of green exercise participation). Although green exercise, as distinct mode of physical activity, has previously been modelled using the TPB (Calogiuri & Chroni, 2014; Nelson et al., 2008), it has not yet been tested empirically. Consistent with the TPB, findings from this unique study reveal that beliefs about green exercise do play a role in intention to perform green exercise and visits to local green space. This is important for public health because visiting local green space once per week has been shown to increase the likelihood of meeting physical activity guidelines by up to four times compared to never going (Chapter 2).

Using a cross-sectional methodology, this study extended previous research (Chapter 2, 3) by examining the role of beliefs on visiting local green space. Consistent with the TPB, the findings suggest that all three components of beliefs (attitudes, subjective norms, and perceived behavioural control) significantly predicted intention to perform green exercise. These findings provide further support for the TPB framework as model for physical activity behaviour (Ajzen, 1991), and particularly green exercise (Chapter 3; Calogiuri & Chroni, 2014; Nelson et al., 2008). Further to this, and importantly for policy makers, intentions also significantly predicted visiting local green space, an environment conducive of green exercise and known for having positive effects on health and wellbeing (Calogiuri & Chroni, 2014). As such, promoting more positive beliefs about green exercise could facilitate increased engagement with local green space, and expose individuals to the health and psychological benefits of being in nature (Gladwell et al., 2013).

Beyond the important role of beliefs, the current findings provide further evidence that other subjective factors play an important role in predicting visits local

green space. Perceived quality of local green space significantly predicted visiting local green space once per week, whereas the objectively measured percentage of local green space did not. This replicates the findings from a similar study (Chapter 2), and supports an emerging body of research that highlights how individuals perceive local green space may be an important determinant of whether they choose to visit it (Bai et al., 2013; Ries et al., 2009; Veitch, Salmon, et al., 2016). Additionally, and congruent with previous research, nature relatedness also significantly predicted visits to local green space (Chapter 2; Zhang et al., 2014). Nature relatedness relates to how individuals feel towards nature, and has previously categorised as a behavioural belief regarding the 'active use' of natural environments (Calogiuri & Chroni, 2014). These findings provide further evidence that feelings about nature and local green space are related to behavioural choices, and support the schematic model proposed by Calogiuri and Chroni (2014).

Although this study has provided important evidence for the impact of beliefs on green exercise behaviours, some limitations should be noted. One of the main strengths of this study was the inclusion of validated green exercise questionnaires (BAGE and INT-GE) to model one aspect of green exercise behaviours (i.e. visiting local green space) using the TPB, but behaviour was assessed retrospectively (a common approach in TPB research; Hagger et al., 2002) and limits the ability to infer causality. Additionally, quantity of local green space was included twice in the regression model: once as a unique variable and once as a contributor to the environmental deprivation factor. However, as with previous research (Chapter 2), this did not influence the key findings[iii].

The present research is a crucial step in understanding the role of beliefs about green exercise on visiting local green space, a crucial initial behaviour in performing green exercise. Given the findings, it is important that future research explores whether beliefs can be modified to increase green exercise behaviours, and thereby

enhance subsequent health benefits. Taff et al. (2017) recently demonstrated that marketing strategies can have a tangible impact on acute behaviour during park visits by using signage to encourage people to walk more during visits to a local park. Further research is therefore warranted to examine whether promoting green exercise more generally can have a positive effect on green exercise behaviour, and if a change in beliefs underpins this effect.

### *Conclusion*

The present research was the first nationwide study to explore the relationship between green exercise beliefs, and visiting local green space (one aspect of green exercise). In keeping with the TPB, beliefs significantly predicted intentions and subsequent behaviours. Furthermore, perceived quality and nature relatedness also significantly predicted visits to local green space. As going to green space is positively linked to increased physical activity levels and better psychological wellbeing, these findings could offer important insights for policy makers.

# Chapter 5

# Enhancing the acute psychological benefits of green exercise: an investigation of expectancy effects

This chapter has been previously submitted to a scientific journal (Psychology of Sport and Exercise). It has been reviewed by three reviewers who each made some recommendations for improvement. This is a revised version which has been resubmitted.

**Table 5.1** Thesis Map outlining chapter aims and key findings

| Ch | Aims | Key findings |
|---|---|---|
| 2 | • To investigate which perceptual and objective indices of local green space predict visit frequency to local green space<br>• To explore the relationship between visiting local green space and physical activity levels | • Perceived quality of local green space predicts visit frequency to local green space, whereas perceived access and amount of local green space did not.<br>• As visit frequency to local green space increases, so does the likelihood of meeting physical activity recommendations. |
| 3 | • To capture salient beliefs about green exercise<br>• To develop and provide initial evidence of validity for questionnaires to assess belief about green exercise and intentions to perform green exercise | • Following systematic guidelines, questionnaires were created to assess indirect and direct beliefs about green exercise, and intention to perform green exercise<br>• Initial evidence for factorial validity, composite reliability and parallel-form reliability. |
| 4 | • To explore whether beliefs about green exercise predict visit frequency intention to perform green exercise<br>• To explore whether intention to perform green exercise predicts visit frequency to green space more than nature relatedness and/or perceptions of local green space | • Attitudes, subjective norm, and perceived behavioural control all predict intention to perform green exercise<br>• Intention to perform green exercise predicts visit frequency to local green space<br>• Nature relatedness predicts both intention to perform green exercise, and visit frequency to local green space |
| 5 | • To assess the effectiveness of a promotional video to enhance the psychological benefits of green exercise<br>• To explore if a promotional video has any immediate effects on attitudes to green exercise | |
| 6 | • To assess the effectiveness of a promotional video to encourage people to do more green exercise<br>• To explore if a promotional video has an immediate effect on attitudes, or a lasting effect on beliefs and intentions towards green exercise. | |

## Introduction

Acute exercise enhances psychological well-being through a number of mechanisms including reducing anxiety (Ensari, Greenlee, Motl, & Petruzzello, 2015; Petruzzello et al., 1991; Stonerock, Hoffman, Smith, & Blumenthal, 2015), and enhancing self-esteem (Fox, 2000; Rogerson, Brown, Sandercock, Wooller, & Barton, 2016; Spence et al., 2005) and mood (R. J. Anderson & Brice, 2011; Berger & Motl, 2000; Helfer, Elhai, & Geers, 2014; Petruzzello, Snook, Gliottoni, & Motl, 2009; Yeung, 1996). This is supported by comprehensive reviews (Arent, Landers, & Etnier, 2000; McDonald & Hodgdon, 2012; Reed & Ones, 2006). For example, Reed and Ones (2006) reported that the average effect size for acute aerobic exercise on positive activated affect was .47 ($d_{corr}$).

A growing body of evidence suggests that greater physiological and psychological benefits occur if exercise takes place in a natural environment (termed green exercise; Barton & Pretty, 2010; Gladwell et al., 2013; Thompson Coon et al., 2011). For example, acute bouts of green exercise have been shown to facilitate increases in happiness (Yeh, Stone, Churchill, Brymer, & Davids, 2017), vigour (Song, Ikei, Igarashi, Takagaki, & Miyazaki, 2015), and self-esteem (Pretty et al., 2005). Moreover, when Mackay and Neill (2010) compared the anxiolytic effects of different exercise types they found a larger effect size for mountain biking ($d$ = 1.02) than road cycling ($d$ = 0.84). Similarly, (Akers et al., 2012) found that during cycling, green scenery elicited greater improvements in mood compared with grey scenery. Importantly, psychological benefits are elicited from as little as 5 minutes (Barton & Pretty, 2010) to 30 minutes (Shanahan et al., 2016) of green exercise. Although a number of theories have been proposed, such as the Biophilia Hypothesis (Wilson, 1984) and Attention Restoration Theory (R. Kaplan & Kaplan, 1989), the mechanisms for the additional psychological benefits of green exercise compared to urban/indoor exercise are still unclear.

A small number of studies have explored the role of individuals' thoughts and feelings on green exercise behaviours (Calogiuri & Elliott, 2017; Curry, Crone, James, & Gidlow, 2011; Groshong, Stanis, Kaczynski, Hipp, & Besenyi, 2017; Ana Loureiro et al., 2014). For example, Calogiuri and Elliott (2017) found that for Norwegian adults, experiencing nature was the second-most important motive for exercise, exceeded only by convenience. Furthermore, individuals who have a higher connectedness with nature tend to spend more time in nature, and subsequently do more green exercise (Chapter 2). Until recently, however, there has been no established measure to assess how individuals feel about green exercise as a distinct mode of physical activity.

Based upon the Theory of Planned Behaviour (Ajzen, 1991), the Beliefs about Green Exercise Questionnaire (BAGE) was developed in Chapter 3 to assess attitudes, subjective norms, and perceived behavioural control towards green exercise. Some items within the attitudes sub-scale assess how individuals feel about performing green exercise (i.e. is it beneficial? Is it pleasant?), and thus may provide key insights into how people expect to feel following the activity. Moreover, evidence from the wider physical activity literature shows an inherent link between attitudes and exercise behaviours (Chatzisarantis, Hagger, Biddle, & Smith, 2005; Rhodes, 2009). Yet, no research to our knowledge has explored whether attitudes towards green exercise influence acute psychological outcomes.

In the exercise domain, some researchers have postulated that expectancy beliefs play a role in the acute psychological benefits of exercise (Bérdi, Köteles, Szabó, & Bárdos, 2011; Lindheimer, O'Connor, & Dishman, 2015; Ojanen, 1994; Szabo, 2013). Empirically, researchers have adopted expectancy manipulations to examine the possible role of expectancy effects. For example, Desharnais et al. (1993) manipulated expectations to elicit greater improvements in self-esteem following a four-week exercise program. The authors used an authoritative statement to manipulate expectations, which is the most commonly used technique within the

exercise domain (Crum & Langer, 2007; Desharnais et al., 1993; Helfer et al., 2014; Kwan, Stevens, & Bryan, 2017; Lindheimer, O'Connor, McCully, & Dishman, 2017). Posters (Stanforth, Steinhardt, Mackert, Stanforth, & Gloria, 2011), videos (Mothes et al., 2017), and sham equipment (Lindheimer et al., 2017; Mothes et al., 2017; Reed, 2014) have also been used to explore the role of expectancy effects in exercise outcomes.

Some evidence indicates that expectations play a role in some of the outcomes of common activities such as running (Berger, Owen, Motl, & Parks, 1998; Kwan et al., 2017; Szabo & Abraham, 2013) and cycling (Helfer et al., 2014; Mothes et al., 2017). For example, Helfer et al. (2014) explored the role of expectancy effects on mood following 10-minutes of light-intensity cycling. Participants ($N$ = 140) were randomly assigned to one of four groups in a 2 (no expectation vs affective expectation) x 2 (no elaboration vs elaboration) between-group design. The affective groups were told that physical activity is good for happiness, mood and self-esteem. The elaboration groups were asked to write the information they had received as a recall task. There was a significant post-exercise main effect for expectation ($\eta_p^2$ = .06), but not for elaboration or an interaction of the two. This finding is supported by recent reviews (Bérdi et al., 2011; Lindheimer et al., 2015; Szabo, 2013). In contrast, the expectancy effect has been more elusive in studies using 30-minute bouts of cycling (Lindheimer et al., 2017; Mothes et al., 2017). Within these studies, the strength of expectancy manipulation and exercise type/duration were noted as possible reasons for non-significant effects. Helfer et al. (2014) suggested that aversive experiences, such as longer moderate intensity exercise that may cause muscular pain or discomfort, are less likely to be influenced by expectation manipulations.

Green Mind Theory, which outlines reciprocal links between each of human behaviour, mind, brain and body, and natural and social environments, forwards that

expectancy effects stemming from beliefs are likely to influence the therapeutic outcomes of spending time in nature (Pretty, Rogerson, & Barton, 2017). For example, Pretty and colleagues proposed that healing gardens in hospitals, promoted through a good patient-practitioner relationship, may induce health related expectancy effects. However, researchers have yet to examine whether expectations play a role in the acute psychological benefits of green exercise, and if modifying expectations can enhance those outcomes further.

Measuring attitudes (as a proxy for expectations) before and after green exercise research may provide important insight into the role of expectancy effects. As studies have shown links between affective states and outdoor exercise (Focht, 2009; Groshong et al., 2017; Lacharite-Lemieux, Brunelle, & Dionne, 2015), then changes in affective attitudes may manifest as additional benefits. More generally though, exploring the role of expectancy effects in green exercise is important for public health. For example, if attitudes are related to green exercise outcomes, then promoting the activity may enhance actual outcomes. This is worthwhile as post-exercise invigoration can increase the likelihood of repeating the behaviour (Ekkekakis, Parfitt, & Petruzzello, 2011; Focht, 2009; Kwan & Bryan, 2010).

The preliminary aim was to examine if exercise in a natural environment would facilitate greater psychological benefits than indoor exercise. We hypothesised that exercising in a natural environment would elicit greater psychological benefits than indoor exercise. The primary aim was to examine if expectancy effects play a role in the acute psychological benefits of green exercise. We hypothesised that compared to a control condition, watching a promotional video about green exercise before undertaking exercise in a green environment would elicit greater psychological benefits (vigour and self-esteem), and a change in attitudes (as a proxy for expectations) towards green exercise may play a role. The secondary aim of the study

was to examine the effect of the same video on indoor exercisers; we hypothesised that watching the video would result in suppressed self-esteem and vigour.

## Method

### Participants

The sample size was based on an a priori power analysis focused on testing the primary aim (G-power version 3.1; Faul, Erdfelder, Lang, & Buchner, 2007). An expected effect size ($f$ = 0.25) was derived from an equivalent effect size ($\eta_p^2$ = 0.06), observed in previous research (Helfer et al., 2014). This was entered along with power at 0.8 and an alpha of .05. This indicated a sample size of 68. Undergraduate students (19 women, 41 men, $M_{age}$ = 19.9 years, $SD$ = 4.26, age range 18-51 years) were recruited using opportunistic sampling (poster and email advertisements) at the University of Essex. Participants reported their ethnicity as White (67%), Asian (13%), Mixed (12%), or Other (8%).

### Design

A single-blind randomised mixed-model design was used: participants cycled at a moderate-intensity for 15 minutes in one of four groups. Treatment (green vs indoor) and condition (expectancy vs control) were the two between-group factors; those in the green treatment (i.e. green exercisers) completed the cycling task in a green-outdoor environment, and those in the indoor treatment completed the entire task inside a laboratory. Further, those in the expectancy condition were shown a promotional video of green exercise, and those in the control condition were not. Measures of self-esteem, and vigour and were taken pre- and post-exercise as repeated measures dependent variables (as described below). Measures of attitudes

(as a proxy for expectations) were taken pre- and post-exercise as a manipulation check to confirm that the video had the anticipated effect.

**Treatments**

Treatments were chosen to replicate that of a previous study (Rogerson, Gladwell, et al., 2016). For the indoor treatment, stationary cycling was completed in a laboratory with a view facing a light grey painted wall (Figure 5.1). Equipment, furniture, and objects were moved from peripheral vision. For the green treatment, stationary cycling was completed on the edge of a large sports field. This consisted of a mostly flat and grass covered expansive area with interspersed trees and hedge perimeter (Figure 5.1). In both treatments, the experimenter stood diagonally behind the ergometer 3m away.

**Figure 5.1** View from the cycle ergometer in the indoor and green conditions.

**Conditions**

Those in the expectancy condition were shown a promotional video of green exercise. This was designed to highlight the benefits of exercising in a natural environment, and manipulate expectations regarding the outcomes of acute green exercise. The video was created using Microsoft PowerPoint 2016 (Redmond, WA, USA). The 3-minute (11 slides), silent video contained a mixture of text and images amongst a bold green background. Information – from credible sources such as the National Health Service and World Health Organisation – was provided about the health and emotional consequences of green exercise. Moreover, the video contained advice on how to perform green exercise.

To test the effectiveness of the promotional video, a pilot study was conducted in a university lecture theatre. Undergraduate students (12 women, 19 men, $M_{age}$ = 21.3 years, *SD* = 2.53, age range: 20-34 years) were recruited in a lecture at the University of Essex. Participants reported their ethnicity as White (87%), Black (10%) or Mixed (3%). Participants were asked to complete the attitudes measure (described later) before and after watching the promotional video. A paired-samples t-test revealed significant increases in attitudes ($t_{30}$ = -3.56, $p$ = .001, $d$ = .31).

**Procedure**

The research was approved by the University of Essex Research Ethics Committee. The main study was conducted during the winter months (October 2016 to February 2017). Participants were divided into one of four-groups using a block approach (block size 60, with a 1:1:1:1 ratio). Each timeslot for participation had been pre-determined by the investigator as a treatment (green or indoor) and condition (expectancy or control), however, this was blinded to participants during sign-up. On a first come, first serve basis, participants self-selected a timeslot for participation and told to bring suitable clothing for indoor and outdoor exercise. Upon arrival at the

laboratory, participants read an information sheet and provided informed consent. Next, height and weight were recorded and a Polar T31 chest strap was fitted (Polar Electro Oy, Kempele, Finland).

At this point, the green treatment groups were escorted to a sports pavilion on the edge of the sports field (approximately a 3-minute walk), whereas the indoor treatment groups remained in the laboratory (Figure 5.2). All participants completed the baseline and control measures on a Dell Inspiron 13 7000 laptop (Dell Inc, Round Rock, Texas, USA), using Qualtrics research software (Qualtrics, Provo, Utah, USA); for those in the outdoor condition this was in the sports pavilion, whereas for those in the indoor this was in the laboratory. Resting heart rate was recorded at its lowest point within 60 seconds after participants had completed the questionnaires while they remained seated.

Prior to cycling, those in the green condition were escorted outside the pavilion and all participants were given time, and help if needed, to adjust the saddle height. Within a single experimental session, participants cycled twice on a CatEye ergociser (EC-1600, CatEye Co. Ltd., Osaka, Japan) ergometer. First, participants performed a submaximal fitness test based on the YMCA protocol (Golding, Myers, & Sinning, 1989). This test required cycling at approximately 50 rpm for 9 minutes. At three-minute intervals, and in accordance with heart rate readings, the resistance of the bike automatically increased from low to high relative resistance. The resistance increased on 2 occasions. The first test was to familiarise participants with using the ergometer and ascertain the data needed to calculate moderate-intensity for the second bout of cycling.

Between the bouts of cycling, participants were escorted back to the desk where they completed the baseline measures. For the green treatment, this involved escorting participants back into the sports pavilion. During this period, those in the expectancy condition were shown the promotional video. Time was also allocated for

rest: up to 10 minutes of just sitting for those who did not watch the promotional video, and up to 10 minutes including 3 minutes for those in the video condition. However, the time was less if heart rate recovered to within 15 beats per minute of their resting heart rate, which was the case for 37 (62%) participants.

After resting, participants were escorted back to the ergometer. For the second (experimental) bout of cycling, the bike was set to an intensity that represented 50% heart rate reserve (Garber et al., 2011). This was calculated using resting heart rate and data collected from the submaximal test. Consistent with Rogerson, Gladwell, et al. (2016), the second bout lasted 15 minutes, and participants were free to choose cadence; the bike automatically adjusted resistance to maintain a constant power output in line with calculated moderate-intensity values. Unlike the first test, the ergometer screen was blanked out to prompt participants to view forwards and experience the environment. At 7.5 minutes, perceived exertion was recorded (see below). Finally, at the same location as they completed the baseline measures, participants repeated the measures of attitudes, self-esteem and vigour, removed the heart-rate monitor, and were debriefed about the design, aims and hypotheses of the research. Outdoor temperature was recorded using data provided by the UK's National Meteorological Service.

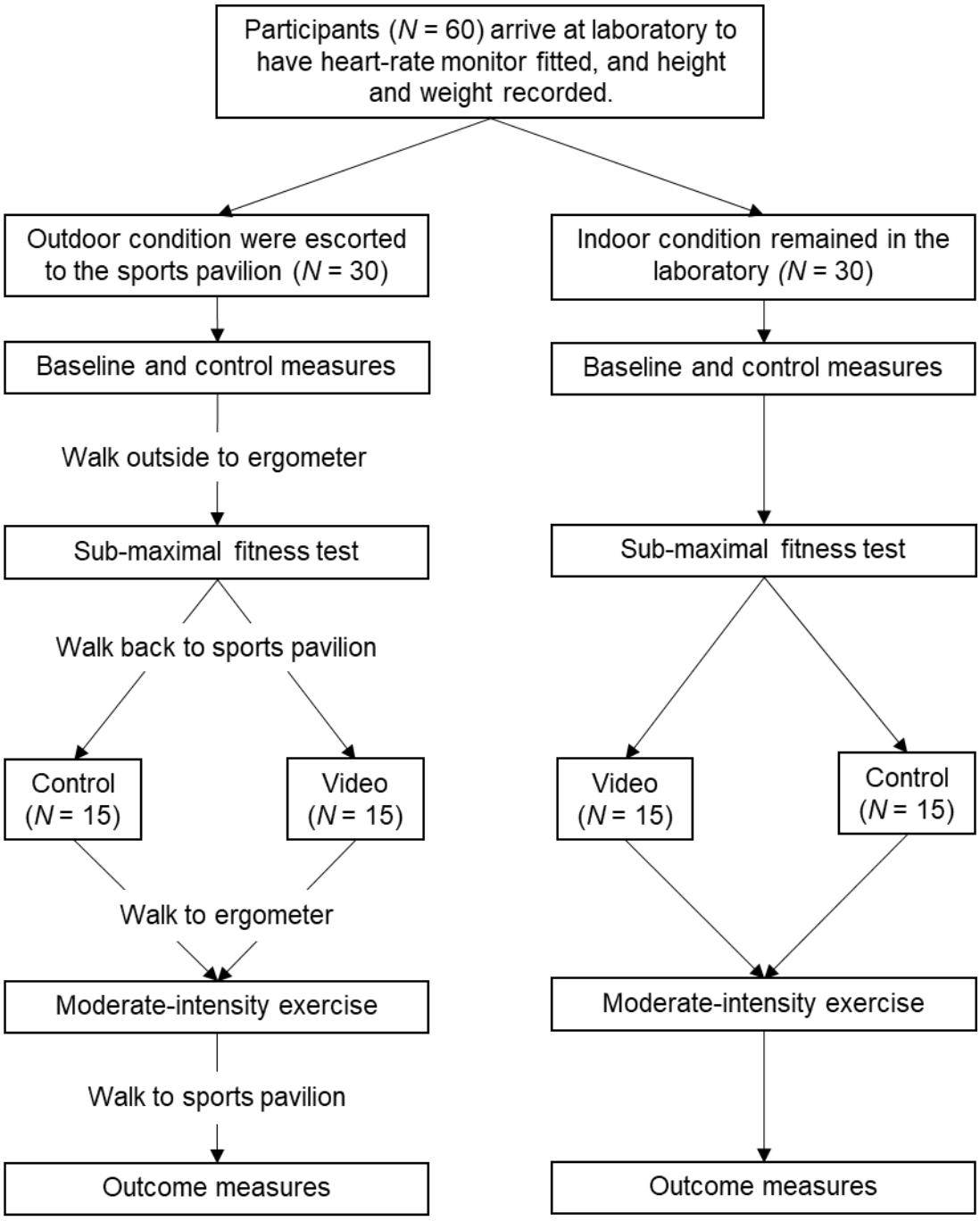



**Figure 5.2** An illustration of the experimental procedure.

## Measures

### Physical activity

Physical activity was assessed using two self-report single-item measures. The Single-item Physical Activity Screening Measure (Zwolinsky, McKenna, Pringle,

Widdop, & Griffiths, 2015) assessed general physical activity, whereas a modified version assessed green exercise. The wording of the general physical activity question was 'In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate. This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job'. For green exercise, participants were asked 'In the past week, on how many days have you done physical activity in the presence of a natural environment, which was enough to raise your breathing rate. This may include activities such as brisk walking/jogging in a park, cycling along a canal path, or playing sport'. Both items captured the number of active days per week on a scale from 0 to 7.

### Perceived exertion

Perceived exertion was measured using the Rating of Perceived Exertion scale (Borg, 1982). The scale consists of 15 vertically aligned numbers (ranging from 6 'no exertion' to 20 'maximal exertion') that allows individuals to subjectively rate their level of exertion during exercise. This is widely used in acute exercise research (Lindheimer et al., 2017; Mothes et al., 2017; Rogerson, Gladwell, et al., 2016), and has been tested for reliability with physiological measures of heart rate, blood lactate, % $VO_2$max, $VO_2$, and respiratory rate (Chen, Fan, & Moe, 2002).

### Attitudes to green exercise

Attitudes were assessed with the five-item attitudes sub-scale of the Belief about Green Exercise questionnaire (BAGE; Chapter 3). The BAGE was developed to assess how people feel regarding physical activity in the presence of natural environments, and was demonstrated to have strong psychometric properties. Items

were preceded with the following statement 'Green Exercise is physical activity that takes place in the presence of nature (e.g., parks, woodlands, sports fields etc)' and scored from 1 to 7, with higher scores reflecting more positive attitudes to green exercise. For example, 'Doing green exercise as part of my weekly physical activity is… (1) *Unpleasant* to (7) *Pleasant'*.

Self-esteem

Self-esteem was assessed using Rosenberg's Self-Esteem Scale (Rosenberg, 1965a), which is a 10-item scale. Each item consists of a brief statement (e.g., I feel that I have a number of good qualities) and participants respond on a Likert scale ranging from (1) *Strongly* Disagree to (4) *Strongly Agree*. The responses to five items are reverse scored so that higher numbers reflect greater self-esteem. Self-esteem was recorded as the sum of all 10 items. The Self-Esteem Scale has previously been used – and shown to be sensitive – in green exercise research (Barton & Pretty, 2010).

Vigour

Vigour was assessed using five items from the shortened, 30-item version of the Profile of Mood States (McNair, 1971; McNair, Lorr, & Droppleman, 1992). Participants indicated how they felt 'right now' towards single-word descriptors of vigour (e.g., Lively), using a Likert scale from (1) *Not at all* to (5) *Extremely*, therefore producing an overall score between 5 and 25. The vigour sub-scale of the Profile of Mood States has previously been used in expectancy research (Lindheimer et al., 2015), and has been shown to be sensitive to acute bouts of cycling (Steptoe & Cox, 1988).

**Data Analysis**

Statistical analyses were carried out to test the preliminary, primary and secondary hypotheses. Initially, analyses were conducted to ensure the groups were equivalent on five variables identified as potential confounders: self-reported physical activity and green exercise levels, perceived exertion, 50% HRR cycling intensity (W), and outdoor temperature during experimental session. A series of two-way between-group ANOVAs were run to assess if there were any condition and/or treatment differences between the four groups ($N$ = 60) on each potential confounder. For the manipulation check, tests were run to assess if the expectancy manipulation had any effect on attitudes following acute exercise. Specifically, a mixed-model ANOVA was run with condition and treatment as between-subjects independent variables, time as a repeated measures variable, and attitudes as a dependant variable ($N$ = 60).

To assess the overall model, a three-way mixed-model MANOVA was run with condition and treatment as between-subjects independent variables, time as a repeated measures variable, and vigour and self-esteem as dependant variables ($N$ = 60). To further explore significant effects, univariate tests were run individually for vigour ($N$ = 60) and self-esteem ($N$ = 60) with condition, treatment and time as independent variables. Planned comparisons were then run to test the preliminary (green exercise effect), primary (expectancy effect), and secondary (negative expectancy effect) hypotheses. To test the preliminary hypothesis, the two control groups were included in the analyses ($N$ = 30), and tests were run individually for vigour and self-esteem. Specifically, two mixed-model ANOVAs were run to assess if treatment (green control vs indoor control) influenced change in psychological wellbeing over time (pre- and post-exercise).

To test the primary hypothesis, analyses were conducted to assess if the expectancy manipulation induced additional psychological benefits over and above that of green exercise. Only the green treatment groups were included ($N$ = 30), and

tests were run individually for self-esteem and vigour (as dependent variables). Specifically, two mixed-model ANOVAs were run to assess if condition (expectancy vs control) influenced self-esteem and vigour over time (pre- and post-exercise).

To test the secondary hypothesis, analyses were conducted to examine if the expectancy manipulation suppressed psychological wellbeing following indoor exercise. Only the indoor treatment groups were included ($N$ = 30), and tests were run individually for self-esteem and vigour (as dependent variables). Specifically, two mixed-model ANOVAs were run to assess if condition (expectancy vs control) influenced changes in self-esteem and vigour over time (pre- and post-exercise). Significance was initially set at $p < .05$ but a Bonferroni-Holm's correction was applied to rule out the possibility of familywise error (Holm, 1979). All analyses were all conducted using IBM SPSS 23 (Armonk, NY, USA).

## Results

### Descriptive and confounder analyses

All descriptive statistics are reported in Table 1. For outdoor temperature a two-way between group ANOVA was run to assess if there were any treatment, condition or interactions effect. There was a significant main effect of treatment on weather ($F_{1,56} = 11.88$, $p < .01$, $\eta_p^2 = .18$), and no significant effects of condition ($F_{1,56} = 0.61$, $p = .81$, $\eta_p^2 = .00$), and interaction ($F_{1,56} = 0.61$, $p = .81$, $\eta_p^2 = .00$). Those in the outdoor-treatment group had a mean temperature of 10°C, whereas the indoor-treatment group had a mean temperature of 7°C outdoors, although they remained indoors.

A series of two-way between-group ANOVAs were run to assess if there were any condition, treatment, or interaction effects for each of the four remaining potential confounders. For all remaining confounders, there were no significant main effects of

treatment ($Fs_{1, 56}$ = 0.01-3.89, *ps* = .05-.35, $\eta_p^2$ = .00-.04), condition ($Fs_{1, 56}$ = 0.00-2.10, *ps* = .26-.70, $\eta_p^2$ = .00-.07), or interactions ($Fs_{1, 56}$ = 0.16-2.57, *ps* = .22-.63, $\eta_p^2$ = .00-.04).

**Manipulation check**

There was not a statistically significant interaction effect of time x treatment x condition on attitudes ($F_{1,54}$ = 2.17, $p$ = .15, $\eta_p^2$ = .04). For the primary analysis (expectancy effect), the manipulation check revealed no significant interaction of time x treatment on attitudes ($F_{1, 28}$ = 0.00, $p$ = .97, $\eta_p^2$ = .00) (Figure 5.4). For the secondary analysis (negative expectancy effect), the manipulation check revealed a significant interaction effect of condition x time on attitudes ($F_{1, 28}$ = 9.98, $p$ = .00, $\eta_p^2$ = .26); the indoor-expectancy group experienced a greater increase in attitudes ($M$ = 0.69, 95% CI 0.42-0.98), compared to the indoor-control group ($M$ = 0.14, 95% CI -0.14- 0.39) (Figure 5.5).

**Mixed-model multivariate analysis of variance**

Using Wilks's statistic, there was a significant interaction of time x condition x treatment on the combined dependent variables (vigour and self-esteem), $\Lambda$ = 0.60, $F_{2,53}$ = 17.97, $p$ < .001, $\eta_p^2$ = .40. Additional univariate tests revealed significant interactions of time x condition x treatment on vigour ($F_{1,54}$ = 27.55, $p$ = < .001, $\eta_p^2$ = .34) and self-esteem ($F_{1,54}$ = 6.10, $p$ = 0.17, $\eta_p^2$ = .10) individually. To further explore these interactions, planned comparisons focused on the preliminary, primary, and secondary hypotheses.

**Table 5.2** Descriptive Statistics

| | Green (*N* = 30) | |
|---|---|---|
| | Expectancy (*N* = 15) | Control (*N* = 15) |
| | *M (SD)* | *M (SD)* |
| Age (yrs.) | 19.67 (1.23) | 19.53 (1.64) |
| Physical activity | 4.33 (1.76) | 4.60 (1.81) |
| Green exercise | 3.13 (2.45) | 2.87 (2.13) |
| Body Mass Index | 22.84 (1.98) | 24.46 (4.68) |
| Cycling (Watts) | 121.60 (40.36) | 109.47 (33.66) |
| RPE (7-minutes) | 11.20 (1.57) | 11.73 (2.09) |
| Temperature (°C) | 9.73 (3.43) | 9.73 (3.26) |
| Pre Attitudes | 5.67 (0.70) | 5.13 (1.19) |
| Post Attitudes | 6.22 (0.67) | 5.68 (0.59) |
| Pre Self-esteem | 32.40 (4.79) | 27.80 (2.21) |
| Post Self-esteem | 36.47 (2.92) | 29.73 (2.15) |
| Pre Vigour | 11.67 (3.11) | 11.87 (3.58) |
| Post Vigour | 15.80 (2.98) | 13.87 (3.14) |
| | Grey (*N* = 30) | |
| | Expectancy (*N* = 15) | Control (*N* = 15) |
| | *M (SD)* | *M (SD)* |
| Age (yrs.) | 21.13 (8.31) | 19.33 (1.05) |
| Physical activity | 3.33 (1.84) | 4.13 (1.73) |
| Green exercise | 2.00 (1.51) | 2.67 (1.76) |
| Body Mass Index | 22.85 (2.73) | 23.40 (2.40) |
| Cycling (Watts) | 106.20 (35.98) | 107.93 (31.13) |
| RPE (7-minutes) | 12.40 (2.32) | 12.40 (1.21) |
| Temperature (°C) | 7.13 (2.83) | 6.73 (3.04) |
| Pre Attitudes | 5.58 (0.68) | 5.59 (0.79) |
| Post Attitudes | 6.28 (0.44) | 5.73 (0.75) |
| Pre Self-esteem | 29.00 (3.27) | 32.27 (4.17) |
| Post Self-esteem | 30.53 (2.90) | 34.60 (4.21) |
| Pre Vigour | 12.00 (5.25) | 11.47 (4.45) |
| Post Vigour | 9.6 (4.91) | 12.07 (3.88) |

*Note.* Physical Activity = self-reported physical activity levels (days per week), Green Exercise = self-reported green exercise levels (days per week), RPE = rating of perceived exertion.

Preliminary hypothesis: the green exercise effect

Due to the Bonferroni-Holm's correction, there was a marginally significant interaction effect of treatment x time on vigour ($F_{1, 28}$ = 4.49, $p$ = .043, $\eta_p^2$ = .14) (Figure 5.3); the green-control group experienced a greater improvement in vigour ($M$ = 2.00, 95% CI 1.06-2.94) than the indoor-control group ($M$ = 0.60, 95% CI -0.46-1.66). The interaction of time x treatment had no significant effect on self-esteem ($F_{1, 28}$ = 0.31, $p$ = .58, $\eta_p^2$ = .01) (Figure 5.3)[iv].

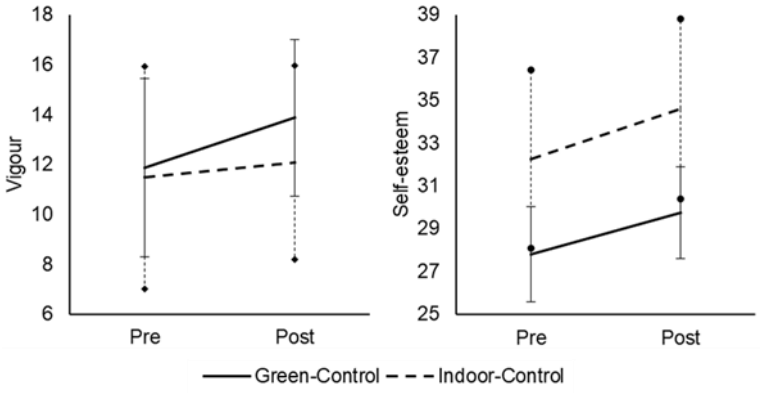



**Figure 5.3** Treatment x time interaction for vigour and self-esteem (*M* and *SD*) between green and indoor control groups (*N* = 30). Due to the Bonferroni-Holm's correction, there was a marginally significant interaction effect of treatment x time on vigour but not for self-esteem.

**Primary hypothesis: the expectancy effect**

The results indicate an expectancy effect; significant interaction effects for condition x time were found for both vigour ($F_{1, 28}$ = 12.96, $p$ = .00, $\eta_p^2$ = .32) and self-esteem ($F_{1, 28}$ = 5.69, $p$ = .02, $\eta_p^2$ = .17) (Figure 5.4). The green-expectancy group experienced a greater improvement in vigour ($M$ = 4.13, 95% CI 3.27-4.99) compared to the green-control group ($M$ = 2.00, 95% CI 1.06-2.94). Similarly, a greater improvement in self-esteem occurred in the green-expectancy group ($M$ = 4.07, 95% CI 2.47-5.67) compared to the green-control group ($M$ = 1.93, 95% CI 0.80-2.99).

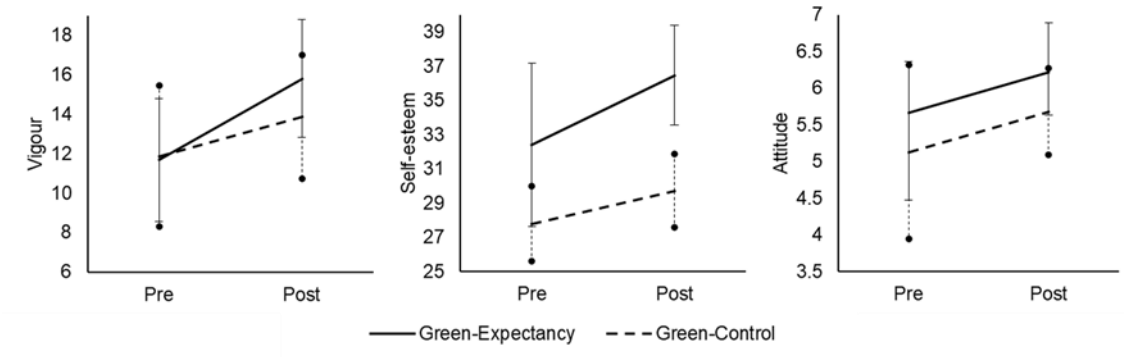



**Figure 5.4** Condition x time interaction for vigour, self-esteem and attitudes (*M* and *SD*) amongst green exercisers (*N* = 30). There was a significant interaction effect of condition x time on vigour and self-esteem.

**Secondary hypothesis: the negative expectancy effect**

The results indicate a negative expectancy effect; there was a significant interaction effect of condition x time on vigour ($F_{1, 28}$ = 15.10, $p$ = .00, $\eta_p^2$ = .35) (Figure 5.5). The indoor-control group experienced an increase in vigour (*M* = 0.60, 95% CI -0.46-1.66), whereas the indoor-expectancy group experienced a decrease in vigour (*M* = -2.40, 95% CI -3.67- 1.13). No significant interaction effect for condition x time was found for self-esteem, although there was a small-medium effect size ($F_{1, 28}$ = 1.08, $p$ = .31, $\eta_p^2$ = .03) (Figure 5.5).

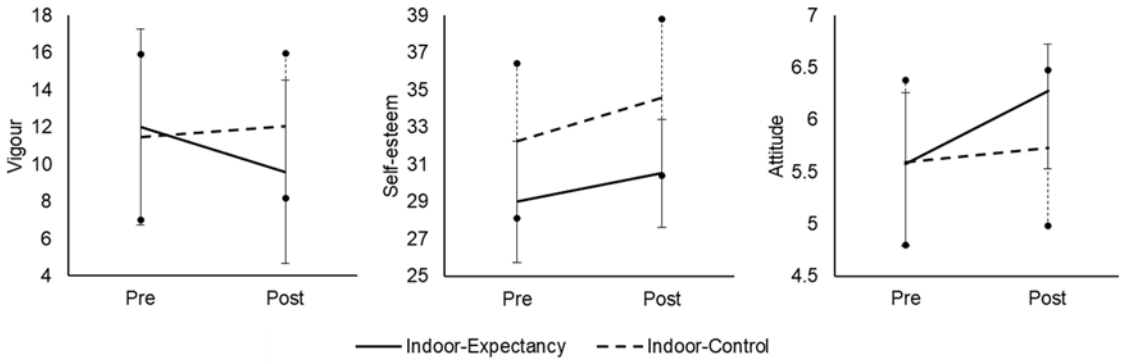



**Figure 5.5** Condition x time interaction for vigour, self-esteem and attitudes (*M* and *SD*) amongst indoor exercisers (*N* = 30). There was a significant interaction effect of condition x time on vigour but not for self-esteem.

## Discussion

We explored the impact of a green exercise promotional video on vigour and self-esteem following an acute bout of moderate-intensity exercise. The video was designed to inform participants of the benefits of green exercise and modify expectations regarding the outcomes of an acute bout of green exercise. Initially, our results provide further evidence for the therapeutic outcomes of green exercise. Consistent with some expectancy research, when we showed the video to green exercisers, the therapeutic outcomes were enhanced. This is important because it shows that promotional tools may be used to enhance acute outcomes of green exercise. Further, the very same video elicited a negative expectation effect amongst indoor exercisers, and subsequently suppressed post exercise vigour.

Consistent with previous research (Barton, Bragg, Wood, & Pretty, 2016; Barton & Pretty, 2010; Gladwell et al., 2013; Thompson Coon et al., 2011), the current findings provide further evidence of the psychological benefits of green exercise. Specifically, participants in the green control group experienced a 17% increase in vigour, whereas the indoor control group only experienced a 5% increase in vigour.

As there were no significant differences in perceived exertion or power output during cycling, changes in vigour may be explained by environmental conditions. Those individuals who exercised outdoors may have benefitted from the synergistic effects of exercising in the presence of nature.

To our knowledge, this is the first study to explore the potential for expectancy effects to enhance the benefits of green exercise. As with previous expectancy exercise research (Desharnais et al., 1993; Helfer et al., 2014), we found that informing participants of the psychological benefits of exercise induced a significant increase in psychological wellbeing. This may be explained by psychological benefits of green exercise being related to both conditioning and expectations. Previous research has shown that the expectancy effect of sham painkillers (Amanzio & Benedetti, 1999) and oxygen (Benedetti, Durando, Giudetti, Pampallona, & Vighetti, 2015) are related to a pre-conditioning of the actual therapeutic effect. In these studies, participants experienced the active ingredient multiple times, prior to receiving a placebo. After pre-conditioning occurred, an expectancy (placebo) effect was more likely to appear following administration of an inert substance.

To assess for pre-conditioning in this study, we asked participants to report attitudes to green exercise and green exercise levels. We are confident that prior to attending the experiment, participants were pre-conditioned to the benefits of green exercise. Descriptive data (Table 1) shows participants perform green exercise over twice per week on average, and also had strong attitudes towards green exercise. This highlights a familiarity with doing green exercise and an appreciation of the benefits. We propose that the green exercise and expectancy effects found in this study are partly due to a pre-conditioning of the psychological benefits of green exercise. Interestingly, we found both a significant environmental effect, and a marginally significant positive expectancy effect. Perhaps, the expectancy

manipulation in this study reminded the participants that they were receiving a therapy, and thus heightened the conditioned response.

In this study, changes in attitudes did not serve as the mechanism for the enhanced psychological wellbeing. There are several possible explanations for this. First, whilst the attitudes dimension of the BAGE is a validated measure designed to capture beliefs about behavioural outcomes of green exercise, it was not designed to capture expectations regarding the acute psychological outcomes of green exercise. In this study, the attitudes measure of the BAGE acted as a proxy for expectations, but perhaps it did not accurately capture subtle, yet important changes in expectations. Second, although the findings are consistent with expectancy effects, a change in expectations may not have served as the mechanism for improved outcomes. Recent advances in placebo research suggest positive effects of some treatments can occur through a variety of psychological, neurological, and biological mechanisms (Benedetti, 2014), and it is possible that expectation is not a mechanism for green exercise. Finally, vigour and self-esteem may have improved for reasons other than expectancy effect. For example, the single-blind design and/or demand characteristics may have contributed to the significant findings.

The indoor-expectancy group experienced suppressed psychological outcomes compared to the indoor-control group. Instead of a conditioned response to a therapy, the negative expectancy effect may have occurred through the rumination of an absent therapy or fear of missing out. Previous research shows that the fear of missing out is associated with lower mood states (Przybylski, Murayama, DeHaan, & Gladwell, 2013). In the indoor-expectancy group, the video may have induced memories of green exercise, and created a dissonance between reality and therapy (e.g., ‘the researchers have shown me a video about the benefits of green exercise, it agrees with some of my previous experiences, and now they have asked me cycle in front of a grey wall’). In support of this, attitudes to green exercise increased

significantly more in the indoor-treatment group compared to the indoor-control group, although this assumes that the strong positive attitudes about green exercise are inherently opposite to negative attitudes about indoor exercise (which we did not assess). However, we suspect that being shown a video of green exercise before being made to cycle indoors (a less invigorating experience) may have coerced participants to make a cognitive comparison about the mode of exercise and in turn increased their attitudes to green exercise. In the absence of prior research relating to negative expectancy effects in the green exercise domain, this speculative explanation warrants further examination.

It is possible that demand characteristics played a role in the reported positive and negative expectancy effects. Demand characteristics are an experimental artefact whereby participants change their behaviour and/or responses based on their interpretation of the research hypothesis (Orne, 1962). Although this can occur with all self-reported measures, our experimental design may have led to different demand characteristics between groups. Although the locations at which baseline measures were completed may have been susceptible to demand characteristics, non-significant differences in baseline attitudes to green exercise lead us to believe that demand characteristics were not present at this stage. However, they may have occurred following the expectancy manipulation. Those in the expectancy groups were shown a promotional video of green exercise, then asked to cycle in either an indoor or outdoor environment. The belief about whether the environment in which they cycled facilitated or inhibited psychological wellbeing may have altered how participant's reported self-esteem and vigour.

The current findings have some important implications for researchers and applied practitioners. First, the findings emphasis that careful consideration of the methodological design and an understanding of pre-existing conditioning and expectations are vital to ensure that expectancy effects are accounted for in green

exercise research. For example, we assessed attitudes to perform green exercise using a validated questionnaire to increase our ability to assess the expectancy effect. Second, acknowledgement of the negative expectancy effect in exercise research will help shape a better understanding of the less well-known phenomena. For example, if policy makers inform people of the benefits of particular types of exercise (such as green exercise) but do not provide appropriate access or facilities to enable people to undertake that exercise (such as safe, accessible green spaces), then it may be detrimental to psychological wellbeing.

Despite the strengths of the research in providing important insight into green exercise, some limitations should be acknowledged. First, although the study examined expectancy effects, it did not assess other possible mechanisms for different outcomes between groups. Using subjective measures, we cannot quantify how much of the expectancy effect was due to a psychoneurological changes or demand characteristics. Second, although efforts were made to create an authentic and controlled outdoor exercise experience that could be accurately compared to indoor exercise, cycling on a stationary bike on the edge of a field is not a common occurrence and may not replicate participants' previous pleasant experience of green exercise. Third, although effort was made to avoid demand characteristics, failure to blind test administrators to the expectation condition may have had an effect. It was not possible to truly blind participants to either condition (as they knew whether they had watched a video or not) nor treatment (as they knew they had exercised indoors or outdoors), however, participants were blinded to the overall design and aims of the study. Fourth, although a power analysis revealed we needed 68 participants for the study, we only recruited 60, therefore increasing the chance of a type-II error. Fifth, as mentioned previously, the participants had high levels of baseline attitudes towards green exercise, and green exercise levels. This may have been a consequence of the opportunistic sampling method used in this study. Finally, although this study is one

of the few to assess attitudes before and after physical activity, the BAGE was designed to assess how individuals feel about green exercise as a contributor to weekly physical activity and not how individuals feel towards the acute psychological benefits of green exercise.

Further research is warranted to understand the mechanisms behind the effects of green exercise, and to understand how promotional tools can be utilised to enhance outcomes. In green exercise literature, a small number of studies (Aspinall et al., 2015; Bratman, Hamilton, Hahn, Daily, & Gross, 2015; He, Chen, & Yu, 2016) have begun to utilise neurophysiological measures to explore the effect of green exercise on psychological wellbeing objectively. For example, portable devices (such as Emotive EPOC; Emotiv Ltd, Hong Kong) could be used to examine the impact of expectancy modification on brain activity during green exercise. This technique may also help identify if a pre-conditioning of green exercise exists and is represented as a heightened anticipatory rise in engagement and/or excitement. Future studies should also consider blinding experimenters where possible and consider the impact of environmental characteristics such as temperature and humidity during outdoor experimental sessions.

## Conclusion

In conclusion, this was the first study to assess the potential role of expectancy effects on the psychological benefits of acute green exercise. The results indicated that an expectancy manipulation can amplify the acute psychological benefits of green exercise. Using simple video editing tools, and a previously designed environmental comparison (Rogerson, Gladwell, et al., 2016), we improved the psychological outcomes of moderate-intensity cycling in a green setting. As affective responses to moderate-intensity exercise have been shown to predict future participation (Williams et al., 2008), this could be an effective way of improving physical activity levels for the

betterment of health and wellbeing and therefore holds great promise for researchers, practitioners and policy makers.

# Chapter 6

# Testing video marketing as a strategy for increasing green exercise levels

This chapter has been written as a standalone paper although it has not yet been submitted to a scientific journal

**Table 6.1** Thesis Map outlining chapter aims and key findings

| Ch | Aims | Key findings |
|---|---|---|
| 2 | • To investigate which perceptual and objective indices of local green space predict visit frequency to local green space<br>• To explore the relationship between visiting local green space and physical activity levels | • Perceived quality of local green space predicts visit frequency to local green space, whereas perceived access and amount of local green space did not.<br>• As visit frequency to local green space increases, so does the likelihood of meeting physical activity recommendations. |
| 3 | • To capture salient beliefs about green exercise<br>• To develop and provide initial evidence of validity for questionnaires to assess belief about green exercise and intentions to perform green exercise | • Following systematic guidelines, questionnaires were created to assess indirect and direct beliefs about green exercise, and intention to perform green exercise<br>• Initial evidence for factorial validity, composite reliability and parallel-form reliability. |
| 4 | • To explore whether beliefs about green exercise predict visit frequency intention to perform green exercise<br>• To explore whether intention to perform green exercise predicts visit frequency to green space more than nature relatedness and/or perceptions of local green space | • Attitudes, subjective norm, and perceived behavioural control all predict intention to perform green exercise<br>• Intention to perform green exercise predicts visit frequency to local green space<br>• Nature relatedness predicts both intention to perform green exercise, and visit frequency to local green space |
| 5 | • To assess the effectiveness of a promotional video to enhance the psychological benefits of green exercise<br>• To explore if a promotional video has any immediate effects on attitudes to green exercise | • Expectancy effects may play a role in the acute psychological benefits of green exercise<br>• A promotional video is not sufficient to significantly alter attitudes to green exercise following green exercise<br>• A promotional video about green exercise can suppress the psychological benefits of indoor exercise via nocebo effects |
| 6 | • To assess the effectiveness of a promotional video to encourage people to do more green exercise<br>• To explore if a promotional video has an immediate effect on attitudes, or a lasting effect on beliefs and intentions towards green exercise. | |

### *Introduction*

Encouraging physical activity is a priority for public health. In the UK, 39% of adults do not meet the recommended weekly physical activity guidelines of 150 or more minutes of moderate-intensity activities or equivalent (Sport England, 2017). One avenue of exploration is the relationship between local green space and physical activity. A plethora of evidence suggests the natural environment is beneficial for good health (Hartig et al., 2011; S. Kaplan, 1995; Kellert & Wilson, 1995). Spending time in nature can alleviate daily stressors (Morita et al., 2007; Triguero-Mas, Gidlow, et al., 2017; Tsunetsugu et al., 2013), and invigorate individuals for upcoming endeavours (Bowler et al., 2010; Pretty et al., 2005) Moreover, living close to accessible green space is beneficial for good health; findings from a number of studies reveals those that those individuals who live in the greenest areas are likely to be more active than those in urban areas (Chapter 2; Chong, Byun, Mazumdar, Bauman, & Jalaludin, 2017; Jansen, Ettema, Kamphuis, Pierik, & Dijst, 2017; Maas et al., 2008; Mytton et al., 2012; Natural England, 2016a; Veitch, Abbott, et al., 2016).

Green exercise is the term used to describe the synergistic benefits of being physically active in the presence of nature. Walking a dog at the local park or gardening are examples of common green exercise activities. As a mode of physical activity, green exercise has been shown to elicit greater benefits than indoor or urban exercise (Barton & Pretty, 2010; Gladwell et al., 2013; Thompson Coon et al., 2011). For example, acute bouts of green exercise have been shown to be more invigorating (Chapter 5; Song et al., 2015) and anxiolytic (Mackay & Neill, 2010; MIND, 2007) than urban exercise. Even at low-intensity, green exercise is beneficial; for example, walking in nature can elicit greater psychological benefits compared to walking in urban environments (Aspinall et al., 2015; Gidlow, Jones, et al., 2016; Lanki et al., 2017; Song et al., 2015; Torrente et al., 2017). Remarkably, and particularly

interesting for policy makers, even as little as 5 minutes of green exercise may have a positive impact on psychological wellbeing (Barton & Pretty, 2010).

An emerging body of evidence indicates that the way individuals feel about green exercise may play a role in whether they choose to participate in green exercise. In this regard, researchers have explored the impact of psychological constructs such as perceptions of local green space, nature relatedness, beliefs about green exercise, and intention to perform green exercise on behaviour (Chapter 2, 3, 4, 5; Calogiuri, 2015; E. Lawton, Brymer, Clough, & Denovan, 2017; A. Loureiro & Veloso, 2014). Two UK based cross-sectional studies have found that perceived quality of local green space, nature relatedness, and intention to perform green exercise all significantly predict visit frequency to local green space (Chapter 2, 4). Moreover, findings suggest that beliefs about particular types of green exercise activities (such as park visitation, outdoor recreation programs, and outdoor pool use) relate to actual behaviours (Kouthouris & Spontis, 2005; Middlestadt et al., 2015; Shrestha & Burns, 2009).

In physical activity research, the TPB is a commonly used model for exploring the role of beliefs on physical activity adoption and maintenance (Downs & Hausenblas, 2005b; Hagger et al., 2002). The underlying premise of the theory is that beliefs (made up of attitudes, subjective norms and perceived behavioural control) predict intentions, which in turn predict behaviours. Therefore, an increase in positive beliefs is accompanied by an increased likelihood of performing behaviour. In the physical activity domain, findings suggests that the attitudes component of the TPB is most closely linked behaviour (Chatzisarantis et al., 2005). Further, a systematic review exploring the relationship between affective judgements (a component of attitudes) and physical activity levels, found a moderate positive effect size ($r = .42$; Rhodes, 2009). In green exercise research, a recent focus-group study found that individuals from low-income urban areas ($N = 41$) reported attitudes reflecting the importance of parks for health and psychological wellbeing (Groshong et al., 2017).

The TPB has been used in green exercise research in a variety of ways: as a model for discussing the role of environment in physical activity behaviours (Calogiuri & Chroni, 2014; Nelson et al., 2008), as a framework for developing belief-based questionnaires (Chapter 3; Shrestha & Burns, 2009), and as a model for assessing predictors of behaviour in cross-sectional research (Chapter 4). Chapter 4 found that attitudes, subjective norms, and perceived behavioural control all significantly predicted intention to perform green exercise (*N* = 338). Subsequently, intention to perform green exercise significantly predicted visiting local green space at least per week. This is important because visiting local green space at least once per week has been shown to quadruple the likelihood of meeting physical activity recommendations (Chapter 2). One possible extension of this research would be to design interventions to increase beliefs about green exercise and thereby facilitate positive behaviours (i.e., more green exercise).

One recent intervention study has successfully increased acute green exercise behaviours amongst the general population. Taff et al. (2017) implemented and evaluated the effectiveness of park signage to promote green exercise at two locations in Gettysburg National Military Park, Pennsylvania, USA. Through observing park visitor behaviour, the authors found that one of the signs was powerful enough to triple the proportion of park visitors engaging in green exercise. The sign included the phrase '*Walk in the footsteps of the Confederate soldiers on one of the most famous attacks in American History; Walk the 1-mile long Pickett's Charge'*. Whilst green exercise interventions have been used before (Natural England, 2011a), they are often designed to target small sub-populations such as the elderly or those with poor mental health. For example, Natural England commissioned 8 pilot projects across multiple regions of the England to try and engage hard to reach groups in green exercise (Natural England, 2011a). The eight projects adopted very different approaches to delivering green exercise. Therefore, the park-signage study was one of the first to

target green exercise behaviours amongst the mass population using a tailored marketing intervention.

Promotional videos are one method for distributing information regarding the benefits of green exercise. For example, the National Health Service in England and Scotland have created videos that promote physical activity to the mass audience. Whilst both videos are not solely focused on green exercise, they do contain footage of people running through local green spaces (https://www.youtube.com/watch?v=of0FZaSRk60 and https://www.youtube.com/watch?v=Qco3RJlbP2o respectively). Additionally, a recent study has explored the use of a green exercise promotional video to enhance the psychological benefits of acute green exercise (Chapter 5). The authors found that a 3-minute video was sufficient to significantly improve vigour and self-esteem following an acute bout of moderate-intensity green exercise, however findings didn't support changing attitudes to be the mechanism. The authors reported that the tool used to measure attitudes was not specifically designed to assess attitudes to psychological benefits of acute green exercise, and therefore may not have been ideal for assessing attitudes in this instance.

Mass media campaigns to promote physical activity have increased recently. The findings from these interventions are mixed; one systematic review found that only seven out of 18 mass media campaigns between 2003 and 2010 significantly increased physical activity levels (Leavy, Bull, Rosenberg, & Bauman, 2011). Moreover, a meta-analysis of nine before-after studies ($N$ = 27,601) found that mass media campaigns had a significant effect on promoting moderate intensity walking, but did not increase the likelihood of meeting physical activity guidelines (Abioye, Hajifathalian, & Danaei, 2013). Interestingly, and consistent with the TPB, campaigns that promoted physical activity as a 'social norm' were more effective than those that used celebrity endorsement or risk prevention messages. In both reviews, the authors

noted a lack of methodological rigour (such as the use of validated questionnaires), amongst some individual studies.

The primary aim of this current study was to assess the effectiveness of a promotional video to encourage people to do more green exercise. We hypothesised that compared to a control group, an evidence-based video would increase green exercise participation amongst the general population. The secondary aims of the study were to explore if the video had an immediate effect on attitudes to green exercise, and if watching the video (and having four-weeks to potentially participate in green exercise), had any effect on overall beliefs and intentions to green exercise. We hypothesised that if amounts of green exercise increased following the video, it would be accompanied by immediate changes in attitudes, and a change in overall beliefs and intentions after four-weeks.

## Method

### Participants

Participants lived and/or worked in the County of Essex, England (97 women, 49 men, $M_{age}$ = 48 years, *SD* = 13.54). Thirty-four participants were not included in the final analysis (14 who watched the video and 20 who did not) as they failed to complete the questionnaire at the 2nd timepoint. The final sample, therefore, included 112 participants (76 women, $M_{age}$ = 50 years, *SD* = 13.28). The majority reported their ethnicity as white (96%) and married was the most common relationship status (62%).

### Design

All participants were asked to report amounts of green exercise, beliefs about green exercise, and intention to perform green exercise at baseline and four-weeks later. A randomised mixed-model design was used (Figure 6.1). Participants were randomly assigned to one of the two groups: video and control conditions. Those in

the video condition (*N* = 50) were shown a green exercise promotional video immediately after baseline measures, whereas those in the control condition were not (*N* = 62). The video condition also repeated the attitudes measure immediately following the video.

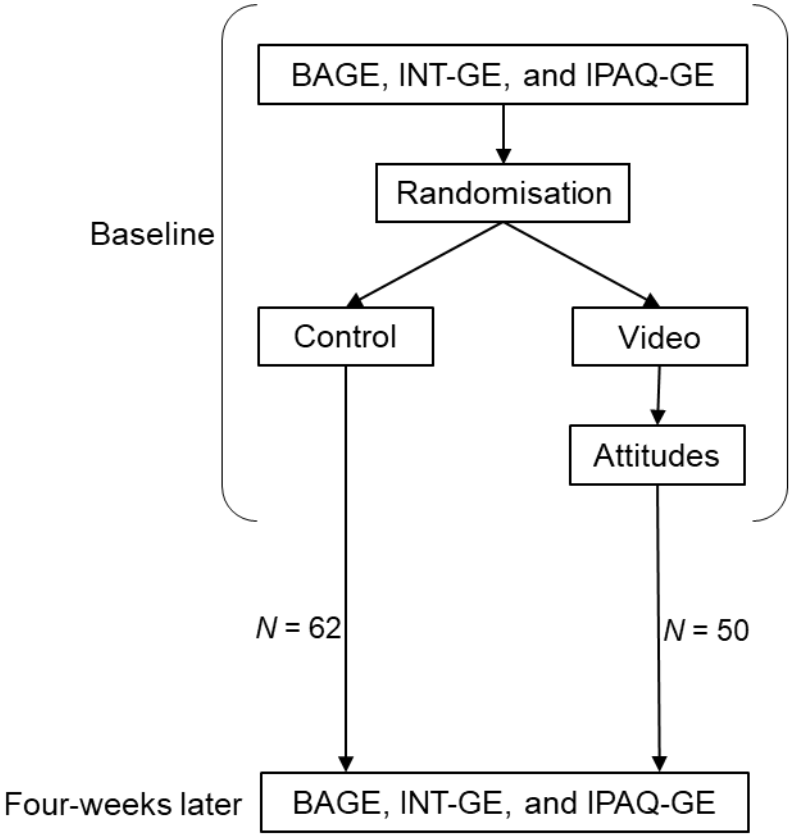



**Figure 6.1** An illustration of the experimental design

**Conditions**

The video condition was shown a green exercise promotional video that was designed to highlight the opportunities for green exercise in Essex and inform participants of the benefits of green exercise. The video was 4 minutes and 14 seconds long and included a mixture of images, text and audio. It was primarily designed to target attitudes to green exercise, however, elements of the video also reflected the subjective norm and perceived behavioural control components of the TPB. The footage highlighted the benefits of green exercise (attitudes), showed

people cycling in a group scenario (subjective norm), and that local parks are suitable for this purpose (perceived behavioural control). The video also included images and maps of green space in Essex, scientific evidence of the benefits of green exercise, and information about green exercise resources. According to the most comprehensive taxonomy of behaviour change strategies (Michie et al., 2013), this video contained 'information about health consequences' (5.1), 'a credible source' (9.1), and 'a demonstration of behaviour' (6.1). Those in the control condition were not shown the video.

**Procedure**

The study was conducted between July and October 2017 following ethical approval from the University of Essex, Ethical Committee and all participants provided informed consent online. An online survey was created using Qualtrics Software (Provo, UT, USA) and was distributed via three channels. It was posted on the Essex County Council intranet, distributed to Essex County Council teachers via a newsletter, and included on a monthly health and wellbeing e-newsletter aimed at residents in the county.

Participants provided demographic information before completing all items from the BAGE, INT-GE, and IPAQ-GE questionnaires (see below for full details). At this point, the Qualtrics Software automatically randomised the participants into the video or control condition. Those in the video condition were shown the green exercise promotional video, whereas those in the control condition were not. After watching the video, participants in the video condition were then asked to repeat the attitudes measure of the BAGE. All participants were thanked for participating and informed they would receive a follow-up email in four weeks. Four weeks later participants were sent a weblink to a second survey that included the BAGE, INT-GE and IPAQ-GE.

Everyone was thanked for their participation and those in the control condition were given access to the video, should they choose to watch it.

**Measures**

*Beliefs about Green Exercise*

The Beliefs about Green Exercise questionnaire (BAGE; Chapter 3) was developed to assess how people feel regarding physical activity in the presence of natural environments. The questionnaire consists of 12 items across three subscales: attitudes (five questions), subjective norms (three questions), and perceived behavioural control (four questions). Each item consists of a statement and a response scale from one to seven (with seven representing more positive beliefs). Examples include 'Doing green exercise as part of my weekly physical activity is… (1) Unpleasant to (7) Pleasant' and 'I choose when and where I do green exercise… (1) Strongly Disagree to (7) Strongly Agree'. Tested with an adult sample (*N* = 230), confirmatory factor analyses revealed all three sub-scales had good composite reliability (ρc = .58-.88) and a good overall model fit (BS$\chi^2$/df = 1.05, CFI = 0.98). Linear regressions also found that the sub-scales significantly predicted intentions to perform green exercise.

*Intention to perform green exercise*

The Intentions to Perform Green Exercise questionnaire (INT-GE; Chapter 3) was developed to assess the likelihood of doing green exercise at least once per week for the next four weeks. The questionnaire contains five items that consist of a statement and a response scale from one to seven (with seven representing stronger intentions). For example, 'I expect to do Green Exercise at least once per week for the next four weeks… (1) Strongly Disagree to (7) Strongly Agree'. When tested on

an adult sample (N = 253), confirmatory factor analysis revealed a good overall model fit (BS$\chi^2$/df = 1.16, CFI = 1.00) and good individual factor loadings (< .70).

*Amount of Green Exercise (IPAQ-GE)*

Self-reported amount of green exercise were recorded using a modified version of the short form International Physical Activity Questionnaire (The IPAQ Group, 2005). Participants were asked to indicate how many days they undertook vigorous exercise, moderate exercise and walking. Furthermore, participants reported how many hours and minutes they usually spent on these activities on one of those days. The items were modified to focus on activities that took place at local green spaces such as playing sport, throwing a frisbee or power walking. The phrase 'at a local green space' was added to end of each question. For example, 'How much time did you usually spend on one of those days doing vigorous activities at a local green space?'. Using the IPAQ-SF scoring guidelines (The IPAQ Group, 2005), raw data were calculated into a weekly green exercise score described as multiples of the resting metabolic rate (METs). According to a 12-country validity and reliability assessment, the IPAQ produces repeatable data (Spearman's *p* clustered around 0.8; Craig et al., 2003).

**Data Analysis**

Preliminary analyses were conducted to ensure the groups were equivalent for baseline beliefs about green exercise, intentions to perform green exercise, and amount of green exercise. First, a series of independent t tests were run to assess if there were any differences between the final sample and those that dropped out (*N* = 146). Second, the t tests were re-run to compare the video and control conditions (*N* = 112).

To test the primary aim, analyses were conducted to assess if the video had any impact on amount of green exercise. A repeated measure ANOVA was conducted to assess if there was a main effect of time, condition or an interaction of condition x time on amount of green exercise (*N* = 112).

To test the secondary aims, first, analyses were conducted to assess if the video had an immediate effect on attitudes to green exercise of the video condition using an independent samples t test (*N* = 50). Second, a series of repeated measures ANOVAs were run to assess for a main effect of time, condition or an interaction effect of condition x time on beliefs about green exercise and intention to perform green exercise (*N* = 112).

### *Results*

After scores were truncated following guidelines (The IPAQ Group, 2005), mean scores revealed that participants met physical activity guidelines (>=600 METs) with green exercise alone; the video condition reported 1559 METs of weekly green exercise whereas the control condition reported 2039 METs (Table 6.2). Further, participants reported strong attitudes to green exercise at baseline (6.39 in the video condition and 6.53 in the control condition out of a possible seven).

Preliminary analysis revealed no statistically significant differences for baseline beliefs, intentions, or amount of green exercise between those that dropped out and the final sample ($ts_{144}$ = -.38-1.71, *p*s = .09-.81, *d*s = .08-.32). Further, a series of independent *t* tests revealed no statistically significant differences in baseline beliefs, and amount of green exercise between conditions in the final sample ($ts_{110}$ = -1.83-0.89, *p*s = .07-.71, *d*s = .22-.29). However, there was a significant difference for baseline intentions to perform green exercise ($t_{110}$ = -2.66, *p* = .01, *d* = .49); those in

the video condition reported lower baseline intentions (*M* = 5.63, *SD* = 1.66), than the control condition (*M* = 6.30, *SD* = 0.98).

For the primary analysis, a repeated measure ANOVA revealed no main effect of time ($F_{1,110}$ = .13, $p$ = .72, $\eta_p^2$ = .00), condition ($F_{1,110}$ = 1.577, p = .21, $\eta_p^2$ = .01) or interaction of time x condition on amount of green exercise ($F_{1,110}$ = .444, $p$ = .51, $\eta_p^2$ = .00; Figure 6.2).

**Table 6.2** Descriptive statistics

| | Dropout | | Final | |
|---|---|---|---|---|
| | Video (*N*=14) *M(SD)* | Control (*N*=20) *M(SD)* | Video *(N*=50) *M(SD)* | Control (*N*=62) *M(SD)* |
| **Demographics** | | | | |
| Age (yrs.) | 41(12) | 48(15) | 51(13) | 48(13) |
| Males (%) | 43 | 35 | 34 | 31 |
| **Baseline** | | | | |
| Green exercise (METs) | 2073(2591) | 1395(1126) | 1559(1412) | 2039(1830) |
| Attitudes | 6.44(0.86) | 6.17(0.87) | 6.39(0.82) | 6.53(0.59) |
| Subjective norms | 4.12(1.44) | 3.78(1.28) | 4.18(1.22) | 4.44(1.11) |
| Perceived behavioural control | 5.82(1.06) | 5.90(0.96) | 5.72(1.16) | 6.08(0.91) |
| Intentions | 6.31(1.13) | 5.95(1.13) | 5.63(1.66) | 6.30(6.30) |
| **Manipulation** | | | | |
| Attitudes | 6.40(1.05) | | 6.44(0.74) | |
| **Outcome** | | | | |
| Green exercise (METs) | | | 1615(1721) | 1853(2028) |
| Attitudes | | | 6.34(0.88) | 6.45(0.75) |
| Subjective norms | | | 4.33(1.49) | 4.34(1.21) |
| Perceived behavioural control | | | 5.59(1.43) | 5.99(0.95) |
| Intentions | | | 5.50(1.66) | 6.10(1.05) |

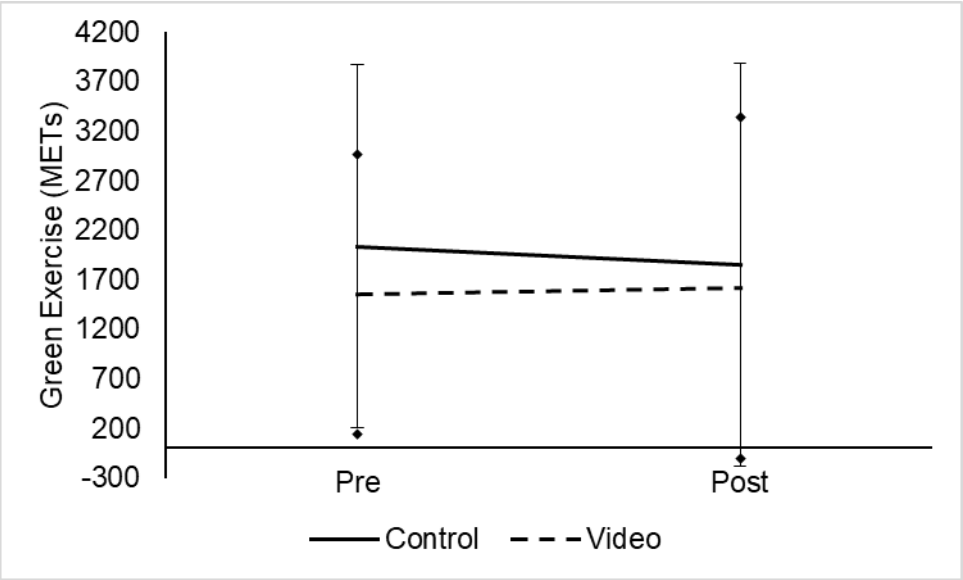



**Figure 6.2** Interaction effect of condition x time (*N* = 112)

For the secondary analyses, an independent samples *t* test (run with the video condition only; *N* = 50) revealed no significant difference between attitudes at baseline and immediately following the video ($t_{49}$ = -.87, *p* = .39, *d* = .06). Additionally, a series of repeated measure ANOVAs revealed no main effect of time ($Fs_{1,110}$ = 0.052 – 2.430, *ps* = .12 – 82, $\eta_p^2$ = .001 - .013), condition ($Fs_{1,110}$ = 0.401 – 7.441, *ps* = .07 – .53, $\eta_p^2$ = .004 - .063) or interaction of time x condition ($Fs_{1,110}$ = 0.061 – 1.295, *ps* = .26 – 81, $\eta_p^2$ = .001 - .012) on beliefs about green exercise and intention to perform green exercise.

### *Discussion*

Encouraging inactive people to do more exercise is vital for public health. As green exercise has been shown to facilitate benefits over and above urban exercise, it is intuitive to try and promote it as a mode of exercise. To date there is a lack of scientific evidence regarding the use of green exercise interventions in the general population. The aim of this study was to explore the impact of a green exercise

promotional video on amount of green exercise amongst an adult population in Essex, England. Underpinned by the TPB, the Essex focused video was carefully designed to highlight the benefits of green exercise, provide an example of people doing it, and suggest potential locations and activities for green exercise.

The findings indicate that the video had no significant impact on amount of green exercise. The most likely explanation for this is a ceiling effect; a statistical concept referring to the point in which an independent variable is no longer affecting the dependent variable (Vogt & Johnson, 2015). High baseline amounts of green exercise and beliefs about green exercise (particularly attitudes) meant that there was very little room for improvement. For example, on average, participants reported obtaining 1825 METs through weekly green exercise activities. This is nearly three times the recommended total physical activity levels for healthy adults, and excludes any indoor or urban activities such as food shopping, cleaning the house etc. There are at least two possible explanations for these high activity values. First, and common with self-report measures of physical activity, participants may have overestimated the amount of green exercise they do on a weekly basis. Comparisons between self-reported and actual physical activity levels often reveal a dissonance (Prince et al., 2008). Second, high amounts of green exercise may have been found because of a sampling bias. The invitation to take part in this study included some information about the type and aims of the research. It is possible that the survey may have been a more attractive proposition for those who already participate in regular green exercise. Conversely, those who predominately exercise indoors, or don't exercise at all, are perhaps less likely to be motivated to participate in research about green exercise.

Another explanation for the null effect on green exercise behaviour is that the video was not effective at increasing attitudes to green exercise. According to previous research, attitudes are associated with physical activity (Chatzisarantis et al., 2005; Rhodes, 2009), and are malleable through behaviour change interventions (Conner, Rhodes, Morris, McEachan, & Lawton, 2011; R. Lawton, Conner, & McEachan, 2009).

Secondary analysis highlighted that attitudes did not increase immediately after watching the video, nor did they increase four-weeks later. Therefore, the video was not effective in this instance. The ceiling effect may also be apparent for attitudes; the video group reported baseline attitudes of 6.39 out of 7. This means that there was only a possible 9% room for improvement to reach maximum attitudes to green exercise. Perhaps the video would be more effective for individuals that (a) don't already strong attitudes to green exercise and (b) are not participating in green exercise on a weekly basis.

This study was unique and expands the literature regarding beliefs and green exercise. However, there were some limitations. First, we used opportunity sampling to recruit participants and we suspect this may have caused a sampling bias and ceiling effect. Second, the participants all lived and/or worked in Essex, UK which is a relatively green county with lots of green spaces, nature reserves, and countryside (Essex Wildlife Trust, 2009). Had we recruited participants from areas with less green space, such as high-density cities, there may have been more opportunity to increase amount of green exercise. Some studies have shown that access to green space is positively related to green space usage, and thus green exercise (Hillsdon et al., 2011; Mytton et al., 2012). Third, whilst efforts were made to produce a high quality promotional video, it perhaps was not adequate to modify attitudes and subsequent behaviours. Finally, we only included self-reported measures of green exercise.

Further research is warranted to discover best practices for encouraging the general population to utilise green exercise as a contributor to weekly physical activity (Chapter 2). Attention should be focused on those who fail to meet recommended physical activity levels, even though they have the capabilities and opportunities to do so. In this regard, a quasi-experimental design is recommended so that only sedentary and/or non-green exercisers are included in the study. Additionally, other marketing tools may also be used such as posters and social media. To overcome one of the

issues found in this study, objective measures of green exercise – obtained through devices such as GPS trackers and activity monitors – are also recommended.

### *Conclusion*

A large portion of the adult population in the UK is inactive, which is detrimental for public health. To try and improve public health, regular physical activity should be promoted. Due to the additional benefits that occur through green exercise, it could be particularly useful to promote it as a mode of activity. Unlike a previous study (Chapter 5), that promoted the outcomes of green exercise, this study targeted green exercise behaviours in the local community. Although the intervention failed to increase green exercise levels amongst our sample, it maybe because the participants were already performing green exercise regularly. However, this approach towards non-green exercisers could still be a worthwhile endeavour because it requires relatively little resources compared to other intervention strategies.

# Chapter 7

# Discussion

### *Summary*

The overall aim of this thesis was to use a mixed method approach to explore the role of beliefs on green exercise behaviours and outcomes. As this topic is relatively unexplored in green exercise research, it was identified as an important area of enquiry (Chapter 1). The experimental chapters sought to investigate this through a variety of research methodologies (such as cross-sectional, questionnaire development, and randomised controlled trials). Two overarching questions guided the research. Question (i) was 'Do subjective measures (such as beliefs about green exercise and perceptions of local green space) predict people visiting local green space and/or doing green exercise? This is an important research questions because Chapter 1 identified that there appears to be a link between local green space, physical activity, and health. Specifically, those that have more access to local green space (measured both objectively and subjectively) are more likely to live an active lifestyle. Prior to this thesis, it was unknown to what extent beliefs about green exercise and perceptions of local green space play a role in this relationship. A greater understanding of the role of subjective measures on green exercise behaviours is needed so that policy makers can deliver successful behaviour change interventions that encourage people to be more active. Question (ii) was 'Can green exercise marketing (such as a promotional video) change an individuals' beliefs about green exercise, improve the experience of green exercise, and the likelihood of doing green exercise? This is an important research question because if beliefs are malleable, then a promotional video may be an effective tool for encouraging people to do more green exercise, and experience more positive outcomes.

Chapter 2 addressed the question of whether perceptions of local green space were stronger predictors of visit frequency to local green space and physical activity levels compared with objectively measured local green space. It also explored the relationship between visit frequency to local green space and the likelihood of meeting

weekly physical activity guidelines (150+ minutes of moderate-intensity exercise, or 75+ minutes of vigorous-intensity exercise, or any combination of the two). It found that perceived access to local green space, and nature relatedness, were stronger predictor of visit frequency to local green space than objectively measured local green space. Furthermore, as visit frequency to local green space increased, so did the likelihood of meeting physical activity guidelines. These are important findings because it highlights the importance that subjective measures such as perceived local green space and nature relatedness play in the relationship between natural environments, physical activity and health. The study was unique in that it compared perceived and actual local green space in a national study, and measured feelings toward nature (nature relatedness).

As nature relatedness appears to be important in visit frequency to local green space, but is not specifically related to green exercise, there was a need to create better tools to assess beliefs about green exercise, and the impact they may have on green exercise behaviours and outcomes. Chapter 3 addressed this issue. Specifically, three questionnaires were developed and validated. The BAGE-ID, BAGE, and INT-GE were designed to assess indirect and direct beliefs about green exercise, and intention to perform green exercise. As the questionnaires were based upon elicited salient beliefs about green exercise, and developed using systematic guidelines, they are currently the most suitable tool for this type of research. Besides evidence for factorial validity, initial evidence was also provided for composite and parallel-form reliability. This advances green exercise research by providing the necessary tools to deeper explore some of the motives and barriers to green exercise and helps policy makers understand more about individual differences and the impact they may have on current and future behaviours.

Chapter 4 was in part like Chapter's 2 and 3 because it explored predictors of visit frequency to local green space using some of the same measures. Using cross-

sectional methodology, it explored beliefs and intentions against previously used measures (nature relatedness, perceptions of local green space, quantity of local green space etc). Firstly, direct beliefs about green exercise, perceptions of local green, nature relatedness and quantity of local green space were assessed as predictors of intention to perform green exercise. It found that as beliefs increased (attitudes, subjective norm, and perceived behavioural control), so did intention to perform green exercise. Like Chapter 2, nature relatedness also significantly predicted intention to perform green exercise. The findings are important for the green exercise field. First, they provide more evidence that subjective measures (e.g. beliefs about green exercise) are fundamentally important in motivating people to visit local green spaces. Second, they provide further evidence of the validity and reliability of the BAGE and INT-GE; all three components of beliefs (attitudes, subjective norm, and perceived behavioural control) predicted intention to perform green exercise.

The next step of Chapter 4 was to explore if intentions to perform green exercise predict visit frequency to local green space. It found that as intention to perform green exercise increased, so did visit frequency to local green space. This is important because the potential intention-behaviour gap is possible in this type of research. As with Chapter 2, nature relatedness (which has previously been categorised as a behavioural belief; Calogiuri & Chroni, 2014), also predicted visit frequency to local green space (behaviour). Prior to this, no study had explored the relationship between beliefs, intentions and behaviour on a national scale. Furthermore, this was the first study to utilise a validated questionnaire that specifically assess green exercise beliefs and intentions.

With some cross-sectional evidence that subjective measures play a role in green exercise behaviours, it was important to test the premise in an experimental environment. Chapter 5 addressed whether beliefs about green exercise influence the acute psychological outcomes of green exercise, and whether attitudes (a

component of beliefs and a proxy for expectations) could be improved to facilitate additional benefits. To do this a marketing tool (a 3-minute promotional video about the benefits of green exercise) was created and shown to half of the participants prior to doing an acute bout of moderate-intensity exercise (cycling on a stationary bicycle whilst facing an open green space). It found that those who watched the video, experienced greater psychological benefits following green exercise, however this was not accompanied by a change in attitudes/expectations. Consistent with literature from general physical activity (Lindheimer et al., 2015), the expectancy effect was offered as a potential explanation for improved psychological outcomes following green exercise, however further investigation is warranted. The findings were described in terms of expectancy effects because the experimental group experienced greater psychological outcomes following a pharmacologically inert intervention (a promotional video). In contrast the nocebo effect was apparent when participants watched the promotional video of green exercise, then exercised indoors facing a grey wall. This is the first time that positive and negative expectancy effects have been researched in a green exercise study and therefore is unique to this thesis.

In Chapter 5, the promotional video improved the psychological outcomes of green exercise. Chapter 6 expanded this research by targeting a promotional video towards trying to change lasting behaviours instead of acute psychological outcomes. This is important because the improved psychological outcomes can only occur if people participate in green exercise. Again, half of participants were shown the promotional video. This time, the video was targeted towards a sample of the general population (recruited from a single geographical area within the UK), and had specific information regarding possible sites and activities for green exercise. In this instance, the video did not increase green exercise participation over a four-week period, nor did it change people's attitudes to green exercise. However, as participants reported

being regular green exercisers at baseline, the non-significant findings were possibly due to ceiling effects (Vogt & Johnson, 2015).

**Table 7.1** Thesis Map outlining chapter aims and key findings

| Ch | Aims | Key findings |
|---|---|---|
| 2 | • To investigate which perceptual and objective indices of local green space predict visit frequency to local green space<br>• To explore the relationship between visiting local green space and physical activity levels | • Perceived quality of local green space predicts visit frequency to local green space, whereas perceived access and amount of local green space did not.<br>• As visit frequency to local green space increases, so does the likelihood of meeting physical activity recommendations. |
| 3 | • To capture salient beliefs about green exercise<br>• To develop and provide initial evidence of validity for questionnaires to assess belief about green exercise and intentions to perform green exercise | • Following systematic guidelines, questionnaires were created to assess indirect and direct beliefs about green exercise, and intention to perform green exercise<br>• Initial evidence for factorial validity, composite reliability and parallel-form reliability. |
| 4 | • To explore whether beliefs about green exercise predict visit frequency intention to perform green exercise<br>• To explore whether intention to perform green exercise predicts visit frequency to green space more than nature relatedness and/or perceptions of local green space | • Attitudes, subjective norm, and perceived behavioural control all predict intention to perform green exercise<br>• Intention to perform green exercise predicts visit frequency to local green space<br>• Nature relatedness predicts both intention to perform green exercise, and visit frequency to local green space |
| 5 | • To assess the effectiveness of a promotional video to enhance the psychological benefits of green exercise<br>• To explore if a promotional video has any immediate effects on attitudes to green exercise | • Expectancy effects may play a role in the acute psychological benefits of green exercise<br>• A promotional video is not sufficient to significantly alter attitudes to green exercise following green exercise<br>• A promotional video about green exercise can suppress the psychological benefits of indoor exercise via nocebo effects |
| 6 | • To assess the effectiveness of a promotional video to encourage people to do more green exercise<br>• To explore if a promotional video has an immediate effect on attitudes, or a lasting effect on beliefs and intentions towards green exercise. | • The promotional video did not increase green exercise behaviours<br>• The promotional video did not have an immediate impact on attitudes, nor did it have an impact on beliefs about green exercise and intention to perform green exercise four-weeks later |

## *Significance of findings*

*Beliefs about Green Exercise*

Overall, the findings of this thesis support the idea that beliefs about green exercise play an important role in green exercise behaviours and outcomes. In relation to Calogiuri and Chroni's (2014) proposal that the relationship between natural environments and physical activity can be mapped using the TPB, findings from Chapters 2, 3 and 4 were consistent, however Chapters 5 and 6 were not. In Chapter 2, perceptions of local green space and nature relatedness were stronger predictors of visit frequency to local green space than objectively measured green space. In this instance perceptions of local green space represent a component of PBC because they relate to how individuals feel about their opportunity to perform the behaviour. Nature relatedness represents a component of attitudes because it relates to feelings about nature – including the benefits it may induce. This was expanded upon in Chapter 4, using questionnaires validated in Chapter 3. Following systematic guidelines, questionnaires were designed to assess individuals' beliefs and intentions towards green exercise as a contributor to weekly physical activity. These questionnaires provided the tools to test the TPB with increased methodological rigour. Consistent with Chapter 2, Chapter 4 found evidence that beliefs about green exercise (attitudes, subjective norms and PBC) predicted intention to perform green exercise, which in turn predicted visit frequency to local green space. Prior to this thesis, the TPB had only been applied to green exercise using ad-hoc questionnaires on specific behaviour such as participation in outdoor recreation programmes (Kouthouris & Spontis, 2005) and state park visitation (Shrestha & Burns, 2009). This thesis did not explore the two distinct pathways suggested in Calogiuri and Chroni's (2014) model; contribution of natural environments on 'active living' and active use of the natural environment. Instead it focused on providing initial evidence of the role of beliefs of green exercise.

As Chapter 2 and 4 both utilised cross-sectional designs, the measures of behaviour were assessed retrospectively, and although this approach is common in TPB research (Biddle et al., 2015), it does limit the inference of causality. Instead, assessing beliefs and intentions at baseline and behaviour after an allocated time allows research gain a deeper understanding of the behaviour in question, specifically when interventions are implemented to alter beliefs and subsequent behaviours. In Chapter 6, green exercise was tested using this approach; beliefs, intention and behaviours were assessed at baseline and after a four-week interval.

In Chapter 6, the intervention – a green exercise promotional video – did not change beliefs about green exercise, nor subsequent behaviour. This was unexpected because a similar video had elicited improved psychological outcomes of acute green exercise (Chapter 5), albeit that a change in attitudes was not the mechanism. This is not consistent with current findings whereby attitudes to physical activity have been shown to be malleable through behaviour change interventions (Chatzisarantis et al., 2005; Conner et al., 2011; R. Lawton et al., 2009; Rhodes, 2009). Therefore, in this thesis, mixed results were found for the use of videos as a method to improve green exercise behaviours and outcomes.

There is also an additional pathway by which acute psychological benefits of green exercise may improve health. Previous research (Focht, 2009; Kwan & Bryan, 2010) shows that the affective outcomes of exercise are related to repeat behaviours i.e. if exercise makes you feel good – and you enjoy it – you are more likely to be motivated to experience those feelings again, and thus exercise again. Intuitively, if green exercise elicits improved post-exercise affective states (as shown in Chapter 5), it is more likely to be repeated than indoor/urban exercise, which is advantageous for health and wellbeing. The government identifies that doing 30 minutes of moderate-intensity exercise on five occasions per week as a potentially sustainable way for

individuals to meet recommended physical activity guidelines. Therefore, regularly visiting local green space may improve the chances of obtaining this recommendation.

Throughout the thesis, a common theme emerged; participants held strong positive attitudes to green exercise. For example, attitudes scores – which are on a scale from 1 to 7 – were high in Chapters 4 (*M* = 6.35), 5 (*M* = 5.26), and 6 (*M* = 6.38). Whilst the BAGE is the most comprehensive tool to assess beliefs about – and specifically attitudes towards – green exercise, it remains untested on different specific sub-populations. Further testing on inactive individuals may provide a clearer understanding of the BAGE's effectiveness at capturing subtle, yet important changes in beliefs about green exercise. Also, as a requirement of rigorous TPB questionnaire development (Ajzen, 2006; Francis, Eccles, et al., 2004), the BAGE – and INT-GE – were designed in relation to one specific behaviour i.e. green exercise as a contributor to weekly physical activity. For this reason, the BAGE may not have been suitable to capture beliefs about the acute psychological benefits of green exercise in Chapter 5. Therefore, the questionnaires were more suited for Chapter 6 than Chapter 5.

High attitudes towards green exercise were also supported by high levels of green exercise participation; in all research chapters, participants reported doing much more green exercise than national averages: In Chapter 4, over 80% of participants reported visiting local green space at least once per week; in Chapter 5, participants reported doing green exercise nearly three times per week; in Chapter 6, participants reported obtaining triple the amount of recommended weekly physical activity through green exercise alone. In comparison, Natural England reports that 34% of people in England visit local green space at least once per week (Natural England, 2016b). As mentioned in Chapters 5 and 6, this additional activity may have produced ceiling effects that contributed to not significant findings.

*Green exercise marketing*

Perhaps the most unique finding in this thesis, is initial evidence for the role of expectancy effects in the acute psychological benefits of green exercise. In Chapter 5, a green exercise promotional video – that is pharmacologically inert – induced greater post-exercise vigour and self-esteem following an acute bout of moderate-intensity green exercise compared to a control. This is important for physical activity research because post-exercise positive affect is related to repeat behaviours (Focht, 2013; Kwan & Bryan, 2010). To date, this remains the only study to specifically investigate expectancy effects in green exercise and find evidence of the phenomena. By accounting for expectancy effects in the design of the study we also added to the growing body of expectancy research in exercise research (Lindheimer et al., 2015; Szabo, 2013). Whilst the mechanism for the expectancy effect (i.e. a change in attitudes) was not found in this study, it did offer some interesting insights into the links between how people think/feel about green exercise and the associated outcome.

However, mixed findings were found for the impact of a promotional video on green exercise behaviours. Specifically, a green exercise promotional video did not increase green exercise participation amongst adults in Essex. As discussed in Chapter 5 and 6, this may have been due to several factors including – but not limited to – the video not being powerful enough to make meaningful changes to beliefs and/or behaviours, sample characteristics, the measures used, and ceiling effects. Marketing green exercise, and thus increasing positive beliefs may be one way to increase green exercise participation and facilitate a plethora of health and wellbeing benefits.

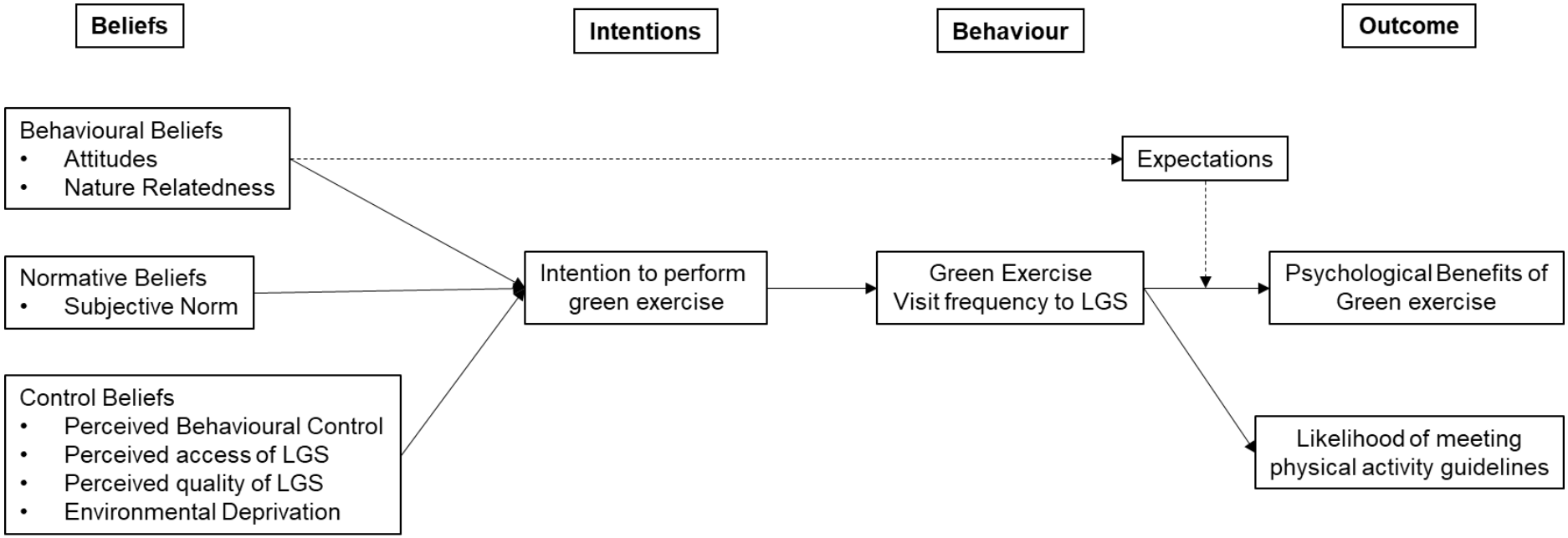
## *Implications*

This implication of the research of the current thesis is that although previously overlooked, beliefs play an important role in (de)motivating people to do green exercise as part of an active lifestyle. This is an important finding for public health

because of the direct pathway it creates between thoughts, health, and wellbeing. As shown by Figure 7.1, beliefs relate to intentions which in turn predict green exercise participation. Thus, an increase in beliefs is accompanied by an increased participation, which is valuable for public health.

First, visit frequency to local green space contributes to overall physical activity levels (Chapter 2), health and wellbeing. Very few activities at local green space are sedentary; even walking to a park bench to read a book or carrying a picnic basket to an idyllic spot require some form of physical activity, albeit that it is not structured sport or exercise. If the walk to the park bench is over 10 minutes in duration, and brisk enough to increase breathing and heart rate, then it contributes weekly physical activity recommendations (National Health Service, 2015). Similarly, if the picnic basket is sufficient heavy to induce sweating and heavy breathing, it too contributes to weekly activity. Subsequently, visiting local green space on a regular basis can contribute to an active lifestyle, facilitate good health, and reduce the likelihood of being obese (Villeneuve et al., 2017); a known predictor of several diseases such as CVD, type 2 diabetes, and some cancers.

Second, green exercise is also beneficial for psychological wellbeing (Chapter 1). When compared to indoor/urban exercise, it has been shown to induce greater acute psychological benefits (Chapter 5; Barton & Pretty, 2010; Gladwell et al., 2013; Thompson Coon et al., 2011), and those that live near green spaces are less likely to have poor psychological wellbeing compared to people with less (Gidlow, Randall, Gillman, Smith, & Jones, 2016; Houlden, Weich, & Jarvis, 2017; Triguero-Mas et al., 2015). This is important for public health because 9.3% of adults suffer from severe symptoms of common mental disorders in the UK (National Health Service Digital, 2016). As spending time at local green space can alleviate some of these symptoms, then it is a worthwhile pursuit for policy makers to try and encourage green exercise.




*Note*. LGS = Local green space.

**Figure 7.1.** Theoretical diagram of how beliefs may play a role in the relationship between natural environment, physical activity and health

Whilst some benefits can occur quickly during an acute bout of green exercise (Chapter 5; Barton & Pretty, 2010; Shanahan, Fuller, Bush, Lin, & Gaston, 2015), the most meaningful changes occur through repeating the behaviour (i.e. regular visits to local green space for physical activity). It is also worth noting that even in the absence of physical activity, spending time at local green space can have positive effects on indices of wellbeing such as heart rate during stressful situations (D. K. Brown et al., 2013) and feelings of restoration (Tsunetsugu et al., 2013).

Researchers interested in the relationship between natural environments, physical activity and health may wish to consider the tools that were developed in this thesis. Using systematic guidelines, and the TPB, three questionnaires were developed (and used). Two of these questionnaires (BAGE-ID and BAGE) assess beliefs about green exercise, and the third (INT-GE) assesses intention to perform green exercise. It is worth reminding that these questionnaires are specifically associated with one behaviour (doing green exercise as part of one's weekly physical activity), and therefore caution is required when assessing beliefs/intentions regarding different behaviours/outcomes. The questionnaires are freely available for use.

### *Limitations*

The limitations of each of the five research chapters are described within the discussion of the respective chapters. There are however some overriding limitations of the thesis. First, as described in Chapter 1, it has been proposed that the green exercise can be categorised as 'active use' of natural environment or 'active living' whereby the natural environment provides background of another activity (Calogiuri & Chroni, 2014). For example, active use is motivated by engaging with nature (hiking, canoeing etc) whereas active living is motivated by being physical active in natural environments (running/cycling through a park). The distinction was not incorporated

into the design of the research chapters; however, this thesis does provide the foundation for future researchers to explore the distinctions. Second, Chapter 4 used participant responses that were already used in Chapter 3. This was deemed worthwhile as it allowed chapter 3 to be solely focused on the development of the questionnaires, without compromise. Had the additional data from Chapter 4 been included in the Chapter 3, it would have certainly lengthened and complicated the chapter. Given that Chapter 3 has now been published in a scientific journal – and requests to use the questionnaires have been made by external green exercise researchers – this decision has been somewhat justified. Finally, this thesis is predominately focused on green exercise (that occurs in local green space such as parks, forests etc), as opposed to other natural environments such as snowy mountains, golden deserts etc. The decision to base this thesis on green exercise was taken due to the large body of evidence that has emerged over the last 15 years, particularly from the University of Essex.

One of the foremost limitations of this thesis is the reliance on subjective measures in the research chapters, particularly with regards to green exercise participation. With the exception of chapter 5, all experimental chapters relied upon self-reported measures of physical activity and green exercise related behaviours. For example, in Chapters 2 and 4, participants were asked to report how often they visited local green space. Whilst this particular behaviour is a necessary requirements of green exercise, it is not a reliable measure of amount of green exercise individuals are performing, nor the subsequent energy expenditure. For example, visiting the local park to have a picnic requires far less energy than running 5km along a canal path, although they both may be consider one visit to local green space. Therefore, visiting local green space may be an indicator of potential green exercise, rather than actual green exercise. Whilst self-report measures are widely used and accepted amongst physical activity research, they do have limitations. First people often overestimate

the amount of physical activity they do (Strath et al., 2013). Additionally, even if they accurately recalled visiting local green space, individuals do not always remember exactly how much physical activity they have done over a specific period, and therefore even with the best intentions, are not able to accurately recall (Rzewnicki, 2003).

In chapter 6, to try and improve the accuracy of measuring green exercise behaviours, an adapted version of the IPAQ (IPAQ-GE) was used to capture green exercise physical activity levels. The questions were targeted towards capturing how often participants visited local green space for walking, moderate- and vigorous-intensity exercise, allowing a calculation of estimated energy expenditure. Whilst the IPAQ, does have limitations, it does provide more insight to actual green exercise behaviours than asking 'how often do you visit local green space? However, what one person considers vigorous intensity activity may be comparable to another person's moderate intensity, and the impact this may have on health and wellbeing is unknown. For example, if a married couple were to walk around a lake together for 2km, they may report the same amount of green exercise, whereas a number of factors (beliefs, expectations, BMI, mood states, fitness etc.) may influence the psychological and physiological outcomes associated with green exercise. Therefore, further research is warranted to determine how individual factors moderate the dose-response relationship between green exercise, and health and wellbeing outcomes.

Additionally, as the IPAQ-GE has only been used on one sample, and responders reported doing nearly three times the recommended amount of physical activity with green exercise along, it is impossible to say at this stage how reliable this measure is. Comparisons between IPAQ-GE responses and objective measures of green exercise may provide initial evidence of reliability. For green exercise objective measures may include GPS tracking, accelerometers, and observations, however this would require greater financial resources, which were beyond the reach of this PhD.

### *Future research*

As the BAGE is the first validated questionnaire to assess beliefs about green exercise, and was created specifically for this thesis, it has not had a vast amount of testing. The decision to base the BAGE on the TPB was taken because it has been used as a model for a recent systematic review (Calogiuri & Chroni, 2014), and there are also published guidelines for developing TPB questionnaires (Ajzen, 2006; Francis, Eccles, et al., 2004). Therefore, whilst the questionnaires are based upon an established model, and supported by a large body of research, they are still new and relatively untested. To test their validity and reliability extensively, they need to be administered to a range of populations and demographic groups. Therefore, one avenue of future research would be to assess beliefs about green exercise amongst specific sample group, such as those that don't do green exercise, or those that live in high density urban areas that lack local green space. By doing this, researchers can gain a deeper understanding of the intricate relationship between green exercise beliefs, intentions and behaviours.

Chapter 5 and 6 did not provide strong evidence that a promotional video could sufficiently alter beliefs about green exercise, nor did Chapter 6 provide evidence that a promotional video could sufficiently alter green exercise behaviours. One indication from these findings is that it is not easy to modify beliefs or behaviours regarding green exercise on individuals that already hold high positive beliefs about green exercise. As mentioned previously, sampling methods and participant demographics may have contributed to this finding. To take this research a step further, interventions should be targeted towards those that are inactive or rely solely or indoor/urban physical activity to maintain an active lifestyle.

When targeting inactive people, other behaviour techniques may also be used alongside a promotional video to increase green exercise levels. For example, researchers at the University College London have developed a model of behaviour

change (COM-B; Michie, Atkins, & West, 2014), and created a complementary taxonomy of behaviour change techniques (Michie, Ashford, et al., 2011). The COM-B model consists of 4 elements; capability, opportunity, motivation, and behaviour. Capability refers to physical and psychological abilities needed to perform the behaviour, motivation refers to reflective and automatic mechanism that activate or inhibit behaviour, and opportunity refers to the physical and social environment that enables the behaviour. With regards to the taxonomy the video used in Chapter 6 may be classified as 'Providing information about the consequences of the behaviour to the individual' or 'Provide information on where and when to perform the behaviour'. However, as the behaviour change technique was limited to a single promotional video, it only targeted one element of the COM-B (i.e. motivation). According to the model, the video could not provide more *opportunity* to perform the behaviour or increase *capability* to perform the behaviour, however it may alter perceptions of both opportunity and capability.

Therefore, further research is warranted to see if additional behaviour change techniques can be used alongside videos to provide a more holistic approach to promoting green exercise. To provide a framework for increasing opportunity, motivation and capability, Mitchie et al produced a behaviour change wheel (Michie et al., 2014; Michie, van Stralen, & West, 2011). The wheel (Figure 7.2) consists of three layers; sources of behaviour (COM-B), intervention functions, and policy categories. The inner red ring, intervention functions, provides nine purposes that interventions serve, and Figure 7.2 highlights some examples that researchers may try to encourage green exercise. For example, green exercise researchers may consider if they can designate areas at local green spaces specifically for green exercise (e.g. outdoor yoga classes) or perhaps educate local people about the benefits of green exercise.

The outer grey ring highlights seven policy categories that governing bodies and policy makers can target to help change behaviour. For example, to increase an

individual's capability to perform green exercise, policy makers could look to provide more accessible local green spaces that are safe, well maintained, and have facilities conducive of physical activity (such as cycle paths, water fountains, etc). Of course, this process is not simple. In reality, governing bodies will likely need further evidence that the cost effectiveness of improving (or adding) green exercise spaces, is greater than other modes of physical activity. For example, would the redevelopment of local green spaces provide more opportunity for physical activity than four open-access tennis courts in a small rural town?

Answering this question requires a comprehensive cost-benefit analysis that is tailored to the circumstances of the individual urban area. Also, as urban areas become more populated, there is increasing pressure on local governments to provide more housing, and amenities (such as schools, doctor's surgeries etc.), and public land use is highly scrutinised. Therefore, it is up to green exercise researchers and health professionals to keep providing reliable evidence that visiting local green spaces for physical activity is beneficial for health and wellbeing across the entire life course, and that providing local green spaces, that are conducive of physical activity, should be a priority for governing bodies.

In regards to increasing opportunity to perform green exercise, policy makers may consider marketing green exercise at local green spaces. For example, as discussed in Chapter 6, Taff et al. (2017) found that a carefully worded message, sign-posted at a military memorial park, increased green exercise behaviours significantly by encourage park visitors to walk more steps. For green exercise intervention to have a better chance of success, they could target the three key elements of the COM-B in an integrated approach.

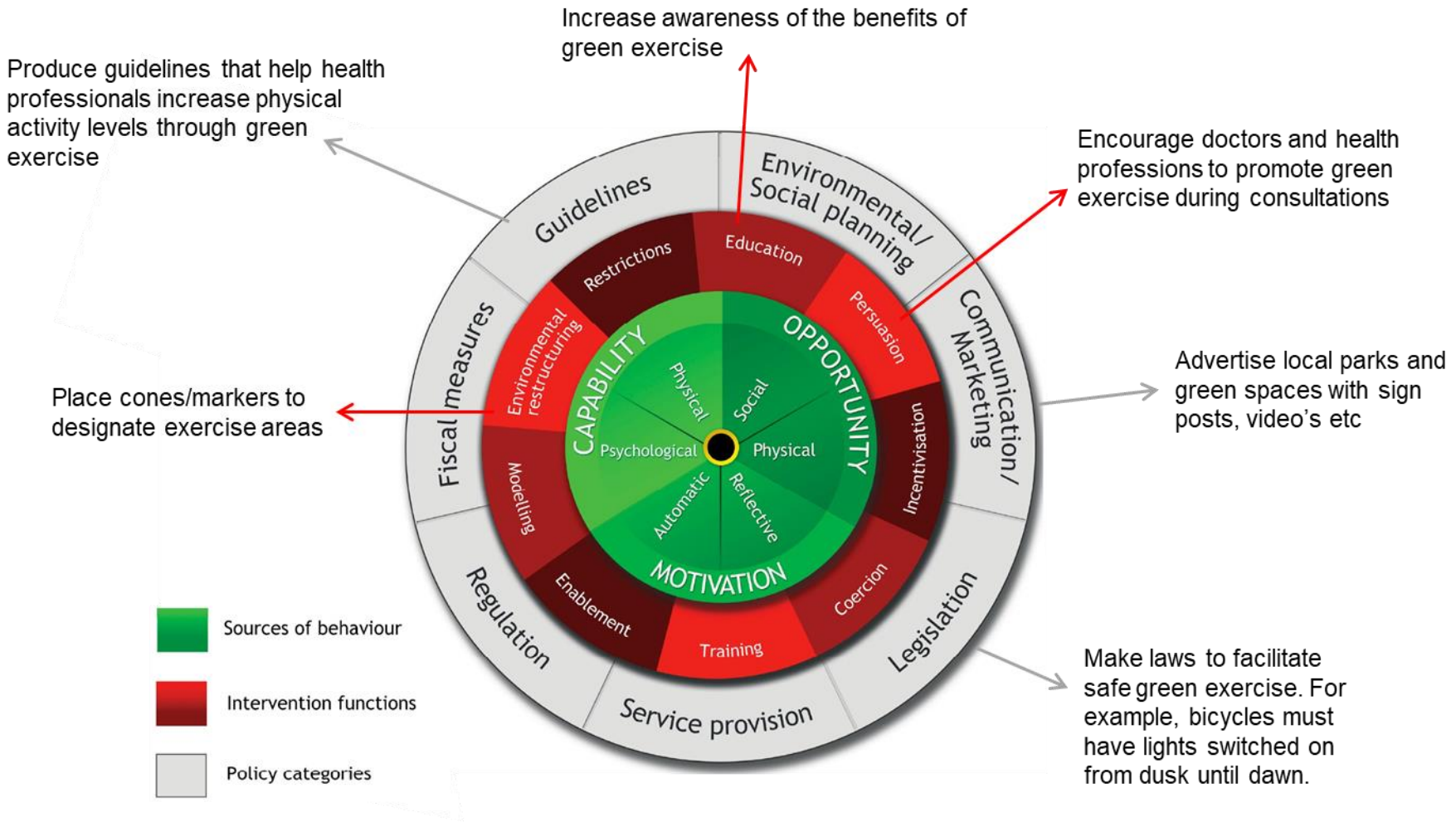



**Figure 7.2** The behaviour change wheel (Michie, van Stralen, et al., 2011), and example of possible green exercise interventions/policies

Furthermore, as some of the previous green exercise research of the psychological benefits of green exercise has focused on people with poor mental health such as young offenders, or members of the local MIND association (Barton & Pretty, 2010), perhaps video interventions could be tailored to these groups to try and capture the belief based mechanisms of green exercise behaviours and outcomes. One possible study could be a green exercise replication of the Desharnais et al (1993) study. In the original study the authors told half of the participants of a four-week tailored exercise programme that the exercise they were doing was specifically designed to increase self-esteem, the other half were not. After four weeks, those that had been informed of psychological benefits of the experienced significantly greater improvement in self-esteem. A replication of this study using a green exercise programme may provide further insights into the outcome mechanisms of green exercise. The BAGE may also be used with this research approach.

## *Conclusion*

This thesis used a mixed model approach to explore the role of beliefs on green exercise behaviours and outcomes. Through a series of unique studies, initial evidence was provided for the impact of beliefs on green exercise participation and outcomes. Specifically, the findings suggest that the way individuals feel about local green space (and green exercise) predicts how often they visit local green space. This is important because visit frequency to local green space is positively linked to the likelihood of meeting physical activity guidelines. Given that activity levels are decreasing, and obesity levels are increasing in the UK, this is a significant finding for public health. Furthermore, findings from this thesis suggest that the experience of visit local green space and performing green exercise differs, depending on expectation of outcomes. Specifically, the actual psychological benefits of green exercise can be enhanced through informing people of the expected psychological benefits. Therefore, increasing green exercise participation and awareness of green exercise benefits, is likely to have a positive effect on health and wellbeing. Another key aspect of this thesis has been the rigorous use of TPB in exploring beliefs, intentions and behaviours. In doing so, new tools have been developed that will help researchers explore these relationships on different populations. Overall, this thesis provides further supportive evidence of the potential benefits that promoting green exercise can have on public health and wellbeing.

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## Endnotes

[i] Road coverage for Scotland, Wales, and Northern Ireland was recorded as missing data and treated as such in the analyses. The analyses were re-run including only participants from England and the same pattern of results was observed. As such, results from the full sample are reported in the manuscript.

[ii] Statistical analysis revealed that when environmental deprivation was removed as a covariate, objectively measure quantity of local green space was not a significant predictor of visit frequency to local green space or physical activity. Therefore, environmental deprivation – as a covariate – was included in the main analysis.

[iii]Statistical analysis revealed that when environmental deprivation was removed as a covariate, objectively measure quantity of local green space was not a significant predictor of intention to perform green exercise or visit frequency to local green space. Therefore, environmental deprivation – as a covariate – was included in the main analysis.

[iv]Additional analyses revealed that attitudes do not mediate the relationship between the independent variables and outcomes.

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# A cross-sectional study examining predictors of visit frequency to local green space and the impact this has on physical activity levels

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## Abstract

**Background:** Lack of physical activity (PA) is a growing public health concern. There is a growing body of literature that suggests a positive relationship may exist between the amount of local green space near one's home and PA levels. For instance, park proximity has been shown to predict PA levels amongst certain populations. However, there is little evidence for the role of relatedness towards nature and perceptions of local green space on this relationship. The aim of this study was to examine, in a National UK sample, whether subjective indices associated with local green space were better predictors of visit frequency to local green space and PA levels compared to objectively measured quantity of local green space.

**Methods:** A cross-sectional survey was designed. From a random sample, 2079 working age adults responded to an online survey in September 2011. Demographics, self-reported PA, objective measures of the local environment (including local green space, road coverage, and environmental deprivation), were assessed in conjunction with perceptions of local green space and nature relatedness. Quantity of local green space was assessed by cross-referencing respondents' home postcodes with general land use databases. Regression models were conducted to assess which of our independent variables best predicted visit frequency to local green space and/or meeting PA guidelines. In addition, an ordinal regression was run to examine the relationship between visit frequency to local green space and the likelihood of meeting national PA guidelines.

**Results:** Nature relatedness was the strongest predictor for both visit frequency to local green space and meeting PA guidelines. Results show that perceived quality is a better predictor of visit frequency to local green space than objective quantity of local green space. The odds of achieving the recommended amount of PA was over four times greater for people who visited local green space once per week compared to never going (OR 4.151; 95 % CI, 2.40 to 7.17).

**Conclusions:** These results suggest that perceptions of local green space and nature relatedness play an important role in the relationship between local green space and PA. Considering the known health benefits of PA, our results are potentially important for public health interventions, policy making and environmental planning.

**Keywords:** Local green space, Nature relatedness, Perceptions, Physical activity, Green exercise

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## Background

Physical activity (PA) is a well-known contributor to good health [1]. Current guidelines for aerobic activity recommend that adults should spend at least 150 min per week in moderately intensive PA or 75 min of vigorous PA (or any combination of the two) [2, 3]. In the most recent Health Survey for England, unfortunately, only 67 % of men and 55 % woman met the recommended guidelines [4]. This is replicated to a lesser extent throughout the whole world, with 20 % of men and 27 % of women considered not to meeting the guidelines [5]. Therefore, increasing levels of PA is a major priority in Public Health, particularly in Westernised countries [6].

An increasing number of studies have investigated the impact of the natural environment on PA behaviours and health. Systematic reviews have found that there is a positive correlation between the availability of local green space (LGS) and PA levels [7–9]. The mechanisms for this, however, remain unclear.

Recently, a schematic model of the motivational processes underlying the relationship between natural environments and PA was proposed [10]. In a compelling argument, the authors suggested two distinct motivational pathways for visiting LGS: firstly the active use of natural environment and secondly as a contributor to active living. Consistent with these pathways, this study explores how feelings about nature influence visits to LGS (active use) and the subsequent relationship this has on PA (active living). Specifically, we examine the influence of both objective and subjective measures of the local environment on visit frequency to LGS and the likelihood of meeting PA guidelines. We also explore the influence of visit frequency to LGS on PA levels.

The literature in this area has predominately focused on two examples of green spaces, namely natural environments and urban green spaces, or a combination of the two [11]. By definition, natural environments are those that occur naturally on earth. They differ from urban green spaces in that they have had minimum human input in their design, creation, and maintenance [11]. Both are used as locations for recreational activities in modern society. For the purposes of this study, LGS is a combination of urban green space and natural environments in close proximity to the home.

Many recreational activities that take place in LGS involve some form of PA such as walking, jogging, and play [12–14]. Even less intense activities like photography, reading, and fishing often require individuals to walk to desired locations. Thus, visit frequency to LGS may be positively associated with overall PA levels and subsequently the likelihood of meeting PA guidelines.

A recent review of the impact of LGS on PA found that there is a huge variety of research methods employed within the field, including objective and subjective measures of LGS [10]. Studies using objective measures have predominately focused on specific locations and used a Geographical Information System (GIS) to assess LGS [15–17]. Using GIS, researchers can analyse geographical data and categorise into various land uses (domestic buildings, roads, green space etc.). Conversely, subjective measures embrace self-report questionnaires to provide vital insight into individuals' perceptions of LGS (pLGS). Requiring fewer resources, subjective measures enable investigation of some variables over much larger geographic areas [18, 19]. Interestingly, when both objective and subjective measures have been used to determine quantity of LGS in the same geographical area contemporaneously, discrepancies have been found between perceptions of park proximity and actual distance to park [20] as well as perceived versus actual quantity [21].

To date, only a small number of studies have investigated the relationships between objectively measured LGS, PA, and health on a national scale [22–25]. These studies have found mixed results. For example, in the Netherlands, the quantity of LGS within a one km radius of home address was associated with 15 indicators of well-being [22]. In contrast, neighbourhood park access was not associated with body mass index (BMI) in New Zealand, although beach access was related to BMI [25].

Furthermore, two studies in the UK have also produced mixed results. In England, individuals who lived in the greenest quintile of England were 1.27 times (95 % CI, 1.13 to 1.44) more likely to meet PA guidelines than individuals in the least green quintile [23]. In contrast, no association was found between LGS and meeting PA guidelines in Scotland [25].

A systematic review [10] suggested that perceptions or subjective measures of LGS access are stronger predictors of PA than environmental barriers such as actual proximity (e.g., [18, 26]). For example, perceived access to LGS has been linked with PA levels in Canada [20] and Australia [27]. In the UK, a few localised studies have investigated the relationship between pLGS and green space usage (e.g., [19, 28]). Results from Oxford and Bristol found that the majority of people were satisfied with accessibility to LGS. In Bristol, however, despite good perceived access, only 31 % of participants visited LGS on a weekly basis. This suggests that other factors are likely to play a crucial role in the actual use of LGS and in turn PA levels.

Beyond the role of perceived access, it is important to consider the perceived quality of LGS. Commonly reported as 'satisfaction with neighbourhood parks', evidence suggests perceived quality of LGS is positively related to PA [18, 29]. This further highlights the potential importance of pLGS for PA.

In addition to perceptions of quality and access, individuals' self-reported relationship with nature may be a

crucial determinant of whether they engage in PA in LGS (termed Green Exercise). Evidence from recent studies suggests that nature relatedness (individual levels of connectedness with the natural world; NR) plays an important role in engagement with nature and subsequent benefits [30, 31]. Indeed, NR has been shown to predict travel distance to parks [30], time spent in gardens [30], and psychological well-being [32]. In their schematic model, Calogiuri et al. [10] proposed that feelings about nature influence intentions to visiting LGS.

In summary, there are a number of factors that influence the relationship between LGS and PA, including actual visits to the LGS. Objective (GIS measured quantity of LGS) and subjective (perceived access and quality) have been shown to predict visit frequency to LGS and overall PA. It is vital, however, to take a more nuanced approach to understand the role of perceptions in the relationship between LGS and PA. No study has investigated which pLGS have greatest impact on visit frequency to LGS and subsequent PA. The aims of the study, therefore, were to examine: 1) which objective and perceptual indices of LGS predict visit frequency to LGS? 2) which objective and perceptual indices of LGS predict whether participants meet PA guidelines? and 3) if visit frequency to LGS predicts whether participants meet PA guidelines? It was hypothesised that perceived access and quality of LGS and NR would be stronger predictors of visit frequency to LGS and PA than objectively measured LGS. It was also hypothesised that the likelihood of meeting PA guidelines will increase in a dose-response pattern with visit frequency to LGS.

## Method

The data used in the present study were extrapolated from a larger research project examining the effects of the environment and exercise on psychological health. Part of the project was conducted using an online questionnaire administered to participants in the 150,000 person Harris Poll panel of Great Britain. The research was approved by the University of Essex Research Ethics Committee and participants provided informed consent. Participants were selected at random from the base sample and invited by email to take part in the survey ($n = 22{,}950$). Data from the responding sample were collected over a 2 week period in late September 2011. Data collection was closed after 2 weeks as it reached the requested number of respondents.

This process yielded a sample of 2079 working age adults. In the current study, data were available for 1988 working age adults (997 males) ranging from 22 to 65 years ($M = 43.19$, $SD = 11.46$), which is the higher than the UK median of 39 years [33]. Only employed individuals were selected for this research in order to control for the impact of active commuting on visiting LGS and PA levels; 69.8 % were in full-time employment, 18.1 % were in part-time employment, and 12.2 % were self-employed.

The UK Meteorological Office [34] reported that in July and August 2011, mean temperatures were 0.5 to 1.0 °C below average across most of the UK. In contrast, during September, 2011 – during data collection – the mean temperatures were around 1.1 °C above average, making it the sixth warmest September in 100 years. Throughout September, most of England experienced below average rainfall; some parts of Northern England and Scotland, however, received over 50 % more rainfall than average [34].

Self-reported health was assessed with a single item which asked "How would you rate your health in the last month?" Participants responded on a Likert scale from "1 = Terrible" to "7 Excellent". This was included as a covariate in all statistical analyses alongside age and gender.

Objective representation of the local environment was given as % of LGS available near home. This was calculated to ward level (primary unit of electoral geography), using participants' home postcodes and Geoconvert (an online geography matching and conversion tool) [35]. For % of LGS, ward coded data were then entered into a database, available from CRESH.org.uk, which has previously been described [36]. In brief, the database used general land use across England, supplemented with a second database covering Scotland, Northern Ireland, and Wales and the coordination of information placed on the environment database [37]. The database provided specific % of LGS, including all vegetated areas larger than 5 $m^2$ in area (excluding domestic gardens) for each ward in the UK. Green spaces included ranged from transport verges (narrow strip of land between carriageway and road boundary) and neighbourhood greens, to parks, playing fields and woodlands.

Perceived access to LGS was assessed by asking participants "How easy is it to get to the green space local to your home?" Participants responded from 1 = "Very difficult" to 7 = "Very easy". Perceived quality of LGS was assessed with a single item that asked "How would you rate the quality of your local accessible green spaces that are close to your home?" Participants responded from 1 = "Terrible" to 7 = "Excellent".

NR was assessed using two sections of the NR Scale (NRS; [38]). The self and experience factors were extrapolated to form the NRS-14. The self and experience factor were used to reflect both how strongly people identify with the natural environment and the attraction people have to nature. The perspective factor of the NRS was excluded as we were not interested in global issues such as conservation and species survival rates. Participants were asked to report how they felt about 14 phrases that described their relationship with nature.

Examples items included, "Even in the middle of the city, I notice nature around me", and "I am not separate from nature, but part of nature". Participants responded using a Likert scale format ranging from 1 = "disagree strongly" to 5 = "agree strongly". Where appropriate, responses were reversed so that higher scores indicated a greater NR. NR was recorded as a mean of 14 items.

Visit frequency to LGS was assessed by asking participants "How often do you visit the green space closest to your home?" This was rated from 1 = "Every day" to 7 = "Never visit my LGS or any other green spaces". This score was then reversed scored so that a higher frequency of visits was represented by a higher numerical value. Participants also indicated via multiple choice selection how they usually travelled to LGS, and how long it usually took them.

Self-reported PA levels were recorded using a short-form version of the International Physical Activity Questionnaire (IPAQ-SF, [39]). Participants were required to indicate how many days they undertook PA activity for more than 10 min. Subdomains were vigorous, moderate and walking. Furthermore, participants reported how many hours and minutes they usually spent on these activities on one of those days. Additionally, participants reported how many hours and minutes they would usually spend sitting on a week day.

Raw data were converted into weekly PA levels using IPAQ-SF scoring guidelines [40]. The raw data were calculated into a weekly score described as multiples of the resting metabolic rate (METs). As recommended by IPAQ scoring guidelines, some of the raw data was truncated to reduce potential outliers. Above 180 min in all categories is considered to be unlikely, suggesting participants' misinterpreted the question. In accordance with guidelines [40], therefore, all moderate minutes that were between 180 and 299 were reduced to 180; those above 299 were divided by seven. Also, vigorous minutes over 180 were divided by seven and walking minutes over 180 were reduced to 180. For the data analysis, participants were dichotomised according to whether they achieved at least 600 MET.min per week or not. Those participants who achieved below 600 MET.min per week in total were classified as not meeting the current minimum requirements for a healthy lifestyle (in accordance with [41]) and in the low category using IPAQ scoring guidelines [40].

A number of variables were included in the study as covariates: age, subjective health, gender, road coverage, environmental deprivation, and active travel to both work and LGS. Environmental Deprivation (at ward level) was obtained from a database that is available on CRESH.org [42]. In summary, ward level measurements were calculated for a variety of environmental dimensions that impact upon health (air pollution, climate, UV radiation, industrial facilities, and green space). Each ward was given a score from −2 to +3, with +3 indicating most deprived environments. For this study, scores of environmental deprivation were reversed so that the most deprived areas had the lowest score.

Road Coverage was calculated by cross referencing ward codes against general land use database [43] across England[1] to give the amount of road coverage in each ward. This was converted to a percentage of the total land area in each ward. For both environmental deprivation and road coverage, participants' home post codes were converted to wards using Geoconvert.

Active travel to work was assessed by asking participants "How do you usually travel to work? Tick all that apply". Any participant who ticked walk or cycle were classified as active commuters. Active travel to LGS was assessed by asking participants "How do you usually travel to your local green space? Tick all that apply" Any participants who ticked walk or cycle were classified as active travellers to LGS.

All data analysis was carried out using IBM SPSS Statistics 20. Three regression models were run. First, an ordinal regression model was run to determine whether objective (% LGS) and subjective (perceived access, perceived quality, and NR) measures predicted frequency of visits to LGS. Additional demographic, objective, and subjective variables were included as covariates in the model (see Table 1).

Second, a binary logistic regression was run to determine whether objective (% LGS) and subjective (perceived access, perceived quality, and NR) measures predicted the likelihood of meeting current UK PA guidelines. Additional demographic, objective, and subjective variables were included as covariates in the model (see Table 2).

Finally, another binary logistic regression was run to determine if visit frequency to LGS predicted the likelihood of meeting current UK PA guidelines. Age, gender and health were included as covariates in the third model. Nagelkerke $R^2$ tests were run to assess how much of the variance in the outcomes could be accounted for by the models. Statistical significance was accepted at $p < 0.05$ throughout the analyses.

## Results

The 1379 urban wards represented in the study had a mean green space coverage of 52.7 % (95 % CI, 51.5 to 53.9). This is nearly 10 % lower than the UK national average of 62.6 %. Furthermore, the wards had a mean road coverage of 10.1 % (95 % CI, 3.7 to 16.6 %) and a mean environmental deprivation score of 0.46 (95 % CI, -0.47 to 1.38).

Overall, participants responded favourably towards perceived access (M = 6.15, SD = 1.14) and perceived

quality (M = 5.41, SD = 1.23) of LGS; 90.1 % of participants reported at least 'somewhat easy' access to LGS and 76.1 % of participants reported perceived quality of LGS as at least 'good'. Participants reported a mean NR score of 3.29 (SD = 0.73). This is comparable to NR scores reported in previous literature [44, 45].

In this study, engagement with the natural environment is indicated by visit frequency to LGS. In total, 67.7 % of participants reported visiting LGS at least a 'few times a month'. Active travel to LGS was reported by 85.6 % of participants and the vast majority reported travel duration to LGS of less than 20 min (86.5 %). Additionally, 18.4 % of participants reported actively commuting to their place of work.

In total, 75.5 % of participants (77.7 % of men and 73.2 % of women) reported meeting the current UK PA guidelines of at least 600 MET.min per week [41]. This is higher than national averages (66 % of men and 56 % of women; [4]). Subsequently, 24.5 % of participants did not complete enough MET.min per week to sustain a healthy lifestyle. Participants obtained the most amount of MET.min through walking (M = 54.7 %).

### What predicts visit frequency to LGS?

An ordinal regression was run to predict visit frequency to LGS based on perceptions and objective measures of LGS (see Table 1). A Nagelkerke $R^2$ of 0.226 indicates that the model explained 22.6 % of the variation in visit frequency. After controlling for covariates, NR was the strongest predictor of visit frequency to LGS. An increase in NR was associated with an increase in the odds of visiting LGS more frequently (OR = 2.234, 95 % CI, 1.937 to 2.581). Perceived quality of LGS also significantly predicted visit frequency (OR = 1.537, 95 % CI, 1.388 to 1.704), but perceived access did not.

**Table 1** Odds ratios of visit frequency to LGS

| | | [a]OR | [b] 95 % CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| Covariates | *Age* | 0.994 | 0.985 | 1.002 |
| | *Health* | 1.071 | 0.985 | 1.165 |
| | *Gender* | 1.003 | 0.832 | 1.210 |
| | *% of Road Coverage* | 1.011 | 0.976 | 1.047 |
| | *Environmental Deprivation* | 1.082 | 0.970 | 1.206 |
| | *Active Travel to Work* | 1.125 | 0.915 | 1.384 |
| Objective | *% of Local Green Space* | 1.006 | 0.998 | 1.015 |
| Subjective | *Perceived Access* | 1.106 | 0.994 | 1.230 |
| | *Perceived Quality* | 1.537* | 1.388 | 1.704 |
| | *Nature Relatedness* | 2.234* | 1.937 | 2.581 |

Note. $R^2$ = .226 (Cox and Snell), .226 (Nagelkerke). Model $\chi^2$ (10) = 348.022, $p < 0.01$. [a]Odds Ratios, [b]95% Confidence Intervals, * indicates significance at $p < 0.01$

### What predicts whether participants meet PA guidelines?

A binary logistic regression was run to determine which variables predicted the likelihood of meeting PA guidelines (see Table 2); the model explained 13.1 % of the variance (Nagelkerke $R^2$ = 0.131). After controlling for covariates, NR was the only significant predictor of meeting PA guidelines (OR = 1.268, 95 % CI, 1.128 to 1.424). Neither pLGS (Access and Quality) nor objectively measured green space were significant predictors. Of the covariates, subjective health and active travel to both work and LGS were significant.

### Does visit frequency to LGS predict whether participants meet PA guidelines?

A binary logistic regression was run to predict the likelihood of meeting PA guidelines based upon visit frequency to LGS. The model explained 16.8 % of the variation in whether participants met PA guidelines (Nagelkerke $R^2$ = 0.168). As illustrated by Fig. 1, as visit frequency to LGS increased so did the likelihood of achieving PA guidelines (compared to never going).

## Discussion

This study found that as the number of visits to LGS increased so did the odds ratio of meeting PA guidelines. The findings also highlight the importance of NR, which was the strongest predictor of both visit frequency to LGS and meeting PA guidelines. In contrast, objectively measured quantity of LGS was not a significant predictor of visit frequency to LGS or meeting PA guidelines. Furthermore, perceived quality and perceived access did not significantly predict the likelihood of meeting PA guidelines, but perceived quality of LGS did significantly predict visit frequency.

**Table 2** Odds ratios of meeting PA guidelines

| | | [a]OR | [b]95% CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| Covariates | *Age* | 0.994 | 0.982 | 1.006 |
| | *Health* | 1.268* | 1.128 | 1.424 |
| | *Gender* | 0.779 | 0.601 | 1.010 |
| | *% of Road Coverage* | 1.017 | 0.969 | 1.067 |
| | *Environmental Deprivation* | 0.997 | 0.859 | 1.158 |
| | *Active Travel to Work* | 1.971* | 1.441 | 2.695 |
| | *Active Travel to Local Green Space* | 1.600* | 1.076 | 2.378 |
| Objective | *% of Local Green Space* | 0.994 | 0.982 | 1.006 |
| Subjective | *Perceived Access* | 0.993 | 0.856 | 1.151 |
| | *Perceived Quality* | 1.042 | 0.908 | 1.197 |
| | *Nature Relatedness* | 1.268* | 1.128 | 1.424 |

Note. $R^2$ = .089 (Cox and Snell), .131 (Nagelkerke). Model $\chi^2$ (11) = 125.680, $p < 0.01$. [a]Odds Ratios, [b]95% Confidence Intervals, * indicates significance at $p < 0.01$

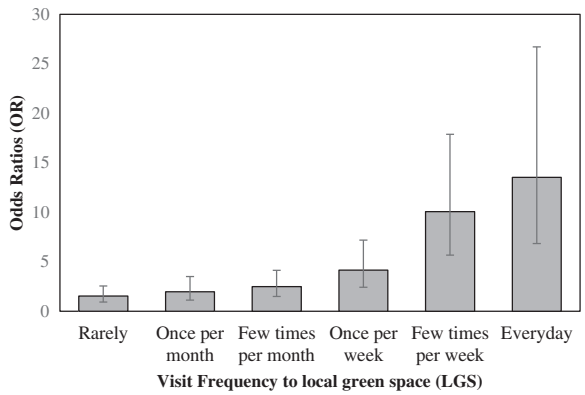


**Fig. 1** Odds ratios of achieving physical activity guidelines by visit frequency to local green space (compared to never going). The odds ratios (OR) and 95 % Confidence Intervals of meeting physical activity guidelines (600 MET.min per week), compared with never going to LGS

The current research was the first nationwide study to examine the relationship between LGS, visits to LGS, and PA in the UK. Previous studies (see [10] for a review) have often investigated visits to all natural or green spaces regardless of proximity to home. This study specifically asked respondents about LGS closest to home. LGS are places that are close to homes and therefore should be accessible for the majority irrespective of whether the household owns a car.

Furthermore, the current study was the first study to assess NR, pLGS, and objectively measured LGS as predictors of visit frequency to LGS and PA levels. Not only does this expand upon the existing literature regarding objectively measured LGS and PA, the findings highlight the importance of subjective variables relating to LGS.

Within this study we examined the influence of subjective measures associated with LGS on green space usage. Consistent with previous research [30] we found that NR was positively associated with visit frequency to LGS. In fact, over and above a variety of independent variables and covariates, NR was the strongest predictor of visit frequency to LGS. In doing so, our evidence supports the schematic model proposed by Calogiuri et al. [10], in which feelings about nature are related to intentions to visit LGS. It also supports the notion that visit frequency to LGS moderates the relationship between NR and psychological well-being (as highlighted by [31]). Green exercise research suggests that PA in LGS can have a positive effect on many indices associated with psychological well-being [46]. Therefore, visiting LGS more often is likely to increase psychological well-being and further investigation is warranted to assess what role NR has on this relationship.

The current findings suggest that pLGS may impact upon behaviour more than quantity of LGS. In addition to the influence of NR, perceived quality also significantly predicted visit frequency to LGS but objectively measured quantity of LGS did not. With regards to perceived quality of LGS, previous research may give an indication of how this could be enhanced, with perceived attractiveness, perceived availability of features [47] and park characteristics [48] all suggested to play an important role in the relationship between LGS and PA.

Neither perceived access nor perceived quality of LGS significantly predicted whether participants met PA guidelines. One possible explanation for this is the high percentage (75.5 %) of participants who met PA guidelines (14.5 % higher than the national average in England). In fact, males were 11.7 % and females were 17.2 % higher than the national average. This is most likely due to the sample being exclusively employed people. Current evidence suggests that those in formal employment were more likely to know the current recommendations for PA in the UK, and be physically active [49].

One of the main strengths of this study is the inclusion of both subjective and objective measures of LGS. Most previous studies in this area compared quantity of LGS (described as objectively measured quantity or perceived access) with PA. Our study added more robustness to this relationship with additional subjective measures. We expanded the limited research on NR and have shown its importance in the relationship between LGS and PA.

Against these contributions, some limitations should be noted. First, due to the correlational nature of the study, causality cannot be inferred in the observed relationships. Second, the study used a self-reported measure of PA. Although the IPAQ is well used in the literature, people often over-estimate PA levels [50]. Furthermore, this study did not explore PA in detail. Had we also explored 'green exercise', as opposed to just overall PA levels, we may have been able to provide stronger explanations for the results. Further investigation of green exercise, distinct from PA, is warranted to provide better understanding of the mechanisms between LGS, PA and health.

One further limitation is the double inclusion of objectively measured LGS: the environmental deprivation score - that was used as a covariate - was calculated in part using objectively measured LGS. This was deemed necessary as it included a variety of additional factors such as climate, and pollution etc..[2] Although efforts were made to account for environmental factors, the level of detail required to accurately portray the favourableness of home location for green exercise was beyond the reach of this study. For example, street lighting and pedestrian pathways that link housing areas to LGS may influence visit frequency.

As mentioned previously, the inclusion of only employed individuals does limit the ability to generalise the findings to other populations e.g. unemployed, retired. Likewise, whilst active commuters were controlled for in statistical

analysis, this analysis did not explore visiting green space during work hours, and the subsequent impact this may have had on PA levels. Additionally, we did not account for variations in employment type. Further work is needed to explore how the complexities of working life (location, activity levels, environment etc.) influence the relationships we found.

Results from this study show that on average participants had less LGS than the national average at ward level. Even though the percentage of employed people is about the same for rural and urban areas in England, the vast majority of people in England live in urban areas (81.5 % of people in 2011). We suggest that the inclusion of only employed participants skewed the results towards more urbanised wards. It is therefore likely that the majority of participants reported visits to urban green space rather than natural environments, although we do not have the data to confirm this.

## Conclusion

This is the first nationwide study to explore the relationship between LGS and PA. We found that visit frequency to LGS is associated with the likelihood of meeting PA guidelines. Furthermore, subjective measures of LGS, and particularly NR, appear to be more important than objectively measured quantity of LGS for predicting both visit frequency to LGS and PA. As PA is known to have many positive health benefits, visits to LGS, especially if active transport is used, potentially could have a significant impact on Public Health.

## Availability of data and materials

The dataset supporting the conclusions of this article is available in the UK Data Service repository http://reshare.ukdataservice.ac.uk/852253/.

## Endnotes

[1]Road coverage for Scotland, Wales, and Northern Ireland was recorded as missing data and treated as such in the analyses. The analyses were re-run including only participants from England and the same pattern of results was observed. As such, results from the full sample are reported in the manuscript.

[2]Statistical analysis revealed that when environmental deprivation was removed as a covariate, objectively measure quantity of LGS was not a significant predictor of visit frequency to LGS or PA. Therefore, environmental deprivation – as a covariate – was included in the main analysis.

### Abbreviations

LGS: local green space; MET.min: MET minutes; METs: multiples of the resting metabolic rate; NR: nature relatedness; PA: physical activity; pLGS: perceptions of local green space.

### Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

EF participated in the design of the study, carried out the statistical analyses, interpreted the data and drafted the manuscript. VG was involved with design of the study, data collection, statistical analyses, and critically revised the manuscript. PF was involved with statistical analyses, interpretation of data and critically revised the manuscript. All authors read and approved the manuscript. Also, all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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# The Development of Three Questionnaires to Assess Beliefs about Green Exercise

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**Abstract:** Green exercise is physical activity that takes place in the presence of natural environments. Despite the promising evidence of the benefits, little is known about how individuals' thoughts and feelings influence participation in green exercise and subsequent outcomes. The aim of the current research was to develop questionnaires using the Theory of Planned Behaviour as a framework that could both directly and indirectly assess attitudes, subjective norms and perceived behaviour control, along with intention toward green exercise. Confirmatory factor analyses confirmed that the indirect, direct, and intention measures all had good overall model fits when tested on a refinement ($n$ = 253) and validation ($n$ = 230) sample. The questionnaires will contribute towards helping to better understanding individuals' beliefs about green exercise, how these influence behaviour, and ultimately to enable the development of effective interventions promoting green exercise.

**Keywords:** attitudes; subjective norms; perceived behavioural control; intentions; theory of planned behaviour; confirmatory factor analysis; physical activity; outdoor recreation

## 1. Introduction

Worldwide figures suggest that around 20% of males and 27% of females are insufficiently active [1]. This is a concern for both public health and the economy, with conservative estimates suggesting that the global economic cost of inactivity is US$53.8b annually [2]. Recently described as a "miracle cure" [3], regular physical activity (PA) is well known to improve health [4] and prevent ill health [5]. Given the importance of PA, a wealth of literature has sought to identify the determinants of exercise behaviour, with individuals' beliefs and attitudes found to play a key role [6,7]. Beliefs and attitudes have subsequently been targeted in PA interventions with positive effects observed on exercise behaviour and in turn physical and mental health [8,9]. Beyond the overall value of exercise, however, PA that is performed in the natural environment (termed green exercise) may have enhanced health benefits [10–12]. To better understand the role of green exercise for health and well-being and to contribute to the development of green exercise interventions, therefore, it is vital to elucidate individuals' beliefs about green exercise. This current paper contributes to these issues by developing and providing initial evidence for the psychometric properties of three questionnaires that assess beliefs about green exercise.

Researchers have increasingly examined the role of urban green spaces (designed and maintained with human input such as parks and domestic gardens) and natural green space (naturally occurring with minimal human input) for PA and health. A growing body of evidence suggests that the natural environment encourages behaviour change by facilitating people to be more active [13–16]. Associations have also been found between local green space and mental well-being [17–19]. For example, national studies in the UK and the Netherlands have found links between accessible local green space and PA levels [14,20,21]. Further, evidence collected at urban green spaces suggest that

people value green spaces for PA and health more so when they view the features and characteristics favourably [22–25]. As such, the link between urban green spaces and health is now formally recognised by the World Health Organisation [26].

Within natural environments and urban green spaces, individuals can participate in green exercise purposefully (as active participation) or incidentally (as functional engagement) [10]. An example of functional engagement would be walking through a park because it is the shortest route to your destinations. In contrast, if the park was not the quickest route, but was selected because it allowed you to experience nature along your journey, this would be considered active participation. As such, although the experience of nature (i.e., seeing trees and grass) may be similar, the motivation for purposeful and incidental green exercise is different. However, the motivation to do green exercise has not been widely researched [27,28]. Instead, a key focus in the literature has been on the psychological benefits of exercising within different environments. For example, comparisons have been made between performing the same exercise in indoor versus outdoor environments [29–32] and in urban versus rural outdoor environments [33–36]. Evidence indicates that green exercise can elicit psychological improvements over and above that of indoor and urban exercise [15,16,30,37–39]. Specifically, acute bouts of green exercise have been shown to facilitate reductions in anxiety [40], reductions in mood disturbance [41,42], and improvements in self-esteem [43–45]. Moreover, dose-response relationships have shown that the greatest benefits on mood and self-esteem occur within the first five minutes of green exercise [42].

Despite the promising evidence for the benefits of green exercise, little is known about how individuals' thoughts and feelings about green exercise influence participation and subsequent outcomes. This is surprising given the myriad of studies that have demonstrated the importance of understanding the beliefs about PA more generally [6,7]. A small number of studies, however, have shown that perceptions of local green space may predict visit frequency more than quantity and proximity [14,46–48]. Additionally, the New Ecological Paradigm [49] and Nature Relatedness Scale [50] are tools that have been developed to measure how people feel towards nature, but these have rarely been applied in the context of PA. Nevertheless, one recent study found that nature relatedness was a strong predictor of visit frequency to local green space [14]. An exploration of green exercise beliefs is needed to better understand how to augment engagement with green exercise behaviours.

The theory of planned behaviour (TPB) is an important framework that has been used to advance understanding of how cognitions influence PA behaviours generally [7,51,52]. Derived from the theory of reasoned action [53], the TPB assumes that intention to perform a behaviour is best predicted when individuals evaluate the behaviour positively (attitudes), believe peers will support the behaviour (subjective norm), and perceive the behaviour to be within their capabilities (perceived behavioural control; PBC). TPB factors can be assessed directly (e.g., by asking people to report attitudes, norms, and PBC) or indirectly (e.g., by asking people about specific behavioural beliefs and combining the scores with a paired evaluation of the belief) (see Figure 1). As such, indirect behavioural, normative, and control beliefs combine with evaluations of those beliefs to predict the respective direct measures of attitudes, subjective norms, and PBC. Not only does this enable correlational analyses to establish convergent validity, but also serves to capture the different underlying cognitive processes of each measure [54]. Despite concerns about the intention-behaviour gap, the TPB [55] has been the most successful approach in exercise psychology for predicting participation from beliefs [56]. One meta-analysis revealed that nearly half of variance in PA intentions, and over a quarter of variance in PA behaviours could be explained by beliefs [7].

As a form of PA, some authors have hypothesised that green exercise can be modelled using the TPB [15,57]. Using a systematic review, Calogiuri and Chroni [15] integrated the green exercise literature with the TPB to propose a schematic model of motivational processes underlying the relationship between natural environments and physical activity behaviours. The evidence collected supports using the TPB framework to explore the green exercise phenomenon. Moreover, empirical evidence—collected using ad hoc TPB questionnaires—has shown that beliefs may predict behaviours

such as park visitation [58], participation in outdoor recreation programs [59], outdoor walking [60], and outdoor pool use [61]. Although these studies have enriched understanding into the role of beliefs on specific green exercise behaviours, the need to create measurement tools for individual studies does not encourage a proliferation of research into green exercise beliefs and also impairs the ability to synthesise evidence across studies. A valid measure of beliefs about green exercise is necessary to deepen our understanding of the relationship between green exercise and health, understand variations in green exercise beliefs, and develop intervention to increases green exercise.

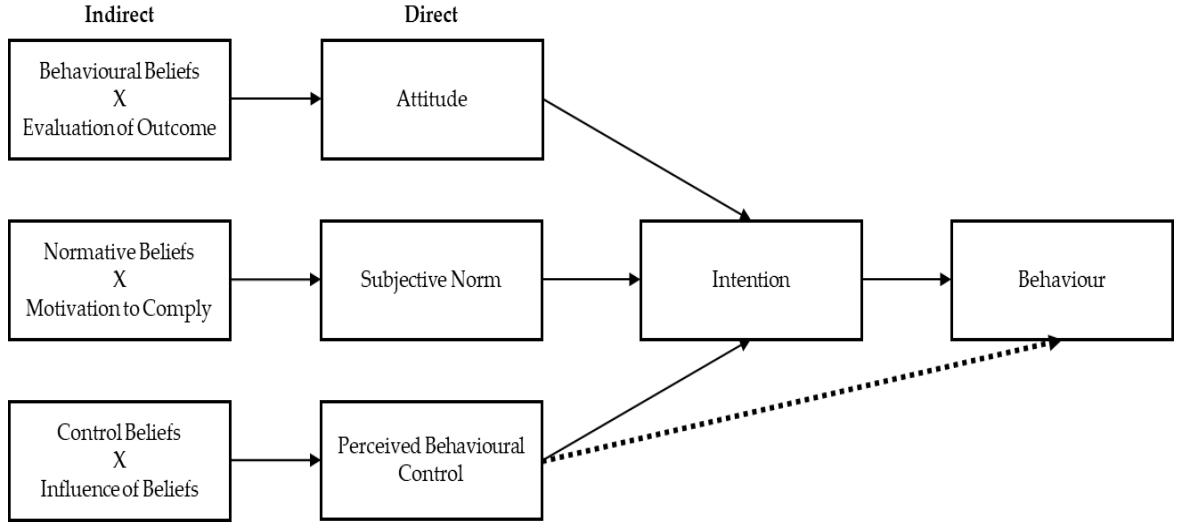


**Figure 1.** The theory of the planned behaviour (adapted from Ajzen, 2006; [62]).

The aim of the current article was to develop and provide initial evidence of the validity of three questionnaires that assess global beliefs about green exercise amongst the general population. The research drew upon comprehensive guidelines for developing TPB questionnaires [63], which provided recommendations for overall structure, item wording, and scoring criteria, and a recent a systematic review that identified a 16-point criteria for assessing the quality of TPB questionnaires [64]. These criteria emphasise the importance of methodological rigour, such as the inclusion of an elicitation study, developing both indirect and direct measures, and establishing content validity. As such, the current research was divided into two distinct studies (see Figure 2). Study 1 focused on the elicitation and content analysis of salient beliefs about green exercise, and Study 2 focused on the development and validation of the three questionnaires that assess indirect beliefs, direct beliefs, and intention to perform green exercise respectively.

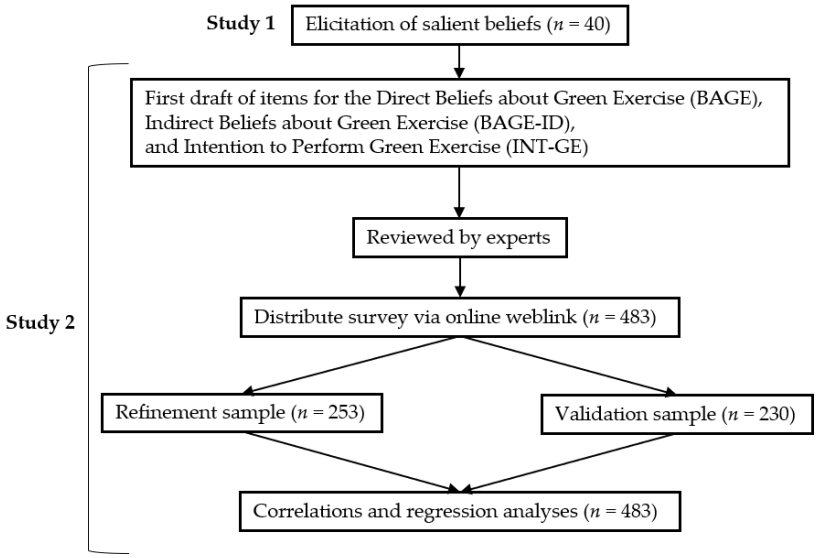


**Figure 2.** Phases in the construction of the questionnaires.

## 2. Study 1

Before creating a TPB questionnaire, an elicitation study is recommended to capture the salient beliefs that individuals hold toward a given behaviour [53,55,64]. Authors suggest that a minimum sample of 25 participants is required to sufficiently ascertain a representation of salient belief amongst a population [63,65]. Content analysis of responses to carefully worded open-ended questions provides the beliefs that underlie the indirect psychological factors of TPB [63]. However, within the PA domain, elicitation studies are not routinely used in TPB research [7,66]. Indeed, out of 150 TPB studies exploring PA, only 47 included a prior elicitation of beliefs [66]. The purpose of Study 1 was to elicit the salient beliefs individuals hold about green exercise.

### *2.1. Method*

#### 2.1.1. Participants

The sample comprised 40 adults (22 women, 18 men, mean age 27.1 ± 10.5 years, age range 18–59 years). Participants were undergraduate students (50%), employed (35%), self-employed (7.5%), or other (7.5%).

#### 2.1.2. Measure

In accordance with recommendations [62], questions were specifically worded to elicit beliefs about the (dis)advantages of green exercise and whether it is liked or disliked (behavioural beliefs), who would (dis)approve of green exercise (normative beliefs), and factors that facilitate or impede green exercise behaviours (control beliefs). The questions were preceded by the following statement: "Some people like to spend free-time in local green spaces such as parks, woodlands and sports fields. When people do exercise at these places, we like to call it green exercise. We want to find out what people think about green exercise". Example questions include: "What do you think are the disadvantages of doing green exercise as part of your weekly physical activity" and "What do you think would make it easy for you to do green exercise as part of your weekly physical activity?". Each question was followed by five blank lines to allow for multiple responses.

#### 2.1.3. Procedure

The research was conducted in December 2015 following ethical approval from the University of Essex, Ethical Committee (15/BS/403/EF). All participants provided informed consent. A hard

copy of the questionnaire was completed by 20 undergraduate students using convenience sampling at University of Essex, Colchester Campus. To reduce order effects, three versions of the questionnaire were created each with a different order of questions. An online version—with randomised question order—was also created using Qualtrics Software (Provo, UT, USA). This was distributed as a short web-link via various social media platforms, such as LinkedIn and Twitter. Data collection was closed once 20 participants had completed the online version and 20 had completed the hard copy version.

#### 2.1.4. Analyses

The lead author conducted line-by-line content analyses to find emerging themes from the responses. Next, all salient beliefs were categorised into the themes and corroborated with a second author. Following recommendations [63], the advantages and disadvantages responses were coupled with the likes and dislikes responses respectively.

### *2.2. Results*

Beliefs pertaining to the advantages and likeable features of green exercise were the most commonly reported ($n$ = 198, see Table 1). In contrast, only 11 responses were given around whether people would disapprove of them doing green exercise. Within the themes, poor weather was the most commonly cited disadvantage/dislikeable feature of green exercise ($n$ = 61; 46%). However, climatic conditions were also reported 19 times as a facilitating factor of green exercise.

Overall, the most prevalent responses which reflected behavioural beliefs were poor weather ($n$ = 61), fresh air ($n$ = 32) and positive affect ($n$ = 31). The most prevalent responses which reflected normative beliefs were family ($n$ = 19), friends ($n$ = 15), and health professionals approving of green exercise ($n$ = 10). Finally, the most prevalent responses relating to control beliefs were weather ($n$ = 20), free time ($n$ = 20), and access ($n$ = 16). There were no discernible differences in the beliefs elicited from the student and general population samples.

## 3. Study 2

The beliefs elicited in Study 1 provided the foundation for the indirect questionnaire in Study 2. According to Oluka, Nie and Sun [64], this is an essential criterion in developing TPB questionnaires. Three separate questionnaires were developed to assess attitudes, subjective norms, and PBC both indirectly and directly, along with intention to perform green exercise: the Indirect Beliefs about Green Exercise Questionnaire (BAGE-ID), the Beliefs about Green Exercise Questionnaire (BAGE), and the Intention to Perform Green Exercise Questionnaire (INT-GE).

### *3.1. Method*

#### 3.1.1. Initial Scale Construction

Adhering to TPB principles, themes from the elicitation study were used to inform the development of the items for the BAGE-ID [64]. As per recommendations [63], over 75% of salient beliefs elicited were covered in the questionnaire items. The responses from each elicitation question corresponded directly to a particular TPB factor in the BAGE-ID: responses from the (dis)advantages/(dis)likes questions provided the themes for the behavioural belief items, (dis)approve questions related to normative beliefs, and easy/difficult questions related to control beliefs. Furthermore, each factor in the BAGE-ID contained particular question types: behavioural beliefs consisted of both instrumental and experiential evaluations of green exercise; normative beliefs consisted of injunctive and descriptive evaluations of norms; and control beliefs consisted of self-efficacy and controllability items. As per the guidelines [63], each belief item was paired with an evaluation item that reflected the same theme.

**Table 1.** Descriptive statistics for the salient beliefs elicited in Study 1.

| **Advantages and Likes** | **Total Beliefs** | **M ± SD** | **Disadvantages and Dislikes** | **Total Beliefs** | **M ± SD** | **Approve** | **Total Beliefs** | **M ± SD** |
|---|---|---|---|---|---|---|---|---|
| | **198** | **4.9 ± 2.2** | | **133** | **3.4 ± 2.1** | | **63** | **1.6 ± 1.0** |
| Fresh Air | 32 (16%) | | Poor weather | 61 (46%) | | Family | 19 (30%) | |
| Positive Affect | 31 (16%) | | Lack of equipment/facilities | 17 (13%) | | Friends | 15 (24%) | |
| Health and Fitness | 29 (15%) | | Safety concerns | 15 (11%) | | Health Professionals | 10 (16%) | |
| Change of Scenery | 23 (12%) | | Time consuming | 11 (10%) | | Sports clubs/Trainers | 5 (8%) | |
| Social | 20 (10%) | | Lack of available green space | 10 (7%) | | Environmental Groups | 5 (8%) | |
| Openness/Freedom | 13 (7%) | | Pollution Levels | 6 (4%) | | Other | 5 (8%) | |
| Costs/Resources | 13 (7%) | | Lack of privacy | 5 (4%) | | Employers/Colleagues | 4 (6%) | |
| Nature/Environment | 10 (5%) | | Cannot find people to do it with | 3 (2%) | | | | |
| Type of activity | 8 (4%) | | Lack of motivation | 3 (2%) | | | | |
| Access/Availability | 8 (4%) | | Other | 3 (2%) | | | | |
| Other | 6 (3%) | | | | | | | |
| Weather/Climate | 5 (3%) | | | | | | | |
| **Disapprove** | **11** | **0.3 ± 0.5** | **Easy** | **65** | **1.6 ± 1.2** | **Difficult** | **68** | **1.7 ± 1.2** |
| Gym Users | 5 (42%) | | Access/Availability | 16 (24%) | | Weather | 20 (29%) | |
| Other | 4 (33%) | | Weather | 14 (21%) | | Time | 20 (29%) | |
| Gym Companies | 3 (25%) | | Facilities/Equipment | 11 (17%) | | Access/Availability | 10 (15%) | |
| | | | Free time | 9 (14%) | | Facilities/Equipment | 8 (12%) | |
| | | | Other | 6 (9%) | | Activity Groups | 5 (7%) | |
| | | | Transport | 5 (8%) | | Lack of motivation | 3 (4%) | |
| | | | Organised Activity | 5 (8%) | | Other | 2 (3%) | |

M ± SD = mean ± standard deviation of beliefs elicited per person. Advantages and Likes = features of green exercise that are perceived favourably. Disadvantages and Dislikes = features of green exercise that are perceived unfavourably. Approve = individuals who would approve of green exercise. Disapprove = individuals who would disapprove of green exercise. Easy = features that would make green exercise easy to do. Difficult = features that would make green exercise difficult to do.

The BAGE and INT-GE were developed using TPB measurement guidelines [62,63]. Items in the BAGE were worded to reflect direct beliefs about attitudes, subjective norms, and PBC towards green exercise. Items in the INT-GE were based on pre-existing phrases from [63]. At least five items (or pairs of items in the BAGE-ID to reflect beliefs and the evaluations of those beliefs) were created by the lead author for each TPB factor. All items were reviewed for wording and relevance by three authors who have previously published peer-reviewed green exercise research. After some minor alterations, the questionnaires were completed by two non-academic professionals who provided external feedback; no further modifications were made. The BAGE-ID, BAGE, and INT-GE consisted of 32 (16 pairs), 16, and 5 items respectively.

#### 3.1.2. Indirect Beliefs about Green Exercise (BAGE-ID)

The 32 items in the BAGE-ID operated in pairs. In the indirect measure of attitudes, six behavioural beliefs (responded to on a 1 to 7 scale) were multiplied with six evaluations of outcomes (responded to on a −3 to +3 scale). Therefore, each pair of items produced a single datum from −21 to +21. For example, the response to "when I do Green Exercise, I feel better about myself afterwards (1) Strongly Agree to (7) Strongly Disagree" was multiplied by the response to "feeling better about myself after Green Exercise is ... (−3) Extremely Undesirable to (+3) Extremely Desirable". For the indirect measure of subjective norm, five normative beliefs (−3 to +3) were multiplied with motivation to comply (1 to 7). For example, "My friends think I should do Green Exercise (−3) Strongly Disagree to (+3) Strongly Agree" was paired with 'My friends approving of me doing Green Exercise is ... (1) Not at all Important to (7) Extremely Important'. For the indirect measure of PBC, five control beliefs (1 to 7) were multiplied with perceived power of beliefs (−3 to +3). For example, "The amount of green space in my local area influences my decision to do Green Exercise (1) Strongly Agree to (7) Strongly Disagree" was paired with "Having more local green space would make me more likely to do Green Exercise (−3) Very Unlikely to (+3) Very Likely".

#### 3.1.3. Direct Beliefs about Green Exercise (BAGE)

Each of the 16 items in the BAGE had a response scale of 1 to 7. The attitudes factor consisted of six items assessed on a bipolar scale of adjectives. An example item and response scale was: "Doing Green Exercise as part of my weekly physical activity is ... (1) Pleasant to (7) Unpleasant". The subjective norms factor included five items that were all scaled from (1) Strongly Disagree to (7) Strongly Agree. For example, "People often ask me to do Green Exercise with them ... ". The PBC factor also had five items; four items were scaled from (1) Strongly Agree to (7) Strongly Disagree, and one item was scaled from (1) Very Difficult to (7) Very Easy. For example, "I am confident I could do Green Exercise if I wanted to ... (1) Strongly Disagree to (7) Strongly Agree".

#### 3.1.4. Intention to Perform Green Exercise (INT-GE)

The INT-GE consisted of five items measured on a 7-point scale; four items were scaled from (1) Strongly Agree to (7) Strongly Disagree, and one item was scaled from (1) Very Unlikely to (7) Very Likely. An example item was "I want to do Green Exercise at least once per week for the next four weeks ... (1) Strongly Disagree to (7) Strongly Agree".

#### 3.1.5. Participants

The total sample comprised 483 adults (306 women, 177 men, mean age 45.4 ± 16.0 years, age range 18–83 years). The majority of the participants were employed (60.5%), with the remaining participants being retired (18.6%), self-employed (8.1%), students (6.8%), or other (6.0%). Additionally, the majority of participants reported their ethnicity as white (95.4%). Over half of participants (52%) reported a household income less than £49,999, 38% reported over £50,000, and 10% reported not knowing or did not wish to say.

For the analyses, the participants were randomly divided into two samples: a refinement sample ($n$ = 253) and a validation sample ($n$ = 230). There was a significant difference in the age for the refinement (M = 48.6 ± 16.5 years) and validation (M = 41.9 ± 14.9 years) groups, $t$ (479) = 4.62, $p < 0.01$. There was no significant difference in gender split ($\chi^2$ (1) = 2.13, $p > 0.05$) or income ($\chi^2$ (7) = 4.85, $p > 0.05$).

#### 3.1.6. Procedure

The research was conducted between February and June 2016 following ethical approval from the University of Essex, Ethical Committee (16/BS/420/EF). All participants provided informed consent. An online survey was created using Qualtrics Software (Provo, UT, USA). The survey was primarily distributed as a short web-link via email to contacts on social media via the lead researchers personal accounts, and internet messaging services to professional networks. It was also marketed via two specialist participant recruitment websites: callforparticipants.com and findparticipants.com. On the first, it was placed as a static advert, and on the second it was distributed to 219 individuals who had registered to receive such surveys. Participants provided demographic information before completing all items from BAGE-ID, BAGE, and INT-GE questionnaires. All items within the three questionnaires were randomised to reduce order effects.

#### 3.1.7. Analyses

Initially, data from the refinement and validation samples was screened for non-normality, missing data, and outliers. Screening revealed multivariate non-normality and less than 1% missing data. Missing data was imputed using the regression method available on IBM SPSS 23 (Chicago, IL, USA) and constrained to match questionnaire item response options (i.e., 1 to 7/−3 to +3 in whole numbers). Where appropriate, items were recoded so that higher numbers reflected stronger agreement with the item. Paired items in the BAGE-ID were multiplied.

Confirmatory factor analyses with maximum likelihood estimation were then performed on IBM AMOS 23 (Chicago, IL, USA) to assess the factorial validity of the BAGE-ID, BAGE, and INT-GE in turn. Initially, analyses were conducted on the refinement sample. A three-stage sequential model testing approach was adopted separately with the BAGE-ID and BAGE in the refinement sample [67], whereas a single stage was used for the INT-GE. First, to assess convergent validity, single-factor models of attitudes, subjective norms and PBC were run individually. Overall model fit and individual item indices (described below) were checked and where necessary items were deleted and the models re-examined.

Second, each subscale within a questionnaire was paired in turn with all subscales in that questionnaire and two-factor models were tested. This allowed identification of ambiguous items. Overall fit indices of each model were considered along with modification indices which indicated whether the fit could be improve if items were freed to cross-load on another subscale. Third, all subscales within a questionnaire were included in a three-factor model and model fit and individual item indices were examined. The final models for the BAGE-ID, BAGE, and INT-GE identified using the refinement sample were then re-tested in the validation sample in turn.

Overall model fit was assessed using numerous indices. Following recommendations [68], Bollen–Stine bootstrapping was used to account for non-normality, thus producing a Bollen-Stine chi-squared score (BS$\chi^2$) for overall model fit. Additionally, the comparative fit index (CFI), Tucker–Lewis index (TLI), and root mean square error of approximation (RMSEA) were also used to examine model fit from three different classes [67,69].

Consistent with recommendations [69,70], scores above 0.95 for the CFI and TLI, and scores below 0.6 for the RMSEA were considered as indicators of good model fit, although these were not applied as "golden rules" [71]. Beyond overall model fit, examination of modification indices, factor loadings, and standardised residuals were screened to help identify poorly fitting items and guide model improvement. Following suggestions [72,73], modification indices above 7, standardised residuals greater than an absolute value of 2, and factor loadings below 0.40 were considered a concern.

Beyond examining the factorial validity of the BAGE-ID, BAGE, and INT-GE, additional analyses were conducted to further assess the psychometric properties of the instruments. First, to account for greater reliability of items with higher weights, composite reliability was calculated using a formula adapted from Fornell and Larcker [74].

Scores above 0.60 were considered acceptable. Using the entire sample ($n$ = 483), parallel-form reliability was assessed by using Pearson's correlation analyses to explore if beliefs obtained indirectly (BAGE-ID) correlated with direct measures of attitudes, subjective norms, and PBC (BAGE). A forced entry regression analysis was also conducted to assess whether the three factors from the BAGE-ID predicted intention (INT-GE). The process was repeated for the BAGE. Statistical significance was accepted at $p < 0.05$ in the correlation and regression analyses.

### 3.2. Results and Discussion

#### 3.2.1. Validation of the Instruments with the Refinement Sample

##### BAGE-ID

The fit statistics and factor loadings at the single-factor stage for the initial BAGE-ID are shown in Table 2. Mixed results were found. All the BS$\chi^2$ to degrees of freedom ratios were below 2, CFI values were 0.91–0.98, TLI values were 0.82–0.97, and RMSEA values were 0.06–0.09. For the indirect measure of attitudes, all items had reasonable factor loadings (>0.54) and were subsequently retained at this stage. For the indirect measure of subjective norms, the item relating to current or potential employers had a low factor loading (0.15) and was removed. This may be due to a disparity between the employment rate of the sample (68.1%) and the general population (74.5%; [75]). The health professionals item also had a low factor loading but was retained at this stage as the overall model fit was good following deletion of the employer item (CFI = 1.00, TLI = 0.99, and RMSEA = 0.03). For the indirect measure of PBC, items relating to the weather and free time were removed due to low factor loadings (0.15 and −0.08, respectively). As with attitudes and subjective norms, once the items with the lowest factor loadings were removed, the overall model fit improved. Therefore, the individual factors were deemed to have sufficient convergent validity to progress to the paired-factor stage.

At the paired-factor stage, the factors were paired into three models (Attitudes × Subjective Norms, Attitudes × PBC, and Subjective Norms × PBC). All of the paired-factor models had good model fits (Table 3). The BS$\chi^2$ to degrees of freedom ratios were below 2, CFI values were 0.93–0.98, TLI values were 0.90–0.97, and RMSEA values were 0.04–0.09. As the overall fits were good and no items had particularly poor factor loadings, the factors progressed onto the final model. This included a combination of all three factors: indirect measures of attitudes, subjective norms, and PBC. The full three-factor model had a good model fit (BS$\chi^2$/df = 1.10, CFI = 0.97 TLI = 0.96, and RMSEA = 0.05), and all factor loadings were above 0.40 (see Table 4). Further, the attitudes factor had good composite reliability (ρc = 0.83), whereas subjective norms and PBC had reasonable composite reliability (both ρc = 0.63).

##### BAGE

The fit statistics and factor loadings at the single-factor stage for the initial BAGE are shown in Table 5. Mixed results were found. All the BS$\chi^2$ to degrees of freedom ratios were below 2, CFI values were 0.89–0.95, TLI values were 0.77–0.90, and RMSEA values were 0.06–0.14. For attitudes and subjective norms, the individual item with the lowest factor loadings was removed. For attitudes, even though the factor loading of the item relating to green exercise being (un)healthy was reasonable (0.54), as the modification indices (>22) revealed that the chi-squared statistic would improve if the item was removed. The overall model fit subsequently improved. For subjective norms, the item relating to social pressure to do green exercise had the lowest factor loading (0.17) and was subsequently removed. After the removal of the items, the subsequent model fits of the attitudes and subjective norms factors were good (CFI = 0.98–1.00, TLI = 0.96–1.05, and RMSEA = 0.00–0.08).

**Table 2.** Fit statistics and factor loadings of single-factor models of the indirect beliefs about green exercise (BAGE-ID).

| Factor and Items | Factor Loadings | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|---|
| **Indirect Measure of Attitudes** | | **10.84** | **9** | **0.13** | **0.98** | **0.97** | **0.06** |
| When I do Green Exercise, I feel like I am getting fresh air | 0.55 | | | | | | |
| When I do Green Exercise, I feel better about myself afterwards | 0.85 | | | | | | |
| Green Exercise is good for my health | 0.60 | | | | | | |
| Green Exercise is good for my fitness | 0.60 | | | | | | |
| Doing Green Exercise helps me feel positive about myself | 0.82 | | | | | | |
| Green Exercise is enjoyable | 0.60 | | | | | | |
| **Indirect Measure of Subjective Norms** | | **6.23** | **5** | **0.05** | **0.94** | **0.89** | **0.08** |
| Health professionals would ( … … … ...) of me doing Green Exercise | 0.31 | | | | | | |
| My friends think I should do Green Exercise | 0.64 | | | | | | |
| My family think I should do Green Exercise | 0.83 | | | | | | |
| My peers do Green Exercise | 0.48 | | | | | | |
| Current or potential employers would approve of me doing Green Exercise | 0.15 | | | | | | |
| **Indirect Measure of Perceived Behavioural Control** | | **6.73** | **5** | **0.06** | **0.91** | **0.82** | **0.88** |
| The weather influences my decision to do Green Exercise | 0.02 | | | | | | |
| The amount of free time I have influences my decision to do Green Exercise | −0.08 | | | | | | |
| The amount of green space in my local area influences my decision to do Green Exercise | 0.70 | | | | | | |
| The facilities at my local green space influence my decision to do Green Exercise | 0.67 | | | | | | |
| Safety at my local green space influences my decision to do Green Exercise | 0.48 | | | | | | |

*n* = 253. BS$\chi^2$ = Bollen–Stine chi-squared. CFI = comparative fit index. TLI = Tucker–Lewis Index. RMSEA = root mean square error of approximation. All items were scored from *Strongly Disagree* to *Strongly Agree*.

**Table 3.** Fit statistics for two-factor and three-factor model of the indirect beliefs about green exercise (BAGE-ID).

| Factor | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|
| Attitudes × Subjective Norms | 28.83 | 26 | 0.03 | 0.96 | 0.95 | 0.06 |
| Attitudes × Perceived Behavioural Control | 32.60 | 26 | 0.00 | 0.93 | 0.90 | 0.09 |
| Subjective Norms × Perceived Behavioural Control | 7.55 | 8 | 0.15 | 0.98 | 0.97 | 0.04 |
| Three-factors | 44.91 | 41 | 0.09 | 0.97 | 0.96 | 0.05 |

*n* = 253. BS$\chi^2$ = Bollen–Stine chi-squared. CFI = comparative fit index. TLI = Tucker–Lewis Index. RMSEA = root mean square error of approximation.

**Table 4.** Descriptive statistics, measurement error variances, factor loadings and composite reliabilities for the indirect beliefs about green exercise (BAGE-ID).

| Items | Refinement Group (*n* = 253) | | | | Validation Group (*n* = 230) | | | |
|---|---|---|---|---|---|---|---|---|
| | Var(e) | Factor Loadings | | | Var(e) | Factor Loadings | | |
| | | ATT | SUB | PBC | | ATT | SUB | PBC |
| When I do Green Exercise, I feel like I am getting fresh air | 0.61 | 0.63 | | | 0.72 | 0.53 | | |
| When I do Green Exercise, I feel better about myself afterwards | 0.37 | 0.79 | | | 0.24 | 0.87 | | |
| Green Exercise is good for my fitness | 0.47 | 0.72 | | | 0.69 | 0.56 | | |
| Doing Green Exercise helps me feel positive about myself | 0.49 | 0.72 | | | 0.31 | 0.83 | | |
| Green Exercise is enjoyable | 0.58 | 0.65 | | | 0.65 | 0.59 | | |
| My friends think I should do Green Exercise | 0.43 | | 0.75 | | 0.61 | | 0.62 | |
| My family think I should do Green Exercise | 0.63 | | 0.61 | | 0.25 | | 0.87 | |
| My peers do Green Exercise | 0.82 | | 0.43 | | 0.79 | | 0.46 | |
| The amount of green space in my local area influences my decision to do Green Exercise | 0.56 | | | 0.66 | 0.56 | | | 0.66 |
| The facilities at my local green space influence my decision to do Green Exercise | 0.73 | | | 0.52 | 0.50 | | | 0.71 |
| Safety at my local green space influences my decision to do Green Exercise | 0.61 | | | 0.62 | 0.77 | | | 0.48 |
| Mean response within factors (standard deviation) | | 15.65 ± 4.66 | 2.89 ± 3.92 | 2.31 ± 4.39 | | 14.28 ± 5.10 | 2.62 ± 3.87 | 3.31 ± 3.76 |
| Composite Reliability | | 0.83 | 0.63 | 0.63 | | 0.81 | 0.70 | 0.65 |

ATT = Attitudes. SUB = Subjective Norms. PBC = Perceived Behavioural Control. Var(e) = Measurement Error Variance. All items were scored from *Strongly Disagree* to *Strongly Agree*.

**Table 5.** Fit statistics and factor loadings of single-factor models of the beliefs about green exercise (BAGE).

| Factor and Items | Factor Loadings | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|---|
| **Attitudes** | | **17.34** | **9** | **0.02** | **0.91** | **0.85** | **0.14** |
| Doing Green Exercise as part of my weekly physical activity is . . . | | | | | | | |
| (*Healthy* to *Unhealthy*) | 0.54 | | | | | | |
| (*Bad* to *Good*) | 0.62 | | | | | | |
| (*Pleasant* to *Unpleasant*) | 0.76 | | | | | | |
| (*Boring* to *Fun*) | 0.63 | | | | | | |
| (*Enjoyable* to *Unenjoyable*) | 0.69 | | | | | | |
| (*Beneficial* to *Harmful*) | 0.73 | | | | | | |
| **Subjective Norms** | | **5.58** | **5** | **0.15** | **0.95** | **0.90** | **0.06** |
| Most people who are important to me believe I should do Green Exercise | 0.44 | | | | | | |
| People often ask me to do Green Exercise with them | 0.57 | | | | | | |
| It is expected of me to do Green Exercise | 0.36 | | | | | | |
| I feel under social pressure to do Green Exercise | 0.17 | | | | | | |
| People that are similar to me do Green Exercise | 0.56 | | | | | | |
| **Perceived Behavioural Control** | | **4.61** | **5** | **0.07** | **0.89** | **0.77** | **0.06** |
| I am confident I could do Green Exercise if I wanted to | 0.56 | | | | | | |
| The decision to do Green Exercise is beyond my control | 0.30 | | | | | | |
| Doing Green Exercise is . . . (*Very Difficult* to Very Easy) | 0.44 | | | | | | |
| Whether I do Green Exercise or not is entirely up to me | 0.21 | | | | | | |
| I choose when and where I do Green Exercise | 0.35 | | | | | | |

*n* = 253. BS$\chi^2$ = Bollen–Stine chi-squared. CFI = comparative fit index. TLI = Tucker–Lewis Index. RMSEA = root mean square error of approximation. All items were scored from *Strongly Disagree* to *Strongly Agree*, unless stated otherwise.

The PBC factor was more problematic as three items had poor factor loadings (<0.40). The individual item ("whether I do Green Exercise or not is entirely up to me") with the lowest factor loading was removed in the first instance, which resulted in a good model fit (CFI = 0.98, TLI = 0.94, and RMSEA = 0.04). Two additional items remained a concern, as both "the decision to do Green Exercise is beyond my control" and "I choose when and where I do Green Exercise" had low factor loadings (0.30 and 0.35, respectively). Given the good overall model fit and similar factor loadings, both items were retained at this stage pending further examination at the paired-factor and three-factor stages.

The fit statistics at the two-factor stage are shown in Table 6. All three paired-factor models had good fits: the BS$\chi^2$ to degrees of freedom ratios were below 2, CFI values were 0.95–0.98, TLI values were 0.92–0.97, and RMSEA values were 0.03–0.05. The factors were therefore progressed to the final three-factor model.

As shown in Table 7, the problematic items in the PBC factor still had poor factor loadings (both 0.27). Further inspection revealed that all modification indices were below 7 and standardised residuals were below 2, and that the full three-factor model had a good model fit (BS$\chi^2$/df = 1.05, CFI = 0.98, TLI = 0.97 and RMSEA = 0.03), so the items were retained for further examination in the validation sample. This kept the minimum number of items within each TPB factor to three, consistent with the three-indicator rule described by Blunch [76]. The attitudes factor had good reliability (ρc = 0.82), whereas subjective norms and PBC had reasonable reliability (ρc = 0.54 and 0.44, respectively).

INT-GE

The fit statistics and factor loadings of the INT-GE are shown in Table 8. The model fit was excellent. The BS$\chi^2$ to degrees of freedom ratio was below 2, the CFI was 1.00, the TLI was 1.01, and the RMSEA was 0.00. The composite reliability was good (ρc = 0.89).

### 3.2.2. Analysis of the Validation Sample

The factor structure of the BAGE-ID, BAGE, and INT-GE were further explored in the validation sample. All models had a good fit (BS$\chi^2$/df = 0.66–1.15, CFI = 0.95–1.00, TLI = 0.91–1.01, and RMSEA = 0.00–0.07). All items in the BAGE-ID, BAGE, and INT-GE had factor loadings above 0.40 (see Tables 4, 7 and 8). The factor loadings of the two problematic direct PBC items from the refinement sample were both higher (0.41 and 0.44) and significant in the validation sample, suggesting that the items should be retained. For the BAGE-ID, each indirect factor had good composite reliability (attitudes ρc = 0.81, subjective norms ρc = 0.70, and PBC ρc = 0.65). Reasonable results were found in the BAGE (attitudes ρc = 0.88, subjective norms ρc = 0.62, and PBC ρc = 0.58). Composite reliability for the INT-GE was good (ρc = 0.86). Overall, the analyses conducted on the validation sample provide additional evidence of the psychometric properties of the BAGE-ID, BAGE, and INT-GE, and the findings suggest that the factor structures and other indices are relatively consistent across the two samples.

### 3.2.3. Correlation and Regression Analyses of the Full Sample

To provide evidence for parallel-form reliability and the theoretical predictions of the TPB, correlations between the respective subscales of the BAGE-ID and BAGE were examined in the full sample ($n$ = 483). The measures of attitudes ($r$ = 0.71, $p$ < 0.01) and subjective norms ($r$ = 0.61, $p$ < 0.01) were significantly correlated, but the measures of PBC were not ($r$ = −0.01, $p$ > 0.05). This may partly be due to the lower factor loadings found within PBC factor of the BAGE in the refinement sample. Further exploration may be warranted to see if the wording of those items could be improved.

Consistent with the predictions of the TPB, linear regressions were run to explore whether attitudes, subjective norms, and PBC predict intention to perform green exercise. First, after controlling for age and gender, the three indirect factors (behavioural, normative, and control beliefs) significantly predicted intention to perform green exercise, $r^2$ = 0.34, $F$(3, 475) = 74.18, $p$ < 0.01. All three factors made unique significant contributions: behavioural beliefs ($b$ = 0.12, $p$ < 0.01, $sr^2$ = 0.23), normative beliefs ($b$ = 0.04, $p$ < 0.01, $sr^2$ = 0.02), and control beliefs ($b$ = 0.03, $p$ < 0.05, $sr^2$ = 0.01).

**Table 6.** Fit statistics for the two-factor and three-factor model of the beliefs about green exercise (BAGE).

| Factor | BS$\chi^2$ | *df* | *p*(BS$\chi^2$) | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|
| Attitudes × Subjective Norms | 22.72 | 19 | 0.20 | 0.98 | 0.97 | 0.05 |
| Attitudes × Perceived Behavioural Control | 27.52 | 26 | 0.31 | 0.99 | 0.99 | 0.03 |
| Subjective Norms × Perceived Behavioural Control | 13.40 | 13 | 0.14 | 0.95 | 0.92 | 0.04 |
| Three-factors | 53.35 | 51 | 0.02 | 0.98 | 0.97 | 0.03 |

$n$ = 253. BS$\chi^2$ = Bollen–Stine chi-squared. CFI = comparative fit index. TLI = Tucker–Lewis Index. RMSEA = root mean square error of approximation.

**Table 7.** Descriptive statistics, measure error variances, factor loadings and composite reliabilities for the beliefs about green exercise (BAGE).

| Items | Refinement Group ($n$ = 253) | | | | Validation Group ($n$ = 230) | | | |
|---|---|---|---|---|---|---|---|---|
| | Var(e) | Factor Loadings | | | Var(e) | Factor Loadings | | |
| | | ATT | SUB | PBC | | ATT | SUB | PBC |
| Doing Green Exercise as part of my weekly physical activity is . . . | | | | | | | | |
| (*Bad* to *Good*) | 0.62 | 0.62 | | | 0.39 | 0.78 | | |
| (*Pleasant* to *Unpleasant*) | 0.42 | 0.76 | | | 0.34 | 0.81 | | |
| (*Boring* to *Fun*) | 0.55 | 0.67 | | | 0.39 | 0.78 | | |
| (*Enjoyable* to *Unenjoyable*) | 0.48 | 0.72 | | | 0.42 | 0.76 | | |
| (*Beneficial* to *Harmful*) | 0.56 | 0.66 | | | 0.52 | 0.69 | | |
| Most people who are important to me believe I should do Green Exercise | 0.80 | | 0.45 | | 0.83 | | 0.41 | |
| People often ask me to do Green Exercise with them | 0.59 | | 0.64 | | 0.48 | | 0.72 | |
| People that are similar to me do Green Exercise | 0.76 | | 0.49 | | 0.60 | | 0.63 | |
| I am confident I could do Green Exercise if I wanted to | 0.80 | | | 0.45 | 0.67 | | | 0.57 |
| The decision to do Green Exercise is beyond my control | 0.93 | | | 0.27 | 0.83 | | | 0.41 |
| Doing Green Exercise is . . . (*Very Difficult* to *Very Easy*) | 0.63 | | | 0.61 | 0.64 | | | 0.60 |
| I choose when and where I do Green Exercise | 0.93 | | | 0.27 | 0.80 | | | 0.44 |
| Mean response within factors (standard deviation) | | 6.41 ± 0.74 | 4.35 ± 0.99 | 5.97 ± 0.73 | | 6.11 ± 0.94 | 4.31 ± 0.99 | 5.63 ± 0.86 |
| Composite Reliability | | 0.82 | 0.54 | 0.44 | | 0.88 | 0.62 | 0.58 |

ATT = Attitudes. SUB = Subjective Norms. PBC = Perceived Behavioural Control. Var(e) = Measurement Error Variance. All response scales ranged from *Strongly Disagree* to *Strongly Agree*, unless stated otherwise.

**Table 8.** Fit statistics and factor loadings of the intentions to perform green exercise (INT-GE).

| Factor and Items | Factor Loadings | $BS\chi^2$ | *df* | $p(BS\chi^2)$ | CFI | TLI | RMSEA |
|---|---|---|---|---|---|---|---|
| Intention | | 5.79 | 5 | 0.66 | 1.00 | 1.01 | 0.00 |
| I expect to do Green Exercise | 0.71 | | | | | | |
| I want to do Green Exercise | 0.70 | | | | | | |
| The likelihood of me doing Green Exercise is … (*Very Unlikely* to *Very Likely*) | 0.87 | | | | | | |
| I plan to do Green Exercise | 0.81 | | | | | | |
| I intend to do Green Exercise | 0.84 | | | | | | |

*n* = 253. $BS\chi^2$ = Bollen–Stine chi-squared. CFI = comparative fit index. TLI = Tucker–Lewis Index. RMSEA = root mean square error of approximation. All items were scored from *Strongly Disagree* to *Strongly Agree*, unless stated otherwise.

Similarly, the direct factors (attitudes, subjective norms, and PBC) significantly predicted intention to perform green exercise, $r^2 = 0.51$, $F(3, 475) = 153.34$, $p < 0.01$. All three factors made unique significant contributions: attitudes ($b = 0.70$, $p < 0.01$, $sr^2 = 0.24$), subjective norms ($b = 0.28$, $p < 0.01$, $sr^2 = 0.08$), and PBC ($b = 0.30$, $p < 0.01$, $sr^2 = 0.06$). These results provide initial evidence that the factors in the questionnaires are broadly related in a manner consistent with TPB.

## 4. General Discussion

The aim of the current study was to develop and provide initial evidence of the validity of three questionnaires that assess individuals' beliefs about green exercise. Using the TPB as a theoretical framework and drawing upon established guidelines [63,64], tools were developed to assess direct and indirect measures of attitudes, subjective norms and PBC, and intention to perform green exercise. Evidence was provided for the factorial validity, composite reliability, and parallel-form reliability for each of the three questionnaires. Consistent with previous studies [15,58–61], our findings support the theoretical structure of the TPB in relation to performing PA. To date though, no other instruments exist that focus explicitly on beliefs about green exercise. As such, the current findings offer a novel suite of measurement instruments that could be used to provide important insight into the role of individuals' beliefs in green exercise, thereby contributing to the development of theory and effective interventions.

For content validity, salient beliefs were established through an elicitation study (Study 1). Although valuable for development of TPB questionnaires [62,64], this step is often overlooked within PA research [66]. The salient beliefs captured in the elicitation study informed the development of the BAGE-ID and provide confidence that the items reflect the key cognitions about green exercise in the general population. Consistent with previous research, the advantages and likeable features of green exercise were the most prevalent [77,78]. Interestingly, however, weather—as a disadvantage or dislikeable feature of green exercise—was the most reported salient belief. This may be because the temperate oceanic climate of the UK is not conducive to green exercise throughout the year. Similarly, previous research has found that climatic conditions have an important impact on PA levels across different populations [79–81].

Evidence was provided for the factorial validity of the three measures across two samples (refinement and validation). Specifically, following modifications in the refinement sample, the BAGE-ID, BAGE, and INT-GE had good model fits and all factors loadings were significant in both the refinement and validation samples. Of note, however, is that the item relating to weather in the BAGE-ID was removed during the modification process. Although weather was identified as dislikeable feature of green exercise in Study 1, climatic conditions were also listed as a facilitating factor. These contrasting views may partly explain why the factor loading of weather on PBC was not as strong as other items in Study 2. Instead—and congruent with previous research [14,23,47]—items relating to the size, facilities, and safety of local green space may be more reflective of PBC. Overall though, the confirmatory factor analyses indicated that the refined questionnaires had a good factorial validity and model fits were comparable to other questionnaires based on the TPB [82,83].

The current findings provide support for using the TPB as a model to explore green exercise, and the proposed relationships between indirect and direct measures of attitudes and subjective norms. Similarly, previous research has successfully employed the TPB to explore the relationship between PA and nature [15,57]. Consistent with Calogiuri and Chroni [15], we found evidence that the motivational processes associated with green exercise can be modelled from beliefs to intentions. Indeed, previous research has demonstrated that TPB factors can predict intention to engage in outdoor recreation programmes [59] and to visit state parks [58]. The current findings extend the literature by demonstrating that both indirect and direct measures of attitudes, subjective norms, and PBC do predict intention to perform green exercise. Beyond the empirical support for the TPB, these findings could underpin the development of evidence-based interventions to promote intention to perform green exercise.

Previous research has made an important contribution in demonstrating that green exercise has important psychological and health benefits [30,37], and that individuals' beliefs can facilitate the benefits of PA [8,9]. The questionnaires developed in this study complement this research and provide tools to explore the role of beliefs in green exercise behaviours and outcomes. The consistent use of the three questionnaires will facilitate attempts to synthesise research findings and enable researchers to address theoretically interesting questions, such as which beliefs are the most salient predictors of green exercise behaviours and under what conditions? In total, the questionnaires contain 39 items, all written in the English language with scaled multiple-choice responses, and can be completed in less than 15 min. As such, researchers and health professionals could utilise the tools to assess beliefs in a variety of settings, including field studies, laboratory-based experiments, and applied interventions.

Key strengths of the present research were the use of an elicitation study, the development of questionnaires that assess both indirect and direct measures of attitudes, subjective norms and PBC about green exercise, and the ability to replicate the observed factor structures in two samples. According to the assessment criteria for TPB questionnaire development [64], such steps would enable the current study to achieve Grade A. Despite these strengths, some limitations should be noted. With regards to methodology, the randomisation of participants to the refinement and validation samples in Study 2 led to significant between-group differences for age and gender. In the future, it might be useful to consider stratified random sampling to control for demographics prior to doing confirmatory factor analyses. The correlational nature of Study 2 also limits the ability to infer causality in the relationships between indirect, direct, and intention measures. Further, although the findings demonstrate that beliefs predict the intention to perform green exercise, the relationship with subsequent behaviour was not explored. Future research should therefore explore whether intentions mediate the relationship between beliefs and green exercise behaviour.

## 5. Conclusions

The current article reported the development of three instruments that have great relevance for green exercise research. Although further research is warranted on different samples and using different research designs, the current studies have provided promising initial evidence of the validity and reliability of all three instruments to assess thoughts towards green exercise. For the first time, researchers and health professionals now have the tools to assess the role of beliefs on green exercise behaviours and associated outcomes. Although the questionnaires are presented separately, researchers are encouraged to select the one(s) most relevant for their research. Hopefully, the instruments will contribute to a better understanding of individuals' beliefs about green exercise, how these influence behaviour, and ultimately to the development of behaviour change interventions designed to promote the use of local green space, and facilitate the psychological and physical outcomes of green exercise.

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## Beliefs about Green Exercise (BAGE)

GREEN EXERCISE is physical activity that takes place in the presence of nature (i.e. parks, woodlands, sports fields etc). The next set of multiple choice questions are about your Green Exercise Beliefs. Please answer openly and honestly...there is no right or wrong answer.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Doing Green Exercise as part of my weekly physical activity is... | Beneficial | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Harmful |
| **2** | Doing Green Exercise as part of my weekly physical activity is... | Bad | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Good |
| **3** | People that are similar to me do Green Exercise | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **4** | I expect to do Green Exercise at least once per week for the next four weeks | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| **5** | Doing Green Exercise as part of my weekly physical activity is... | Enjoyable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Unenjoyable |
| **6** | The likelihood of me doing Green Exercise at least once per week for the next four weeks is... | Very Unlikely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very Likely |
| **7** | Doing Green Exercise as part of my weekly physical activity is... | Boring | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Fun |
| **8** | I choose when and where I do Green Exercise | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **9** | I plan to do Green Exercise at least once per week for the next four weeks | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **10** | I am confident I could do Green Exercise if I wanted to | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| **11** | Doing Green Exercise is... | Very Difficult | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very East |
| **12** | Doing Green Exercise as part of my weekly physical activity is... | Pleasant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Unpleasant |
| **13** | I want to do Green Exercise at least once per week for the next four weeks | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **14** | I intend to do Green Exercise at least once per week for the next four weeks | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **15** | The decision to do Green Exercise is beyond my control | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **16** | People often ask me to do Green Exercise with them | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **17** | Most people who are important to me believe I should do Green Exercise | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |

**Scoring Procedure**

Step 1. Reverse scores from items 1, 4, 5, 10, 12, 15, 17

Step 2. Group Scores into Theory of Planned Behaviour factors and calculate means.

Intention = 4 + 6 + 9 + 13 + 14 / 5

Attitude = 1 + 2 + 5 + 7 + 11 + 12 / 6

Subjective Norm = 3 + 16 + 17 / 3

Perceived Behavioural Control = 8 + 10 + 15 / 3

# Beliefs about Green Exercise (BAGE-ID)

GREEN EXERCISE is physical activity that takes place in the presence of nature (i.e. parks, woodlands, sports fields etc). The next set of multiple choice questions are about your Green Exercise Beliefs. Please answer openly and honestly...there is no right or wrong answer.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | The facilities at my local green space influence my decision to do Green Exercise | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| **2** | When I do Green Exercise, I feel like I am getting fresh air | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **3** | When I do Green Exercise, I feel better about myself afterwards | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| **4** | Feeling safer at my local green space would make me (fill in the blank) to do Green Exercise | Very Unlikely | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Very Likely |
| **5** | Feeling positive after doing Green Exercise is... | Extremely Undesirable | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Extremely Desirable |
| **6** | The likelihood of me doing Green Exercise at least once per week for the next four weeks is... | Very Unlikely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very Likely |
| **7** | I want to do Green Exercise at least once per week for the next four weeks | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **8** | I intend to do Green Exercise at least once per week for the next four weeks | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **9** | My family approving of me doing Green Exercise is... | Not at all Important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Extremely Important |
| **10** | Improving or maintaining my fitness by doing Green Exercise is... | Extremely Undesirable | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Extremely Desirable |
| **11** | My family think I should do Green Exercise | Strongly Disagree | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Strongly Agree |
| **12** | My friends approving of me doing Green Exercise is... | Not at all Important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Extremely Important |
| **13** | Feeling better about myself after Green Exercise is... | Extremely Undesirable | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Extremely Desirable |
| **14** | Doing the same Green Exercise as my peers do is important to me | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| **15** | Getting fresh air during Green Exercise is... | Extremely Undesirable | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Extremely Desirable |
| **16** | Better local facilities would make me (fill in the blank) to do Green Exercise | Very Unlikely | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Very Likely |
| **17** | I expect to do Green Exercise at least once per week for the next four weeks | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| **18** | My friends think I should do Green Exercise | Strongly Disagree | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Strongly Agree |
| **19** | My peers do Green Exercise | Strongly Disagree | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Strongly Agree |
| **20** | Having more local green space would make me (fill in the blank) to do Green Exercise | Very Unlikely | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Very Likely |
| **21** | The amount of green space in my local area influences my decision to do Green Exercise | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **22** | Green Exercise is good for my fitness | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **23** | Having fun whilst doing Green Exercise is... | Extremely Undesirable | -3 | -2 | -1 | 0 | 1 | 2 | 3 | Extremely Desirable |
| **24** | Green Exercise is enjoyable | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| **25** | I plan to do Green Exercise at least once per week for the next four weeks | Strongly Disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Agree |
| **26** | Safety at my local green space influences my decision to do Green Exercise | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| **27** | Doing Green Exercise helps me feel positive about myself | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |

**Scoring Procedure**

Step 1. Reverse score items 3, 4, 14, 16, 17, 20, 24, 27

Step 2. Group scores into Theory of Planned Behaviour factors and multiply items from pairing factors (see tables below)

Step 3. Calculate means for each factor

**Intention** = 6 + 7 + 8 + 17 + 25 / 5

| Attitude | Outcome Beliefs | Evaluations of Outcomes | Total |
|---|---|---|---|
| 1 | 2 | 15 | (2 x 15) = |
| 2 | 3 | 13 | (3 x 13) = |
| 3 | 22 | 10 | (22 x 10) = |
| 4 | 27 | 5 | (27 x 5) = |
| 5 | 24 | 23 | (24 x 23) = |

**Attitude** = 1 + 2 + 3 + 4 + 5 / 5

| Subjective Norm | Normative Expectations | Motivation to Comply | Total |
|---|---|---|---|
| 1 | 18 | 12 | (18 x 12) = |
| 2 | 11 | 9 | (11 x 9) = |
| 3 | 19 | 14 | (19 x 14) = |

**Subjective Norm** = 1 + 2 + 3 / 3

| Perceived Behavioural Control | Factors that facilitate or impede | Perceived Power of factors | Total |
|---|---|---|---|
| 1 | 21 | 20 | (21 x 20) = |
| 2 | 1 | 16 | (1 x 16) = |
| 3 | 26 | 4 | (26 x 4) = |

**Perceived Behavioural Control** = 1 + 2 + 3 / 3

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# Enhancing the acute psychological benefits of green exercise: An investigation of expectancy effects☆

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ABSTRACT

*Objective:* Exercising in the presence of a natural environment (termed green exercise) appears to provide addition benefits compared to indoor exercise. We assessed the impact of a green exercise promotional video on the acute psychological benefits of green-outdoor and indoor exercise.
*Design:* Participants were randomly assigned to one of four groups. Two groups undertook green exercise (with one of these groups watching a green exercise promotional video). The other two groups undertook indoor exercise (with one of these groups watching the promotional video). The green-outdoor and indoor exercise conditions were created to replicate those of a previous study (Rogerson, Gladwell, Gallagher, & Barton, 2016b). The promotional video was designed to highlight benefits of green exercise and was used to manipulate expectations of acute green exercise.
*Method:* Participants ($N = 60$) completed 15-min of moderate-intensity cycling, with self-esteem, vigour (dependent variables), and attitudes (manipulation check) assessed pre- and post-activity. Measures of physical activity and green exercise levels were also recorded at baseline.
*Results:* The findings suggest that green exercise elicits greater psychological benefits than indoor exercise, and those benefits can be increased via expectancy modification. In contrast, the same expectancy modification suppressed the psychological benefits of cycling indoors.
*Conclusions:* A promotional video can further enhance the affective response to green exercise. This may help to encourage future physical activity participation holding great promise for researchers, practitioners and policy makers.

Acute exercise enhances psychological well-being through a number of mechanisms including reducing anxiety (Ensari, Greenlee, Motl, & Petruzzello, 2015; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991; Stonerock, Hoffman, Smith, & Blumenthal, 2015), and enhancing self-esteem (Fox, 2000; Rogerson, Brown, Sandercock, Wooller, & Barton, 2016; Spence, McGannon, & Poon, 2005) and mood (Anderson & Brice, 2011; Berger & Motl, 2000; Helfer, Elhai, & Geers, 2014; Petruzzello, Snook, Gliottoni, & Motl, 2009; Yeung, 1996). This is supported by comprehensive reviews (Arent, Landers, & Etnier, 2000; McDonald & Hodgdon, 2012; Reed & Ones, 2006). For example, Reed and Ones (2006) reported that the average effect size for acute aerobic exercise on positive activated affect was 0.47 ($d_{corr}$).

A growing body of evidence suggests that greater physiological and psychological benefits occur if exercise takes place in a natural environment (termed green exercise; Barton & Pretty, 2010; Gladwell, Brown, Wood, Sandercock, & Barton, 2013; Thompson Coon et al., 2011). For example, acute bouts of green exercise have been shown to facilitate increases in happiness (Yeh, Stone, Churchill, Brymer, & Davids, 2017), vigour (Song, Ikei, Igarashi, Takagaki, & Miyazaki, 2015), and self-esteem (Pretty, Peacock, Sellens, & Griffin, 2005). Moreover, when Mackay and Neill (2010) compared the anxiolytic effects of different exercise types they found a larger effect size for mountain biking ($d = 1.02$) than road cycling ($d = 0.84$). Similarly (Akers et al., 2012), found that during cycling, green scenery elicited greater improvements in mood compared with grey scenery. Importantly, psychological benefits are elicited from as little as 5 min (Barton & Pretty, 2010) to 30 min (Shanahan et al., 2016) of green exercise. Although a number of theories have been proposed, such as the Biophilia Hypothesis (Wilson, 1984) and Attention Restoration Theory (Kaplan & Kaplan, 1989), the mechanisms for the additional psychological bene-

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fits of green exercise compared to urban/indoor exercise are still unclear.

A small number of studies have explored the role of individuals' thoughts and feelings on green exercise behaviours (Calogiuri & Elliott, 2017; Curry, Crone, James, & Gidlow, 2011; Groshong, Stanis, Kaczynski, Hipp, & Besenyi, 2017; Loureiro et al., 2014). For example, Calogiuri and Elliott (2017) found that for Norwegian adults, experiencing nature was the second-most important motive for exercise, exceeded only by convenience. Furthermore, individuals who have a higher connectedness with nature tend to spend more time in nature, and subsequently do more green exercise (Flowers, Freeman, & Gladwell, 2016). Until recently, however, there has been no established measure to assess how individuals feel about green exercise as a distinct mode of physical activity.

Based upon the Theory of Planned Behaviour (Ajzen, 1991), Flowers, Freeman, and Gladwell (2017) developed the Beliefs about Green Exercise Questionnaire (BAGE) to assess attitudes, subjective norms, and perceived behavioural control towards green exercise. Some items within the attitudes sub-scale assess how individuals feel about performing green exercise (i.e. is it beneficial? is it pleasant?), and thus may provide key insights into how people expect to feel following the activity. Moreover, evidence from the wider physical activity literature shows an inherent link between attitudes and exercise behaviours (Chatzisarantis, Hagger, Biddle, & Smith, 2005; Rhodes, 2009). Yet, no research to our knowledge has explored whether attitudes towards green exercise influence acute psychological outcomes.

In the exercise domain, some researchers have postulated that expectancy beliefs play a role in the acute psychological benefits of exercise (Bérdi, Köteles, Szabó, & Bárdos, 2011; Lindheimer, O'Connor, & Dishman, 2015; Ojanen, 1994; Szabo, 2013). Empirically, researchers have adopted expectancy manipulations to examine the possible role of expectancy effects. For example, Desharnais, Jobin, Cote, Levesque, and Godin (1993) manipulated expectations to elicit greater improvements in self-esteem following a four-week exercise program. The authors used an authoritative statement to manipulate expectations, which is the most commonly used technique within the exercise domain (Crum & Langer, 2007; Desharnais et al., 1993; Helfer et al., 2014; Kwan, Stevens, & Bryan, 2017; Lindheimer, O'Connor, McCully, & Dishman, 2017). Posters (Stanforth, Steinhardt, Mackert, Stanforth, & Gloria, 2011), videos (Mothes et al., 2017), and sham equipment (Lindheimer et al., 2017; Mothes et al., 2017; Reed, 2014) have also been used to explore the role of expectancy effects in exercise outcomes.

Some evidence indicates that expectations play a role in some of the outcomes of common activities such as running (Berger, Owen, Motl, & Parks, 1998; Kwan et al., 2017; Szabo & Abraham, 2013) and cycling (Helfer et al., 2014; Mothes et al., 2017). For example, Helfer et al. (2014) explored the role of expectancy effects on mood following 10-min of light-intensity cycling. Participants ($N = 140$) were randomly assigned to one of four groups in a 2 (no expectation vs affective expectation) x 2 (no elaboration vs elaboration) between-group design. The affective groups were told that physical activity is good for happiness, mood and self-esteem. The elaboration groups were asked to write the information they had received as a recall task. There was a significant post-exercise main effect for expectation ($\eta_p^2 = 0.06$), but not for elaboration or an interaction of the two. This finding is supported by recent reviews (Bérdi et al., 2011; Lindheimer et al., 2015; Szabo, 2013). In contrast, the expectancy effect has been more elusive in studies using 30-min bouts of cycling (Lindheimer et al., 2017; Mothes et al., 2017). Within these studies, the strength of expectancy manipulation and exercise type/duration were noted as possible reasons for non-significant effects. Helfer et al. (2014) suggested that aversive experiences, such as longer moderate-intensity exercise, that may cause muscular pain or discomfort, are less likely to be influenced by expectation manipulations.

Green Mind Theory, which outlines reciprocal links between each of human behaviour, mind, brain and body, and natural and social environments, forwards that expectancy effects stemming from beliefs are likely to influence the therapeutic outcomes of spending time in nature (Pretty, Rogerson, & Barton, 2017). For example, Pretty and colleagues proposed that healing gardens in hospitals, promoted through a good patient-practitioner relationship, may induce health related expectancy effects. However, researchers have yet to examine whether expectations play a role in the acute psychological benefits of green exercise, and if modifying expectations can enhance those outcomes further.

Measuring attitudes (as a proxy for expectations) before and after green exercise research may provide important insight into the role of expectancy effects. As studies have shown links between affective states and outdoor exercise (Focht, 2009; Groshong et al., 2017; Lacharite-Lemieux, Brunelle, & Dionne, 2015), then changes in affective attitudes may manifest as additional benefits. More generally though, exploring the role of expectancy effects in green exercise is important for public health. For example, if attitudes are related to green exercise outcomes, then promoting the activity may enhance actual outcomes. This is worthwhile as post-exercise invigoration can increase the likelihood of repeating the behaviour (Ekkekakis, Parfitt, & Petruzzello, 2011; Focht, 2009; Kwan & Bryan, 2010).

The preliminary aim was to examine if exercise in a natural environment would facilitate greater psychological benefits than indoor exercise. We hypothesised that exercising in a natural environment would elicit greater psychological benefits than indoor exercise. The primary aim was to examine if expectancy effects play a role in the acute psychological benefits of green exercise. We hypothesised that compared to a control condition, watching a promotional video about green exercise before undertaking exercise in a green environment would elicit greater psychological benefits (vigour and self-esteem), and a change in attitudes (as a proxy for expectations) towards green exercise may play a role. The secondary aim of the study was to examine the effect of the same video on indoor exercisers; we hypothesised that watching the video would result in suppressed self-esteem and vigour.

## 1. Method

### 1.1. Participants

The sample size was based on an a priori power analysis focused on testing the primary aim (G-power version 3.1; Faul, Erdfelder, Lang, & Buchner, 2007). An expected effect size ($f = 0.25$) was derived from an equivalent effect size ($\eta_p^2 = 0.06$), observed in previous research (Helfer et al., 2014). This was entered along with power at 0.8 and an alpha of .05. This indicated a sample size of 68. Undergraduate students (19 women, 41 men, $M_{age} = 19.9$ years, $SD = 4.26$, age range 18–51 years) were recruited using opportunistic sampling (poster and email advertisements) at the University of Essex. Participants reported their ethnicity as White (67%), Asian (13%), Mixed (12%), or Other (8%).

### 1.2. Design

A single-blind randomised mixed-model design was used: participants cycled at a moderate-intensity for 15-min in one of four groups. Treatment (green vs indoor) and condition (expectancy vs control) were the two between-group factors; those in the green treatment (i.e. green exercisers) completed the cycling task in a green-outdoor environment, and those in the indoor treatment completed the entire task inside a laboratory. Further, those in the expectancy condition were shown a promotional video of green exercise, and those in the control

condition were not. Measures of self-esteem, and vigour and were taken pre- and post-exercise as repeated measures dependent variables (as described below). Measures of attitudes (as a proxy for expectations) were taken pre- and post-exercise as a manipulation check to confirm that the video had the anticipated effect.

**Treatments.** Treatments were chosen to replicate that of a previous study (Rogerson, Gladwell, Gallagher, & Barton, 2016). For the indoor treatment, stationary cycling was completed in a laboratory with a view facing a blank screen and light grey painted wall (Fig. 1). Equipment, furniture, and objects were moved from peripheral vision. For the green treatment, stationary cycling was completed on the edge of a large sports field. This consisted of a mostly flat and grass covered expansive area with interspersed trees and hedge perimeter (Fig. 1). In both treatments, the experimenter stood diagonally behind the ergometer 3 m away.

**Conditions.** Those in the expectancy condition were shown a promotional video of green exercise. This was designed to highlight the benefits of exercising in a natural environment, and manipulate expectations regarding the outcomes of acute green exercise. The video was created using Microsoft PowerPoint 2016 (Redmond, WA, USA). The 3-min (11 slides), silent video contained a mixture of text and images amongst a bold green background. Information – from credible sources such as the National Health Service and World Health Organisation – was provided about the health and emotional consequences of green exercise. Moreover, the video contained advice on how to perform green exercise.

To test the effectiveness of the promotional video, a pilot study was conducted in a university lecture theatre. Undergraduate students (12 women, 19 men, $M_{age} = 21.3$ years, $SD = 2.53$, age range: 20–34 years) were recruited in a lecture at the University of Essex. Participants reported their ethnicity as White (87%), Black (10%) or Mixed (3%). Participants were asked to complete the attitudes measure (described below) before and after watching the promotional video. A paired-samples $t$-test revealed significant increases in attitudes ($t_{30} = -3.56$, $p = .001$, $d = 0.31$).

### 1.3. Procedure

The research was approved by the University of Essex Research Ethics Committee. The main study was conducted during the winter months (October 2016 to February 2017). Participants were divided into one of four-groups using a block approach (block size 60, with a 1:1:1:1 ratio). Each timeslot for participation had been pre-determined by the investigator as a treatment (green or indoor) and condition (expectancy or control), however, this was blinded to participants during sign-up. On a first come, first serve basis, participants self-selected a timeslot for participation and told to bring suitable clothing for indoor and outdoor exercise. Upon arrival at the laboratory, participants read an information sheet and provided informed consent. Next, height and weight were recorded and a Polar T31 chest strap was fitted (Polar Electro Oy, Kempele, Finland).

At this point, the green treatment groups were escorted to a sports pavilion on the edge of the sports field (approximately a 3-min walk), whereas the indoor treatment groups remained in the laboratory (Fig. 2). All participants completed the baseline and control measures on a Dell Inspiron 13 7000 laptop (Dell Inc, Round Rock, Texas, USA), using Qualtrics research software (Qualtrics, Provo, Utah, USA); for those in the outdoor condition this was in the sports pavilion, whereas for those in the indoor condition this was in the laboratory. Resting heart rate was recorded at its lowest point within 60s after participants had completed the questionnaires and while they remained seated.

Prior to cycling, those in the green condition were escorted outside the pavilion and all participants were given time, and help if needed, to adjust the saddle height. Within a single experimental session, participants cycled twice on a CatEye ergociser (EC-1600, CatEye Co. Ltd., Osaka, Japan) ergometer. First, participants performed a submaximal fitness test based on the YMCA protocol (Golding, Myers, & Sinning, 1989). This test required cycling at approximately 50 rpm for 9-min. At 3-min intervals, and in accordance with heart rate readings, the resistance of the bike automatically increased from low to high relative resistance. The resistance increased on 2 occasions. The first test was to familiarise participants with using the ergometer and ascertain the data needed to calculate moderate-intensity for the second bout of cycling.

Between the bouts of cycling, participants were escorted back to the desk where they completed the baseline measures. For the green treatment, this involved escorting participants back into the sports pavilion. During this period, those in the expectancy condition were shown the promotional video. Time was also allocated for rest: up to 10-min of just sitting for those who did not watch the promotional video, and up to 10-min including 3-min of watching the video for those in the expectancy condition. However, the time was less if heart rate recovered to within 15 beats per minute of their resting heart rate, which was the case for 37 (62%) participants.

After resting, participants were escorted back to the ergometer. For the second (experimental) bout of cycling, the bike was set to an intensity that represented 50% heart rate reserve (Garber et al., 2011). This was calculated using resting heart rate and data collected from the submaximal test. Consistent with Rogerson et al. (2016), the second bout lasted 15 min, and participants were free to choose cadence; the bike automatically adjusted resistance to maintain a constant power output

**Fig. 1.** View from the cycle ergometer in the indoor and green conditions. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

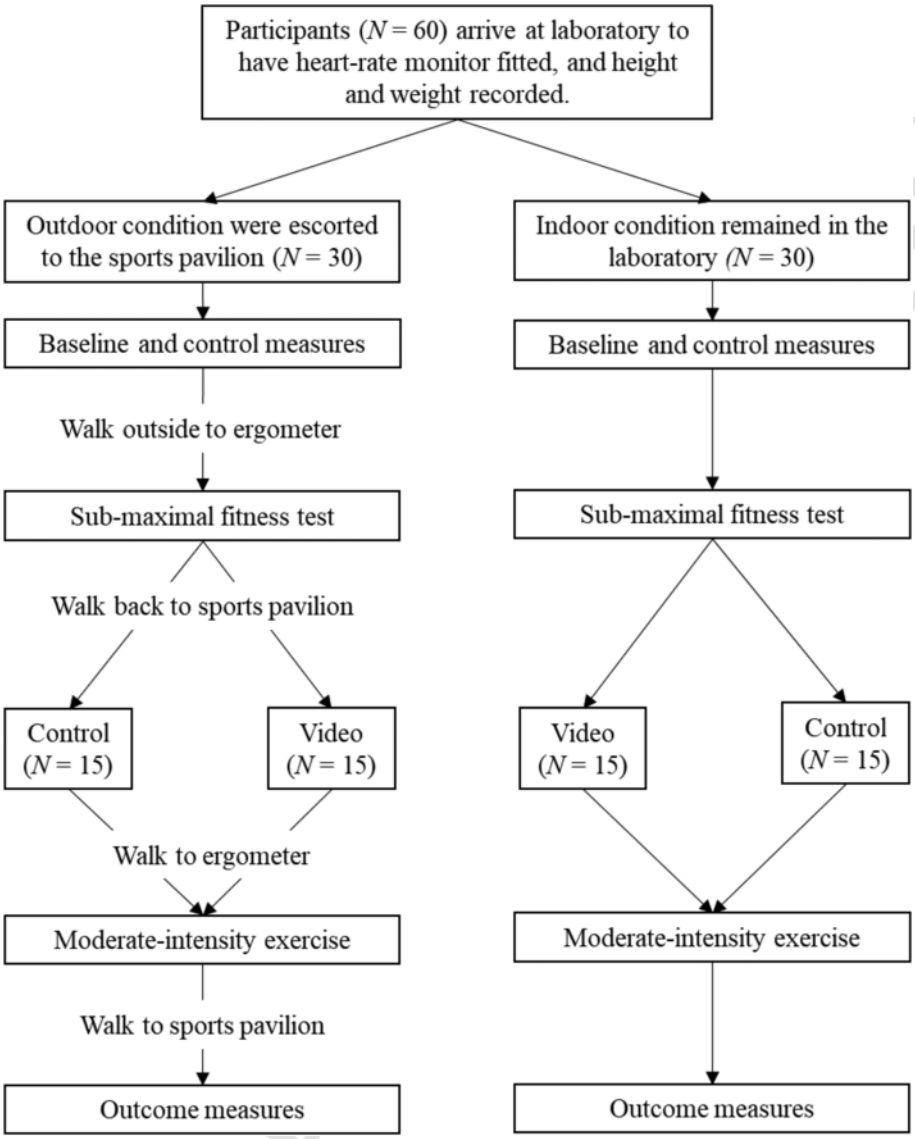


**Fig. 2.** An illustration of the experimental procedure.

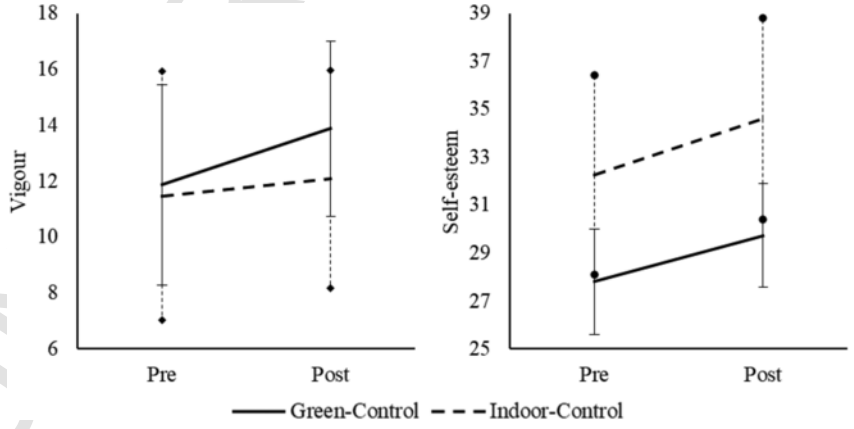


**Fig. 3.** Treatment x time interaction for vigour and self-esteem (*M* and *SD*) between green and indoor control groups ($N = 30$). Due to the Bonferroni-Holm's correction, there was a marginally significant interaction effect of treatment x time on vigour but not for self-esteem.

in line with calculated moderate-intensity values. Unlike the first test, the ergometer screen was blanked out to prompt participants to view forwards and experience the environment. At 7.5 min, perceived exertion was recorded (see below). Finally, at the same location as they completed the baseline measures, participants repeated the measures of attitudes, self-esteem and vigour, removed the heart-rate monitor, and

were debriefed about the design, aims and hypotheses of the research. Outdoor temperature was recorded using data provided by the UK's National Meteorological Service.

### 1.4. Measures

**Physical activity.** Physical activity was assessed using two self-report single-item measures. The Single-item Physical Activity Screening Measure (Zwolinsky, McKenna, Pringle, Widdop, & Griffiths, 2015) assessed general physical activity, whereas a modified version assessed green exercise. The wording of the general physical activity question was 'In the past week, on how many days have you done a total of 30 min or more of physical activity, which was enough to raise your breathing rate. This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job'. For green exercise, participants were asked 'In the past week, on how many days have you done physical activity in the presence of a natural environment, which was enough to raise your breathing rate. This may include activities such as brisk walking/jogging in a park, cycling along a canal path, or playing sport'. Both items captured the number of active days per week on a scale from 0 to 7.

**Perceived exertion.** Perceived exertion was measured using the Rating of Perceived Exertion scale (Borg, 1982). The scale consists of 15 vertically aligned numbers (ranging from 6 'no exertion' to 20 'maximal exertion') that allows individuals to subjectively rate their level of exertion during exercise. This is widely used in acute exercise research (Lindheimer et al., 2017; Mothes et al., 2017; Rogerson et al, 2016), and has been tested for reliability with physiological measures of heart rate, blood lactate, % $VO_2$max, $VO_2$, and respiratory rate (Chen, Fan, & Moe, 2002).

**Attitudes to green exercise.** Attitudes were assessed with the five-item attitudes sub-scale of the Belief about Green Exercise questionnaire (BAGE; Flowers et al., 2017). The BAGE was developed to assess how people feel regarding physical activity in the presence of natural environments, and was demonstrated to have strong psychometric properties. Items were preceded with the following statement 'Green Exercise is physical activity that takes place in the presence of nature (e.g., parks, woodlands, sports fields etc)' and scored from 1 to 7, with higher scores reflecting more positive attitudes to green exercise. For example, 'Doing green exercise as part of my weekly physical activity is… (1) *Unpleasant* to (7) *Pleasant*'.

**Self-esteem.** Self-esteem was assessed using Rosenberg's Self-Esteem Scale (Rosenberg, 1965), which is a 10-item scale. Each item consists of a brief statement (e.g., I feel that I have a number of good qualities) and participants respond on a Likert scale ranging from (1) *Strongly* Disagree to (4) *Strongly Agree*. The responses to five items are reverse scored so that higher numbers reflect greater self-esteem. Self-esteem was recorded as the sum of all 10 items. The Self-Esteem Scale has previously been used – and shown to be sensitive – in green exercise research (Barton & Pretty, 2010).

**Vigour.** Vigour was assessed using five items from the shortened, 30-item version of the Profile of Mood States (McNair, 1971; McNair, Lorr, & Droppleman, 1992). Participants indicated how they felt 'right now' towards single-word descriptors of vigour (e.g., Lively), using a Likert scale from (1) *Not at all* to (5) *Extremely*, therefore producing an overall score between 5 and 25. The vigour sub-scale of the Profile of Mood States has previously been used in expectancy research (Lindheimer et al., 2015), and has been shown to be sensitive to acute bouts of cycling (Steptoe & Cox, 1988).

### 1.5. Data analysis

Statistical analyses were carried out to test the preliminary, primary and secondary hypotheses. Initially, analyses were conducted to ensure the groups were equivalent on five variables identified as potential confounders: self-reported physical activity and green exercise levels, perceived exertion, 50% HRR cycling intensity (W), and outdoor temperature during experimental session. A series of two-way between-group ANOVAs were run to assess if there were any condition and/or treatment differences between the four groups ($N = 60$) on each potential confounder. For the manipulation check, tests were run to assess if the expectancy manipulation had any effect on attitudes following acute exercise. Specifically, a mixed-model ANOVA was run with condition and treatment as between-subjects independent variables, time as a repeated measures variable, and attitudes as a dependant variable ($N = 60$).

To assess the overall model, a three-way mixed-model MANOVA was run with condition and treatment as between-subjects independent variables, time as a repeated measures variable, and vigour and self-esteem as dependant variables ($N = 60$). To further explore significant effects, univariate tests were run individually for vigour ($N = 60$) and self-esteem ($N = 60$) with condition, treatment and time as independent variables. Planned comparisons were then run to test the preliminary (green exercise effect), primary (positive expectancy effect), and secondary (negative expectancy effect) hypotheses. To test the preliminary hypothesis, the two control groups were included in the analyses ($N = 30$), and tests were run individually for vigour and self-esteem. Specifically, two mixed-model ANOVAs were run to assess if treatment (green control vs indoor control) influenced change in psychological wellbeing over time (pre- and post-exercise).

To test the primary hypothesis, analyses were conducted to assess if the expectancy manipulation induced additional psychological benefits over and above that of green exercise. Only the green treatment groups were included ($N = 30$), and tests were run individually for self-esteem and vigour (as dependent variables). Specifically, two mixed-model ANOVAs were run to assess if condition (expectancy vs control) influenced self-esteem and vigour over time (pre- and post-exercise).

To test the secondary hypothesis, analyses were conducted to examine if the expectancy manipulation suppressed psychological wellbeing following indoor exercise. Only the indoor treatment groups were included ($N = 30$), and tests were run individually for self-esteem and vigour (as dependent variables). Specifically, two mixed-model ANOVAs were run to assess if condition (expectancy vs control) influenced changes in self-esteem and vigour over time (pre- and post-exercise). Significance was initially set at $p < .05$ but a Bonferroni-Holm's correction was applied to rule out the possibility of familywise error (Holm, 1979). All analyses were all conducted using IBM SPSS 23 (Armonk, NY, USA).

## 2. Results

### 2.1. Descriptive and confounder analyses

All descriptive statistics are reported in Table 1. For outdoor temperature a two-way between group ANOVA was run to assess if there were any treatment, condition or interactions effect. There was a significant main effect of treatment on temperature ($F_{1,56} = 11.88$, $p < .01$, $\eta_p^2 = 0.18$), and no significant effects of condition ($F_{1,56} = 0.61$, $p = .81$, $\eta_p^2 = 0.00$), and interaction ($F_{1,56} = 0.61$, $p = .81$, $\eta_p^2 = 0.00$). Those in the outdoor-treatment group had a mean temperature of 10 °C, whereas the indoor-treatment group had a mean temperature of 7 °C outdoors, although they remained indoors.

**Table 1**
Descriptive statistics.

| | Green ($N$ = 30) | |
|---|---|---|
| | Expectancy ($N$ = 15) | Control ($N$ = 15) |
| | M (SD) | M (SD) |
| Age (yrs) | 19.67 (1.23) | 19.53 (1.64) |
| Physical activity | 4.33 (1.76) | 4.60 (1.81) |
| Green exercise | 3.13 (2.45) | 2.87 (2.13) |
| Body Mass Index | 22.84 (1.98) | 24.46 (4.68) |
| Cycling (Watts) | 121.60 (40.36) | 109.47 (33.66) |
| RPE (7-min) | 11.20 (1.57) | 11.73 (2.09) |
| Temperature (°C) | 9.73 (3.43) | 9.73 (3.26) |
| Pre Attitudes | 5.67 (0.70) | 5.13 (1.19) |
| Post Attitudes | 6.22 (0.67) | 5.68 (0.59) |
| Pre Self-esteem | 32.40 (4.79) | 27.80 (2.21) |
| Post Self-esteem | 36.47 (2.92) | 29.73 (2.15) |
| Pre Vigour | 11.67 (3.11) | 11.87 (3.58) |
| Post Vigour | 15.80 (2.98) | 13.87 (3.14) |
| | Indoor ($N$ = 30) | |
| | Expectancy ($N$ = 15) | Control ($N$ = 15) |
| | M (SD) | M (SD) |
| Age (yrs) | 21.13 (8.31) | 19.33 (1.05) |
| Physical activity | 3.33 (1.84) | 4.13 (1.73) |
| Green exercise | 2.00 (1.51) | 2.67 (1.76) |
| Body Mass Index | 22.85 (2.73) | 23.40 (2.40) |
| Cycling (Watts) | 106.20 (35.98) | 107.93 (31.13) |
| RPE (7-min) | 12.40 (2.32) | 12.40 (1.21) |
| Temperature (°C) | 7.13 (2.83) | 6.73 (3.04) |
| Pre Attitudes | 5.58 (0.68) | 5.59 (0.79) |
| Post Attitudes | 6.28 (0.44) | 5.73 (0.75) |
| Pre Self-esteem | 29.00 (3.27) | 32.27 (4.17) |
| Post Self-esteem | 30.53 (2.90) | 34.60 (4.21) |
| Pre Vigour | 12.00 (5.25) | 11.47 (4.45) |
| Post Vigour | 9.6 (4.91) | 12.07 (3.88) |

*Note*. Physical Activity = self-reported physical activity levels (days per week), Green Exercise = self-reported green exercise levels (days per week), RPE = rating of perceived exertion.

A series of two-way between-group ANOVAs were run to assess if there were any condition, treatment, or interaction effects for each of the four remaining potential confounders. For all remaining confounders, there were no significant main effects of treatment ($Fs_{1, 56}$ = 0.01–3.89, $ps$ = .05-.35, $\eta_p^2$ = 0.00-0.04), condition ($Fs_{1, 56}$ = 0.00–2.10, $ps$ = .26-.70, $\eta_p^2$ = 0.00-0.07), or interactions ($Fs_{1, 56}$ = 0.16–2.57, $ps$ = .22-.63, $\eta_p^2$ = 0.00-0.04).

### 2.2. Manipulation check

There was not a statistically significant interaction effect of time x treatment x condition on attitudes ($F_{1,54}$ = 2.17, $p$ = .15, $\eta_p^2$ = 0.04). For the primary analysis (expectancy effect), the manipulation check revealed no significant interaction of time x treatment on attitudes ($F_{1, 28}$ = 0.00, $p$ = .97, $\eta_p^2$ = 0.00) (Fig. 4). For the secondary analysis (negative expectancy effect), the manipulation check revealed a significant interaction effect of condition x time on attitudes ($F_{1, 28}$ = 9.98, $p$ < .01, $\eta_p^2$ = 0.26); the indoor-expectancy group experienced a greater increase in attitudes ($M$ = 0.69, 95% CI 0.42–0.98), compared to the indoor-control group ($M$ = 0.14, 95% CI -0.14- 0.39) (Fig. 5).

### 2.3. Mixed-model multivariate analysis of variance

Using Wilks's statistic, there was a significant interaction of time x condition x treatment on the combined dependent variables (vigour and self-esteem), $\Lambda$ = 0.60, $F_{2,53}$ = 17.97, $p$ < .001, $\eta_p^2$ = 0.40. Additional univariate tests revealed significant interactions of time x condition x treatment on vigour ($F_{1,54}$ = 27.55, $p$ = < .001, $\eta_p^2$ = 0.34) and self-esteem ($F_{1,54}$ = 6.10, $p$ = .17, $\eta_p^2$ = 0.10) individually. To further explore these interactions, planned comparisons focused on the preliminary, primary, and secondary hypotheses.

**Preliminary hypothesis: the green exercise effect.** Due to the Bonferroni-Holm's correction, there was a marginally significant interaction effect of treatment x time on vigour ($F_{1, 28}$ = 4.49, $p$ = .043, $\eta_p^2$ = 0.14) (Fig. 3); the green-control group experienced a greater improvement in vigour ($M$ = 2.00, 95% CI 1.06–2.94) than the indoor-control group ($M$ = 0.60, 95% CI -0.46-1.66). The interaction of time x treatment had no significant effect on self-esteem ($F_{1, 28}$ = 0.31, $p$ = .58, $\eta_p^2$ = 0.01) (Fig. 3)[1].

**Primary hypothesis: the expectancy effect**. The results indicate an expectancy effect; significant interaction effects for condition x time were found for both vigour ($F_{1, 28}$ = 12.96, $p$ = .00, $\eta_p^2$ = 0.32) and self-esteem ($F_{1, 28}$ = 5.69, $p$ = .02, $\eta_p^2$ = 0.17) (Fig. 4). The green-expectancy group experienced a greater improvement in vigour ($M$ = 4.13, 95% CI 3.27–4.99) compared to the green-control group ($M$ = 2.00, 95% CI 1.06–2.94). Similarly, a greater improvement in self-esteem occurred in the green-expectancy group ($M$ = 4.07, 95% CI 2.47–5.67) compared to the green-control group ($M$ = 1.93, 95% CI 0.80–2.99).

**Secondary hypothesis: the negative expectancy effect**. The results indicate a negative expectancy effect; there was a significant interaction effect of condition x time on vigour ($F_{1, 28}$ = 15.10, $p$ = .00, $\eta_p^2$ = 0.35) (Fig. 5). The indoor-control group experienced an increase in vigour ($M$ = 0.60, 95% CI -0.46-1.66), whereas the indoor-expectancy group experienced a decrease in vigour ($M$ = −2.40, 95% CI -3.67- 1.13). No significant interaction effect for condition x time was found for self-esteem, although there was a small-medium effect size ($F_{1, 28}$ = 1.08, $p$ = .31, $\eta_p^2$ = 0.03) (Fig. 5).

## 3. Discussion

We explored the impact of a green exercise promotional video on vigour and self-esteem following an acute bout of moderate-intensity exercise. The video was designed to inform participants of the benefits of green exercise and modify expectations regarding the outcomes of an acute bout of green exercise. Initially, our results provide further evidence for the therapeutic outcomes of green exercise. Consistent with some expectancy research, when we showed the video to green exercisers, the therapeutic outcomes were enhanced. This is important because it shows that promotional tools may be used to enhance acute outcomes of green exercise. Further, the very same video elicited a negative expectation effect amongst indoor exercisers, and subsequently suppressed post exercise vigour.

Consistent with previous research (Barton & Pretty, 2010; Barton, Bragg, Wood, & Pretty, 2016; Gladwell et al., 2013; Thompson Coon et al., 2011), the current findings provide further evidence of the psychological benefits of green exercise. Specifically, participants in the green-control group experienced a 17% increase in vigour, whereas the indoor-control group only experienced a 5% increase in vigour. As there were no significant differences in perceived exertion or power output during cycling, changes in vigour may be explained by environmental conditions. Those individuals who exercised outdoors may have benefitted from the synergistic effects of exercising in the presence of nature.

To our knowledge, this is the first study to explore the potential for expectancy effects to enhance the benefits of green exercise. As with previous expectancy exercise research (Desharnais et al., 1993; Helfer et al., 2014), we found that informing participants of the psychological benefits of exercise induced a significant increase in psychological

[1] Additional analyses revealed that attitudes do not mediate the relationship between the independent variables and outcomes.

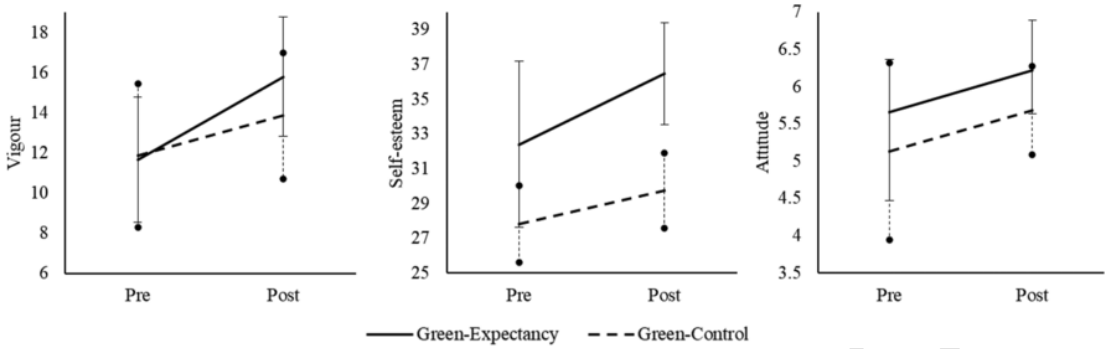


**Fig. 4.** Condition x time interaction for vigour, self-esteem and attitudes (*M* and *SD*) amongst green exercisers ($N = 30$). There was a significant interaction effect of condition x time on vigour and self-esteem.

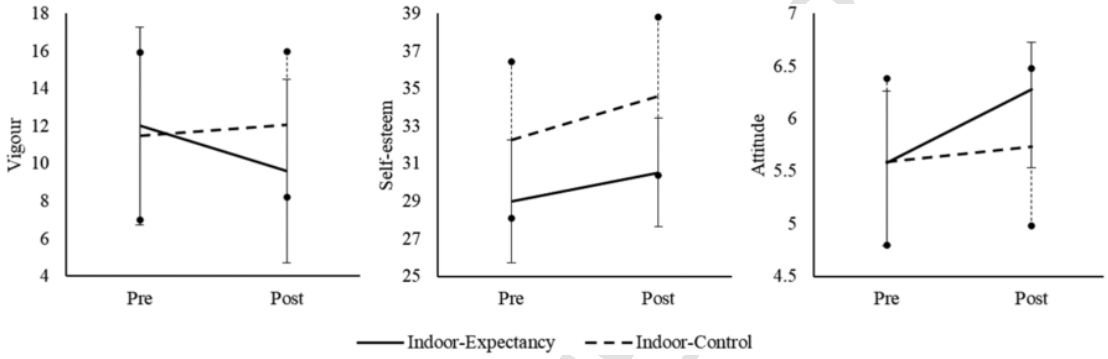


**Fig. 5.** Condition x time interaction for vigour, self-esteem and attitudes (*M* and *SD*) amongst indoor exercisers ($N = 30$). There was a significant interaction effect of condition x time on vigour but not for self-esteem.

wellbeing. This may be explained by psychological benefits of green exercise being related to both conditioning and expectations. Previous research has shown that the expectancy effect of sham painkillers (Amanzio & Benedetti, 1999) and oxygen (Benedetti, Durando, Giudetti, Pampallona, & Vighetti, 2015) are related to a pre-conditioning of the actual therapeutic effect. In these studies, participants experienced the active ingredient multiple times, prior to receiving a placebo. After pre-conditioning occurred, an expectancy (placebo) effect was more likely to appear following administration of an inert substance.

To assess for pre-conditioning in this study, we asked participants to report attitudes to green exercise and green exercise levels. We are confident that prior to attending the experiment, participants were pre-conditioned to the benefits of green exercise. Descriptive data (Table 1) shows participants perform green exercise over twice per week on average, and also had strong attitudes towards green exercise. This highlights a familiarity with doing green exercise and an appreciation of the benefits. We propose that the green exercise and expectancy effects found in this study are partly due to a pre-conditioning of the psychological benefits of green exercise. Interestingly, we found both a significant environmental effect, and a marginally significant positive expectancy effect. Perhaps, the expectancy manipulation in this study reminded the participants that they were receiving a therapy, and thus heightened the conditioned response.

In this study, changes in attitudes did not serve as the mechanism for the enhanced psychological wellbeing. There are several possible explanations for this. First, whilst the attitudes dimension of the BAGE is a validated measure designed to capture beliefs about behavioural outcomes of green exercise, it was not designed to capture expectations regarding the acute psychological outcomes of green exercise. In this study, the attitudes measure of the BAGE acted as a proxy for expectations, but perhaps it did not accurately capture subtle, yet important changes in expectations. Second, although the findings are consistent with expectancy effects, a change in expectations may not have served as the mechanism for improved outcomes. Recent advances in placebo research suggest positive effects of some treatments can occur through a variety of psychological, neurological, and biological mechanisms (Benedetti, 2014), and it is possible that expectation is not a mechanism for green exercise. Finally, vigour and self-esteem may have improved for reasons other than expectancy effect. For example, the single-blind design and/or demand characteristics may have contributed to the significant findings.

The indoor-expectancy group experienced suppressed psychological outcomes compared to the indoor-control group. Instead of a conditioned response to a therapy, the negative expectancy effect may have occurred through the rumination of an absent therapy or fear of missing out. Previous research shows that the fear of missing out is associated with lower mood states (Przybylski, Murayama, DeHaan, & Gladwell, 2013). In the indoor-expectancy group, the video may have induced memories of green exercise, and created a dissonance between reality and therapy (e.g., 'the researchers have shown me a video about the benefits of green exercise, it agrees with some of my previous experiences, and now they have asked me cycle in front of a grey wall'). In support of this, attitudes to green exercise increased significantly more in the indoor-treatment group compared to the indoor-control group, although this assumes that the strong positive attitudes about green exercise are inherently opposite to negative attitudes about indoor exercise (which we did not assess). However, we suspect that being shown a video of green exercise before being made to cycle indoors (a less invigorating experience) may have coerced participants to make a cognitive comparison about the mode of exercise and in turn increased their attitudes to green exercise. In the absence of prior research relating to negative expectancy effects in the green exercise domain, this speculative explanation warrants further examination.

It is possible that demand characteristics played a role in the reported positive and negative expectancy effects. Demand characteris-

tics are an experimental artefact whereby participants change their behaviour and/or responses based on their interpretation of the research hypothesis (Orne, 1962). Although this can occur with all self-reported measures, our experimental design may have led to different demand characteristics between groups. Although the locations at which baseline measures were completed may have been susceptible to demand characteristics, non-significant differences in baseline attitudes to green exercise lead us to believe that demand characteristics were not present at this stage. However, they may have occurred following the expectancy manipulation. Those in the expectancy groups were shown a promotional video of green exercise, then asked to cycle in either an indoor or outdoor environment. The belief about whether the environment in which they cycled facilitated or inhibited psychological wellbeing may have altered how participant's reported self-esteem and vigour.

The current findings have some important implications for researchers and applied practitioners. First, the findings emphasis that careful consideration of the methodological design and an understanding of pre-existing conditioning and expectations are vital to ensure that expectancy effects are accounted for in green exercise research. For example, we assessed attitudes to perform green exercise using a validated questionnaire to increase our ability to assess the expectancy effect. Second, acknowledgement of the negative expectancy effect in exercise research will help shape a better understanding of the less well-known phenomena. For example, if policy makers inform people of the benefits of particular types of exercise (such as green exercise) but do not provide appropriate access or facilities to enable people to undertake that exercise (such as safe, accessible green spaces), then it may be detrimental to psychological wellbeing.

Despite the strengths of the research in providing important insight into green exercise, some limitations should be acknowledged. First, although the study examined expectancy effects, it did not assess other possible mechanisms for different outcomes between groups. Using subjective measures, we cannot quantify how much of the expectancy effect was due to a neuropsychological changes or demand characteristics. Second, although efforts were made to create an authentic and controlled outdoor exercise experience that could be accurately compared to indoor exercise, cycling on a stationary bike on the edge of a field is not a common occurrence and may not replicate participants previous pleasant experience of green exercise. Third, although effort was made to avoid demand characteristics, failure to blind test administrators to the expectation condition may have had an effect. It was not possible to truly blind participants to either condition (as they knew whether they had watched a video or not) nor treatment (as they knew they had exercised indoors or outdoors), however, participants were blinded to the overall design and aims of the study. Fourth, although a power analysis revealed we needed 68 participants for the study, we only recruited 60, therefore increasing the chance of a type-II error. Fifth, as mentioned previously, the participants had high levels of baseline attitudes towards green exercise, and green exercise levels. This may have been a consequence of the opportunistic sampling method used in this study. Finally, although this study is one of the few to assess attitudes before and after physical activity, the BAGE was designed to assess how individuals feel about green exercise as a contributor to weekly physical activity and not how individuals feel towards the acute psychological benefits of green exercise.

Further research is warranted to understand the mechanisms behind the effects of green exercise, and to understand how promotional tools can be utilised to enhance outcomes. In green exercise literature, a small number of studies (Aspinall, Mavros, Coyne, & Roe, 2015; Bratman, Hamilton, Hahn, Daily, & Gross, 2015; He, Chen, & Yu, 2016) have begun to utilise neurophysiological measures to explore the effect of green exercise on psychological wellbeing objectively. For example, portable devices (such as Emotive EPOC; Emotiv Ltd, Hong Kong) could be used to examine the impact of expectancy modification on brain activity during green exercise. This technique may also help identify if a pre-conditioning of green exercise exists and is represented as a heightened anticipatory rise in engagement and/or excitement. Future studies should also consider blinding experimenters where possible and consider the impact of environmental characteristics such as temperature and humidity during outdoor experimental sessions.

In conclusion, this was the first study to assess the potential role of expectancy effects on the psychological benefits of acute green exercise. The results indicated that an expectancy manipulation can amplify the acute psychological benefits of green exercise. Using simple video editing tools, and a previously designed environmental comparison Rogerson et al. (2016), we improved the psychological outcomes of moderate-intensity cycling in a green setting. As affective responses to moderate-intensity exercise have been shown to predict future participation (Williams et al., 2008), this could be an effective way of improving physical activity levels for the betterment of health and wellbeing and therefore holds great promise for researchers, practitioners and policy makers.

## Declaration of interest

None.

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