



## The effect of “green exercise” on state anxiety and the role of exercise duration, intensity, and greenness: A quasi-experimental study

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### ABSTRACT

**Objective:** The study aimed to explore the short-term effects of “green exercise” on state anxiety and to examine the influence of exercise type, intensity, duration, and degree of greenness.

**Method:** A quasi-experimental design involved eight pre-existing outdoor exercise groups ( $N = 101$ ) who completed pre- and post-exercise questionnaires.

**Results:** Results indicated a significant reduction in participants' state anxiety following green exercise experiences ( $d = -0.47$ ). However, there was a significant interaction between anxiety changes and the type of green exercise, with effect sizes for the groups ranging between 0.14 and 1.02. The largest anxiety reductions were reported by the Road Cycling, Boxercise, and Mountain Biking groups. Exercise intensity and duration did not impact on state-anxiety changes, however higher degrees of perceived environmental greenness were associated with larger reductions in anxiety.

**Conclusions:** Green exercise effected moderate short-term reductions in anxiety, with greater reductions evident for some exercise groups and for participants who perceived themselves to be exercising in more natural environments. These findings support claims for mental health benefits of green exercise but they also highlight the need to better understand individual and group differences and the role of perceived environmental “greenness”.

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### Introduction

There is good evidence that regular physical activity contributes to physical and psychological health (e.g., Biddle, Fox, & Boutcher, 2001; Netz, Wu, Becker, & Tenebaum, 2005; Penedo & Dahn, 2005; Salmon, 2001; Scully, Kremer, Meade, Graham, & Dudgeon, 1998; Warburton, Nicol, & Bredin, 2006). There also exists a notable body of research about physical and psychological benefits from exposure to natural environments (e.g., Frumkin, 2001; Kaplan, 2001a; Maller et al., 2008; Pretty, Griffin, Sellens, & Pretty, 2003; Ulrich, 1979, 1984; Ulrich et al., 1991; Vemuri & Constanza, 2006). Combining physical exercise and natural environments, then, would seem to offer the prospect of potentially greater benefits than either undertaken in isolation. Hence, the notion of “green exercise” has developed (Larkin, 2000; Mind, 2007; Pretty et al., 2003; Pretty, Peacock, Sellens, & Griffen, 2005). Green exercise, in its simplest form, is exercise performed in (relatively) natural environments such as parks. Much remains unknown, however, about physiological and psychological processes involved in green exercise, and

particularly about possible causal elements (such as exercise duration, intensity, and naturalness of the environment) involved in facilitating desirable psychological outcomes.

#### *Psychological effects of exercise*

The psychological benefits of exercise are less well understood than the physical benefits, although evidence has been progressively accumulating (e.g., Emery, Shermer, Hauck, Hsiao, & MacIntyre, 2003; Hartig, Mang, & Evans, 1991; Hug, Hartig, Hansmann, Seeland, & Hornung, 2009; International Society of Sport Psychology, 1992; Maller et al., 2008; Netz et al., 2005; Scully et al., 1998; Seraganian, 1993) and include improvements in cognitive functioning (Cassilhas et al., 2007; Tomporowski & Ellis, 1986), mental health (Landers, 1997; Richardson et al., 2005), and psychological well-being (Hansen, Stevens, & Coast, 2001; Scully et al., 1998). Amongst the most researched psychological outcomes of physical exercise is its effect on anxiety.

#### *Effects of aerobic exercise on anxiety*

There appears to be small to moderate anxiety-reducing effects of aerobic physical exercise, based on studies which have measured state, trait, and psychophysiological changes (Landers, 1997;

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Seraganian, 1993). Tuson and Sinyor (1993) noted that anxiety reduction was the only reliable effect of aerobic exercise when examining various affective states. Six meta-analyses have found that acute and chronic physical exercise significantly reduces anxiety levels (Calfas & Taylor, 1994; Kugler, Seelback, & Krüskemper, 1994; Landers & Petruzzello, 1994; Long & van Stavel, 1995; McDonald & Hodgdon, 1991; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991). The largest of these meta-analyses (based on 104 studies) found an overall standardised mean effect size of 0.24 for state-anxiety reduction effects of physical exercise (Petruzzello et al., 1991). More recently, Wipfli, Rethorst, and Landers (2008) meta-analysis focused on 49 studies of the effects of aerobic exercise on anxiety which used randomised-controlled trials. Results indicated moderate reductions in anxiety amongst aerobic exercise groups ( $g = -0.48$ ) compared to other forms of anxiety treatment (e.g. group therapy, relaxation, pharmacotherapy) ( $g = -0.19$ ), providing strong evidence for the anxiolytic effects of aerobic exercise.

Although numerous exercise and participant variables need to be considered, research evidence tends to support the notion that acute bouts of aerobic exercise are effective in reducing state-anxiety levels (Althiler & Motta, 1994; Landers, 1997; Millet, Gros Lambert, Barbier, Rouillon, & Candau, 2005). However, studies focusing on moderating variables are less common (e.g. exercise intensity, duration, frequency). The largest meta-analysis of physical exercise effects on anxiety identified only one significant moderating variable: exercise duration (Petruzzello et al., 1991).

#### *Exercise duration*

The duration of acute exercise required to achieve positive psychological effects remains unclear. Exercise bouts of 15–30 min, three times per week (expending approximately 4000–10,000 kJ/week) (Selig, 2003) have been recommended for physical and psychological benefits (Berger, 1994; Haskell et al., 2007; Leith, 1998). However, some research has found improved levels of vigour and reduced levels of fatigue and total negative mood to occur after as little as 10 min of exercise (Hansen et al., 2001; Haskell et al., 2007). Despite this, longer and more regular periods of 20 min or more appear to have the greatest psychological benefit (Hansen et al., 2001; Pate et al., 1995).

#### *Exercise intensity*

Despite a multitude of research studies investigating the relationship between exercise intensity level and psychological benefits (e.g., Daley & Huffen, 2003; Dunn & McAuley, 2000), there is no definitive answer about optimal intensity. The most reliable benefits appear to be associated with moderate intensity exercise (Berger & Motl, 2001). However, some research has shown exercise intensity not to be a significant factor in attaining psychological benefits (King, Taylor, & Haskell, 1993), including self-reported state anxiety (Petruzzello et al., 1991). Other research has suggested that a low-intensity exercise program of 60 min duration provided significant positive improvements in self-reported health and self-efficacy for exercise (Temple et al., 2008). Most research, however, recommend moderate to high exercise intensity (Carr, 2001). In older adults, moderate intensity exercise appears to benefit psychological well-being to the greatest extent, with low intensity benefiting the least (Netz et al., 2005).

#### *Green exercise*

An additional potential moderating factor in physical exercise's psychological effects is the surrounding environment. There is recent, growing interest in the potential benefits of exercising in relatively natural environments – or “green exercise”. Green exercise refers to physical activities undertaken whilst exposed to natural

environments (Pretty et al., 2005). Green exercise, however, might be better conceptualised as exercise performed in environments with a greater ratio of natural to artificial elements than is typically encountered by someone in everyday life. Sugiyama, Leslie, Giles-Corti, and Owen (2008) define “green” environments as vegetated areas such as parks, open spaces, and playgrounds. Further conceptualisation and measurement of “greenness”, particularly as a psychological construct, however, remains underexplored (Bodin & Hartig, 2003).

#### *Nature, mental health, and restoration*

Natural environments are often hypothesised to be restorative (Hartig, 2004) which refers to the “process of renewing, recovering, or reestablishing physical, psychological, and social resources or capabilities diminished in ongoing efforts to meet adaptive needs” (Hartig, p. 273). Two major theories have been proposed to explain restorative environments (Hartig): psychophysiological stress recovery theory (Ulrich et al., 1991) and attention restoration theory (Kaplan, 2001b; Kaplan & Kaplan, 1989).

Psychophysiological stress recovery theory focuses on patterns of affective and aesthetic response to visual stimulus characteristics of an environment (Ulrich et al., 1991). It proposes that restoration can occur when a scene elicits feelings of mild to moderate interest, pleasantness, and calm, and that whilst viewing nature, positive affect replaces negative affect resulting in lower physiological arousal (Hartig, 2004).

Attention restoration theory refers to how our direct attention mechanism, which is largely under voluntary and effortful control, becomes fatigued (Kaplan, 2001b). Restorative environments, such as natural environments, are proposed to facilitate recovery from directed attention fatigue.

#### *Engagement with nature*

Pretty (2004) proposed three levels of engagement with nature: viewing nature, being in the presence of nature, and active participation and involvement with nature, each of which may play a role in understanding the psychological effects of green exercise.

#### *Viewing nature*

Ulrich's (1984) seminal study found health benefits for being in a hospital room with a view of nature compared to not having a view of nature in terms of recovery time. Kaplan's (2001a) research further identified psychological benefits of natural home environments for residents of low-rise apartments. Numerous other studies have followed, particularly on the mood benefits of nature scenes (e.g., Kweon, Ulrich, Walker, & Tassinary, 2008).

#### *Presence of nature*

As urbanisation increases, people find themselves concentrated in neighbourhoods of impoverished biodiversity, bringing with it the possible loss of the opportunity to appreciate and benefit from nature (Louv, 2008; Turner, Nakamura, & Dinetti, 2004). Exposure to green space has numerous psychological and physical health benefits (Groeneweg, van den Berg, de Vries, & Verheij, 2006). Sugiyama et al. (2008) found that perceived greenness of the local neighbourhood had a strong positive relation with perceived mental health. The presence of greenness in the immediate surroundings was also positively associated with recreational walking, social cohesion, and local social interaction. Exposure to nature while engaging in some form of activity generally reduces stress and increases health benefits (Pretty, 2004). Whilst residential access to natural environments appears to be associated with better quality of life (Henderson-Wilson, 2005) and health (Mitchell & Popham, 2007), the relationship

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