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

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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 of this study 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

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.)

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 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.

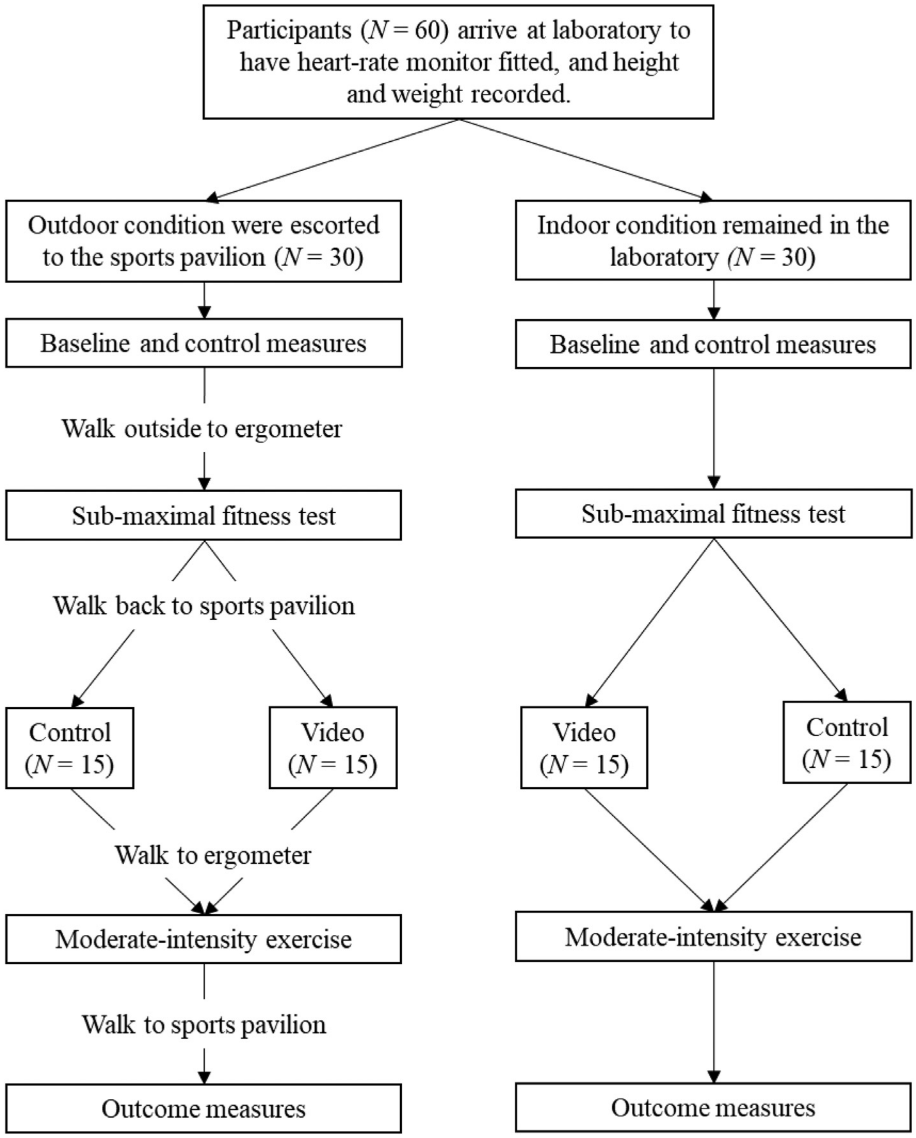

Fig. 2. An illustration of the experimental procedure.

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_2max, 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

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)
Outdoor 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)
Outdoor 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	9.60 (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.

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 dependent 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 ($F_{1,56} = 0.61$, $p = .81$, $\eta_p^2 = 0.00$). During participation, mean outdoor temperature was greater for those in the outdoor condition (10 °C), compared to those in the indoor condition (7 °C), however the indoor condition remained in the laboratory throughout.

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 positive expectancy effect. The results indicated a positive 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 indicated 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 well-being. 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 positive 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

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

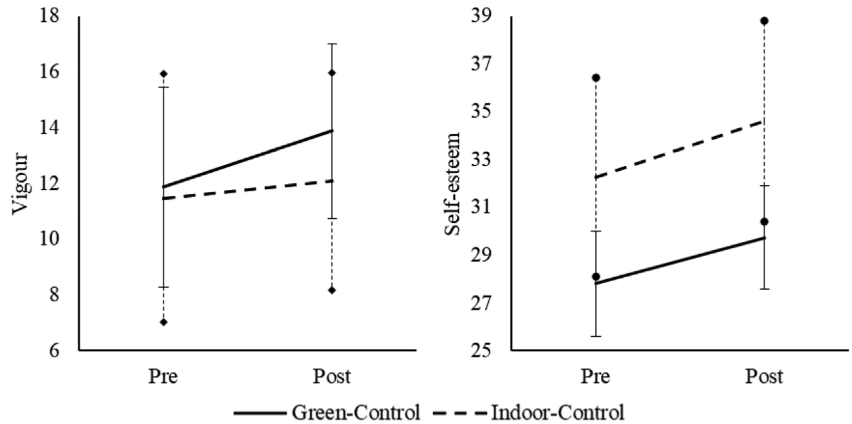

Fig. 3. Treatment x time interaction for vigour and self-esteem (*M* and *SD*) between green and indoor control groups ($N = 30$). Due to the Bonferroni-Holm's correction, there was a marginally significant interaction effect of treatment x time on vigour but not for self-esteem.

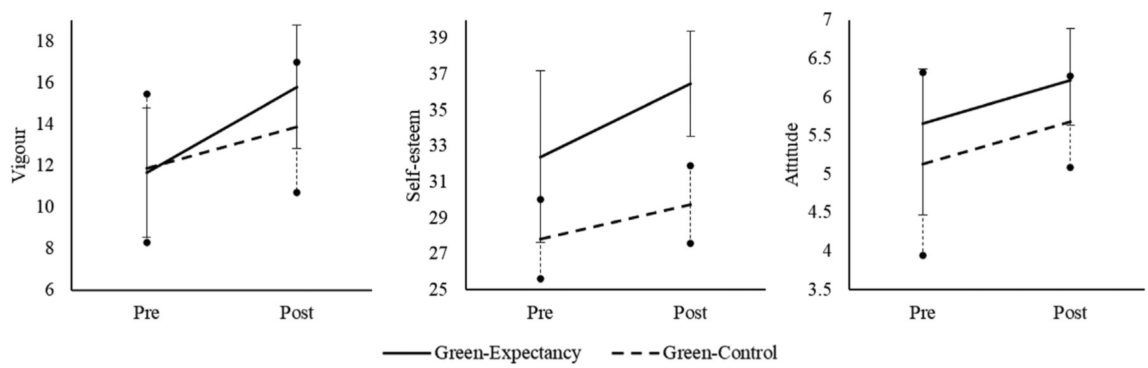

Fig. 4. Condition x time interaction for vigour, self-esteem and attitudes (*M* and *SD*) amongst green exercisers ($N = 30$). There was a significant interaction effect of condition x time on vigour and self-esteem, but not for attitudes.

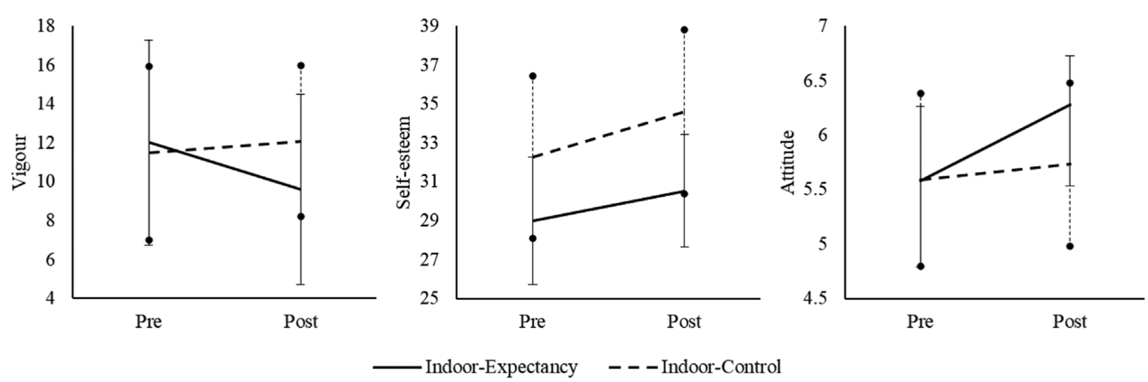

Fig. 5. Condition x time interaction for vigour, self-esteem and attitudes (*M* and *SD*) amongst indoor exercisers ($N = 30$). There was a significant interaction effect of condition x time on vigour but not for self-esteem, nor attitudes.

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 emphasise 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 as a proxy for expectation, and green exercise levels.. 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), the psychological outcomes of moderate-intensity cycling in a green setting were improved. 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.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.

Akers, A., Barton, J., Cossey, R., Gainsford, P., Griffin, M., & Micklewright, D. (2012). Visual color perception in green exercise: Positive effects on mood and perceived exertion. *Environmental Science & Technology, 46*(16), 8661–8666. https://doi.org/10.1021/es301685g.

Amanzio, M., & Benedetti, F. (1999). Neuropharmacological dissection of placebo analgesia: Expectation-activated opioid systems versus conditioning-activated specific subsystems. *Journal of Neuroscience, 19*(1), 484–494.

Anderson, R. J., & Brice, S. (2011). The mood-enhancing benefits of exercise: Memory biases augment the effect. *Psychology of Sport and Exercise, 12*(2), 79–82. https://doi.org/10.1016/j.psychsport.2010.08.003.

Arent, S. M., Landers, D. M., & Etnier, J. L. (2000). The effects of exercise on mood in older adults: A meta-analytic review. *Journal of Aging and Physical Activity, 8*(4), 407–430.

Aspinall, P., Mavros, P., Coyne, R., & Roe, J. (2015). The urban brain: Analysing outdoor physical activity with mobile EEG. *British Journal of Sports Medicine, 49*(4), 272–276. https://doi.org/10.1136/bjsports-2012-091877.

Barton, J., Bragg, R., Wood, C., & Pretty, J. (2016). *Green exercise: Linking nature, health and well-being.* Taylor & Francis.

Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise lor improving mental health? A multi-study analysis. *Envonmental Science & Technology, 44*, 3947–3955.

Benedetti, F. (2014). *Placebo effects.* Oxford University Press.

Benedetti, F., Durando, J., Giudetti, L., Pampallona, A., & Vighetti, S. (2015). High-altitude headache: The effects of real vs sham oxygen administration. *Pain, 156*(11), 2326–2336. https://doi.org/10.1097/j.pain.0000000000000288.

Bérdi, M., Köteles, F., Szabó, A., & Bárdos, G. (2011). Placebo effects in sport and exercise: A meta-analysis. *European Journal of Mental Health, 6*(2), 196–212. https://doi.org/10.5708/ejmh.6.2011.2.5.

Berger, B. G., & Motl, R. W. (2000). Exercise and mood: A selective review and synthesis of research employing the profile of mood states. *Journal of Applied Sport Psychology, 12*(1), 69–92.

Berger, B. G., Owen, D. R., Motl, R. W., & Parks, L. (1998). Relationship between expectancy of psychological benefits and mood alteration in joggers. *International Journal of Sport Psychology, 29*, 1–16.

Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Medicine & Science in Sports & Exercise, 14*(5), 377–381.

Bratman, G. N., Hamilton, J. P., Hahn, K. S., Daily, G. C., & Gross, J. J. (2015). Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proceedings of the National Academy of Sciences of the U S A, 112*(28), 8567–8572. https://doi.org/10.1073/pnas.1510459112.

Calogiuri, G., & Elliott, L. R. (2017). Why do people exercise in natural environments? Norwegian adults' motives for nature-, gym-, and sports-based exercise. *International Journal of Environmental Research and Public Health, 14*(4), https://doi.org/10.3390/ijerph14040377.

Chatzisarantis, N. L., Hagger, M. S., Biddle, S. J., & Smith, B. (2005). The stability of the attitude-intention relationship in the context of physical activity. *Journal of Sports Sciences, 23*(1), 49–61. https://doi.org/10.1080/02640410410001730070.

Chen, M. J., Fan, X., & Moe, S. T. (2002). Criterion-related validity of the borg ratings of perceived exertion scale in healthy individuals: A meta-analysis. *Journal of Sports Sciences, 20*(11), 873–899. https://doi.org/10.1080/026404102320761787.

Crum, A. J., & Langer, E. J. (2007). Mind-set matters: Exercise and the placebo effect. *Psychological Science, 18*(2), 165–171. https://doi.org/10.1111/j.1467-9280.2007.01867.x.

Curry, N. R., Crone, D., James, D., & Gidlow, C. (2011). Factors influencing participation in outdoor physical activity promotion schemes: The case of south staffordshire, england. *Leisure Studies, 31*(4), 447–463. https://doi.org/10.1080/02614367.2011.600322.

Desharnais, R., Jobin, J., Cote, C., Levesque, L., & Godin, G. (1993). Aerobic exercise and the placebo effect: A controlled study. *Psychosomatic Medicine, 55*(2), 149–154.

Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011). The pleasure and displeasure people feel when they exercise at different intensities: Decennial update and progress towards a tripartite rationale for exercise intensity prescription. *Sports Medicine, 41*(8), 641–671. https://doi.org/10.2165/11590680-000000000-00000.

Ensari, I., Greenlee, T. A., Motl, R. W., & Petruzzello, S. J. (2015). Meta-analysis of acute exercise effects on state anxiety: An update of randomized controlled trials over the past 25 years. *Depression and Anxiety, 32*(8), 624–634. https://doi.org/10.1002/da.22370.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. https://doi.org/10.3758/bf03193146.

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*, 420. https://doi.org/10.1186/s12889-016-3050-9.

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), https://doi.org/10.3390/ijerph14101172.

Focht, B. C. (2009). Brief walks in outdoor and laboratory environments: Effects on affective responses, enjoyment, and intentions to walk for exercise. *Research Quarterly for Exercise & Sport, 80*(3), 611–620. https://doi.org/10.1080/02701367.2009.10599600.

Fox, K. R. (2000). The effects of exercise on self-perceptions and self-esteem. *Physical Activity and Psychological Well-being, 13*, 81–118.
Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I.-M., ... Swain, D. P. (2011). Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine & Science in Sports & Exercise, 43*(7), 1334–1359.
Gladwell, V. F., Brown, D. K., Wood, C., Sandercock, G. R., & Barton, J. L. (2013). The great outdoors: How a green exercise environment can benefit all. *Extreme Physiology & Medicine, 2*(1), 3. https://doi.org/10.1186/2046-7648-2-3.
Golding, L. A., Myers, C. R., & Sinning, W. E. (1989). *Y's way to physical fitness: The complete guide to fitness testing and instruction.* YMCA of the USA.
Groshong, L., Stanis, S. A., Kaczynski, A. T., Hipp, J. A., & Besenyi, G. M. (2017). Exploring attitudes, perceived norms, and personal agency: Insights into theory-based messages to encourage park-based physical activity in low-income urban neighborhoods. *Journal of Physical Activity and Health, 14*(2), 108–116. https://doi.org/10.1123/jpah.2016-0069.
He, Y., Chen, Z., & Yu, Y. (2016). Visual Experience in natural environment promotes better brain functions than built environment? *Paper presented at the advances in cognitive neurodynamics (V): Proceedings of the fifth international conference on cognitive neurodynamics - 2015*.
Helfer, S. G., Elhai, J. D., & Geers, A. L. (2014). Affect and exercise positive affective expectations can increase post-exercise mood and exercise intentions. *Annals of Behavioral Medicine, 49*(2).
Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics, 6*(2), 65–70.
Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective.* Cambridge University Press.
Kwan, B. M., & Bryan, A. D. (2010). Affective response to exercise as a component of exercise motivation: Attitudes, norms, self-efficacy, and temporal stability of intentions. *Psychology of Sport and Exercise, 11*(1), 71–79.
Kwan, B. M., Stevens, C. J., & Bryan, A. D. (2017). What to expect when you're exercising: An experimental test of the anticipated affect-exercise relationship. *Health Psychology, 36*(4), 309–319. https://doi.org/10.1037/hea0000453.
Lacharite-Lemieux, M., Brunelle, J. P., & Dionne, I. J. (2015). Adherence to exercise and affective responses: Comparison between outdoor and indoor training. *Menopause, 22*(7), 731–740. https://doi.org/10.1097/GME.0000000000000366.
Lindheimer, J. B., O'Connor, P. J., & Dishman, R. K. (2015). Quantifying the placebo effect in psychological outcomes of exercise training: A meta-analysis of randomized trials. *Sports Medicine, 45*(5), 693–711. https://doi.org/10.1007/s40279-015-0303-1.
Lindheimer, J. B., O'Connor, P. J., McCully, K. K., & Dishman, R. K. (2017). The effect of light-intensity cycling on mood and working memory in response to a randomized, placebo-controlled design. *Psychosomatic Medicine, 79*(2), 243–253. https://doi.org/10.1097/PSY.0000000000000381.
Loureiro, A., Veloso, S., Rebola, F., Olivos, P., Lima, M. L., Aragonés, J. I., et al. (2014). *Outdoor exercise and connectedness with nature: Relation to wellbeing*.
Mackay, G. J., & Neill, J. T. (2010). The effect of "green exercise" on state anxiety and the role of exercise duration, intensity, and greenness: A quasi-experimental study. *Psychology of Sport and Exercise, 11*(3), 238–245. https://doi.org/10.1016/j.psychsport.2010.01.002.
McDonald, D. G., & Hodgdon, J. A. (2012). *The psychological effects of aerobic fitness training: Research and theory.* New York: Springer.
McNair, D. M. (1971). *Manual profile of mood states: Educational & Industrial testing service*.
McNair, D. M., Lorr, M., & Droppleman, L. F. (1992). *Profile of mood states: Educational and industrial testing service San Diego, CA*.
Mothes, H., Leukel, C., Jo, H. G., Seelig, H., Schmidt, S., & Fuchs, R. (2017). Expectations affect psychological and neurophysiological benefits even after a single bout of exercise. *Journal of Behavioral Medicine, 40*(2), 293–306. https://doi.org/10.1007/s10865-016-9781-3.
Ojanen, M. (1994). Can the true effects of exercise on psychological variables be separated from placebo effects? *International Journal of Sport Psychology, 25*(1), 63–80.
Orne, M. T. (1962). On the social psychology of the psychological experiment: With particular reference to demand characteristics and their implications. *American Psychologist, 17*(11), 776.
Petruzzello, S. J., Landers, D. M., Hatfield, B. D., Kubitz, K. A., & Salazar, W. (1991). A meta-analysis on the anxiety-reducing effects of acute and chronic exercise. Outcomes and mechanisms. *Sports Medicine, 11*(3), 143–182.
Petruzzello, S. J., Snook, E. M., Gliottoni, R. C., & Motl, R. W. (2009). Anxiety and mood changes associated with acute cycling in persons with multiple sclerosis. *Anxiety, Stress & Coping, 22*(3), 297–307. https://doi.org/10.1080/10615800802441245.
Pretty, J., Peacock, J., Sellens, M., & Griffin, M. (2005). The mental and physical health outcomes of green exercise. *International Journal of Environmental Health Research, 15*(5), 319–337. https://doi.org/10.1080/09603120500155963.
Pretty, J., Rogerson, M., & Barton, J. (2017). Green mind theory: How brain-body-behaviour links into natural and social environments for healthy habits. *International Journal of Environmental Research and Public Health, 14*(7), https://doi.org/10.3390/ijerph14070706.
Przybylski, A. K., Murayama, K., DeHaan, C. R., & Gladwell, V. (2013). Motivational, emotional, and behavioral correlates of fear of missing out. *Computers in Human Behavior, 29*(4), 1841–1848. https://doi.org/10.1016/j.chb.2013.02.014.
Reed, J. (2014). Effect of placebo-induced changes in expectancies on self-reported affect associated with yoga practice. *Journal of Sport Behaviour, 37*(3), 268–285.
Reed, J., & Ones, D. S. (2006). The effect of acute aerobic exercise on positive activated affect: A meta-analysis. *Psychology of Sport and Exercise, 7*(5), 477–514. https://doi.org/10.1016/j.psychsport.2005.11.003.
Rhodes, R. E. (2009). *A review and meta-analysis of affective judgments and physical activity in adult populations.* https://doi.org/10.1007/s12160-009-9147-y.
Rogerson, M., Brown, D. K., Sandercock, G., Wooller, J. J., & Barton, J. (2016a). A comparison of four typical green exercise environments and prediction of psychological health outcomes. *Perspect Public Health, 136*(3), 171–180. https://doi.org/10.1177/1757913915589845.
Rogerson, M., Gladwell, V. F., Gallagher, D. J., & Barton, J. L. (2016b). Influences of green outdoors versus indoors environmental settings on psychological and social outcomes of controlled exercise. *International Journal of Environmental Research and Public Health, 13*(4), 363. https://doi.org/10.3390/ijerph13040363.
Rosenberg, M. (1965). Rosenberg self-esteem scale (RSE). *Acceptance and commitment therapy. Measures Package, 61*, 52.
Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., et al. (2016). Health benefits from nature experiences depend on dose. *Scientific Reports, 6*, 28551. https://doi.org/10.1038/srep28551.
Song, C., Ikei, H., Igarashi, M., Takagaki, M., & Miyazaki, Y. (2015). Physiological and psychological effects of a walk in urban parks in fall. *International Journal of Environmental Research and Public Health, 12*(11), 14216–14228. https://doi.org/10.3390/ijerph121114216.
Spence, J. C., McGannon, K. R., & Poon, P. (2005). The effect of exercise on global self-esteem: A quantitative review. *Journal of Sport & Exercise Psychology, 27*(3), 311–334.
Stanforth, D., Steinhardt, M., Mackert, M., Stanforth, P. R., & Gloria, C. T. (2011). An investigation of exercise and the placebo effect. *American Journal of Health Behavior, 35*(3), 257–268.
Steptoe, A., & Cox, S. (1988). Acute effects of aerobic exercise on mood. *Health Psychology, 7*(4), 329–340.
Stonerock, G. L., Hoffman, B. M., Smith, P. J., & Blumenthal, J. A. (2015). Exercise as treatment for anxiety: Systematic review and analysis. *Annals of Behavioral Medicine, 49*(4), 542–556.
Szabo, A. (2013). Acute psychological benefits of exercise: Reconsideration of the placebo effect. *Journal of Mental Health, 22*(5), 449–455. https://doi.org/10.3109/09638237.2012.734657.
Szabo, A., & Abraham, J. (2013). The psychological benefits of recreational running: A field study. *Psychology Health & Medicine, 18*(3), 251–261. https://doi.org/10.1080/13548506.2012.701755.
Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., & Depledge, M. H. (2011). Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science & Technology, 45*(5), 1761–1772. https://doi.org/10.1021/es102947t.
Williams, D. M., Dunsiger, S., Ciccolo, J. T., Lewis, B. A., Albrecht, A. E., & Marcus, B. H. (2008). Acute affective response to a moderate-intensity exercise stimulus predicts physical activity participation 6 and 12 Months later. *Psychology of Sport and Exercise, 9*(3), 231–245. https://doi.org/10.1016/j.psychsport.2007.04.002.
Wilson, E. O. (1984). *Biophilia.* Harvard University Press.
Yeh, H. P., Stone, J. A., Churchill, S. M., Brymer, E., & Davids, K. (2017). Physical and emotional benefits of different exercise environments designed for treadmill running. *International Journal of Environmental Research and Public Health, 14*(7), https://doi.org/10.3390/ijerph14070752.
Yeung, R. R. (1996). The acute effects of exercise on mood state. *Journal of Psychosomatic Research, 40*(2), 123–141.
Zwolinsky, S., McKenna, J., Pringle, A., Widdop, P., & Griffiths, C. (2015). Physical activity assessment for public health: Efficacious use of the single-item measure. *Public Health, 129*(12), 1630–1636.