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A randomised control trial of physical activity in a perceived environment on self-esteem and mood in UK adolescents

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This study assessed whether exercising whilst viewing natural or built scenes affected self-esteem (SE) and mood in adolescents. Twenty-five adolescents participated in three exercise tests on consecutive days. A graded exercise test established the work rate equivalent to 50% heart rate reserve for use in subsequent constant load tests (CLTs). Participants undertook two 15-min CLTs in random order viewing scenes of either natural or built environments. Participants completed Rosenberg's SE scale and the adolescent profile of mood states questionnaire pre- and post-exercise. There was a significant main effect for SE ($F(1) = 6.10$; $P < 0.05$) and mood ($F(6) = 5.29$; $P < 0.001$) due to exercise, but no effect of viewing different environmental scenes ($P > 0.05$). Short bouts of moderate physical activity can have a positive impact on SE and mood in adolescents. Future research should incorporate field studies to examine the psychological effects of contact with real environments.

Keywords: self-esteem; mood; physical activity; natural environment; adolescents

1. Introduction

The health benefits of engaging in physical activity (PA) during adolescence include reduced risks of developing: high blood cholesterol, hypertension or suffering from low bone mineral density (Biddle et al. 2004; Hallal et al. 2006; Janssen and Leblanc 2010; Janz et al. 2010). Physical activity has been shown to have a positive impact on psychological well-being (PWB) (Ortega et al. 2008; Kristjansson et al. 2010) and can improve both self-esteem (SE) and mood (Calfas and Taylor 1994; Ekeland et al. 2005), two commonly used indicators of PWB. However, the duration and intensity of exercise required for optimal gains in SE and mood is not clear (Parfitt and Eston 2005). Less healthy individuals have an increased frequency of illness and psychological symptoms (Paluska and Schwenk 2000), highlighting the importance of PA in the prevention of poor physical and mental health.

Despite the importance of PA for health, only 57–71% of UK adolescents (11–15 years) achieve the recommended 60 min of daily PA (NHS Information Centre 2011). Physical activity often declines during adolescence, particularly in girls (NHS Information Centre 2011), so finding the best approach to increase PA levels is paramount. Natural environments can facilitate activity in youth (Taylor et al. 1998) as individuals with access to nature are three times as likely to be active (Wells et al.

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2007). However, parental fear of crime, abduction and increased traffic has resulted in reduced opportunities for outdoor PA (Davis 1999; Orr 2000; Biddle et al. 2004). Less than 10% of youth utilise natural environments, compared with 40% of adults, who did so as children (Natural England 2009). Young people are regularly confined to activities that take place in indoor spaces (Fjortoft 2001; Pretty et al. 2009), thus contributing to the low levels of PA.

Natural environments are also important for PWB (Kaplan and Kaplan 1989; Kaplan 2001; Kahn and Kellert 2002; Maller et al. 2006). Simply living in a more natural environment and having green views from the home can have a positive effect on cognitive function (Wells 2000; Wells and Evans 2003). Access to natural environments can be protective against stressful life events and reduce associated psychological distress (Wells and Evans 2003), whilst also influencing educational and social development (Natural England 2009). The well-being of youth is closely linked to their ability to access natural environments (Thomas and Thompson 2004; Maller et al. 2006).

In adults, there is an additive health benefit of performing PA in natural environments, so-called "green exercise" (Pretty et al. 2005). Exercising whilst viewing scenes of natural environments improves SE and mood more, than equivalent exercise whilst viewing built environments lacking nature (Pretty et al. 2005). Engaging in physical activities within real natural environments also significantly improves SE and mood in adults (Morita et al. 2007; Pretty et al. 2007; Barton et al. 2009, 2011). However, whilst young adults often show the largest gains in SE due to green exercise (Barton and Pretty 2010), there is a paucity of evidence for such effects in adolescents. The aim of this study was to analyse the effects of exercising whilst viewing natural and built environments on adolescent SE and mood.

2. Method

2.1. Participants

Twenty-five healthy adolescents were recruited from a suburban local secondary school to participate in the study. Students were selected by the school to attend an annual University science week in July 2009, but inclusion in the research study was voluntary. All students who were invited to participate completed the study and were deemed fit and healthy by school, parental and individual consent. Eleven males and 14 females volunteered to take part, aged (mean $\pm$ SD) 13.1 $\pm$ 0.3 years. A written informed consent was obtained from both the participant and a parent/guardian prior to testing. Institutional ethical approval for the study was granted.

2.2. Experimental procedures

Participants performed three exercise tests on consecutive days. On day 1, a graded exercise test (GXT) was undertaken and basic anthropometric data were collected, comprising the participant's stature to the nearest 0.1 cm, with the participant barefoot (Seca 220 stadiometer) and mass, to the nearest 0.1 kg (Seca 770 digital scale). Body mass index (BMI) and BMI *z*-scores relative to the individual's age and sex were also calculated (Cole et al. 1995). On days 2 and 3, participants completed two constant load tests (CLTs) whilst viewing a series of scenes consisting of either natural or built environments. Participants completed both conditions and the order

of the scenes was randomised and counterbalanced to eliminate any order effects. The randomisation of scenes was performed by the authors on arrival of the participant to the laboratory. The participant selected a piece of paper from a bag, numbered with either 1 or 2. Participants who selected number 1 were allocated to the natural environment condition first, whilst participants who selected number 2 were allocated to the built environment condition first. The authors did not allow their knowledge of which pictures were being viewed to affect the experimental procedures. Psychological assessment took place immediately prior to and following the completion of the CLTs. As soon as each participant had finished cycling, they were requested to sit down and complete the questionnaires.

2.3. *Exercise tests*

Participants completed a GXT on a cycle ergometer (Monark 814 or 824; Monark Exercise AB, Varberg, Sweden) until volitional fatigue. Cycling speed was set at 60 rpm, initial resistance was 0.5 W/kg body weight and increased by 0.5 W/kg body weight at 2 min increments. Heart rate was recorded at 5 s intervals throughout the test (Polar S610i; Polar Electro Oy, Finland). Participants rested for 5 min prior to the GXT and the resting heart rate was also measured.

Days 2 and 3 required two CLTs to be completed on the same cycle ergometer, lasting 10 min each. The participants were instructed to cycle at a constant speed and the exercise intensity adjusted in order that participants were cycling at 50% heart rate reserve (HRR) (ACSM 2006), as determined by the GXT. Subjects viewed scenes of the natural or built environment on a projector screen positioned 4 m in front of the cycle ergometer, whilst performing the CLT. The scenes of the built environment comprised views of buildings containing no green spaces, whilst the scenes of the natural environment consisted of entirely green and natural areas. The series of pictures appeared sequentially and were viewed in a randomised order for 15 s intervals. Heart rate was measured during the test at 5 s intervals.

2.4. *Picture categorisation*

Independent assessment for the categorisation of pictures as either natural or built are detailed previously (Pretty et al. 2005). To be included, 95% of 50 panel members had to agree that the picture strongly represented the target description.

2.5. *Assessment of SE and mood*

Monitoring of SE and mood took place immediately pre- and post- each CLT using standardised questionnaires. Self-esteem was assessed using the Rosenberg Self–Esteem Scale (Rosenberg 1965) and mood was monitored using the Adolescent Profile of Mood States Questionnaire (POMS-A) (Terry et al. 1999).

2.6. *Statistical analysis*

Independent *t*-tests examined sex differences in participant anthropometric and exercise test parameters. Two paired *t*-tests examined differences in baseline SE and total mood disturbance (TMD) between the two environmental conditions. Two mixed factorial ANOVAs determined the effect of PA, environmental scenes and sex

on SE and TMD, respectively. One way within MANOVA examined the differences in the baseline sub-scale mood factors between the two environmental conditions. A mixed factorial MANOVA assessed the effects of PA whilst viewing different environmental scenes on sub-scale mood, by sex. Significance was accepted at an alpha level of 0.05. Bonferroni corrected alpha levels were used to indicate statistical differences between the six sub-scale components of mood ($\alpha = 0.0083$).

3. Results

All 25 participants completed the study. A total of 22 participants had complete data sets. Three participants had missing data due to absence or incomplete questionnaires. The missing data were labelled in SPSS, so that all data and participants could be included in the analysis.

There were no significant differences in anthropometric characteristics between males and females (Table 1). BMI *z*-scores indicate above average BMI for age and sex in boys and girls. Compared with girls, boys achieved significantly greater: absolute peak power ($t(23) = 3.30$; $P < 0.01$), relative peak power ($t(23) = 3.44$; $P < 0.01$) and higher peak heart rates ($t(23) = 2.34$; $P < 0.05$). The CLTs were, therefore, performed at the power outputs of 89.5 ± 21.4 W and 62.6 ± 11.9 W in boys and girls, respectively.

A paired *t*-test revealed no significant difference between the baseline SE scores between the two environmental viewing conditions ($P > 0.05$). Mixed ANOVA revealed a significant main effect on SE due to PA ($F(1) = 6.10$, $P < 0.05$) but not due to the environmental viewing condition (urban vs. rural) ($P > 0.05$) (Figure 1), indicating that PA alone improved SE. No sex differences in SE were identified ($P > 0.05$).

One way within MANOVA revealed no significant differences between the baseline sub-scale mood scores between the two conditions ($P > 0.05$). For mood, there was no significant effect of viewing different environmental conditions ($P > 0.05$), or a sex effect ($P > 0.05$) (Table 2). There was a significant main effect for mood changes due to participating in PA ($F(6) = 5.29$, $P < 0.001$). The mixed MANOVA revealed that PA resulted in a significant increase in fatigue ($F(1) = 8.11$, $P < 0.0083$) together with a concomitant decrease in tension ($F(1) = 11.56$,

Table 1. Mean ± SD participant demographics and fitness test results.

	Male	Female	All
Age (years)	13.2 ± 0.2	13.0 ± 0.3	13.1 ± 0.3
Stature (m)	1.58 ± 0.09	1.56 ± 0.06	1.57 ± 0.07
Mass (kg)	49.4 ± 10.5	47.3 ± 6.1	48.2 ± 8.2
BMI (kg m^{-2})	19.6 ± 2.5	19.3 ± 1.7	19.4 ± 2.0
BMI (*z*-score)	0.45 ± 0.96	0.14 ± 0.72	0.27 ± 0.83
Peak heart rate GXT (b min^{-1})	198.6 ± 6.3	188.5 ± 13.0*	193.0 ± 11.6
Peak power GXT (W)	192.6 ± 63.1	132.0 ± 24.5**	158.6 ± 54.1
Relative peak power GXT (W/kg body mass)	3.96 ± 1.11	2.82 ± 0.52**	3.32 ± 1.00

Notes: *$P < 0.05$ and **$P < 0.01$ indicates significant gender differences.

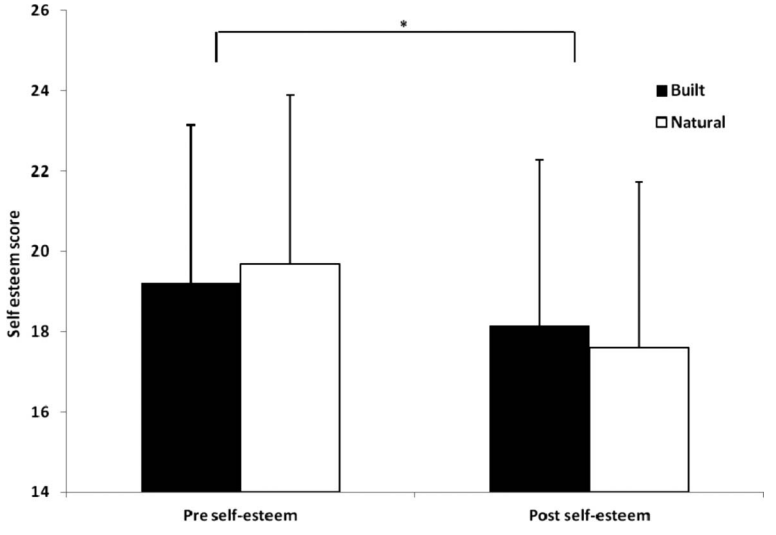

Figure 1. Self-esteem scores in adolescents' pre- and post-exercise, following viewing of natural or built scenes. The lower the score, the better the self-esteem (Asterisk indicates a significant difference between pre- and post-self-esteem, irrespective of viewing condition, $P < 0.05$).

Table 2. Mean ± SD sub-scale mood factors in males and females pre- and post-viewing environmental scenes.

	Urban		Rural	
	Pre	Post	Pre	Post
Tension				
Male	50.3 ± 11.5	46.2 ± 8.6	48.6 ± 8.6	45.8 ± 6.3
Female	50.3 ± 7.6	43.6 ± 2.9	50.6 ± 7.4	44.0 ± 4.1
All	50.3 ± 9.3	44.7 ± 6.1	49.7 ± 7.9	44.8 ± 5.2
Depression				
Male	46.3 ± 4.6	46.4 ± 5.3	45.8 ± 4.1	47.3 ± 5.7
Female	44.1 ± 0.3	44.5 ± 1.6	45.7 ± 4.2	44.9 ± 2.7
All	45.0 ± 3.2	45.3 ± 3.7	45.8 ± 4.0	45.9 ± 4.3
Anger				
Male	48.0 ± 7.4	49.5 ± 9.3	46.9 ± 8.4	50.2 ± 13.8
Female	45.7 ± 3.8	44.9 ± 2.3	46.3 ± 3.8	44.6 ± 1.5
All	46.7 ± 5.6	46.9 ± 6.7	46.6 ± 6.1	47.0 ± 9.4
Vigour				
Male	51.2 ± 5.8	49.4 ± 9.3	52.9 ± 8.0	50.0 ± 8.6
Female	49.6 ± 10.6	48.1 ± 9.7	53.9 ± 10.2	49.6 ± 10.2
All	50.3 ± 8.7	48.6 ± 9.3	53.4 ± 9.1	49.8 ± 9.4
Fatigue				
Male	45.2 ± 7.8	53.6 ± 10.2	45.8 ± 9.7	53.1 ± 9.8
Female	47.6 ± 10.8	51.9 ± 10.5	48.9 ± 10.6	52.0 ± 9.5
All	46.6 ± 9.5	52.6 ± 10.2	47.6 ± 10.1	52.4 ± 9.5
Confusion				
Male	47.9 ± 6.8	45.8 ± 6.3	46.7 ± 7.1	45.5 ± 4.4
Female	45.1 ± 4.0	44.7 ± 4.1	47.1 ± 4.4	44.9 ± 4.8
All	46.4 ± 5.5	45.2 ± 5.1	46.9 ± 5.6	45.2 ± 4.5

$P < 0.0083$) (Figure 2). All other sub-scale mood factors showed no significant difference between the pre- and post-exercise scores ($P > 0.0083$).

A paired *t*-test revealed that there were no differences in baseline TMD scores between the two environmental viewing conditions ($P > 0.05$). Mixed ANOVA revealed no significant main effect for TMD due to participation in PA ($P > 0.05$), viewing different environmental scenes ($P > 0.05$) or sex ($P > 0.05$).

4. Discussion

The findings of this study suggest that engaging in PA improves SE and mood in adolescents. Viewing different environmental scenes did not, however, affect SE or mood changes. Previous studies have shown that PA improves PWB (Calfas and Taylor 1994; Tremblay et al. 2000; Ekeland et al. 2005; Ortega et al. 2008; Kristjansson et al. 2010). In the present study, participation in PA enhanced SE and also improved mood, mostly via decreases in tension. Improvements in PWB may be linked to a concomitant improvement in cardio respiratory fitness achieved through increased levels of PA (Crews et al. 2004). If PA is of a sufficient intensity to incur a change in fitness, it can also influence factors such as SE and mood (Ortega et al. 2008). However, vigorous PA equivalent to or greater than 80% maximum heart rate or six metabolic equivalents is required to enhance fitness in adolescents (Ortega et al. 2008). The improvements in SE and tension found in this study occurred after a single bout of exercise at a relatively moderate intensity (50% HRR), equivalent to brisk walking (ACSM 2006). This intensity is some 10% lower

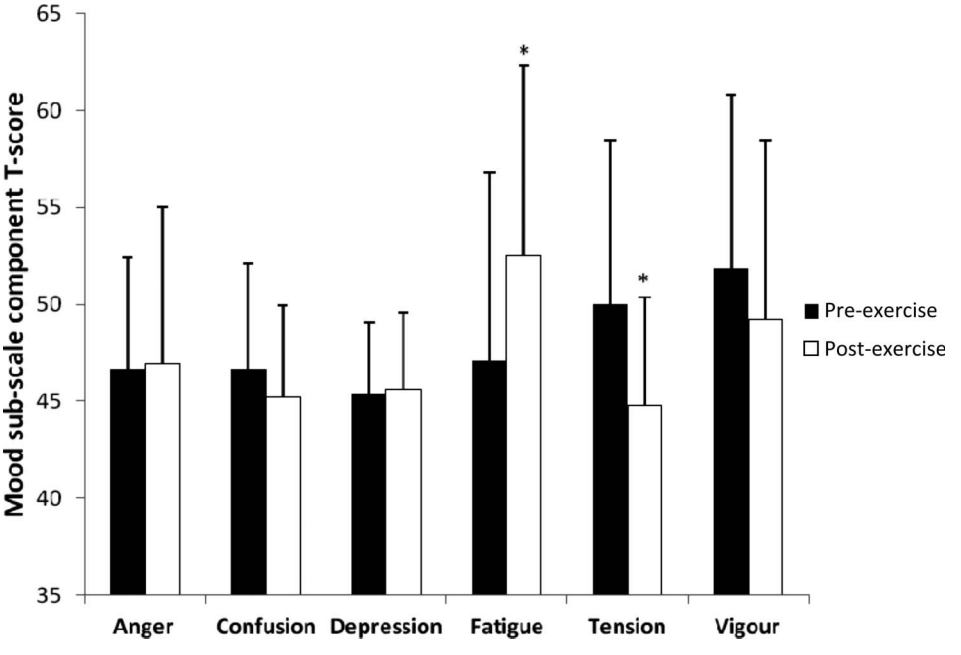

Figure 2. Change in the six sub-scale components of mood as a result of exercise participation (Asterisk indicates a significant difference between pre- and post-exercise condition, $P < 0.0083$).

than required to improve fitness in young people (Stratton 1996). Thus, an acute bout of moderate PA may improve PWB, even though it does not influence fitness. Observing such an effect may be an important finding as it is more accessible, achievable and can easily be built into every day routines (Fairclough et al. 2012).

Adult PA recommendations can be achieved by performing 10 min bouts of PA throughout the day (Department of Health 2009). To improve PWB in adolescents, short bouts of moderate PA should therefore be encouraged. The school day provides regular breaks suitable for short bouts of PA (Ridgers et al. 2006) and our findings that moderate intensity exercise of short duration improved PWB are encouraging. Compared with hour-long bouts or high-intensity workouts, such a low dose of exercise is likely to be more achievable to habitual non-exercisers (Fairclough et al. 2012).

Despite the low overall exercise dose, participants unexpectedly reported increased feelings of fatigue. This may be due to participants being unaccustomed to the exercise mode, but despite the perception of some fatigue exercise still reduced tension and improved SE.

In adults viewing scenes of natural environments has been shown to improve SE and mood to a greater extent than either PA alone or viewing scenes of the built environment (Pretty et al. 2005). The results of the current study suggest that there is no effect of the environment on SE or mood in adolescents, and therefore contradict the results of Pretty et al (2005). Whilst no mechanisms to explain the effect of green exercise on PWB have been identified, the psychological changes experienced through contact with nature are proposed to occur due to the stimulation of the endocrine stress system and associated reductions in blood pressure and cortisol concentrations and the enhanced activity of the parasympathetic nervous system (Park et al. 2010). However, in adolescents, it may be that these changes do not occur during exposure to nature or that they do not affect adolescents in the same way that they do adults. The next section will outline some tentative hypotheses to explain the lack of environmental effect in youth.

The current generation of youth spends less time interacting with natural environments than previous generations (Bird 2007). Parental fears over stranger-danger and increases in traffic mean that PA is restricted to indoor spaces (Biddle et al. 2004; Department for Children Schools and Families and Department for Culture Media and Sport 2008). Furthermore, the availability of green spaces continues to decline as natural areas are often built upon to provide housing and amenities (Maller et al. 2006; Maas et al. 2006). The lack of contact with the natural environment during youth may have resulted in a disconnection from and poor understanding of the natural world (Brid 2007). An individual's level of connection to the natural environment may be an important factor in determining the degree of health benefits received from having contact (Bratman et al. 2012), thus a lack of connection may result in a lack of benefits for PWB.

There were no sex differences in SE or mood. Whilst evidence regarding sex differences in PWB is sparse, research examining the relationship between PA and PWB is indicative of a greater PWB in males (Feingold 1994; Kling et al. 1999). Higher levels of PA are associated with increased levels of fitness (Ortega et al. 2008) and thus greater SE and mood (Calfas and Taylor 1994; Tremblay et al. 2000; Ekeland et al. 2005; Kristjansson et al. 2010). Males engage in more PA than females (Department of Health 2009) and performed better on the GXT in the current study, demonstrating higher cardio respiratory fitness. Physical activity and fitness are both correlated to PWB. As such, it might be expected that SE and mood would be higher

in males (Ortega et al. 2008); however, in our study, females benefited as much from the exercise irrespective of their inferior fitness.

There are a number of limitations that should be noted within this study. Firstly, the questionnaires are open to a "ceiling and floor effect." A participant may rate themselves as having the best possible level of SE pre-exercise. Therefore, any improvement in SE due to the intervention cannot be quantified since a maximum questionnaire score has already been achieved. The study also lacks ecological validity. The environmental scenes were artificial and viewed from within a laboratory to enable potential confounding variables such as the exercise intensity, temperature, terrain and social interactions to be controlled for. However, exposure to the real environment would provide a multi-sensory experience of nature. The variety of sights and sounds experienced within natural environments cannot be reflected by simply viewing scenes indoors. The small sample size could also be considered as a study limitation, particularly when analysing sub-groups of participants. A greater sample size would have allowed for greater statistical power when analysing for changes in SE and mood.

5. Conclusion

While there was no environmental effect for PWB, adolescents' SE and mood were significantly improved by a short bout of moderate-intensity PA. The ability to positively alter SE and mood after an acute bout of activity has important implications for adolescent health and behaviour, curriculum design and school activities. The findings also inform the methodology of future studies, as it may be possible to encourage people to take part in green exercise if they feel that the bout of PA is achievable. This approach might be effective at targeting and engaging sedentary adolescents, who would benefit the most from engaging in PA. Thus, strategies to improve PWB in adolescents should target PA levels and provide regular opportunities for short bouts of non-intensive PA.

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