Let's go outside! Environmental restoration amongst adolescents and the impact of friends and phones

Alison Greenwood

*Birgitta Gatersleben

*Corresponding author

b.gatersleben@surrey.ac.uk

School of Psychology

University of Surrey

Guildford

Surrey

GU2 7XH

Abstract

Adolescents are experiencing an increasing number of psychological difficulties due to mental fatigue and stress. Natural environments have been found to be beneficial to psychological wellbeing by reducing stress and improving mood and concentration for most people. However, a number of studies have suggested that this may not be the case for adolescents perhaps because they have different social and emotional needs (to be with friends, not to be bored), although evidence is lacking. In a field experiment with 120 16-18 year olds in the UK we tested restoration of stress and mental fatigue in an outdoor or indoor environment, alone, with a friend or while playing a game on a mobile phone. The findings showed greater restoration amongst adolescents who had been in an outdoor setting containing natural elements, compared with those who had been in an indoor one. Moreover, being with a friend considerably increased positive affect in nature for this age group. The findings indicated that spending short school breaks in a natural environment with a friend can have a significant positive impact on the psychological wellbeing of teenagers.

Keywords: adolescents, teenagers, nature, restoration, outdoors

1. Introduction

Adolescents in modern western societies are said to be experiencing an unprecedented number of psychological problems due to stress and mental fatigue. In the UK, for instance, the number of 15 and 16 year olds with depression doubled between the 1980s and 2010s (Nuffield Foundation, 2013). A 2004 survey demonstrated that 11.5% of 11-16 year olds suffer from a mental disorder (Green, McGinnity, & Metzger, 2005). Alongside growing pressures to achieve academically, socially and professionally, sedentary indoor lifestyles increasingly dependent upon technology have been implicated in the declining mental health of young people (Higley & Milton, 2008; Louv, 2005; Moss, 2012; Pretty et al., 2009). Although it is well established that spending time outdoors in natural environments can aid recovery from stress and mental fatigue and thereby help combat mental health issues (Bowler et al., 2010) there is very little research that has examined the restorative benefits of nature among teenagers.

The healing benefits of exposure to nature are often assumed to be universal. The two dominant theories of environmental restoration: Kaplan and Kaplan's Attention Restoration Theory (ART; 1989) and Ulrich's Stress Reduction Theory (SRT; 1983) both have a basis in Wilson's concept of 'biophilia' (1984), which purports that all human beings have an innate propensity to affiliate with nature, and as a consequence, exposure to life and lifelike features has a positive effect on wellbeing. However, there is some empirical support for the notion that teenagers may not share these same biophilic responses (Kaplan, 1984; Kaplan, 1989; Owens, 1994). Studies conducted across all age groups have revealed teenage preferences for natural environments to be significantly lower than preferences of younger and older age groups (Balling & Falk, 1982; Herzog et al., 2000; Medina, 1983). A number of studies have also reported negative responses by teenagers towards nature, such as 'fear', 'disgust' and 'discomfort' (Bixler et al., 1994; Bixler & Floyd, 1997; Bixler & Floyd, 1999; Davidson et al., 1989; Ollendick, Matson & Helsel, 1985). Furthermore, preference studies and favourite place research frequently reveals adolescents' preferences for urban environments where there are likely to be groups of people gathered, such as shopping precincts and sports centres, over natural environments, such as parks and gardens, which are more likely to offer opportunities for solitude

(Clark & Uzzell, 2002; Korpela, 1992; Korpela, Kytta & Hartig, 2002; Sommer, 1990; Vanderbeck & Johnson, 2000).

Kaplan and Kaplan (2002) explain these differences by suggesting that adolescents may not experience the same biological connection with nature as other groups, due to different adaptive priorities at this point in their development. They hypothesise that adolescence may represent a ‘time out’ period from a preference for the natural environment, which may mean they neither profit from the same restorative benefits of nature as other groups, nor suffer from a loss of relationship due to reduced engagement.

In recent years there has been a great deal of attention given to *children’s* declining relationship with nature (Louv, 2005; Moss, 2012; Pretty, 2009), whilst the increasing time teenagers spend indoors seems to have gone largely unnoticed. A large number of studies have examined the detrimental effects of teenagers’ increased engagement with technology (David-Ferdon & Hertz, 2007; Gentile, Lynch, Linder, & Walsh, 2004; Oshima et al., 2012; Punamäki, Wallenius, Nygård, & Saarni, 2007; von Marees, 2012). However, few have attempted to understand why adolescents are choosing to spend such a huge proportion of their time on their mobile phones and playing computer games, keeping them largely indoors, when they might be engaging in other activities outdoors in natural environments. In a qualitative study amongst 22 16 to 18 year olds, Greenwood (2013) found that many reported both negative attitudes towards visiting nature and negative experiences whilst in natural environments. However, two factors emerged as significant in transforming these negative views and experiences: being with a friend and being occupied. This empirical study then, sought firstly to investigate whether natural environments are indeed restorative for this population, and secondly, to examine the role of social context and ‘doing something’ in nature: namely, playing a game on a mobile phone.

Since adolescence is a period of life when social interaction is a crucial developmental need (Magen, 1998; Piaget, 1932; Spear, 2000), it seems likely that being in the company of a friend in nature might influence a teenager’s experience of it. The importance of the presence of others in situations of stress and external demands has been extensively studied (e.g., Kulik et al., 1994; Schacter, 1959).

Surprisingly, very little is known about restoration in a social context, and it seems that those studies which have examined the impact of company (Johansson, Hartig & Staats, 2011; Staats & Hartig, 2004) have not involved adolescent populations. In Johansson et al.'s study (2011), revitalisation in nature increased more when alone than when with a friend. Staats & Hartig's study (2004) revealed a similar positive effect for being alone in nature, although in this study there was no overall effect of solitude on restoration, due to the counter-balancing effect of an increased feeling of safety provided by being with a friend. It is possible that with an adolescent population the effect of increased safety might be similar, since 'fear' is one of the negative responses reported by teenagers in natural environments (Bixler & Floyd, 1997; Kaplan, 1984); 'solitude', however, may not be as positively experienced.

A further impediment to the enjoyment of natural environments and consequently their potential restorative value that is frequently cited by young people is 'boredom' (Greenwood, 2013; Herzog et al., 2000; Kaplan & Kaplan, 2002; Louv, 2005; Community Heritage Initiative, 2004). The problem of boredom and experiences has been extensively studied, for instance in the work on flow by Csikszentmihalyi (1990), but not in relation to environmental restoration. Teenagers often associate nature with isolation and inactivity and consequently consider it to possess little to stimulate them at a time when they are perhaps hard-wired to be their most active (Cardinal, 2010; Hills et al., 2007; Moss, 2012). Indeed those studies reporting the most positive responses towards natural environments for this age group have been wilderness projects and outward-bound trips, where physical activity has been central to the experience and natural environments have been exciting and challenging (Cason & Gillis, 1994; Thompson, Travlou, & Roe, 2006). "Doing something" in nature then may play an important positive role in its ability to be restorative for adolescents, in contrast with adult populations, who seem to appreciate the opportunity afforded by natural environments to be still and to reflect, without other distractions (Milton, 2008; Raanaas et al., 2011; Staats & Hartig, 2004).

This study sought to counter teenagers' potential boredom in nature, by providing an activity, but an 'everyday' one, rather than an exceptional one, in order to investigate circumstances in which teenagers might actually experience an outdoor natural setting on a daily basis. With 93% of British teenagers now possessing a

mobile phone (Pew Research Internet Project, 2013) and reportedly using them to play games ‘in order to pass the time of day when they are bored’ (Haddon, 2008), this is an activity that might readily be engaged in by almost all teenagers when they are alone in natural settings, which they might otherwise experience as ‘boring’. This would contradict Kaplans’ Attention Restoration Theory (1989), which proposes that two of the characteristics of nature that render it restorative, are its capacity to allow escape from everyday distractions (‘being away’) and its provision of ‘fascinating objects’ that demand effortless attention, both of which might not be features of a natural environment for someone who was using a mobile phone. In fact, from that perspective, using a mobile phone in nature would distract attention away from the restorative features of the natural environment and thereby undermine restorative experiences.

The vast majority of previous research in this area has been conducted in laboratory settings, with images and videos of different environments presented to participants, and self-report questionnaires used to evaluate their preferences and measure their affective responses (Balling & Falk, 1982; Choker & Mene, 1992; Hull & Revell, 1989; Staats & Hartig, 2004; Ulrich, 1981; Valtchanov, 2010; Yi, 1992). Moreover, these studies have often employed idealised or romanticised images of nature to measure perceived restoration in the different settings, and then compared these with uninspiring, often bleak urban settings, which may also be unrepresentative of most people’s actual experience of non-natural environments. This study adopted a more ecologically valid methodology and design, investigating *actual* restoration, by exposing teenagers to different environments and then measuring changes in heart rate, blood pressure, concentration and mood. Moreover, with adolescents spending between seven and eight daylight hours a day at school, we chose to conduct this study in a school environment, where young people frequently experience stress and mental fatigue. With only short breaks between lessons and at lunchtime in which to recuperate from cognitive depletion, teenagers spend their free time in classrooms and corridors, and rarely expose themselves to the potential restorative powers of a natural environment. This study then examined restoration amongst adolescents, comparing environments in which they might actually spend time: an *outdoor* environment close to the school building but containing natural elements, and an *indoor* environment. As

such it examines the potential restorative benefits of short-term passive exposure to proximal nature.

To summarise, nature has been empirically shown to be restorative for most people, across diverse backgrounds and cultures, and amongst adult and children populations, but there is some research to suggest that adolescents, with their particular developmental needs, may experience natural environments differently from other groups. This research aimed to find out whether teenagers do indeed experience the same psychological benefits in nature as others do. The study investigated actual restoration experienced by teenagers in everyday environments, by exposing them to cognitively demanding, stressful tasks in order to create a state conducive to restoration, and then asking them to spend 20 minutes in a familiar indoor or outdoor setting. It further investigated the effects on restoration of a social context and using a mobile phone, by assigning each participant in both environments to one of three conditions: 'alone', 'with a friend' or 'playing a game on a mobile phone'. Restoration was assessed in terms of changes in physiological responses, cognitive functioning and mood, using a heart rate and blood pressure monitor, a visual attention task and a self-report measure. It was expected that adolescents would experience greater psychological restoration in outdoor natural settings compared with indoor settings. Furthermore, this study examined whether and how restoration indoors and outdoors was affected by being alone, the presence of a friend and playing a game on a mobile phone.

2. Method

2.1 Participants and design

One hundred and twenty participants (66 female), all aged 16-18 years, participated in the study. After completing a series of stressor tasks they were randomly assigned to one of two environments, 'indoor' or 'outdoor', in one of three contexts, 'alone', 'with a friend' or 'with a mobile phone', with 20 students in each condition. See Table 1 for an overview of the design.

Participants volunteered by inserting their name next to a particular time slot on a sign-up sheet. They were asked to volunteer in groups of three friends. Many were Psychology 'A' level students, who gained course credits for participation, but cupcakes, chocolate and a £50 prize draw were offered as further incentive to participate.

Table 1

2.2 Materials

A series of tasks were designed to induce both stress and attentional fatigue amongst adolescents: one speech task and three cognitive tests. Given practical time constraints (the whole experiment had to take place in a one hour free period), the tasks were designed to exert maximum mental fatigue within a short space of time, and each lasted three minutes. For the speech, respondents were asked to talk about their own positive characteristics. The three cognitive tasks selected included a memory task in which participants were required to replicate an increasingly long sequence of coloured lights ('Simon' game, commercially available); a mental arithmetic task, requiring students to subtract 13 repeatedly, beginning at 1022; and a shape-sorting task, in which students had to fit as many small shapes as possible into the correct slots, whilst a timer ticked loudly next to them ('Time Shock', commercially available).

The tests were chosen on the basis of two pilot studies. In a first pilot ($n = 8$, 16-17 year olds), a STROOP task, frequently used in restorative research experiments (e.g., Gatersleben & Andrews, 2013; Hartig, Mang & Evans, 1991), was found to be ineffective in inducing a state of measurable stress and attentional fatigue amongst this age group. Consequently, in consultation with other teenagers a variety of cognitive tasks were proposed as likely stressors, along with 'giving a speech in front of peers', a task well known to induce stress (Feldman, Cohen, Hamrick & Lepore,

2004). Six tasks were then trialed with 10 pupils and three of these were found to induce considerably more stress (using the same measures as for the main study) than the other three, but differed for different people, and so it was decided to include all three tasks.

2.3 Environments

The study took place in a sixth-form college in South-West London. Consistent with the ecological validity of this study, indoor and outdoor environments were chosen specifically to represent spaces accessible to adolescents and realistic examples of places in which students might choose to spend time. In fact these two environments were places that had not been previously visited by the participants, since they were not normally open to students.

The outdoor environment was a peaceful grassed quadrangle surrounded by the school building on all four sides, but with a high degree of greenery, including a number of large trees, shrubs and flowers. It was accessed by fire doors, which were usually kept locked. The indoor environment was a small neutral room, with minimal natural light and no view of nature (see Fig. 1).

Figure 1

2.4 Measures

Three separate indicators of restoration were used, measuring physiological, cognitive and affective changes. The measures were all taken immediately following the stressor tasks, and again after the participant had spent 20 minutes in one of the six conditions. An initial heart rate and blood pressure reading was also taken prior to the stressor tasks.

A digital blood pressure and heart rate monitor was used to measure both systolic (SBP) and diastolic blood pressure (DBP) in mmHg, and heart rate (HR) in beats per minute. The monitor was wrapped around the participant's wrist whilst seated and the participant was instructed to remain still and silent whilst the measurements were taken. These measurements have also been widely used in

experiments measuring physiological restoration (e.g., De Kort et al., 2006; Gatersleben & Andrews, 2013; Laumann et al., 2003; Ulrich et al., 1991). Baseline HR ranged from 43 to 127 beats per minute, $M = 78.79$, $SD = 13.74$. Baseline SBP ranged from 74 mmHg to 145 mmHg, $M = 115.64$, $SD = 11.73$, and baseline DBP ranged from 42mmHg to 122mmHg, $M = 73.13$, $SD = 10.31$. All readings were within the normal range (Hartig et al., 2003).

Attention was measured using the Necker Cube Pattern Control Task (NCPCT). Participants were shown a line drawing of a three-dimensional cube and told that people's perspective on the cube tends to shift when they look at the drawing for a prolonged period of time, with the front and back faces of the cube apparently reversing their relative positions. Once familiar with this property of the Necker Cube, they were instructed to focus on one perspective for as long as they could, and then tap on the table every time the pattern shifted. The average number of reversals occurring across two 30-second periods was recorded. Reversals that occur despite the effort to hold the pattern are thought to be due to attentional fatigue (Kaplan, 1995). This measure has also been successfully used in studies examining environmental restoration (e.g. Hartig et al., 2003, Tennessen & Cimprich, 1995).

Zuckerman's (1977) Inventory of Personal Reactions (ZIPERS) was employed to measure mood. The ZIPERS is a 12-item measure, consisting of five factors: positive affect, attentiveness, fear, sadness and anger. Participants indicate the extent to which statements reflect their current feeling on a five-point Likert scale (e.g. I feel elated or pleased; 1 = not at all, 5 = very much). The ZIPERS has been a sensitive measure in previous restorative environment studies (e.g. Gatersleben & Andrews, 2013; Hartig et al., 1991, 1996, 2003; Ulrich et al., 1991), with higher emotional restoration characterised by higher scores on positive mood states and lower scores on negative mood states.

2.5 Procedure

The study received ethical approval from the University prior to commencing. Five female Psychology A level students were recruited to help with the experiment as student assistants. They were involved from the beginning with a number of aspects of the project: they were actively involved in the recruitment of 120 participants,

advising on appropriate and effective incentives, designing and distributing posters, and encouraging students to volunteer; they advised on tests and tasks most likely to stress adolescents; and they helped with the selection of appropriate indoor and outdoor settings around the college in which the experiment could take place. A research assistant was also present throughout the eight days of testing and assisted with the procedure.

Data collection took place during the school day at the beginning of May. Weather conditions were reasonably similar throughout the testing period, and consistent with a British Spring, with warm and sunny periods interspersed with cooler and cloudier conditions. The outdoor environment was avoided during a brief period of rain.

Participants arrived in groups of three at the test room at an appointed time, with the understanding that the experiment would last approximately one hour. They were given an information sheet about the study, invited to ask any questions, and informed of their right to withdraw, before being asked to give their signed consent.

Participants were shown how to attach the monitors to their wrists, and asked to remain still and relaxed whilst initial heart rate and blood pressure readings were taken. They then each undertook one of the three activities (the memory task, the mental arithmetic task and the shape sorting task), which lasted for three minutes. At the end of the three minutes they swapped activity, performed the new task for a further three minutes and then repeated the process for the final task. They were instructed to try their best, and their scores were all carefully recorded at the end of each task. On completion of all three activities, they were informed that they would be giving a three minute presentation about themselves, entitled, "What I like about me", in front of the two friends they brought along, the research assistant and the first author, and that this would be recorded. They were given five minutes to prepare, and then led into an adjacent formal conference room, with a video camera in place, where they then delivered their speeches in turn. This process of inducing stress, and creating a state from which restoration could occur, lasted approximately 20 minutes.

At the end of this stressor phase, blood pressure and heart rate measures were taken again, and participants were asked to complete the ZIPERS and NCPCT. Male

and female participants then selected a piece of paper from the appropriate male or female boxes, which randomly assigned them to one of six conditions: ‘outside alone’, ‘outside with a friend’, ‘outside with a phone’, ‘inside alone’, ‘inside with a friend’, ‘inside with a phone’. The participants were then split up and led by the researcher and the trained research assistant to the relevant environment. Both the indoor and outdoor environments were next to the testing room, requiring only a few moments to reach. Those participants assigned to the ‘being alone’ condition were asked to relax in their environment and observe their surroundings, adopting a mindful approach to just *being*; those assigned to ‘being with a friend’ were invited to chat in a relaxed manner about anything they wanted to; and those assigned to ‘being with a phone’, were asked to play a favourite game on their mobile phone. They were then left in the environment for 20 minutes. At the end of this period, they were collected and led back to the testing room, where blood pressure and heart rate measures were repeated, and ZIPERS and NCPCT completed again. The whole procedure lasted approximately one hour.

3. Results

3.1 Manipulation checks

To examine whether the stress induction was successful and whether participants were in a state conducive to restoration, heart rate (HR) and systolic (SBP) and diastolic blood pressure (DBP) levels were obtained pre and post the stressor tasks, (and then analysed using paired-samples *t*-tests). The means and standard deviations are indicated in Table 2. Heart rate, SBP and DBP all increased from baseline levels following the stressor tasks. There was a statistically significant increase in SBP from pre-stressor levels to post-stressor levels ($t(119) = 4.24, p < .001$). Similarly there was a statistically significant increase in DBP from pre-stressor levels to post-stressor levels ($t(119) = 2.60, p < .01$). Although the increase in heart rate did not reach statistical significance, $t(119) = 1.68, p = .09$, the results suggest that the stressor tasks were successful in inducing physiological stress.

Table 2

3.2 Physiology

To test whether participants showed differences in restoration of physiological arousal in different conditions, mixed between-within subjects analyses of variance were conducted with time as the within-subject factor, environment (indoor, outdoor) and context (alone, with a friend, with a mobile phone) as between-subject factors, and heart rate, systolic and diastolic blood pressure as dependent variables.

3.3 Heart Rate

Overall there was a significant main effect for time, with reductions in heart rate after spending 20 minutes in both indoor and outdoor environments ($M_{pre} = 80.20$, $SD = 13.94$, $M_{post} = 76.55$, $SD = 12.97$; $F(1, 114) = 24.63$, $p < 0.001$, partial eta squared = 0.18). There was a marginally significant interaction effect for environment, with heart rate reducing more in the indoor environment over time ($M_{pre} = 81.33$, $SD = 15.74$, $M_{post} = 76.33$, $SD = 13.63$) compared with the outdoor environment ($M_{pre} = 79.06$, $SD = 11.90$, $M_{post} = 76.77$, $SD = 12.39$; $F(1, 114) = 3.37$, $p = .07$, partial eta squared = .03). There was also a significant interaction effect for context ($F(2, 114) = 3.21$, $p = .04$, partial eta squared = .05). Follow-up t -tests revealed a significant difference in reduction in heart rate between both ‘friend’ ($M = -1.03$, $SD = 7.79$) and ‘alone’ contexts ($M = -5.15$, $SD = 7.61$; $t(78) = 2.40$, $p = .02$), and between ‘friend’ and ‘phone’ contexts ($M = -5.13$, $SD = 9.00$; $t(78) = 2.16$, $p = .03$), but no significant difference between phone and alone contexts ($t(78) = 0.01$, $p = .99$), suggesting that heart rate did not reduce as rapidly when with a friend for 20 minutes as it did when alone or playing a game on a mobile phone.

Although there was no significant three-way interaction between environment and context over time ($F(2, 114) = 1.04$, $p = .36$), Figure 2 shows that whilst heart rate reduces over 20 minutes in all three indoor conditions, and outdoors both when alone and playing a game on a phone, there is a small *increase* in heart rate ($M_{pre} = 82.80$, $SD = 8.97$; $M_{post} = 84.45$, $SD = 10.47$) when with a friend outdoors.

Figure 2

3.4 Blood Pressure

Overall there was a significant main effect for time for both systolic (SBP) and diastolic blood pressure (DBP): after 20 minutes SBP significantly reduced in all conditions ($M_{\text{pre}} = 120.29$, $SD = 13.31$, $M_{\text{post}} = 113.90$, $SD = 10.74$; $F(1,114) = 34.29$, $p < .001$, partial eta squared = 0.23), as did DBP ($M_{\text{pre}} = 75.47$, $SD = 9.58$, $M_{\text{post}} = 72.55$, $SD = 8.93$; $F(1, 114) = 10.78$, $p < .001$, partial eta squared = 0.09). However, there were no significant interaction effects for SBP, for either environment ($F(1,114) = 1.00$, $p = .32$) or context ($F(2,114) = 1.62$, $p = .20$), or for DBP, for either environment ($F(1,114) = .009$, $p = .925$) or context ($F(2,114) = .23$, $p = .80$), indicating that there were no differences between groups for either measure of blood pressure.

3.5 Attention

To test whether teenagers showed significant differences in restoration of attention fatigue in different conditions, scores on the Necker Cube Pattern Control Task (NCPCT) were recorded pre- and post- spending 20 minutes in the condition and analysed using mixed between-within subjects analyses of variance. When interaction effects reached significance, follow-up *t*-tests were conducted to examine specific contrasts.

There was a significant main effect for time, with NCPCT scores reducing following 20 minutes spent in all conditions ($M_{\text{pre}} = 5.54$, $SD = 2.16$, $M_{\text{post}} = 4.2$, $SD = 2.14$; $F(1,114) = 58.21$, $p < .001$, partial eta squared = .34). There was a significant interaction effect for environment, with NCPCT scores reducing significantly more in the outdoor environment ($M_{\text{pre}} = 5.76$, $SD = 1.99$, $M_{\text{post}} = 3.84$, $SD = 1.69$) than in the indoor environment ($M_{\text{pre}} = 5.32$, $SD = 2.32$, $M_{\text{post}} = 4.59$, $SD = 2.46$; $F(1,114) = 11.85$, $p < .001$). The partial eta squared was .09, indicating a moderate effect size (Cohen, 1988). There was also a marginally significant interaction effect for context ($F(2,114) = 2.71$, $p = .07$, partial eta squared = .05). Follow-up *t*-tests indicated that whilst mean reductions in scores were greater in the 'with a friend' context ($M = -1.70$, $SD = 1.89$) and the 'alone' context ($M = -1.50$, $SD = 1.71$) than the 'with a phone' context ($M = -.76$, $SD = 2.27$), they were only significantly so in the 'with a friend' context compared with 'with a phone' ($t(78) = 2.01$, $p = .05$). There was no significant

three-way interaction effect between environment and context over time ($F(2,114) = 2.00, p = .78$).

These results indicate that teenagers could concentrate better (i.e. had fewer pattern shifts on the Necker cube) after spending 20 minutes outside compared with 20 minutes inside, across all contexts, and better when they had been with a friend, compared with when they had been playing a game on a mobile phone.

3.6 Affect

To test whether teenagers showed greater emotional restoration in outdoor settings compared with indoor ones, and to examine the impact on mood of being alone, being with a friend or playing a game on a mobile phone, scores were computed for each of the variables, measured by items on the Zuckerman's (1977) Inventory of Personal Reaction, pre- and post- spending 20 minutes in the condition; mixed between-within subjects analyses of variance were then conducted to examine whether there were significant differences between groups, with follow-up *t*-tests examining specific contrasts when significant interaction effects occurred.

Insufficient variance, resulting in highly skewed variables, was found in the scores relating to states of fear (skew between 2 and 3; kurtosis between 7 and 8), sadness (skew between 3 and 4; kurtosis between 12 and 13) and anger/aggression (skew between 3 and 4; kurtosis between 12 and 13). It was thought that questions referring to these negative states may not have been meaningful for teenagers in this familiar school setting, and therefore only positive affect and attentiveness were analysed.

3.7 Positive affect

There was no main effect for time ($F(1,114) = 2.63, p = .11$). Taken across all contexts, there was a significant interaction effect for environment, with teenagers reporting an increase in positive affect in the outdoor environment ($M_{\text{pre}} = 11.48, SD = 3.20, M_{\text{post}} = 12.57, SD = 3.58$) compared with a reduction in positive affect in the indoor environment ($M_{\text{pre}} = 11.03, SD = 4.09, M_{\text{post}} = 10.75, SD = 4.26; F(1,114) = 7.68, p = .007, \text{partial eta squared} = .06$).

There was also a significant interaction effect for context, with positive affect increasing when with a friend ($M_{\text{pre}} = 10.77, SD = 3.75, M_{\text{post}} = 12.95, SD = 4.06$) and

decreasing both when alone ($M_{\text{pre}} = 11.28$, $SD = 3.73$, $M_{\text{post}} = 10.83$, $SD = 4.02$) and when playing a game on a mobile phone ($M_{\text{pre}} = 11.72$, $SD = 3.53$, $M_{\text{post}} = 11.20$, $SD = 3.77$; $F(2,114) = 12.95$; $p < .001$). Partial eta squared was .19, representing a large effect size. Follow-up t -tests revealed a significant difference in change in positive affect between being with a friend ($M = 2.2$, $SD = 3.11$) and being on a phone ($M = -.53$, $SD = 2.47$; $t(78) = 4.34$, $p < 0.001$); there was also a significant difference between being with a friend and being alone ($M = -.45$, $SD = 2.91$; $t(78) = 3.93$, $p < 0.001$).

There was also a three-way interaction between environment and context over time ($F(2,114) = 4.06$, $p = .02$, partial eta squared = .07). This suggests that the effect of being indoors or outdoors on changes in positive mood was influenced by the context, i.e. being alone, being with a friend or playing a game on a mobile phone. Follow-up t -tests suggest that being with a friend outside differed significantly from all other conditions; in particular, being with friend had a greater influence on increase in positive affect when in an outdoor environment ($M = 3.85$, $SD = 2.46$) than it did when in an indoor environment ($M = .55$, $SD = 2.86$; $t(38) = 3.9$, $p < .001$). Moreover, being with a friend outside significantly improved positive affect compared with being alone outside ($M = -.02$; $SD = 3.55$; $t(38) = 4.20$, $p < .001$) (see Figure 3).

Figure 3

3.8 Attentiveness

There was a main effect for time with the self-report measure of attentiveness significantly decreasing after 20 minutes in the conditions ($M_{\text{pre}} = 3.38$, $SD = 1.05$, $M_{\text{post}} = 2.95$, $SD = 1.20$; $F(1,114) = 14.71$, $p < .001$). There was no interaction effect for either environment ($F(1,114) = 1.07$, $p = .30$) or context ($F(2,114) = .43$, $p = .65$), although there was a marginally significant three-way interaction ($F(2,114) = 2.58$, $p = .08$, partial eta squared = .04, which represents a small to moderate effect size). Follow up t -tests revealed that being alone and playing a game on a phone may not influence a self-report measure of attentiveness, whether in an indoor or outdoor setting. However, being with a friend *increases* attentiveness when indoors ($M = .05$, $SD = 1.54$) and *decreases* attentiveness when outdoors ($M = -.85$, $SD = .99$; $t(38) =$

2.20, $p = .03$). There was also a marginally significant difference in attentiveness between the indoor condition with a friend ($M = .05$, $SD = 1.54$) and the indoor condition with a phone ($M = -0.75$, $SD = 1.07$; $t(38) = 1.90$, $p = .06$); adolescents' self-report attentiveness appeared to decrease more rapidly when playing a game on a mobile phone than when with a friend, but only in an indoor setting.

4. Discussion

This study examined the restorative effects of nature amongst adolescents, adopting an ecologically valid design which compared teenagers' reactions to *outdoor* environments containing natural elements with *indoor* environments, both settings representing spaces students are likely to encounter in their daily lives at school. It further considered the influence on restoration of being alone, with a friend and playing a game on a mobile phone. The results showed that after spending time in an outdoor setting with natural elements, both concentration and positive affect appeared to improve more than after spending time in the indoor setting. These positive responses by teenagers support 'the biophilia hypothesis' (Wilson, 1984), which asserts that all human beings have evolved to respond favourably to non-threatening nature, and are in line with other restoration studies which show the positive benefits of nature across all groups (Bowler et al., 2010; Coon et al., 2011; Sonntag-Öström et al., 2014; Takano et al., 2002; Wells & Evans, 2003).

The results could arguably be seen as providing particularly strong evidence for the restorative effects of nature amongst adolescents, since these effects have been found in an ordinary everyday environment, containing elements of nature in amongst buildings, and not relied on a design which has employed scenes of exceptional natural beauty, where one might expect nature to have a greater impact. The spaces chosen then for this experiment (at school) represent settings in which teenagers might actually spend time. A typical school day for a British teenager involves five or six 50 minute lessons with perhaps five to ten minutes break in-between lessons, a 20 minute break in the middle of the morning and a 45 minute break at lunchtime. Most of these breaks are spent in corridors, empty classrooms and canteens. This research suggests

students could benefit from the restorative value of outdoor green environments around the school.

Although there was converging evidence from two different measures (from the visual attention task and the self-report questionnaire) to suggest that the outdoor setting contributed to more positive outcomes, it should be noted that the size of the differences in concentration and mood between the two environments may not be entirely due to the restorative effects of the outdoor environment, but may also be due to the negative effects of being in a windowless classroom, a stressor which has been found to reduce students' positive mood (Ahrentzen et al., 1982; Weinstein, 1979) and lower concentration (Küller and Lindsten, 1992). It is a limitation of this study that it did not take base-line measurements of both mood and attention alongside physiological measures, in order to give an indication of the extent to which a short break in an outdoor environment containing elements of nature might foster positive mood and improve concentration above what is a normal level for students who spend most of their day indoors.

This study further examined the role of being alone or in company on the restorative effects of nature. In spite of most people visiting natural settings with others, very few previous studies have considered the social context in which natural environments are experienced, and those that have (Johansson et al., 2011; Staats & Hartig, 2004), have not involved adolescents, for whom a social context may be particularly significant (Piaget, 1932; Magen, 1998; Spear, 2000). The results from this study taken overall, suggest that being with a friend, compared with being alone and playing a game on a mobile phone, may cause greater increases in both positive affect and concentration, but smaller reductions in heart rate. However, what is particularly interesting here, given the focus of this study, are the restorative effects, measured in terms of physiological, attentional and emotional changes, of being with a friend compared with being alone in a natural outdoor environment. There were no significant differences in increased concentration levels between the two contexts outside; however, there was a significant difference in increase in positive affect between being outside alone and being outside with a friend. In fact 'being outside with a friend' was the only condition outside in which we found an *increase* in self-report measures of positive affect, with 'being alone' and 'playing a game on a mobile

phone' outside both resulting in decreases. This is in contrast with the findings of the two previous studies that have considered the influence of company on restoration: both Staats and Hartig's study (2004) and Johansson et al.'s study (2011) found that being alone in nature was more restorative than being in company. The Staats and Hartig study (2004) did find that being with a friend in nature had a positive impact on account of an increased sense of safety; however, this is unlikely to explain the findings of this study, with the outdoor environment being an unthreatening, enclosed quadrangle within the school grounds.

These findings are also contrary to Kaplan and Kaplan's Attention Restoration Theory (ART), which suggests that one of the factors responsible for nature's restorative value is its provision of a space for 'being away', in which to feel removed from the busyness of other people and the demands of everyday life. It may be that the specific developmental and cultural priorities of teenagers mean that 'being away', far from being beneficial, is in fact detrimental to their wellbeing. Another component of ART, however, is supported by our findings: ART suggests that an environment is only restorative when it is 'compatible' with an individual's intended purpose or desire; the Kaplans claim this is *usually* a quality of natural environments, but perhaps for adolescents, with their strong social orientation, natural places are not able to readily support their needs.

Kaplan and Kaplan have proposed 'A Time Out' hypothesis (2002) to explain adolescents' less favourable responses to nature: they claim that it is not that nature is necessarily disliked by this age group, but just that places which most easily provide settings for interaction with peers are preferred. This would explain the findings of our study: the slight decrease in positive affect when alone outside, having left the company of their peers, and the much larger increase in positive affect when with a friend outside. It seems that nature may represent a place of solitude for them, and as such holds little appeal, and leaves them experiencing reduced positive affect. However, when in the company of a friend, the negative influence of being alone is removed, and they are able to access the same restorative benefits as other groups.

Similarly, changes in heart rate demonstrated that being outside with a friend affected adolescents differently from all other five conditions. Whilst being with a

friend in both indoor and outdoor environments resulted in significantly smaller reductions in heart rate than being alone or with a phone, when in the company of a friend *outside*, heart rate actually increased. This suggests that whilst being with a friend has a physiologically arousing effect, the effect may be intensified in an outdoor environment. Once again, this is contrary to the findings of previous restorative literature, which reports reductions in physiological measures after time spent in natural environments (Gatersleben & Andrews, 2013; Sonntag-Öström et al., 2014). However, for a teenage population this result may not represent an inconsistent finding: with their self-report measures indicating that being outside with a friend also increased positive affect, it may be that teenagers experience being in an outdoor environment in the company of a friend as stimulating and exciting, thus increasing their heart rate at the same time as improving their mood. A further possibility is that teenagers who are used to spending their entire school day indoors, experience being outside as novel and interesting, resulting in increased arousal. Given adolescents experienced both emotional and attentional restoration in the outdoor environment, alongside this increase in heart rate, it may be that restoration for teenagers has a different meaning, and when considering the benefits of natural environments for teenage wellbeing, it may not be appropriate to consider increases or smaller reductions in heart rate as inconsistent with restoration for this age group. Certainly more research focusing on the physiological impact of natural environments on adolescents, and including other physiological measures such as salivary cortisol, is needed to shed further light on this apparent anomaly.

Since many teenagers report ‘boredom’ as a factor for not experiencing nature in a positive way (Greenwood, 2013; Kaplan, 1984; Louv, 2005), this study also tested whether ‘doing something’ in an outdoor environment influenced restoration. We chose playing a game on a mobile phone as a means of occupation, since this is an activity commonly performed by most teenagers, particularly when feeling bored (Madden, 2013). The only differences, however, found in the ‘with a phone’ context were negative ones, where playing a game on a mobile phone had a negative impact on concentration and on positive affect compared with being with a friend in both environments, and a marginal negative impact on a self-report measure of attentiveness, although only when inside with a phone. This study did not produce any

evidence to suggest that ‘doing something’ in nature might counter the negative appraisal sometimes made by teenagers of nature as ‘boring’. However, it may be that our choice of ‘activity’ was not an appropriate one for a number of reasons. Firstly, it represented an activity which teenagers may have found similar to the cognitive stressor tasks, and consequently reduced the likelihood of any effects. In addition, concentrating on a small mobile phone screen may have reduced the impact of both environments, with participants focusing on the screen and therefore not as cognizant of their surroundings. In particular looking at the screen may have distracted the teenagers’ attention away from the soft fascinating features of the natural environment. Unfortunately, we did not know what games the participants were playing. It is likely that the type of game as well as the extent to which the game demands attention will have influenced the findings.

Future research might consider other ways to counteract teenagers’ apparent ‘boredom’ in nature, which would allow them to fully experience their environment at the same time, and therefore benefit from its restorative potential. The current study focused on a specific restorative experience which involved short-term passive exposure to a small scale natural environment surrounded by natural elements. It is well known that adventurous physical pursuits in wild nature are restorative for young people (Thompson et al., 2006; Moss, 2012); however, further research investigating less extreme activity, in natural spaces that are readily accessible to all adolescents, is called for.

5. Conclusion

The results of this study suggest that natural environments can provide restoration for adolescents. Moreover, they demonstrate that even a short break in an environment that may not be entirely natural, but contains elements of nature, can restore attention fatigue more effectively than a break in an indoor environment. However, current restoration theories may not be sufficient to fully explain adolescents’ experience of nature. Whilst improvements in concentration were evident across all contexts outside, positive mood only increased after being with a friend in an outdoor environment. Clearly then, in order for adolescents to fully profit from the restorative benefits of outdoor natural settings, they need to be made into spaces

conducive to social interaction, with benches, blankets and beanbags enticing young people outside, and into settings which they might otherwise experience as dull or isolating. It may also be important to provide the potential for activity, such as table tennis tables or giant outdoor chess sets, although further research is needed to investigate whether 'being active' or 'doing something' in nature increases its restorative effects for teenagers.

According to government statistics the mental health of the nation's teenagers is worse than ever before (Nuffield Foundation, 2013). Surveys show that around 13% of teenage boys and 10% of teenage girls have mental health problems, with the numbers of adolescents diagnosed with depression, anxiety, eating disorders and attention deficit disorders rising annually (Hagell, Coleman, & Brooks, 2013). Schools have becoming increasingly stressful environments, with growing pressures to succeed academically often at the route of many mental health problems. There is an urgent need therefore to seek ways in which to reduce students' stress at school, and encouraging teenagers to spend their breaks in natural places in order to recuperate from mental fatigue and stress may be one answer to the problem.

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