Green and Screen

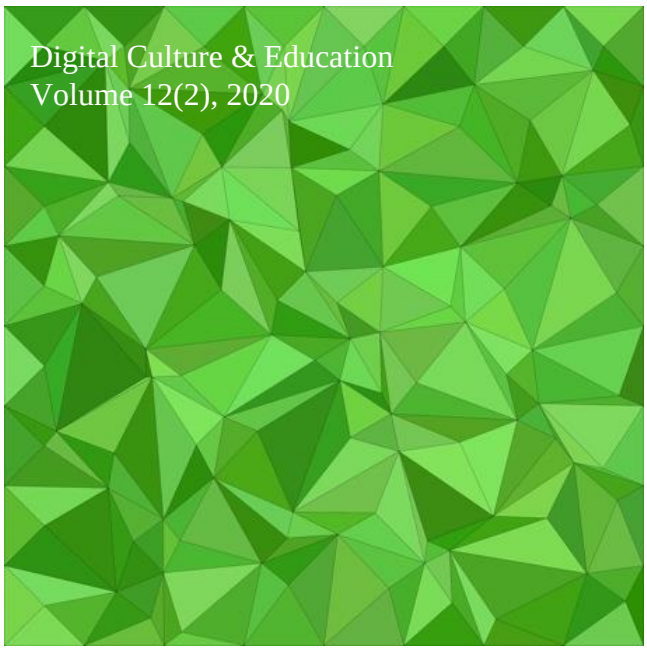
Barrable, Alexia; Booth, David

Published in:
Digital Culture & Education

Publication date:
2020

Document Version
Publisher's PDF, also known as Version of record

DIGITAL CULTURE & EDUCATION, 12(2)
2020, ISSN 1836-8301



Green and Screen: Does Mobile Photography Enhance or Hinder Our Connection to Nature?

Alexia Barrable and David Booth
University of Dundee

Online Publication Date: 02nd July 2020

To cite this Article: Barrable, A., & Booth D. (2020) Green and Screen: Does Mobile Photography Enhance or Hinder Our Connection to Nature?. Digital Culture & Education, 12(2)

URL: https://www.digitalcultureandeducation.com/volume-12-2

PLEASE SCROLL DOWN FOR ARTICLE

GREEN AND SCREEN: DOES MOBILE PHOTOGRAPHY ENHANCE OR HINDER OUR CONNECTION TO NATURE?

Alexia Barrable and David Booth

University of Dundee

*Correspondence for this article should be addressed to Dr Alexia Barrable, a.barrable@dundee.ac.uk

Abstract: *Connection to nature, which describes the affective, experiential and cognitive aspects of our relationship with the natural world, has been positively associated with increased wellbeing, as well as pro-environmental beliefs and behaviours. It has also been identified as a worthwhile and distinct goal of education, both in terms of environmental education assessment, as well as in broader terms. This short article aims to explore the effect of using mobile technology to enhance our connection to nature, through a short-term intervention. A total of 57 undergraduates (age range 20 - 31) were randomised into two groups and undertook a short walk in urban nature, with the instruction to notice the beauty in nature and note three beautiful things. One of the groups was asked to record these beautiful things using mobile technology (photography, audio or video recording). Pre- and post-activity measures of the nature connection, using the Connection to Nature Scale (CNS) State were taken and analysed. Results showed that although the intervention had an overall positive effect on participants' connection to nature, technology neither enhanced nor hindered it. Qualitative analysis of participants' description of the activity shows a largely positive experience. Limitations of this small trial are presented, and the potential to build an application to engage young people with nature, for increased wellbeing and sustainability, is discussed as a future direction.*

Keywords: *nature connection, technology, photography, beauty, attention*

Introduction

The ubiquity of mobile devices is a characteristic of the 21st century. Smartphone use is now at record high, with more than 2.5 billion people around the world owning a smartphone (Pew Research, 2019). In developed economies, such as the UK and Germany, almost 80% of adults report owning a smart mobile device (Pew Research, 2019). Although this is largely viewed as a positive development, the debate over digital technology use, especially as it relates to young people is a complex one. Prominent researchers in a variety of fields have noted the need for more measured and evidence-based approaches towards digital technology and youth (Bell *et al.*, 2015).

At the same time there have been numerous calls for both adults and children to connect, or re-connect, with the natural world (Louv, 2008; Zylstra et al., 2014). This is largely driven by a push for

pro-environmental and sustainable behaviours (Ives et al., 2018), and the positive associations of nature connections with increased wellbeing (Capaldi et al., 2014; Pritchard et al., 2019). Moreover, it has been identified as a worthwhile separate goal for education at different levels, including early childhood education (Barrable, 2019), environmental education at secondary level (Frantz and Mayer, 2014), and within higher education (Lankenau, 2015).

A variety of interventions have been found to be effective in increasing nature connection in participants. Of these, some of them have been long term campaigns such as "30 days wild" (Richardson et al., 2016) and an intervention to notice nature (Passmore and Holder, 2017) both evidencing the efficacy of such activities to increase nature connection and wellbeing in adults. In the above long-term campaigns participants are encouraged to engage with the natural world in ways that they don't normally do, mainly by diverting attention and noticing things in nature, or undertaking activities in natural environments. A variety of benefits of such attempts to connect to the natural world have also been reported in the above studies alongside an increase in connection to nature, namely increased wellbeing (Richardson et al., 2016), prosocial behaviours (Passmore and Holder, 2017), and meaning in life (Passmore and Howell, 2014). These interventions that lasted between two weeks and thirty days showed effect sizes in relation to nature connection ranging from d=.29 (Richardson et al., 2016) to *d*=.63 (Passmore and Howell, 2014). These number represent a substantial change to participants' connection to nature.

However, long term nature involvement is not the only way to promote connection to nature in adults. In studies that have looked at shorter activities, similar or larger effect sizes have been reported. Lumber et al. (2017) studied the impact of three 20 minute walks on participants' connection to nature. In that study, an activity that involved a walk around a green college campus combined with noticing natural beauty and emotions that arose had the largest effect on participants' nature connection. The effect size for the nature walk/noticing nature intervention was reported as *d*=.9 (Lumber et al., 2017). Complementing this, Nisbet and Zelenski (2011) found that a short walk in accessible urban nature not only improved connection to nature (*d*=.86), but also increased positive affect.

However problematic use of smartphones, including mobile phone addiction, has been reported (Choliz, 2010), and percentages of British young people for whom use of smartphones is deemed as problematic is around 25% (Sohn et al., 2019). In other countries, such as Spain, Australia and the United Arab Emirates, this is estimated to be even higher (Oviedo-Trespalacios et al., 2019; Sánchez-Martínez & Otero, 2009; Vally & Hichami, 2019). The term 'problematic' is generally used by research in psychology and cognate disciplines to indicate impairment in functioning (Yen et al., 2009).

The use of technology as a vehicle to connect to the natural world has only briefly been examined in previous research studies. In one study of young adults, the use of both traditional and immersive video technology was found to increase connection to nature in participants (*d*=.32; Soliman et al., 2017). No significant difference was reported between the two different types of technology (traditional computer monitor vs immersive video). In another study, this time with teenagers and young adults (aged 11-20) it was found that a short intervention promoted engagement with nature through the use of mobile technologies; in this instance some GeoGames which assess participants'

mapping skills in an interactive way, increased participants' connection to the natural world (*d*=.34; Schneider and Schaal, 2018). However, this particular study had no control for comparison as both groups involved engaged with similar technologies, differing only in complexity.

Engaging mindfully with the natural world[1], seems to have an effect on how we connect to it too. Mindfulness, the "moment-to-moment, non-judgmental awareness, cultivated by paying attention in a specific way, that is, in the present moment, and as non-reactively, as non-judgmentally, and as open heartedly as possible" (Kabat-Zinn 2005, p. 108), has been one of the pathways that has been used in interventions that attempt to increase nature connection in adults. There are studies that look at the effect of mindful engagement with nature in promoting a connection to the natural world (Unsworth et al., 2016; Wang et al., 2016) and which report increases in feelings of connectedness with the natural world post intervention.

Mindfulness, although not exclusively a cognitive process, can be partly conceptualised as one (Konstanski and Hassed, 2008). In this way it can be seen as a process of selective attention – of directing attention to different aspects of one's experience (Unsworth et al., 2016). It may be hypothesised that this process of directing attention to nature, and engaging with it through sensory experience, is one of the pathways to connection (Lumber et al., 2017). Previous research suggests that photographs can act as a valuable retrieval tool that can enhance memory in both healthy and amnesic patients (St. Jacques et al., 2008; Loveday and Conway, 2011). Other studies have highlighted a photo-impairment effect that is characterised by diminished memory of objects that people photographed as a whole (Henkel, 2014); it is notable that in this study, when participants zoomed into particular details of the objects, changing the focus of their attention, no impairment was found. Therefore, it is plausible that several conflicting attentional processes may be occurring whilst taking a photograph. It is therefore unclear, whether photography may add or detract from the experience itself. It seems that it is the *kind* of photography that the individual engages in that may have a greater effect, rather than the simple act of taking a photograph. In a study by Kurtz (2015) this is made clear by discriminating between creative (compositional) and mindful (expressive) photography, neutral photography and another common positive psychology intervention of counting one's blessings. Results suggest that mindful photography and counting blessings both had a positive effect on subjective wellbeing levels, while neutral photography didn't (Kurtz, 2015).

In the present study we want to examine the effect that photography may have on participants' connection to the natural world. We, therefore, bring forward a hypothesis that using technology, in this instance mobile photography, may act as an attention enhancer, enhancing the selective attention focused on what the participants' perceived as beautiful natural objects and, therefore, increase participants' nature connection. We, therefore, put forward the two following hypotheses:

[1] We are aware there are many definitions of the 'natural world' but for the purpose of this paper the authors will use the definition of Mausner (1996) to encompass all four types, including 'totally natural', 'civilized natural', 'seminatural' and 'quasi-natural'. These four types are used to come into contrast with 'non-natural' environments. We feel that the use this terms facilitates the inclusion of the maximum possible settings that may be identified by participants and reader alike as 'natural'.

1) Mindful engagement with nature will have a positive effect on nature connection score of participants.

2) Enhancing attention through technology through mobile phone photography will have a positive effect on nature connection.

Methods

Participants

A total of 57 participants were recruited ($Mean_{ageinyears}$=21.82, SD=2.84; range 20-31, 49 of whom were female. One participant chose to not disclose their age or gender. All participants were students enrolled on a research methods module at a Scottish university. Twenty-seven of the participants were randomised into condition one, which involved a ten minute walk engaging with nature's beauty, while 30 undertook the activity in condition two, which was identical to condition one but also included engaging with digital technologies.

Ethics

The study was reviewed and given approval by the Ethics Committee of the University of Dundee. Informed consent was sought and freely given by all participants, who were also informed that they could withdraw at any time. Finally, anonymity was ensured by use of a code number, randomly assigned by the lead researcher, instead of names. Participation in the project was voluntary, was not credit bearing and not linked to assessment.

Procedure

A pre- and post- randomised design was used to investigate the research questions. Three data collection points were established, before an activity, after an activity and a follow up three weeks later. Participants were randomised into two groups by being allocated a number on arrival. Participants that were allocated odd numbers were randomised onto condition one and even numbers onto condition two. Condition one involved a 10-minute walk around the campus. Participants were instructed to 'notice the beauty in nature and mentally note three beautiful things' by the lead researcher. Condition two involved the same 10-minute walk, including having to 'notice the beauty in nature'. However, in this condition, participants were asked to use their mobile phones to 'capture three beautiful things'. This could be done through photography, a video or an audio recording.

Materials

A pen and paper questionnaire was completed by all participants. It included some demographic information, namely sex and age, as well as the Connectedness to Nature Scale - State (CNS; Mayer et al., 2009). The CNS is a 13-item, seven-Likert response scale that measures state, as opposed to trait, connection to nature. Sample items include "Right now I'm feeling a sense of oneness with the natural

world around me" and "At this moment, I am feeling like I am only a part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees."

In the second version of the questionnaire, delivered straight after the activity, participants were also asked to record any feelings or emotions experienced during the activity, as well as a repeat measure of the CNS. Finally, a follow-up questionnaire, that included the CNS, as well as a question that related to the frequency that the participant voluntarily engaged with noticing nature since the initial activity, was completed three weeks later. However, only 11 of the original 57 participants were able to participate, due to the follow-up date being out of term time, and so, although the results are reported descriptively below (see table 1 & 2, figure 1), statistical analysis was not deemed appropriate.

Analysis

For descriptive statistics, the mean and confidence interval were calculated overall for each condition, and as the mean and confidence interval of the difference in participant score between pre-post surveys and post–follow up surveys. All graphing and analyses were conducted in the R environment (R Core Team, 2019). Power analysis conducted on preliminary data (n=20) with the SIMR package (Green and MacLeod, 2016), estimated a study size of n=50 for models with small to medium sized. A linear model with mixed effects (LMM) and generalised linear model with mixed effects and binomial errors (GLMM) was fitted to the data, using the LME4 package (Bates *et al.* 2015). The linear model response variable was calculated as a mean of the seven point CNS questions (with negatively worded questions subtracted from 8), resulting in a score between one and seven; the generalised linear model response variable was calculated as a proportion of the total CNS score resulting in a score between zero and one. The following model was used as a saturated statistical model for the study with intervention and timing of survey as fixed effects with a interaction assessed relative to the participants initial CNS score (study participants categorised into quartiles), and participant as a random effect.

Response ~ Condition + Timing + baseline + Timing:Baseline + (1|participant)

This saturated model was simplified using backward elimination with a likelihood ratio (LR) test at each step to justify removal of a predictor, to a minimal adequate (most parsimonious model) that was finally contrasted against a null model (a model with only intercepts). The formula for the LR test statistic is as follows.

$$\mathrm{LR} = -2\ln\left(\frac{L(\text{simplified})}{L(\text{complex})}\right) = 2(loglik(\text{complex}) - loglik(\text{simplified}))$$

The minimal adequate model was bootstrapped with 1000 replicates to estimate a 95% confidence interval on the regression coefficients.

The qualitative data that were collected, in the form of free text to describe the feelings experienced during the activity were analyses through the use of a word cloud. Word clouds (or tag clouds) have become a popular way to visualise qualitative data and can easily produce a visual representation of the frequency of words within a qualitative dataset (DePaolo & Wilkinson, 2014). We felt that this

level of analysis was appropriate in this instance, as the data were not in the form of sentences, but rather mostly expressed by the participants in single words or lists of words.

Results

Descriptive results for the intervention are presented in table 1 & 2 and figure 1. Notably the participants exhibited a wide range of CNS scores regardless of intervention in the pre intervention survey (1.54 – 6.77), this range shifts in the post intervention survey (1.61-6.92). In both interventions there was a positive increase in CNS score observed between pre-post, but not in the post-follow up comparison. Both interventions produced an equivalent overlapping change in CNS score, with no evidence of either being more effective. It should be noted that due to study attrition there was a significant drop out rate between the post and follow up survey, and as such the confidence interval estimate on the difference is almost an order of magnitude larger reflecting the reduction in power. Inferential statistics looking only at the pre and post survey set follow.

Table 1. Sample size, repeated measure difference score and confidence interval in difference across conditions

	Pre – Post			Post - Follow up		
	n	$\bar{x}$ diff	CI	n	$\bar{x}$ diff	CI
No technology	28	.28 [.42]	[.12 - .44]	6	.17 [.76]	[-.63 - .97]
Technology activity	29	.41 [.53]	[.21 - .61]	5	-.14 [.44]	[-.68 - .41]

Table 2. Mean and confidence interval for each condition at three time points.

	Pre			Post			Follow-up		
	n	$\bar{x}$ [sd]	CI	N	$\bar{x}$ [sd]	CI	n	$\bar{x}$ [sd]	CI
No technology	28	4.22 [1.09]	[4.64 - 3.80]	28	4.50 [1.17]	[4.95 - 4.05]	6	4.21 [1.11]	[5.37 - 3.04]
Technology activity	29	4.23 [.92]	[4.58 - 3.88]	29	4.64 [.96]	[5.00 - 4.27]	5	3.89 [.28]	[4.23 - 3.55]

Inferential statistics

The saturated statistical model was assessed for collinearity with VIF values ranging from 1.00 through to 1.11, with a mean of 1.07 indicating that collinearity is likely not present. The generalised linear model with binomial errors was evaluated to be a "better fit" to the data through model plot diagnostics (residual vs fitted values), and was simplified to a minimal adequate model (most parsimonious) of CNS score as a function of timing, the baseline CNS value and an interaction between CNS score and baseline CNS value [$\chi(1)=.01$, $p=.91$]. The minimal adequate model was evaluated against the null model to assess fit of the retained predictors see table 3, [$\chi(7)=102.54$, $p<2.2\times10^{-16}$] and to estimate effect size which was found to be in the small to medium range $R^2_{McFadden}=$

.12. Timing of survey was a significant predictor with a positive coefficient [.28 (CI95%: .12 - .44)]; the intervention was not found to be a predictor [.07 (CI95%: -.13 - .29)]; interestingly the quartiles interacted in the Pre-Post survey with the above average set producing a overall reduction in score [-.25 (CI95%: -.48 - -.02)]. Individual questions were examined to determine if any were contributory in a substantive fashion to this effect, but it was notable that individual questions produced a very small additive effect.

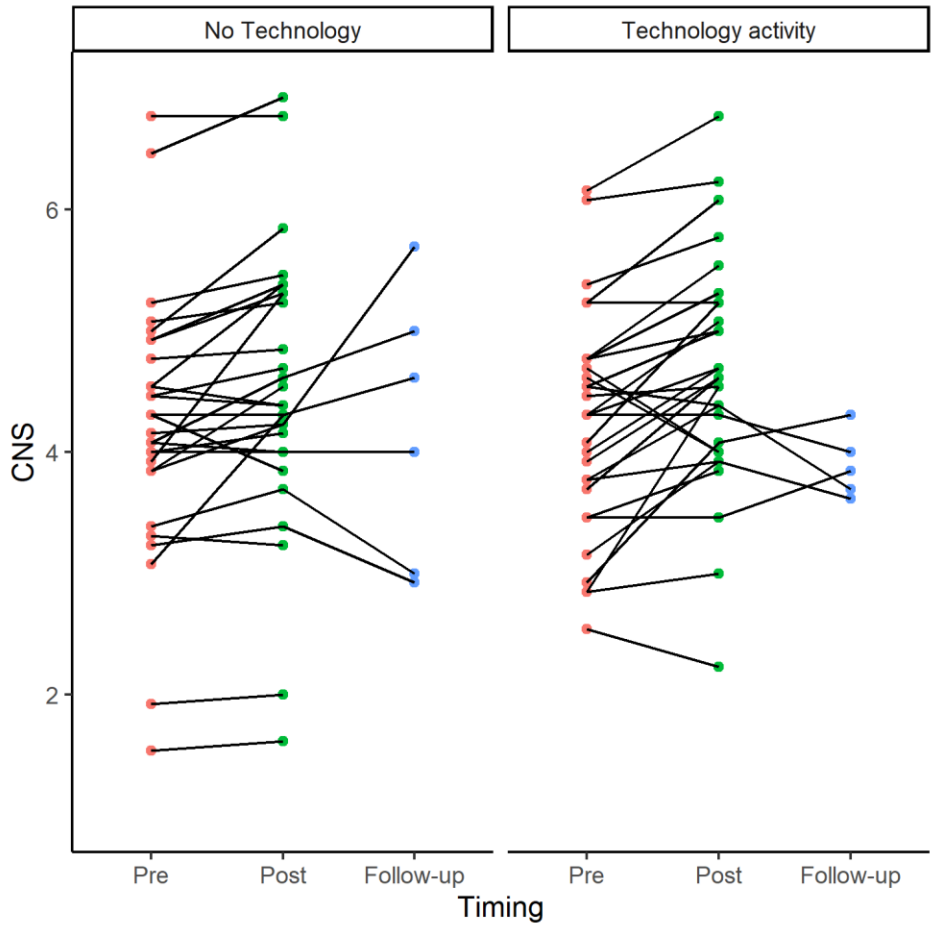


Figure 1. Individual CNS scores tied across study survey points.

Table 3. Coefficients from generalised linear mixed effect model. Response variable is logit transformed.

	Fixed effect	Est	Std. err	z-value	pr(>|z|)	Sig	CI95
	Intercept	-.33	.11	-2.91	3.65×10^{-3}	**	[-.55 - -.11]
Timing	**Post**	.28	.08	3.44	5.9×10^{-4}	***	[.12 - .44]
Baseline CNS	**Below Av**	.59	.16	3.66	2.6×10^{-4}	***	[.25 - .92]
	Above Av	.89	.16	5.58	2.4×10^{-8}	***	[.57 - 1.21]
	Top	1.57	.16	9.9	2×10^{-16}	***	[1.27 - 1.91]
Timing:Baseline Interaction	**Post:Below Av**	.02	.12	.17	.86		[-.21 - .26]
	Post:Above Av	-.25	.11	-2.17	.03	*	[-.48 - -.02]
	Post:Top	.07	.12	.54	.59		[-.17 - .32]
	Random effect	St dev					
	Participant	.36					[.27 - .43]
		R^2_{McFadden} .12					

Qualitative analysis

The data that were collected in the post-activity questionnaire were in written form, and mainly in the lists or single word format. It was, therefore, deemed appropriate to analyse these using a simple form of word cloud. This technique, which is gaining traction in qualitative analysis (e.g. Bletzer, 2015; Sellars et al., 2018) is useful in providing a very visual representation of the frequencies of words in the participants' descriptions. We felt that this approach was more useful than thematic or content analysis to give a simple yet effective overview of the frequency in which words appeared in the participants' free text input. The word cloud for the two groups combined is presented below in figure 3.

Figure 2. Word cloud representing participants reported feelings as experienced during the activity.

Looking at the frequency of words, there is an overwhelming majority of adjectives describing positive affective states, with "happy/happiness" being the most common word used to describe the experience, followed by "calm/calmness", "relaxed" and "appreciative". Words associated with cognition were also used, including "contemplative", "reflective" and "thoughtfulness". Very few participants used negative words to describe their state, such as "boredom", "sadness", "frustration" and "confusion", which may be an effect of social desirability bias. However, all data were anonymous to try and minimise such bias.

Overall, participants used positive language to describe their experience. There was no difference between the language used by participants taking part in the two different activities, with positive words being used in the majority of both conditions.

Discussion

The pre and post-activity nature connection score analysis suggests that both activities had a significant effect on participants' feelings of connection to the natural world. As presented in the results (table , the pre-activity mean score for the group that did not engage with technology was M=4.22 (SD 1.09), while the post-activity men score was M=4.50 (SD=1.17). A similar positive shift was seen in the pre- and post-activities scores of participants who did engage with technology, by taking pictures of the beautiful things that they observed in nature, namely a pre-activity mean score of M=4.23 (SD=.92) and a post-activity mean score of M= 4.64 (SD=.96). The effect size for each activity were calculated at d=.24 for the activity that involved the walk without the use of photography, and d=.44 for the activity that involved engaging with nature's beauty using mobile technology. This represents a small to medium effect size for both activities, and it is comparable to the effect size reported in previous short interventions using technology (e.g. Schneider and Schaal, 2018; Soliman et al., 2017). However, it should also be noted that the effect sizes reported here are markedly smaller than those reported in other short-term interventions to increase nature connection, as for example in Lumber et al. (2017) and Nisbet and Zelenski (2011). This may be due to the nature of the intervention, the latter two studies were more prescriptive and the participants were accompanied by a research associate and guided in their engagement with nature. In the current study this was not the case, and participants were simply given a set of verbal instructions prior to commencing the activity. Therefore, adherence to the protocol could not be verified.

Most notably, and relating to our second hypothesis, there was no significant difference between the two activities in terms of their effect on nature connection. We can, therefore, propose that given the results of this study, using mobile technology to engage with nature neither enhances nor does it hinder the process of connecting to it. There may be a case to be made that young people may be more likely to engage with nature through the use of technology, by taking pictures for example, although this was not studied in this particular project. Further projects that look at the likelihood of sustaining a habit of engaging with nature through the use of digital technologies may be a valid follow-up to this study.

Moreover, engaging with the beauty in nature, as in the above short intervention, appears to have produced on positive affective responses, as seen in the qualitative aspect of the study. Participants' records of their affective responses were largely positive, with "happiness" and "calmness" being the most oft-reported words to describe their feelings during the activity. Again, as reflected in the quantitative data, no difference was seen between the two groups in the qualitative analysis.

There are several limitations to this study. The sample size is relatively small, though it should be noted that the power and subsequent analysis detected the small to medium size effect associated with the activity the students were exposed to. In this case it may be that the photography would produce a very small effect, or perhaps even an interaction, in which case the sample size would potentially have to be several orders of magnitude larger; and though an effect was observed, the possibility of a false positive result cannot be discounted.

As this study was effectively an assessment of state it is possible that the survey should have been deployed digitally with state assessed during the activity rather than post; or that survey attrition would impact negatively with the instrument. It may even have been appropriate to assess the trait of nature connection a priori, with this as a covariate to the state.

It is highly likely that there are covariates or confounds that were not considered; for example the base affinity for technology or photography may be a strongly influencing factor, as there are potentially a suite of skills employed that are assumed to be ubiquitous in the study group, that if not present may detract from the goal of the activity which was mindfulness. An inability to recognise or identify natural objects, a sense of the aesthetic, or capacity to capture this information with relative ease could be a barrier to mindfulness. Participants were requested to think of or capture three things; whilst these data were collected, due to the anonymous nature of the pen and paper survey it was impossible to tie the responses to the three items. Likewise the style of photography may be counter-intuitive or alien to the study group. For example it could be quite common for participants in the study group to normally include the photographer with the participant, i.e. the "selfie".

Finally, the study group was almost entirely composed of female students, enrolled to an education course at a Scottish university. The ecological validity of this sample is questionable, and it would certainly be difficult to generalise these findings due to the idiosyncratic nature of this set.

Conclusion

Nature connection has increasing been seen as a worthwhile goal for adults and children, both for its association with positive wellbeing (Capaldi et al., 2014; Pritchard et al., 2019), as well as because of its link with sustainable and pro-environmental behaviour (Ives et al., 2018). It is, therefore, important to study the processes that may improve our connection to nature, both in terms of short and long-term interventions. Several studies have done that in the past (Lumber et al., 2017; Passmore and Howell, 2014; Richardson et al., 2016) with varying effect sizes being reported.

This was a small experimental study that aimed to explore the effects of a short-term intervention on nature connection, with and without the use of mobile technology. Results in this study suggest that although there is a small to medium positive effect of briefly engaging with nature's beauty on a 10-

minute campus walk, no significant difference is seen between the two groups. Finally, it should be noted that the activity was well-received, with qualitative data gathered post-activity indicating that most participants found the activity pleasant and experienced positive affective states during the walk.

Further research could look at the effects of a more sustained intervention, over several days or weeks, or measure the likelihood of changing behaviour and adhering to such an intervention on a daily basis. Moreover, it would be of interest to see what the follow-up effect of such a short term intervention would be, which in this particular case was not possible to quantify due to large attrition rates. Finally, using other more immersive type of technologies, or adding a social media aspect to the activity could also be explored in further research.

References

Barrable, A. (2019). The Case for Nature Connectedness as a Distinct Goal of Early Childhood Education. *International Journal of Early Childhood Environmental Education, 6*(2), 59-70.

Bletzer, K.V., (2015). Visualizing the qualitative: making sense of written comments from an evaluative satisfaction survey. *Journal of educational evaluation for health professions*, 12 (12). doi: 10.3352/jeehp.2015.12.12

Douglas Bates, Martin Maechler, Ben Bolker and Steve Walker (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1), 1-48. doi:10.18637/jss.v067.i01.

Bell, V., Bishop, D.V. and Przybylski, A.K., (2015). The debate over digital technology and young people. *British Medical Journal.* 351 https://doi.org/10.1136/bmj.h3064

Capaldi, C.A., Dopko, R.L. and Zelenski, J.M., (2014). The relationship between nature connectedness and happiness: a meta-analysis. *Frontiers in psychology,* 5, p.976.

Choliz, M., (2010). Mobile phone addiction: a point of issue. *Addiction*, 105(2), pp.373-374.

DePaolo, C.A. and Wilkinson, K., (2014). Get your head into the clouds: Using word clouds for analyzing qualitative assessment data. *TechTrends*, 58(3), pp.38-44.

Douglas Bates, Martin Maechler, Ben Bolker, Steve Walker (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1), 1-48. doi:10.18637/jss.v067.i01.

Green, P. and MacLeod, C.J. (2016), SIMR: an R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution*, 7: 493-498. doi:10.1111/2041-210X.12504

Frantz, C.M. and Mayer, F.S., (2014). The importance of connection to nature in assessing environmental education programs. St*udies in Educational Evaluation*, 41, pp.85-89.

Green, P. and MacLeod, C. J. (2016). SIMR: An R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution* 7(4): 493–498, DOI: https://doi.org/10.1111/2041-210X.12504

Henkel, L.A., (2014). Point-and-shoot memories: The influence of taking photos on memory for a museum tour. *Psychological science*, 25(2), pp.396-402.

Ives, C.D., Abson, D.J., von Wehrden, H., Dorninger, C., Klaniecki, K. and Fischer, J., (2018). Reconnecting with nature for sustainability. *Sustainability science*, 13(5), pp.1389-1397.

Kabat-Zinn, J. (2005). *Coming to our senses: healing ourselves and our world though mindfulness.* New York: Hyperion.

Kostanski, M. and Hassed, C., (2008). Mindfulness as a concept and a process. *Australian Psychologist*, 43(1), pp.15-21.

Kurtz, J.L., (2015). Seeing through new eyes: An experimental investigation of the benefits of photography. *Journal of Basic and Applied Sciences,* 11, pp.354-358.

Lankenau, G.R., (2018). Fostering connectedness to nature in higher education. *Environmental Education Research*, 24(2), pp.230-244.

Lopez-Fernandez, O., Honrubia-Serrano, L., Freixa-Blanxart, M. and Gibson, W., (2014). Prevalence of problematic mobile phone use in British adolescents. *CyberPsychology, Behavior, and social networking*, 17(2), pp.91-98.

Louv, R., (2008). L*ast child in the woods: Saving our children from nature-deficit disorder.* New York: Algonquin books.

Loveday, C. and Conway, M.A., (2011). Using SenseCam with an amnesic patient: Accessing inaccessible everyday memories. *Memory*, 19(7), pp.697-704.

Mausner, C. (1996). A kaleidoscope model: defining natural environments. J*ournal of Environmental Psychology*, 16(4), 335-348

Mayer, F.S., Frantz, C.M., Bruehlman-Senecal, E. and Dolliver, K., (2009). Why is nature beneficial? The role of connectedness to nature. *Environment and behavior,* 41(5), pp.607-643.

Nisbet, E.K. and Zelenski, J.M., (2011). Underestimating nearby nature: Affective forecasting errors obscure the happy path to sustainability. *Psychological science*, 22(9), pp.1101-1106.

Oviedo-Trespalacios, O., Nandavar, S., Newton, J.D.A., Demant, D. and Phillips, J.G., (2019). Problematic use of mobile phones in Australia… is it getting worse?. *Frontiers in psychiatry, 10*, p.105.

Passmore, H.A. and Holder, M.D., (2017). Noticing nature: Individual and social benefits of a two-week intervention. *The Journal of Positive Psychology,* 12(6), pp.537-546.

Passmore, H.A. and Howell, A.J., (2014). Nature involvement increases hedonic and eudaimonic well-being: A two-week experimental study. *Ecopsychology*, 6(3), pp.148-154.

Pew Research, (2019). *Smartphone Ownership Is Growing Rapidly Around the World, but Not Always Equally.* Available at https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/ Accessed on 25th November 2019

Pritchard, A., Richardson, M., Sheffield, D. and McEwan, K., (2019). The Relationship Between Nature Connectedness and Eudaimonic Well-Being: A Meta-Analysis. *Journal of Happiness Studies*, pp.1-23.

Richardson, M., Cormack, A., McRobert, L. and Underhill, R., (2016). 30 days wild: Development and evaluation of a large-scale nature engagement campaign to improve well-being. *PloS one*, 11(2), p.e0149777.

R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. 2019.

Sánchez-Martínez, M., & Otero, A. 2009. Factors associated with cell phone use in adolescents in the community of Madrid (Spain). *CyberPsychology & Behavior,* 12(2), 131–137.

Schneider, J. and Schaal, S., (2018). Location-based smartphone games in the context of environmental education and education for sustainable development: fostering connectedness to nature with Geogames. *Environmental Education Research*, 24(11), pp.1597-1610.

Sellars, B.B., Sherrod, D.R. and Chappel-Aiken, L., (2018). Using word clouds to analyze qualitative data in clinical settings. *Nursing management*, 49(10), pp.51-53.

Sohn, S., Rees, P., Wildridge, B., Kalk, N.J. and Carter, B., (2019). Prevalence of problematic smartphone usage and associated mental health outcomes amongst children and young people: a systematic review, meta-analysis and GRADE of the evidence. *BMC psychiatry*, 19(1), pp.1-10.

Soliman, M., Peetz, J. and Davydenko, M., (2017). The impact of immersive technology on nature relatedness and pro-environmental behavior. *Journal of Media Psychology*. 29, 8-17. https://doi.org/10.1027/1864-1105/a000213

St. Jacques, P., Rubin, D.C., LaBar, K.S. and Cabeza, R., (2008). The short and long of it: Neural correlates of temporal-order memory for autobiographical events. *Journal of cognitive neuroscience*, 20(7), pp.1327-1341.

Unsworth, S., Palicki, S.K. and Lustig, J., (2016). The impact of mindful meditation in nature on self-nature interconnectedness. Mindfulness, 7(5), pp.1052-1060.

Vally, Z. and El Hichami, F., (2019). An examination of problematic mobile phone use in the United Arab Emirates: Prevalence, correlates, and predictors in a college-aged sample of young adults. *Addictive behaviors reports*, 9, p.100185.

Wald A ., (1943). Tests of statistical hypotheses concerning several parameters when the number of observations is large. *Transactions of the American Mathematical Society*, 54(3), 426-483.

Wang, X., Geng, L., Zhou, K., Ye, L., Ma, Y. and Zhang, S., (2016). Mindful learning can promote connectedness to nature: Implicit and explicit evidence. *Consciousness and cognition,* 44, pp.1-7.

Yen, C. F., Tang, T. C., Yen, J. Y., Lin, H. C., Huang, C. F., Liu, S. C., & Ko, C. H., (2009). Symptoms of problematic cellular phone use, functional impairment and its association with depression among adolescents in Southern Taiwan. *Journal of adolescence,* 32(4), 863-873.

Zylstra, M.J., Knight, A.T., Esler, K.J. and Le Grange, L.L., (2014). Connectedness as a core conservation concern: An interdisciplinary review of theory and a call for practice. *Springer Science Reviews*, 2(1-2), pp.119-143.