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RESEARCH ARTICLE

Nature on screen: The implications of visual media for human-nature relationships

Stepping into the Wildeverse: Evaluating the impact of augmented reality mobile gaming on pro-conservation behaviours

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Abstract

 Promoting pro-conservation behaviours has become a priority for conservation organisations world-wide. Yet, current engagement strategies still face a number of barriers to creating successful interventions at the scale needed to meet global sustainability challenges.

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- 2. Online and mobile games enjoy immense world-wide popularity, tapping into an audience not normally reached through conventional conservation outreach channels. Despite this potential to be a new, high impact and scalable platform for promoting pro-environmental behaviours, the opportunities within digital games for conservation have thus far been little explored and organisations have called for robust impact evaluations for this medium. Therefore, we investigated the effectiveness of the augmented reality game Wildeverse, which seeks to generate support for ape conservation and encourage pro-environmental behaviours.
- 3. We conducted a randomised control trial to experimentally compare the impacts of this game against watching a documentary, a conventional conservation outreach intervention. We compared changes in participants' knowledge, attitudes and revealed donation behaviours across the two groups and found that games performed as well as documentaries in supporting positive environmental knowledge and attitudes.
- 4. The results gathered from this study provide experimental insight into the potential for the broader use of digital games for conservation outreach and also provide evidence against the argument that gaming can detract from real-world environmental problems creating a disconnect with these issues. However, results from this study could not provide any evidence that Wildeverse was successful in achieving its additional aim of encouraging players to donate to conservation, which provides evidence for the existence of an environmental values-behaviour gap in conservation gaming.
- 5. The gaming industry is global and rapidly growing and should no longer be ignored as an avenue for conservation outreach. We recommend several ways in

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which future studies can expand on this work to better understand how to effectively harness the power of digital games to drive tangible change that benefits biodiversity.

KEYWORDS

augmented reality, behaviour change, digital games, donation behaviours, evaluation, species conservation, theory of planned behaviour

1 | INTRODUCTION

As human behaviour is a key driver behind the major threats to biodiversity loss, encouraging pro-environmental behaviours has become an important and established goal of biodiversity conservation (Nielsen et al., 2021). Conservation focussed organisations world-wide have invested considerable amounts in education and awareness-raising activities, whether this is to promote individual behaviours like recycling or donating to conservation or encourage public behaviours such as supporting environmental policies (Kapos et al., 2008). However, despite this investment, public support for and engagement with conservation has been limited as these behaviour change interventions often fail to reach audiences and effectively influence their behaviours (Wright et al., 2015).

One issue faced when designing conservation interventions is how to engage urban populations with environmental problems. Individuals living in urban areas have the highest environmental impacts, for example, cities are the source of 75% of the global CO₂ emissions (Bai et al., 2018), but also have the highest levels of disconnection to the environment due to limited direct access to nature (Hodson & Sander, 2017). These issues are likely to become increasingly prominent with estimates that an additional 2.5 billion people will be added to the world's urban populations by 2050 (UN, 2018). Additionally, while some experienced a greater re-connection with nature during the enforced lockdowns across many countries in response to the Covid-19 pandemic (Pouso et al., 2021), contrasting research suggests this scenario had further limited urban populations' access to nature (Slater et al., 2020). Another challenge is effectively communicating the complex 'wicked problems' that often arise when managing both the environmental and social aspects of conservation which can result in trade-offs and unintended consequences (Redpath et al., 2015). Providing the public with the information necessary to understand these complexities is a vital step towards influencing a behaviour change (Tonglet et al., 2004), but can often compete with the need to keep an intervention's messaging simple and engaging, often resulting in campaigns being either information intensive or limited and oversimplified (Bickford et al., 2012).

Traditional conservation outreach efforts have attempted to drive positive environmental action by sharing information with as many people as possible about a given cause, utilising mass media campaigns, and the distribution of printed materials to foster behaviour change (Wright et al., 2015). One such example is nature documentaries, which have increasingly recognised the anthropogenic threats faced by many species globally (Jones et al., 2019). Nature documentaries represent a mass media tool that has been proposed to be used for conservation outreach. For example, the BBC Natural History Unit state that their Natural World films aimed to 'entertain as well as inform' (BBC, n.d.). However, nature documentary interventions are likely affected by self-selection bias, where those already interested in the environment will be more likely engage with the intervention, a phenomenon that can lead to these outreach interventions 'preaching to the converted' (Howell, 2012). In addition, there is little evidence supporting the ability of nature documentaries to effectively foster pro-environmental behaviours among its audiences (Dunn et al., 2020; Fernández-Bellon & Kane, 2019). There is therefore a need for conservationists to take advantage of a novel intervention opportunity with wide engagement that is also effective in changing behaviours (Mazur-Stommen & Farley, 2016).

1.1 | Mobile app gaming

Online gaming has been hailed as a new public engagement platform for conservation outreach to effectively foster proenvironmental behaviour change (Sandbrook et al., 2015). This kind of platform is appealing for conservationists as it boasts a vast and diverse audience. In 2019 there was an estimated 2.7 billion gamers globally (NewZoo, 2020), with mobile gaming a fastgrowing section of the global gaming market (NewZoo, 2020). In addition, digital and online games boast a huge indirect online audience through video game live streaming sites such as Twitch, where there are currently 26.5 million daily active users (Dean, 2021). Digital games have come to play an important role in many individuals' daily lives as a means of relaxation and social interaction. The digital gaming medium therefore offers the opportunity for conservationists to tap into and engage with a diverse audience in a way that is not off-putting and moves past passive viewing (Salvador, 2017). In addition, digital games have been found to be an important force for behaviour change, having already been shown to be successful in health-related behaviour interventions (Baranowski et al., 2008). Digital games have been found to use several mechanisms, such as repetitive play, motivated working, skills development and multi-user play, which have the potential to support pro-social behaviours (Baranowski, 2018; Berger et al., 2014; Berger & Schrader, 2016; McGonigal, 2010).

Digital gamers are already expanding into conservation and environmental topics, such Planet Zoo released in 2019. This game tasks players with creating a virtual zoo, and covers real-world topics related to this ex-situ conservation, such as, breeding species for genetic diversity and even gives player's zoos a 'conservation rating' (Hafer, 2019). In addition, in 2019 Internet of Elephants released the mobile app game 'Wildeverse: A Wildlife AR Game', or 'Wildeverse' (https://www.internetofelephants.com/wildeverse), which aims to educate players about the threats faced by great apes using augmented reality (AR) technology.

Despite the high potential value of this medium for conservation (Sandbrook et al., 2015), there have been concerns in using digital games to drive pro-environmental behaviours. Kahn (2011) argued that games could detract from real-world environmental problems and create an even greater disconnect with these issues. The risks and opportunities within digital games for conservation have thus far been little explored and organisations have called for robust impact evaluations for this medium (Arts et al., 2015; Fletcher, 2017; Rai & Beck, 2017; Truong & Clayton, 2020).

Human behaviour is complex and influenced by an array of internal and external factors (Tonglet et al., 2004). Several theoretical frameworks for identifying the influencers and barriers to pro-environmental behaviours have been developed (Davis et al., 2015), one of the most widely used being the theory of planned behaviour (TPB; Ajzen, 2011). The TPB identifies the main constructs guiding behaviours and behavioural intention to be: knowledge of the behaviour and its outcomes; attitudes towards the behaviour; subjective social norms around performing this behaviour; and the perceived ability to exert control over one's behaviours and the subsequent outcomes, or perceived behavioural control. There has been a call for conservation researchers to utilise the wealth of knowledge from the behavioural science in applying models, such as the TPB, to conservation-related behaviours (St. John et al., 2010). We, therefore, used the TPB to guide this research, as this model has also previously been found to be an appropriate predictor of evaluating the impact of digital games on pro-environmental behaviours (Rai & Beck, 2017).

1.2 | Aims and objectives

Our research aimed to evaluate the impact of the conservation mobile app game 'Wildeverse' on players' donation behaviours. For this study, we focussed on addressing two main research questions:



FIGURE 1 Screenshots showing the in-game play of Wildeverse: A Wildlife AR Game, courtesy of Internet of Elephants

- What is the effect of 'Wildeverse' on players' knowledge, attitudes, subjective social norms, perceived behavioural control and behavioural intentions when compared to a conventional conservation intervention?
- 2. Can playing 'Wildeverse' influence players' willingness to donate to a charity related to the conservation of great apes when compared to a conventional conservation intervention?

2 | METHODS

Wildeverse is set up to allow players to track and monitor virtual animals, taking the player behind the scenes of real conservation work and introducing them to the complex and multi-faceted world of conservation, with the ultimate goal to generate support for great ape conservation through increased donation behaviours (Figure 1). To determine if Wildeverse achieves its aims of promoting pro-conservation behaviours among players, any assessments of Wildeverse must use a meaningful measure of behaviour and a robust experimental design to understand cause-effect relationships.

To test these research questions, we designed a randomised control trial (RCT) experiment with two conditions: a treatment condition (which consisted of playing the game 'Wildeverse' for 3 hr), and a control condition (which consisted of watching three 1 hr episodes of the BBC nature documentary series 'Primates'). We used a nature documentary as our control condition as documentaries are a more conventional method of raising public awareness about conservation issues when compared to mobile app games. We specifically used the nature documentary 'Primates', a three-part documentary series from the BBC Natural History unit, first released in May 2020 (Selby, 2020), as the series explored the animal behaviour and conservation of primates across the globe and covered similar topics on great ape conservation as mobile app game Wildeverse.

The RCT experiment was conducted with participants based in the United Kingdom who were recruited online using a recruitment agency. Those invited were offered to take part in an online research project requiring them to complete a 3 hr assigned task and two short questionnaires. Each participant was offered a cash incentive of GB£50. Prior to their inclusion in the research, we screened each participant against an inclusion criteria to ensure our final sample was representative across age, gender and ethnicity. In addition to these demographic screeners, we also screened potential participants against their prior conservation experience and gaming interest. We asked all participants if they were a member of an environmental organisation or had any previous experience of volunteering for one. Those that selected 'yes' to one or both of these questions were classified as having previous experience in the environment sector. Similarly, we also asked participants how long they had spent playing a mobile game in the last week and those that answered over 3 hr were classified as having an interest in gaming. Only individuals with either a prior interest in conservation, gaming or both were included in our final sample to better represent the true players of the Wildeverse game.

Study participants were asked to complete a 10-min questionnaire (Appendix 2) before spending the following 7 days completing their assigned task for a total of 3 hr. Three hours was used as a threshold as this was estimated to be the length of time it would take to complete the Wildeverse game by Internet of Elephants. After the 7 days were complete, all participants were asked to re-take this questionnaire (Figure 2). The questions outlined in this second questionnaire were in a different order to the first questionnaire to account for any order effect.

This questionnaire was designed to elicit information on the behavioural constructs identified within the Theory of Planned Behaviour model (Ajzen, 2011), including a set of core questions relating to attitudes towards general pro-environmental actions; subjective social norms around preforming pro-environmental behaviours; and perceived control of wider environmental issues. The questions were structured as statements with a Likert scale response such as:

Q. My concern for environmental issues is not particularly high.

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

We also included demographic questions to elicit information on the participant's background, including their formal education level, age and gender. As well as these core set of questions, we included a set of specific questions on participants' knowledge, attitudes, subjective social norms and perceived behavioural control relating to the threats and conservation of great apes. Such as:

Q. It is impossible to stop species going extinct.

- a. Strongly agree
- b. Agree
- c. Neither agree nor disagree
- d. Disagree
- e. Strongly disagree

Measures relating to the behavioural intentions of respondents were also included within the survey. Participants were asked how regularly they would purchase palm oil free and FSC certified products in stores on a scale of never to frequently. Intentions of performing these specific behaviours were included as they relate to the threats faced by great apes that were discussed in the control and treatment intervention. We measured actual donation behaviours by asking participants at the end of the second survey if they would like to donate a portion of their incentive payment (GB£50) to one of four charities that were connected with the conservation of apes, or to a charity of their choosing. The charities listed at the end did not include the charities that were linked to the Wildeverse game.



FIGURE 2 Flowchart showing the randomised control trial experimental design including pre-experimental and post-experimental measures

2.1 | Ethical approval

All participants included in this study were over 18 years of age and were required to electronically sign an informed consent form prior to their participation in the research (see Appendix 1). This consent form outlined how participant data would be used by the researchers, highlighting that post-data collection, personal identifiers would be permanently deleted and all data collected would be reported as aggregates in publications. The experimental design and participant consent process were approved by the University of Oxford Medical Science Interdivisional Research Ethics Committee (R70049/RE001).

2.2 | Sample size

We conducted an a priori power analysis in R (version 4.1.0) using the package PWR (Champely, 2018). We used the following parameters to determine our recommended sample size for testing the difference between two groups: alpha = 0.05, power = 0.8 and between-group effect size = 0.2 (Cohen, 1977). We sampled 182 participants in total (91 in the control group and 91 in the treatment group), which provides a statistical power of 0.8 for the stated effect size.

2.3 | Analysis

We analysed the data collected using the statistical programme R (version 4.1.0) and the packages EPIR (Stevenson et al., 2020), LME4 (Bates et al., 2015), EFFECTSIZE (Sacher et al., 2021) and MASS (Venables & Ripley, 2002). The R code used for this analysis has been included as an appendix (Appendix 3).

First, we calculated participants' overall knowledge scores by summing the total number of correct answers which were then presented on an ordinal scale from 1 to 5. Attitudes, subjective social norms and perceived behavioural control scores were calculated by converting the Likert scale to a numeric scores. Questions that were negatively worded were reverse scored and included in this calculation. We also coded participants' behavioural intentions and donation behaviours as binary responses with '1' for a donation to a charity related to ape conservation or an intention to purchase environmental products and '0' for no donation or no intention.

We used standardised mean difference (SMD) testing to compare the baseline characteristics of the control and treatment groups to ensure an even baseline across the sample groups by observing how the categories of these additional explanatory variables were divided between the control and treatment groups. For these analyses, we further grouped ethnicities into four categories 'Asian', 'Black', 'Mixed' and 'White' to retain a degree of statistical power by ensuring that these groups were not too small and thus less likely to be representative. The SMD scores for each variable were compared using Cohen's effect size measurements (Cohen, 1977), whereby a large effect implies the difference is observable when comparing two groups. If a variable was found to have a large effect size, it was added as a fixed effect in our subsequent analysis models to account for this.

To examine the research questions: (1) What is the effect of 'Wildeverse' on players' knowledge, attitudes, subjective social norms, perceived behavioural control and behavioural intentions when compared to a conventional conservation intervention, we used an ordinal logistic regression model to measure the influence of the interaction between the intervention group and pre- and postmeasure on participant questionnaire scores for each TPB construct. We used a generalised linear mixed model (GLMM) to measure the influence of the interaction between the intervention group and pre- and post-measure on behavioural intention (which were coded as binary responses). Therefore for each of these models, the explanatory variable used was a fixed interaction effect between the task group (treatment or control) and stage of questionnaire (before or after; i.e. Group × Questionnaire stage). We also included participants' unique ID as a random effect, with education level and ethnicity included as fixed effects in the model. Effect sizes were then extracted from these models to examine the size and direction of the influence of both the control and treatment intervention on the likelihood of a change in questionnaire answers.

We also used a GLMM to examine the research questions (2) Can playing 'Wildeverse' influence players' willingness to donate to a charity related to the conservation of great apes when compared to a conventional conservation intervention. The GLMM was used to take into account the influence of any covariates (including participants' unique ID as a random effect and education level and ethnicity included as fixed effects) on the observed outcome (donation behaviour, coded as a binary response). However, unlike the models used for the TPB constructs and behavioural intention, pre- and post-measures were not included in this model as the donation behaviour was only recorded after the intervention. Therefore, the fixed explanatory variable for this model was just the task group (treatment or control). Effect sizes were then extracted from these models to examine the size and direction of the influence of both the control and treatment intervention on the likelihood of participants donating to ape conservation.

3 | RESULTS

3.1 | Sample

The majority of participants were aged between 18 and 25 years in both the control and treatment groups (24% and 25% of participants respectively). This was followed by the age categories 26–35 (control = 24% and treatment = 20%) and 46–55 (control = 21% and treatment = 21%). The sample was also slightly skewed towards female participants with 54% of participants in the control group and 56% of participants in the treatment group identifying as female. The majority of participants across both the control and treatment groups had either completed high school (43% and 35% respectively) or an undergraduate degree (43% and 49% respectively). In answer to the survey question 'Over the past year, how many times have you donated money to an environmental conservation charity?' the majority of participants across both the control and treatment group chose the option 'not at all' (37% and 33% respectively). The next most frequently selected option within both groups was 'once in the past year' (control = 35% and treatment = 32%) and the option 'once a month' was the least frequently selected (control = 12% and treatment = 11%).

When comparing the two groups using standard mean differences, ethnicity and education were found to have a higher mean difference (SMD = 0.27 and 0.19 respectively) between the control and treatment groups (Table S1). These factors were therefore included as fixed effects within our mixed models.

3.2 | Knowledge, attitudes, social norms and behavioural control

Participants across both the control and treatment groups had high pre-existing positive attitudes towards great ape conservation, with average scores on the pre-survey of 90%. A similar trend was found for perceived behavioural control scores (pre-survey average of 82%) indicating that, before the intervention, participants perceived themselves to have high levels of control over pro-environmental behaviours and their outcomes.

When first entering Wildeverse, players are asked some questions relating to their interest in and understanding of the environment and conservation issues. As of December 2020, we found that 72% of Wildeverse players answered the question 'What brings you to the Wildeverse' with 'Anything to do with animals I'm in!' whereas the remaining 28% of players indicated that they had been more attracted by the tech or virtual elements of the game. Similarly, in answer to the question 'Do you know much about wildlife', 51% of players indicated they had a high level of knowledge about the environment by answering 'Yes! I love wildlife and even get involved in conservation', whereas 49% indicated they had less understanding, answering either 'A bit ... I like animals but don't know much about them'. or 'Not really. But I like a good adventure'. These findings do indicate that the majority of Wildeverse players are already interested in and knowledgeable about the environment, which is similar to our sample for this study.

Across both the control and treatment groups, the mean participants' knowledge, attitudes, subjective social norms and perceived behavioural control scores all increased from before to after these interventions. The largest mean increase in scores for the control group was seen in perceived behavioural control scores (average increase of 1.03 points) and for the treatment group was seen in knowledge scores (average increase of 0.48 points).

The results indicated that exposure to either the nature documentary (control intervention) or Wildeverse (treatment intervention) was associated with a higher likelihood of being knowledgeable about the environment, having a positive attitude about the environment and having a greater sense of perceived control over protecting the environment. Results from the ordinal logistic regression model found participant's knowledge, attitudes, social norms and perceived behavioural control questionnaire scores had all been significantly positively influenced moving from pre to post the intervention (knowledge: ordered log odds estimate = 1.26, 95% CI [0.68, 1.84], p < 0.001; attitudes: ordered log odds estimate = 0.53, 95% CI [-0.14, 0.95], p = 0.036; social norms: ordered log odds estimate = 0.59, 95% CI [0.05, 1.12], p = 0.031; perceived behavioural control: ordered log odds estimate = 0.80, 95% CI [0.30, 1.34], p = 0.001), but not by placement in the control or treatment group or the interaction between these two factors (Table S2a-d). Neither education level nor ethnicity of participants was found to be associated with a change in TPB scores, except for participants' attitudes where ethnicity was found to have a statistically significantly effect on positive attitudes (Table S2c).

Effect sizes extracted from the ordinal logistic regression model highlighted that for the questions on participants' environmental knowledge there was a 63% chance that participants would get more answers correct when moving from before to after either the control or treatment interventions (95% CI 0.34, 0.92). Additionally, for the questions on participant's environmental attitudes, social norms and perceived control over environmental behaviours there was a 28% (95% CI 0.02, 0.54), 29% (95% CI 0.03, 0.56) and 42% (95% CI 0.17, 0.70) chance respectively that participants would move from disagree to these statements to agreeing with these statements (Figure 3).

3.3 | Behaviour and behavioural intention

The results from the survey questions covering participants' behavioural intentions of purchasing palm oil free or FSC products have been summarised in Table 1. We found that the majority of participants in both the control and treatment groups did not change their intention to purchase palm oil free products (53.8% and 68.1% of participants respectively) or FSC certified products (60.4% and 68.1% of participants respectively). Of those that did change their behavioural intention, within the treatment group 14.3% of participants went from not purchasing palm oil free product to purchasing these products compared to 27.5% of participants in the control group. Similarly, within the treatment group 17.6% of participants went from not purchasing FSC certified product to purchasing these products compared to 25.3% of participants in the control group.

The survey results indicated that exposure to either the nature documentary (control intervention) or Wildeverse (treatment intervention) was not associated with changes in the likelihood of increasing one's intention to purchase environmentally friendly products. Results from the GLMM found that the intention to purchase FSC certified or palm oil free products was not significantly influenced by placement in the intervention group (log odds = 0.20, 95% CI [-0.46, 0.86], p = 0.557; log odds = 0.36, 95% CI [-0.23, 0.96], p = 0.227 respectively), the pre-post-stage of the intervention (log odds = 0.47,



FIGURE 3 Effect sizes of participants' questionnaire scores increasing (a) moving from before to after playing either the control or treatment game, (b) compared between the control to the treatment group and (c) change in the treatment group between the pre- and post-intervention period, relative to the control group, for each TPB construct assessed. The dashed line indicated an effect size of 0

95% CI [-0.16, 1.12], p = 0.127; log odds = 0.36, 95% CI [-0.23, 0.96], p = 0.197 respectively), or the interaction between these two variables (log odds = -0.32, 95% CI [-1.22, 5.74], p = 0.454; log odds = -0.50, 95% CI [-1.34, 0.34], p = 0.208 respectively; Table S3).

Model results highlighted that the likelihood of participants changing their intent to purchase FSC or palm oil free products from either before to after either of the intervention was an unlikely occurrence as the 95% confidence intervals for all effects of interest overlapped zero (Figure 4).

Within the control group, 26 participants chose to donate part of their incentive payment to one of the ape conservation charities, with an average donation amount of £8.26 (SD = 5.028). Comparatively, 16 participants in the treatment group chose to donate part of their incentive, with an average donation amount of £9.06 (SD = 8.797).

Results indicated that from the GLMM model found the log odds estimate of participants donating to an ape conservation charity was not significantly influenced by the intervention group (log odds estimate = -0.13, 95% CI [-0.25, -0.002], p = 0.054; Table S4). Effect sizes extracted from this model highlighted that it was unlikely that donation behaviours would increase in the treatment group compared to the control, with an effect size of -0.27 (95% CI -0.56, 0.02).

4 | DISCUSSION

While past research into harnessing digital games for biodiversity conservation has theorised about the potential benefits and drawbacks of this platform, this work has remained largely speculative (Büscher, 2016; Sandbrook et al., 2015). Our evaluation,

	Control		Treatment	
Question	Before the intervention	After the intervention	Before the intervention	After the intervention
When grocery shopping, do you look out for palm oil free products?	50.6%	59.4%	59.3%	56.0%
When buying paper-based products, do you look to see if they come from FSC (Forest Stewardship Council) certified sources?	26.4%	36.3%	30.8%	34.1%

TABLE 1 Percentage of participants who answered 'Yes' to survey questions relating to their intention to purchase palm oil free and FSC products before and after either the control or treatment intervention

therefore, provides important empirical evidence on which to base these theories as well as a robust and replicable methodology upon which future evaluations of conservation games can be constructed.

4.1 | Games for conservation outreach

The findings from this research suggest that, when it comes to changing environmental knowledge, attitudes, social norms and perceived behavioural control, mobile app games perform as well as documentaries in influencing positive change. The results gathered from this study provide experimental insight into the potential for the broader use of digital games for conservation outreach. Although there are currently few robust evaluations of digital games for environmental outreach (Sandbrook et al., 2015), these results add to the available evidence that conservation games can influence positive knowledge and attitudes towards the environment through a virtual experience, rather than a real one. For example, De Vries et al. (2011) tested the effectiveness of the digital game 'EnerCities' and also found that playing this game had a positive influence on players knowledge and attitudes towards energy-saving behaviours. This result has also been found for games that are not overtly conservation themed. A study from Crowley et al. published in 2021 found that players of the actionadventure game Red Dead Redemption 2, which is based in a late 19th century North American ecosystem, had an increased knowledge of identifying wildlife species.

However, there has previously been a degree of scepticism over the use of digital games for conservation (Greenwood, 2012; Kahn, 2011). Specifically, there is a concern that the focus of these games on virtual settings will draw the users' attention away from interest in and engagement with the natural landscapes and create a disconnect with conservation issues (Greenwood, 2012; Kahn, 2011; Sandbrook et al., 2015). This study offers experimental evidence to counter this argument, concluding that a game focussed on species conservation can increase understanding of environmental issues as well as positive attitudes, and perceived behavioural control among players in a virtual setting. While previous research has found that direct access to nature is also important for promoting positive impacts on mental and physical health (Bratman et al., 2019; Hartig et al., 2014; Tillmann et al., 2018), a recent study from Yeo et al. (2020) found that these benefits could also be derived from digital technologies that create immersive experiences of nature, such as virtual reality (VR) headsets. The study demonstrated the potential of using digital technologies to provide players with boosts in wellbeing when direct access to nature is limited or not possible, such as during the current wave of nationwide lockdowns due to the Covid-19 pandemic (Yeo et al., 2020). Although measures of positive and negative feelings were not something that was included in this study, we recommend researchers to consider these factors for future evaluations of conservation games to further assess their potential impacts.

While Yeo et al. (2020) focussed on the influence of VR, a fully immersive technology which brings the player into a completely virtual world, there is also the potential for AR, which merges virtual nature and the real environment, to positively influence player's connection to nature (McMillan et al., 2017). A unique element of the Wildeverse gameplay is that it harnesses this AR technology, allowing players to be immersed in the habitats of great apes while also encouraging players to go outside and explore their local environments, something currently not achieved by nature documentaries. While environmentalists have expressed concern that electronic technology is contributing to a growing 'nature-deficit disorder' (NDD; Fletcher, 2017), the use of AR has previously been found to have a significant influence in driving players outdoors and increasing the time they spend there, for example in the popular mobile app game 'Pokémon Go' (Dorward et al., 2017). Although Pokémon Go has been found to increase interactions with non-virtual wildlife among players (Brulliard, 2016), the game does not make an explicit attempt to connect players to conservation issues (Dorward et al., 2017). Wildeverse, therefore, offers an exciting opportunity by both encouraging players into natural settings using AR as well as employing a conservation focussed narrative. Unfortunately, within the present study, we were not able to fully explore the influence of Wildeverse in encouraging greater interaction with nature as, due to the UK-wide restrictions imposed by Covid-19 at the time of this study, the game had to be adapted for indoor play. We, therefore, encourage future studies to expand on this research by exploring the influence of playing AR conservation games in a natural setting.



FIGURE 4 Effect sizes of participants' increasing their intention of either purchasing palm oil free products or FSC products (a) moving from before to after playing either the control or treatment game, (b) compared between the control to the treatment group and (c) change in the treatment group between the pre- and post-intervention period, relative to the control group, for each TPB construct assessed. The dashed line indicated an effect size of 0

4.2 | Games for behaviour change

While the above results demonstrate the ability of Wildeverse to encourage players to think about species conservation, an important first step for successful conservation intervention, a key aim of this game was to increase support for species conservation through changes in consumer purchasing behaviours and promoting donations towards great ape conservation. However, results from this study could not provide any evidence that Wildeverse was successful in achieving this aim, as both the intention to purchase environmentally friendly products as well as donation behaviours were not significantly influenced by playing Wildeverse.

The results from this study therefore provide evidence for the existence of an environmental values-behaviour (EVB) gap in conservation gaming (Fletcher, 2017). This occurs when an intervention

is able to inspire concern about environmental issues but fails to precipitate the corresponding action among participants (Kennedy et al., 2009). Past research has found this EVB gap to occur with other types of media-based conservation interventions such as documentaries (Dunn et al., 2020), as well as other digital games (Gremaud, 2013). The concern with employing digital games for conservation is that the instant gratification achieved while playing games could offer the false pretence that the player has accomplished something for conservation despite this action not translating this into a real-world impact (Fletcher, 2017). In the case of Wildeverse, although playing the game was found to positively influence players' understanding of and concern towards great ape conservation, this did not translate into a significant behavioural action such as donating towards great ape conservation. It should be noted that while efforts were made to measure the true donation behaviours of individuals, the set up of the experiment could have influenced how willing participants were to part with this money. For example, offering participants their compensation just before asking them if they would like to make a donation could have made it easier for participants to part with this money, known as the payday effect (Gelman et al., 2014).

However, it is important to remember that there are also many factors relating to the specific design of a digital game itself that can determine its effectiveness in promoting pro-environmental behaviour change. One example is how the game frames a conservation issue, with conservation games being previously found to vary in their views of nature and explicitly of conservation messaging (Sandbrook et al., 2015). This feeds into the debate surrounding the use of entertainment-education (or edutainment), which states that there is a trade-off between these two goals which must be carefully weighed as there is a danger that a heavy focus on entertainment can in fact distract the audience from any issues being discussed (Okan, 2003). This trade-off can be particularly challenging when educating audiences on complex and multi-faceted problems, which describe many issues that exist within environmental conservation. One example of this within the context of the Wildeverse game relates to the complex issue of harvesting palm oil. While palm oil plantations are recognised to cause destruction of species habitat, popular alternatives to this product are have actually been found to be more environmentally damaging (Beyer et al., 2020). Therefore, it is important to consider that the relationship between environmental knowledge and behavioural intentions is not straightforward nor linear when it comes to complex conservation issues such as palm oil. It is therefore important that future research builds upon this current study by evaluating the effectiveness of a variety of conservation digital games in promoting a behaviour change to build up a comparative evidence base of digital games for conservation. This could also include digital games that use a variety of methods for behavioural responses, such as embedding real donation payments within the gameplay in the form of microtransactions (Sandbrook et al., 2015).

In addition, scholars have also pointed to the difference in impact on the individual resulting from the specific species that is displayed during an intervention. Truong and Clayton (2020) argue that digital games have the potential to feed into the disconnect between people and their local biodiversity as media interventions tend to over-represent charismatic megafauna, such as great apes (Clucas et al., 2008). Truong and Clayton (2020) go on to postulate that lack of awareness about local species could lead to a lack of interest in their conservation. It is therefore important that future studies on the impact of digital games for conservation build on this work and evaluate the impact of games based on local or less well-known species, such as those in the Evolutionarily Distinct and Globally Endangered category (EDGE-species; Isaac et al., 2007).

Our findings further postulate that behavioural drivers beyond those identified in the TPB are important for influencing an individual's donation behaviours and intention to purchase environmental products. For example, an extended TPB model which included the additional measures of individual moral norms surrounding giving to charity and past donation behaviours was found to be a better predictor of actual donation behaviours (Smith & McSweeney, 2007). Similarly, Triandis' theory of interpersonal behaviour incorporates the function of habitual response, arguing that habits are mediators in influencing a given behaviour (Triandis, 1994), such as in the intention to purchase environmentally friendly products (Kim, 2011).

4.3 | Research limitations and future directions

There are some limitations to this research that should be acknowledged before the results are applied to future research and practice of conservation digital games. First, while carrying out the randomised control trials a total of 41 participants in the treatment group experienced technical issues with the Wildeverse gameplay which ranged from glitches in the AR map to the game closing down frequently. While the results from this study do not suggest that these technical issue had a detrimental impact on players' donation behaviours (of the individuals that made a donation within the treatment group, nine did not experience technical issues and seven did), it is not clear if these issues had the potential to distract players from the immersive gameplay in Wildeverse and could therefore have reduced the effects of playing the game when compared to the control group. We recommend that future studies carefully consider the technical requirements necessary when testing digital games, and in particular more advanced technologies such as AR, as digital games require the active participation of players, who may not be well adept or knowledgeable with these technological requirements. However, this should also be recognised as a limitation of using AR in digital games as this advanced technology makes the player base more restricted.

Another limitation of this study is that, while participants were exposed to either the control or treatment intervention for a week, this time period may not have been long enough to record the sustainment of any influence from these interventions. Previous research has found that, while knowledge and attitudes may increase during or immediately after exposure to digital interventions, these changes will often not persist in the long term (Howell, 2012; Rondon et al., 2013). It is therefore important that evaluations of digital games should consider how well these changes are retained post-exposure to the game to fully understand the impacts of this intervention.

Finally, although we included a mixture of both individuals interested in the environment and those interested in gaming within the sample for this study, our final sample size was not large enough for us to explore the effect of the intervention on these sub-groups. The sample size was restricted for this study due to the fixed compensation amount per participant required by the recruitment agency. Findings from the in-game measures of real-world Wildeverse players suggest that Wildeverse can reach a diverse audience and not just individuals with prior environmental interest, although these measures were based on self-reported responses and so offer a degree of uncertainty (Pahl & Wyles, 2017). Therefore, a comparison of how these different types of players are influenced by playing Wildeverse would be an interesting and important measure to consider when evaluating the real-world implications of the game (Mazur-Stommen & Farley, 2016).

5 | CONCLUSION

Digital games have often been met with the perception that they are a waste of time (McGonigal, 2010), or can result in behavioural problems (Ryan et al., 2006), but an increasing body of evidence is finding that, in actuality, playing digital games can offer a broad range of societal benefits (Baranowski et al., 2008, 2019; Johannes et al., 2021). This study offers an example of how digital games can be as successful as traditional conservation interventions in promoting positive ideas about nature and conservation and highlights that this technology can no longer be ignored as a potential avenue for outreach and engagement by conservation practitioners. We acknowledge that engagement through digital games is not a 'panacea' to the issues associated with conservation outreach, but at a time when conservationists need to engage more broadly with the public (Butchart et al., 2010), they may provide a high potential value to tap into the gaming audience and motivate engagement with global threats to biodiversity. However, to fully harness the potential that this platform can offer, we need to better understand in what ways digital games can influence proenvironmental behaviours to ensure they can also be used drive tangible change that benefits biodiversity.

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CONFLICT OF INTEREST

Game developers Internet of Elephants funded part of this research which aims to evaluate their products.

AUTHORS' CONTRIBUTIONS

M.E.D., G.S. and D.V. conceived the project; M.E.D. and D.V. designed the methodology and collected the data; M.E.D. analysed the data and led the writing of the manuscripts and all authors edited the manuscript draft and approved its publication.

DATA AVAILABILITY STATEMENT

The authors have archived the data collected during this research in the online, publicly available database Dryad Digital Repository https://doi.org/10.5061/dryad.5hqbzkh6n (Dunn et al., 2021). Data can also be accessed upon request via the corresponding author.

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