

Research article

Battitude: A virtual zoo ‘bat experience’ produces positive change in attitudes to an unpopular species

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Abstract

Despite the wide-ranging benefits of bats for people, bats are poorly understood and often feared. The coronavirus pandemic has highlighted these issues, but has also provided opportunities to develop new approaches to tackle misconceptions and transform attitudes. A ‘virtual bat experience’ (VBE) was designed, which lasted 5 minutes and incorporated videos and images of zoo-housed fruit bats, along with information highlighting the important roles of bats and the need to protect them. Using an online survey, attitudes of a sample of 316 people were evaluated both before and after watching the VBE using semantic differentials and Likert scale responses. There were significant positive changes in attitudes to bats on all measures as a result of viewing the VBE. Participants who had previously visited a zoo bat exhibit were more likely to have positive attitudes to bats, and the two experiences (online and in-person) appeared to have additive effects.

Introduction

Bats are the second largest order of mammals in terms of number of species (Reeder et al. 2007), but are perhaps the least well understood (Lunney and Moon 2011). While they provide wide-ranging ecosystem services, from seed dispersal and pollination of a huge variety of plant species, to control of insect populations (Ramírez-Fráncel et al. 2022), they are nevertheless disliked or feared by many people, at least in modern times (Eklöf and Rydell 2021). Bats are frequently viewed as pests (Florens and Vincenot 2018), reservoirs for disease—whether or not this is justified (López-Baucells et al. 2018; Lu et al. 2021)—or simply as frightening (Boso et al. 2021; Castilla et al. 2020). The emergence of new viruses, including COVID-19, has brought many of these arguments to the forefront once again (Nanni et al. 2022; Sasse and Gramza 2021; Tuttle 2017).

About one in five of the world’s bat species are currently in the top three risk categories recognised by the IUCN (2021), i.e. Critically Endangered, Endangered or Vulnerable. The Old World fruit bats (Pteropodidae) are particularly at risk: 39% of species fall into these threat categories (IUCN 2021). Island endemics are under the greatest pressure of all (Conenna et al. 2017), but remain under-researched and despite major differences in size, appearance, habitat use and diet of micro and megabats (Altringham 1996), pteropodids suffer from all the associations that have accompanied their fellow chiropterans through history. Challenging such erroneous beliefs is crucial, as people who understand and value bats are more likely to be willing to support their conservation (Jaunky et al. 2021).

The conservation of fruit bats is therefore dependent on transforming these widespread and largely negative attitudes (Hoffmaster et al. 2016; Musila et al. 2018). Despite their global reach (Consorte-McCrea et al. 2019), zoos have often

not helped to dispel the misconceptions surrounding bats. Fruit bats are typically housed in nocturnal exhibits with reversed light cycles, so that the exhibits are dark and unwelcoming, and play into the basic human instinct that darkness is dangerous (Packer et al. 2011). Furthermore, zoo enclosures are often designed to look like caves, whereas fruit bats roost in trees in the daylight (Granek 2002; Hahn et al. 2014; Roberts et al. 2012), and even insectivorous bats are highly dependent on forests for their food (Frick et al. 2020). Zoo visitors are therefore unlikely to gain an accurate impression of the appearance, behaviour and lifestyles of fruit bats.

With rapid growth in technology, zoos now have the opportunity to develop innovative methods of engaging and communicating with both existing and new audiences (Rose et al. 2018), for example through webcams and other ways of presenting information about threatened species (Llewellyn and Rose 2021). The COVID-19 pandemic, which forced many zoos to close for long periods, has focused zoos' attention on these methods (Ryder et al. 2021). However, in their social media feeds and on platforms such as YouTube, zoos still typically dwell predominantly on entertainment, highlighting species that people find attractive and news items that will be appealing (e.g. births) (Llewellyn and Rose 2021; Rose et al. 2018).

In contrast, the authors' goal was to design an online experience that could simulate a visit to a fruit bat exhibit and promote positive images of and messages about these often unpopular animals. Jersey Zoo, headquarters of Durrell Wildlife Conservation Trust, has maintained colonies of two island fruit bat species for many years—the Endangered Rodrigues fruit bat *Pteropus rodricensis* since 1976, and the Critically Endangered Livingstone's fruit bat *P. livingstonii*, one of the largest bat species, since 1992. Although the Rodrigues fruit bats have at times had a reversed lighting regime, the Livingstone's fruit bats have always been housed on a natural light cycle. Both bat species now share an enclosure that has been developed over the past decade or so into a large, well-lit flight aviary with abundant vegetation (Edwards et al. 2021; Wormell 2012).

The aim of this study was to assess the extent to which providing a close-up view of bats in a naturalistic enclosure under natural light, along with information about their ecological importance and conservation, could alter perceptions of these animals. A 'virtual bat experience' (VBE) was developed using images and video material from the Jersey bat exhibit, and a repeated-measures survey design was used to investigate how viewing the VBE affected attitudes to bats and their conservation.

Methods

Location

Jersey Zoo's 'Island Bat Roost' exhibit is 38 m long × 14 m wide × 4 m high. Visitors can get quite close to the animals (sometimes within a metre), but people and bats are separated by nylon mesh screening. The enclosure is based on an agricultural polytunnel and is therefore well-lit, with luxuriant vegetation (Edwards et al. 2021; Wormell 2012).

Participants

The snowball sampling method (Parker et al. 2019) was used to reach as many potential participants as possible, using LJ's contacts as seeds. Use of Durrell's own social media and website to promote the study was deliberately avoided, so that the sample was as unaffected as possible by bias towards people who already support conservation efforts. A link to the survey was posted to multiple different forms of social media, encouraging people to share the link with others once they had completed the questionnaire. The survey was available to access between 19

January and 8 April 2021.

A total of 470 responses were received, of which 316 were completed in full. The 154 partially completed responses were reviewed to check for any difference between those who had and had not completed the survey in full (such as highly negative views towards bats), but there was none. Overall, 70% of respondents were female, 29% were male and 1% did not identify as male or female. Age was categorised as 18–20 years (5.8% of participants), 21–29 years (21.5%), 30–39 years (10.0%), 40–49 years (14.8%), 50–59 years (19.3%) and 60 or over (28.6%).

Design of virtual bat experience (VBE)

The VBE attempted to recreate, as far as possible, what a visitor to the Island Bat Roost would experience. It consisted of photos and videos (Figure 1) displaying the two species of bat living in the enclosure; photos of the signage in the enclosure (which described

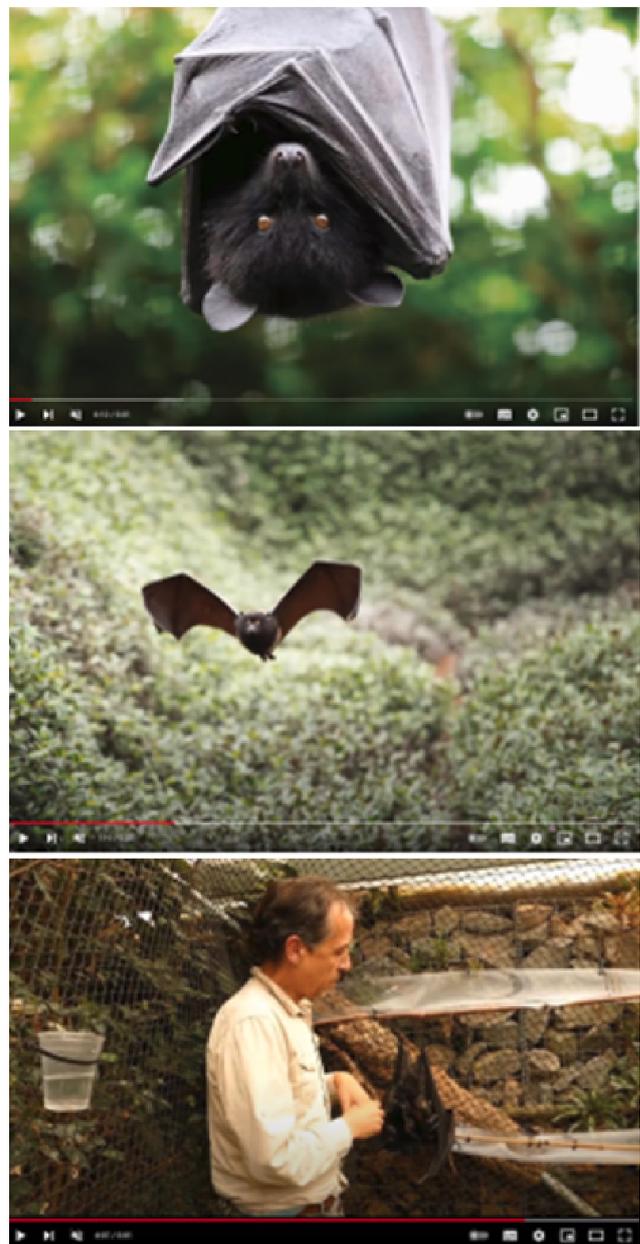


Figure 1. Stills from the virtual bat experience to illustrate the type of images included.

the importance of fruit bats to ecosystems, and dispelled some of the myths surrounding bats); multiple videos of bats in flight and engaging in a variety of other behaviours; many professionally taken bat images; and a video featuring a senior member of staff giving a talk about the bats, which included close-up footage of a mother fruit bat with her infant. The aim of this was to present bats in a positive light, emphasising their attractive characteristics and their nurturing behaviour. The VBE lasted approximately 5 minutes. Previous observations of 59 visitors to the zoo's bat house showed that people spent an average of 6.4 minutes in the exhibit (C. Firth, personal communication), so the VBE was comparable to the experience of visitors at the exhibit.

Survey design

The VBE was embedded within an online questionnaire using SmartSurvey (<https://www.smartsurvey.co.uk/>). At the start of the questionnaire, participants were asked for their gender, age, where they lived and whether they had visited the Jersey Zoo bat enclosure previously. A consent statement was also included.

Participants were asked to respond to a series of questions before watching the VBE. The first eight questions asked the participant to indicate, on a Likert-type scale of 1–5, how they felt towards bats in terms of seven different word pairs (i.e. semantic differentials). Word pairs were chosen based on previous studies (Perry-Hill et al. 2014; Poresky et al. 1988) and pilot observations of visitors in and near the fruit bat exhibit, including words that reflected aspects such as the appeal of the animals in terms of appearance and behaviour, how much they were valued and how dangerous they were perceived to be. The word pairs selected

were: unappealing–beautiful; dangerous–harmless; aggressive–friendly; dull–interesting; unimportant–valuable; lethargic–active and ugly–cute.

Participants were also asked to rate, on a scale of 1–5: (a) how much they associated bats with COVID-19; (b) how important they felt bat conservation was; and (c) how willing they would be to donate to bat conservation projects. The most negative response was always 1 on the scale and the most positive response 5. Pilot studies suggested that although reversing the negative and positive ends of the scale for some statements is often recommended, this confused some participants, resulting in inaccurate responses.

Finally, participants were asked to give three words that they associated with bats. They were then asked to watch the VBE. The same questions were repeated after the VBE, with the addition of a final question asking participants to rank how they had found the virtual experience overall, again on a scale of 1 (negative) to 5 (positive).

Statistical analysis

Because Likert scale data are ordinal, cumulative link mixed models (CLMMs) with a logit link function were run using the package 'ordinal' (Christensen 2019) in R version 4.0.3 (R Core Team 2020). The region from which the respondent came was closely associated with the likelihood that they had visited the bat exhibit at Jersey Zoo, so region was not included as a factor in the final analysis. The fixed factors analysed were therefore time (before or after watching the video), gender, age and whether the respondent had visited the bat exhibit before. An interaction term was also included to investigate whether the VBE had a different

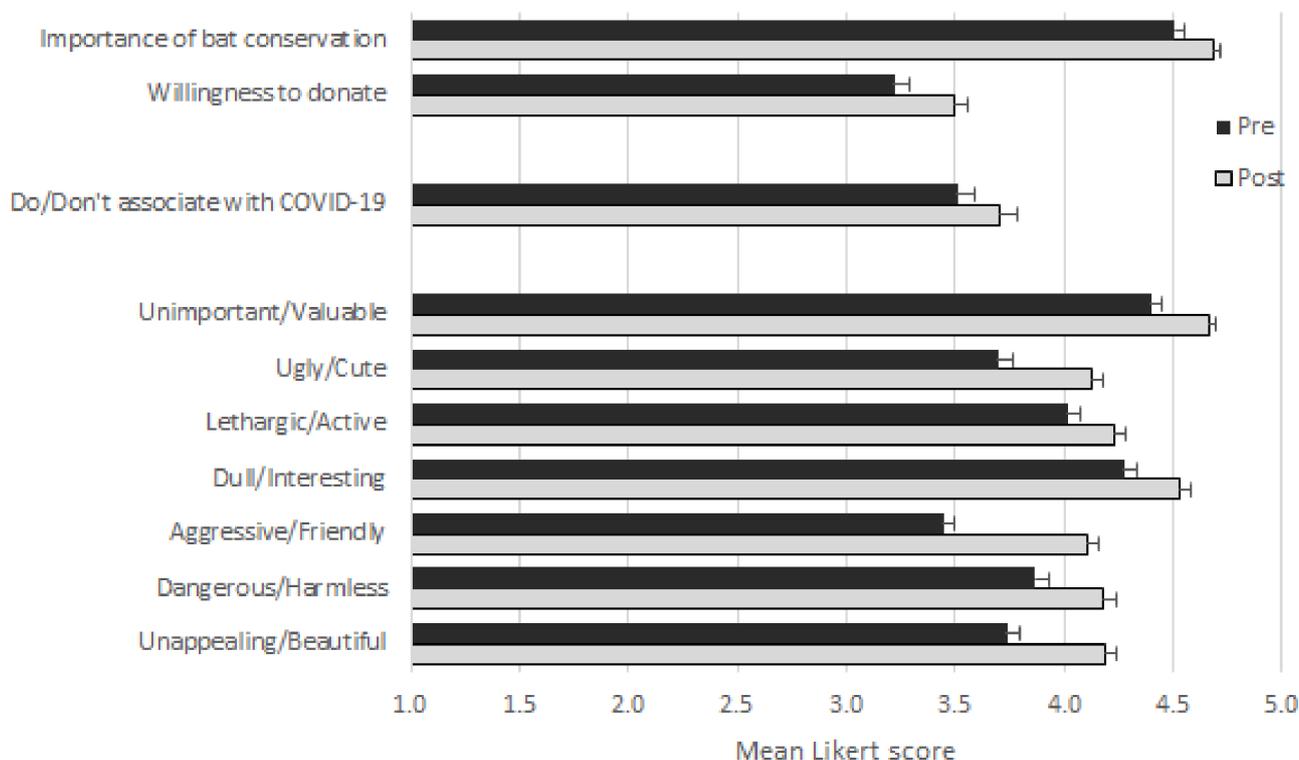


Figure 2. Change in mean Likert scores on seven semantic differentials and three attitudinal questions before (pre) and after (post) viewing a virtual bat experience. Likert scores were on a scale of 1–5. End bars indicate standard errors.

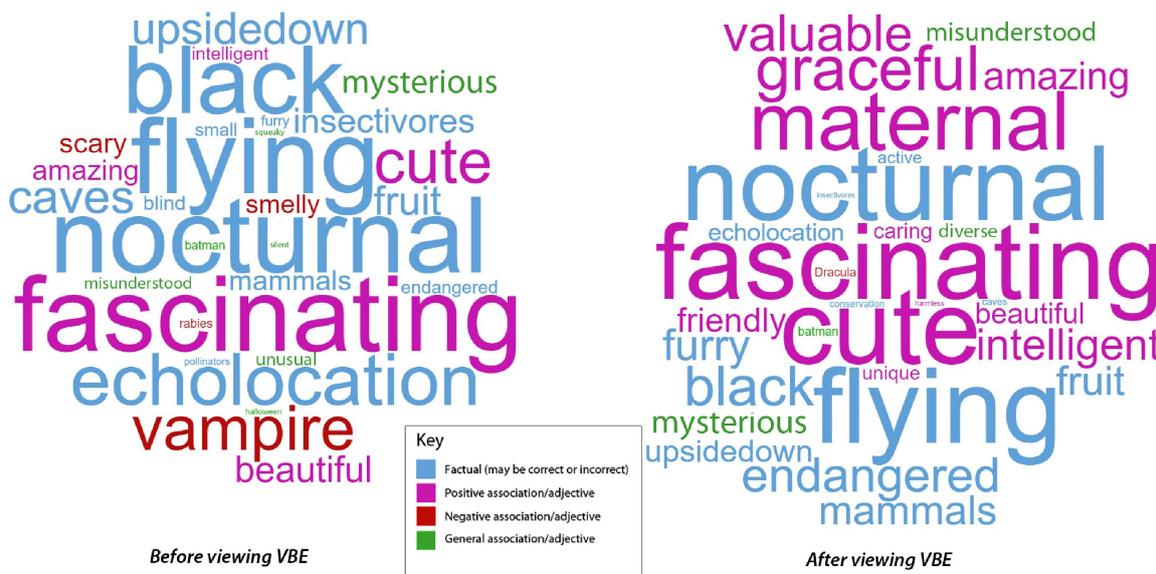


Figure 3. Word clouds showing words used to describe bats before (left) and after (right) viewing the virtual bat experience.

impact on participants depending on whether they had previously visited the bat exhibit. Participant ID was included as a random factor to account for the repeated measures design. Separate analyses were run for each question to evaluate the effects of viewing the virtual bat experience. The sample size was 316.

Cronbach’s alpha was used to investigate the consistency of participants’ responses to the seven semantic differential items.

Words used to describe bats were categorised into four classes: factual descriptions (which could be either correct or incorrect), positive associations/adjectives, negative associations/adjectives and general associations/adjectives. LJ initially coded all words and EP subsequently checked the codes and agreed in every case. A chi-squared test was used to investigate changes in the types and frequencies of words used by participants to describe bats before and after viewing the VBE.

Results

The results are summarised in Figure 2 and statistically significant results from the CLMMs are reported in Table 1. The only measure affected by sex was the ugly/cute semantic differential, with male participants scoring lower than females. There were also relatively few effects of age; where age was an influence, the typical pattern was for older participants (especially those aged 30–49) to have more positive attitudes.

In contrast, all measures were strongly affected by time (before versus after viewing the VBE), with positive changes following the VBE in each case. Most measures were strongly affected by whether the respondent had previously visited the Jersey Zoo bat exhibit, again with a positive effect of a previous visit.

For two word pairs, lethargic/active and ugly/cute, there was also a significant interaction between time and previous visits. For the ugly/cute word pair, those participants who had not previously seen the exhibit shifted their response more strongly towards ‘cute’ than did people who had visited the exhibit, but the difference between the two groups was not large. For lethargic/active, participants who had previously seen the bats shifted their rating of the bats much more strongly towards ‘active’ after the VBE than people who had not visited the exhibit. Participants who had previously visited the bat exhibit also showed a stronger

influence of the VBE on association of bats with COVID-19.

Cronbach’s alpha levels were high for scores on the semantic differential items both pre VBE ($\alpha=0.828$) and post VBE ($\alpha=0.844$), indicating that participants were consistent in how positive they were in their responses to the word pairs.

The two conservation indicators produced slightly different results. The importance of bat conservation was the only measure not influenced by a previous visit to the enclosure. This was affected only by time (before versus after viewing the VBE). In contrast, willingness to donate to bat conservation showed the same pattern as the majority of the semantic differential elements, being affected by a previous visit and by time.

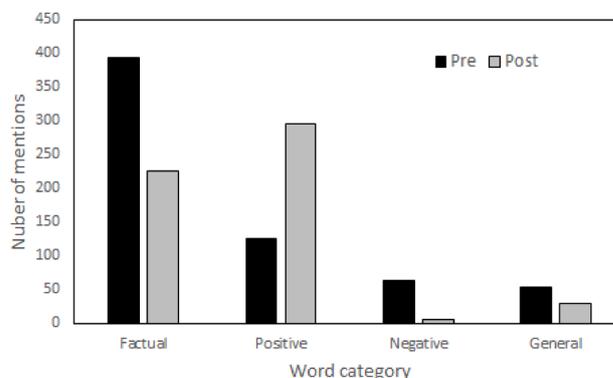


Figure 4. Frequencies with which words in four different categories (factual, positive associations/adjectives, negative associations/adjectives and general associations/adjectives) were mentioned by participants before (pre) and after (post) viewing the virtual bat experience.

Table 1. Summary of statistically significant cumulative link mixed model (CLMM) results. *P<0.05; **P<0.01; ***P<0.001. Reference levels: Time=before watching VBE; Sex=female; Age=18–20; Previous visit=no.

Unappealing/beautiful	Estimate	Standard error	Z value
Time	1.8702	0.2517	7.431***
Previous visit	2.1953	0.5268	4.167***
Age 40–49	2.3765	1.0178	2.335*
Dangerous/harmless			
Time	0.7892	0.2153	3.666***
Previous visit	1.4908	0.4101	3.636***
Age 40–49	1.5952	0.7777	2.051*
Aggressive/friendly			
Time	2.0646	0.2398	8.611***
Previous visit	0.9008	0.3283	2.744**
Dull/interesting			
Time	1.0664	0.2524	4.225***
Previous visit	2.0317	0.5647	3.598***
Unimportant/valuable			
Time	1.4129	0.2880	4.906***
Previous visit	1.9258	0.6317	3.049**
Age 30–39	2.8114	1.2329	2.280*
Lethargic/active			
Time	0.3474	0.0020	175.107***
Previous visit	1.0161	0.3761	2.702**
Time × Previous visit	-0.9293	0.2795	-3.325***
Age 50–59	1.0615	0.4169	2.546*
Age 60+	0.9288	0.0020	468.584***
Ugly/cute			
Time	1.7577	0.0031	571.090***
Previous visit	2.2409	0.5487	4.084***
Time × Previous visit	0.5491	0.0032	169.961***
Sex	-0.7988	0.0031	-255.352***
Age 21–29	0.3751	0.0031	119.898***
Age 30–39	1.7365	0.7042	2.466*
Age 40–49	0.7709	0.0032	238.598***
Age 50–59	0.9334	0.0031	300.339***
Age 60+	0.2416	0.0031	77.254***
Do/don't associate with COVID-19			
Previous visit	1.5740	0.4689	3.357***
Time × Previous visit	-0.8386	0.3596	-2.332*
Willingness to donate to bat conservation			
Time	1.4430	0.2601	5.548***
Age 30–39	3.5749	1.3945	2.564*
Previous visit	4.1365	0.7689	5.380***
Importance of bat conservation			
Time	2.4433	0.4653	5.251***

Words used by participants to describe bats both before and after the VBE are shown in Figure 3. The number of different words used was the same both before and after the VBE (30 in each case), but there was a significant effect of time on the relative frequencies with which words in each of the four categories were mentioned ($\chi^2=166.2$, $P<0.00001$; Figure 4). Positive associations/adjectives were mentioned more frequently after the VBE, and factual descriptions and negative and general associations/adjectives less frequently.

The average rating given by participants when asked to evaluate their experience of the VBE was very positive, at 4.46. Less than 2% of respondents gave a rating of 1 or 2, while 88% scored 4 or 5.

Discussion

It is becoming increasingly important for zoos to use their access to a large audience to change attitudes in support of conservation (Maynard et al. 2020). The results of this study show that in addition to in-person experiences, zoos can, through their social media and websites, provide opportunities for people to view positive images and messages online about unpopular species such as fruit bats, and that these can have immediate benefits in terms of changing attitudes and prompting positive emotional engagement. The latter is important as emotional experiences are more memorable (Prokop and Tunnicliffe 2008) and more likely to produce the desired change. For example, people are more likely to support conservation efforts, such as by donating to conservation projects, for animals with which they have had a memorable experience (Kingston 2016). When asked to think emotionally rather than deliberately, people are less likely to prioritise humans over animals (Caviola and Capraro 2020). An obvious question is: can an online experience produce similar reactions to seeing animals in person? In this study, while participants who had previously visited the Jersey Zoo bat exhibit had more positive feelings about fruit bats than people who had not visited in person before the VBE, the online experience produced the same positive change in their reactions. This indicates that both prior knowledge or exposure and virtual experiences can have an impact on attitudes to and perceptions of these species, and that these effects can add together to produce greater change. These results contrast in this respect with those of Miller et al. (2020), who found that an in-person visit to a zoo polar bear training session led to a stronger positive emotional change than a video of a similar session. It may be that the specific content included in an experience leads to varying responses.

Although people with greater knowledge about bats have more positive attitudes towards them (Lu et al. 2021), in general, increasing knowledge alone does not necessarily change attitudes or behaviour (Green et al. 2019; Moss et al. 2017). In contrast, the concept of nature connectedness, which refers to a person's belief about the extent to which they are part of the natural environment, their emotional relationship with it and their experience within it (Mayer and Frantz 2004; Schultz 2002), is a strong predictor of both pro-environmental and pro-conservation behaviour (Martin et al. 2020; Richardson et al. 2020). In the VBE, positive images and videos were used to tap into some of the "pathways to nature connection" identified by Lumber et al. (2017). These pathways—routes through which people can be engaged with the natural world—include "emotion", "compassion" and "beauty", all of which were considered in the VBE through images and video focusing on the most attractive features of fruit bats and behaviour such as mothers caring for their offspring. Tapping into these pathways can change attitudes, and the results suggest that the VBE was successful in doing this.

"Contact", another pathway identified by Lumber et al. (2017), can also lead to a greater sense of nature connection and more

positive feelings towards less attractive species. For example, Kellert et al. (1996) found people who had greater exposure to large carnivores felt more positive emotions towards them than those with little or no exposure. The current results suggest that such contact does not need to be in-person to promote positive changes in attitude, as long as it is effective in promoting an emotional response in the viewer.

Unstructured in-person zoo visits may in fact not lead to increased learning about a given species (Randler et al. 2012) and may give an inaccurate picture of species-typical behaviour if the animals are seen only at certain times. This is one explanation for the interaction effect found for the lethargic/active word pair: many participants who had previously seen the bats at the zoo may well have visited at times of day when the animals were mostly roosting and therefore may have seen little activity. In contrast, the images and video in the VBE focused on activity and showed behaviour such as flight, feeding and maternal care, giving a broader, more comprehensive picture of the full range of fruit bat behaviour. However, the majority of the VBE lacked sound (and, of course, smell), inclusion of which would have made viewing the VBE much more like the experience of being in the bat exhibit itself. As technology enabling the use of multiple sensory modalities develops, these experiences will become richer and more relevant, potentially having a stronger impact (Kaninsky et al. 2018).

In any experience, appropriate framing is vital to ensure that negative associations, for example between bats and disease risk, are reduced or eliminated (López-Baucells et al. 2018; MacFarlane and Rocha 2020), and positive images promoted (Kingston 2016). One of the current study's aims was to provide accurate information as well as positive images in the VBE. This information was the same as that available to in-person visitors at the exhibit. On average, after exposure to bats during the VBE, respondents decreased the degree to which they associated bats with COVID-19, although it is not clear why there was a much stronger (positive) effect of the VBE on associations with COVID-19 on people who had previously visited the bat exhibit.

The fact that one of the two measures of conservation attitudes was unaffected by a previous visit to the enclosure also suggests that information on the ecological importance of fruit bats and the threats they face was not picked up fully during in-person visits. What people see and read during an in-person visit is under their control, whereas the VBE was a standardised experience for everyone. Many zoo visitors either do not read signage or do not really take it in (Kelling and Kelling 2014; Smith and Broad 2007). Appropriate placement and design of messaging at zoo exhibits is therefore essential to ensure that zoos are communicating effectively with their audience. New technology such as augmented reality could be used to communicate more effectively (Kelling and Kelling 2014), and the current findings also point to the importance of continuing to engage with people even after their visit to the zoo is over (Ballantyne et al. 2018), which is now much easier through technology.

The impact on people of alternative ways of experiencing nature has been investigated in other studies. Arendt and Matthes (2016) reported that although watching a nature documentary did not increase nature connectedness, it did lead to increases in donations to animal charities from people who were already strongly connected to nature. Similarly, Fukano et al. (2020) found that viewing animations about animals led to increased support in terms of donations for zoos working with those species, while in a study by Fernández-Bellon and Kane (2019), watching a documentary led to increased awareness of species. Fernández-Bellon and Kane (2019) concluded that natural history films can lead to long-lasting shifts in awareness, which are key to changing attitudes. Kaninsky et al. (2018) point out that as technology

develops, it will enable design of multi-sensory experiences, which are likely to be more effective at engaging people. Rule and Zhanova (2012) reported success with less direct methods of promoting unpopular species, using puppets and poetry in education sessions with children.

It was interesting that even before viewing the VBE, most participants thought that bat conservation was important and that bats were valuable. These figures increased even further after the VBE. Similarly, scores on the unimportant/valuable semantic differential were second highest after conservation importance. This suggests that participants were either already aware of some of the environmental services that bats provide or they assumed that they must play some sort of vital role within the environment. It is quite possible, though, that potential participants picked up on the authors' interests and affiliations, and that this led to a biased sample. The snowball sampling method used also meant that the participant sample might be biased in favour of species like bats, so further studies of a more representative demographic will be important.

Follow-up studies are also needed to investigate whether the effect of the VBE on participants was short- or long-term. As the survey was anonymised at source, it was not possible to repeat the survey to assess changes in responses over time. It will be important to compare the impact of the VBE with in-person exposure to the bats.

In conclusion, these results suggest that creating virtual experiences for unpopular yet vital and endangered animals such as invertebrates and snakes could be beneficial. This inexpensive way of promoting animals and educating the public about their unique beauty and importance could help zoos support conservation programmes through increased donations specifically for species for which public donations are least likely, but most needed.

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