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Evaluating the impacts of theatre-based wildlife and conservation education at the zoo

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ABSTRACT

The experience of visiting a zoo as a child can be remembered decades later and potentially influences future environmental attitudes. In light of steadily growing criticism of the ethics and value of live animal shows, some zoos are seeking alternative means of delivering 'edutainment' to a broad audience. One such alternative is through theatre. We examine whether a family-orientated zoo theatre performance achieved animal knowledge and conservation awareness impacts. Impact was demonstrated if individuals correctly stated more animal and conservation facts post-performance compared to pre-performance. The theatre production was seen to have a very strong positive effect on both children's (pre-performance s.d.=1.69, post-performance s.d.=1.79 effect size (d)=0.70, w = 4403.5, $p \le 0.001$) and adults' (preperformance s.d.=1.88, post-performance s.d.=2.14, effect size (d)=0.71, w = 1931.5, $p \le 0.001$) learning. Significantly more correct answers were given post-performance compared to pre-performance. We conclude that educational, family theatre can effectively deliver animal information and raise awareness of conservation efforts within a leisure setting. Further studies are needed to investigate the impact of theatre on conservation actions. Comparative studies between live animal shows and theatre could establish the best methods for conveying conservation information to zoo visitors.

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Children's learning; conservation theatre; environmental education; puppets; anthropomorphic

Introduction

Globally, zoos receive over 700 million visits each year (Gusset and Dick 2011) representing a wide range of demographic categories (Bruni et al. 2008). This means there is a vast potential audience for teaching. The World Association of Zoos and Aquariums (WAZA) has aligned its mission with the Aichi targets set by the United Nations Convention on Biodiversity. These targets aim to improve public awareness of biodiversity and to encourage actions to protect it (Barongi et al. 2015; CBD 2011; WAZA 2005). Zoos present scientific information in settings which are more realistic and applicable to daily life than school classrooms (Braund and Reiss 2006). Given the potential to inspire behaviour change in visitors and consequently reduce

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human environmental impacts, evaluation of zoo education is a priority in order to assess the effectiveness of current provision and lead to future improvement (Jensen et al. 2017; Moss et al. 2017).

It is well established that zoos are fundamentally places of leisure (Carr and Cohen 2011). Over 80% of zoo visitors are families (Andersen 2003) with children typically driving the decision to visit a zoo (Turley 2001). Zoo experiences are viewed by parents as important for building connections to nature and as a family bonding experience (Fraser 2009; Puan and Zakaria 2007). Childhood experiences of wildlife can contribute to an individual's attitudes towards the environment. Individual attitudes in turn have been shown to affect behaviour as an adult (Stern and Dietz 1994, Bixler et al. 2011). Bixler et al. (2011) found that adults employed as conservation professionals had been exposed to nature throughout their childhood and had developed a positive association to it through varied and repeated experiences. Social support and leisure time spent in nature were also important. Consequently, family leisure settings which focus on nature, such as zoos, could be a crucial part of developing a connection to the natural world. Oreg and Katz-Gerro (2006) found, in their large scale study of adults across 27 countries, that environmental actions such as recycling are directly and positively correlated with environmental concern and perceived behavioural control. Therefore, the public and especially children, need to be inspired to develop a lifelong concern for nature as part of their embedded beliefs. Understanding how children and accompanying adults engage with zoo education experiences in a free choice learning situation, i.e. when visiting the zoo for leisure is, therefore, vital.

The nature of free choice means that what interests the visitor may not align with the learning intention of the organisation. However, any learning which does occur is likely to be deeply imbedded as the learner themself has selected content to engage with.

International zoo studies have demonstrated that a single zoo visit can increase biodiversity knowledge, including raising public awareness of conservation actions (Moss et al. 2015). More than 5600 visitors across 26 WAZA member institutions were asked to explain their understanding of biodiversity and actions to help conservation, both before and after a zoo visit. A significant positive change in public awareness of biodiversity was noted after the zoo visits. In another study, school children's knowledge was found to significantly improve after attending presentations led by zoo education staff (Jensen 2014a).

Whilst there are several studies which examine the overall impact of a zoo visit (Jensen et al. 2017; Moss et al. 2015, 2017) and the impact of live animal interactions (Miller et al. 2013, Povey and Rios 2002) fewer studies examine the more novel elements of zoo conservation education such as the impact of theatre.

Theatre, puppet shows and other performance genres are beginning to gain popularity as an educational device within zoos (Hawkey 2003; Proffitt 2013). We define theatre as a scripted performance intended to convey a particular message or story. Unlike traditional zoo animal shows, theatre can be performed without live animals, thus avoiding the risks of negative learning (Jensen 2014a) or false learning (Spooner et al. 2017) which can occur when presenting species as tame or performing tricks (Acampora 2005; Finlay et al. 1988, Hotchkiss 1991). Theatre can also combine visual, audio and narrative elements to provide a more inclusive learning experience (Peleg and Baram-Tsabari 2011) in ways that would not be possible when using live animals.

In non-zoo settings, educational theatre has shown promise as a method of communicating scientific concepts to school children and museum visitors. For example, visitors have been shown to be more likely to visit exhibits and stay longer during a theatre performance than when an exhibit is presented on its own (Baum and Hughes 2001; Hawkey 2003). Theatre with participatory elements has been shown to be especially effective at challenging existing perceptions. Evans (2013) found that adults' perspectives about historical figures dramatically changed during a museum visit after they were able to question the individuals (actors playing the historical figure). Educational theatre has also been found to be more effective than conventional

presentations at delivering environmental conservation information to school children both within and outside the school setting (Okur-Berberoglu et al. 2014).

Although theatre and puppets have long been used in zoos, there is very limited evidence of their success at educating modern zoo audiences. Major shifts in zoo attitudes and practice mean that studies conducted pre-1990 within zoos are less applicable to the modern zoo. Anecdotal evidence, for example the Wildlife Conservation Society's 'Reusable the Musical', indicates that educational theatre within zoos is enormously popular and has the potential for informing visitors about conservation issues (Beach 2016). However, evaluations of theatre's educational effectiveness are limited.

The only zoo-based peer-reviewed study on this topic showed that audiences generally enjoyed theatre performances (Penn 2009). The study found adults indicated significant learning and children (aged 6–9) collectively recalled overall concepts whilst younger children were limited to a descriptive awareness of content. Furthermore, half of the adults questioned (52%, n = 313) stated that the performances had a positive influence on their children's pro-environmental feelings. Whilst this is admirable, we note that reporting on others' experience is prone to bias and must be viewed with caution (Donaldson and Grant-Vallone 2002; Jensen 2014b, 2017). Penn's (2009) study examined children's collective recall but did not consider individual knowledge changes. Penn also suggested that song is often an important element of theatre, although their study did not explicitly test its impact.

This study aimed to determine the effectiveness of theatre for educating zoo visitors. The objectives were to determine whether a single exposure to a family-orientated, puppet-based, zoo-theatre performance could convey: (a) animal facts, and (b) a basic understanding of the zoo's conservation efforts to both children and accompanying adults. This is a case study demonstrating the immediate impact of a single zoo experience (a theatre performance) on learning. We acknowledge that this experience is a small, yet potentially significant, aspect of a zoo visitor's journey towards conservation caring and is part of wider experiences and influences.

Background

The study was undertaken at Flamingo Land Resort, a combined theme park and zoo in the UK. The zoo is a member of WAZA, and therefore is formally committed to conservation education in its mission. Although the zoo forms a significant part of the study site, marketing was focused on the theme park and strongly promoted 'entertainment' (Flamingo Land Ltd 2016). Flamingo Land has had overall success at increasing visitor knowledge about animals, but previous studies indicate that animal information signs are more effective than existing live animal shows at conveying animal facts and information about zoo conservation efforts (Spooner et al. 2017).

We investigated the impact of a zoo theatre performance, the 'Mia and Mylo Show', on children's and adults' knowledge of animal facts and basic understanding of the conservation efforts undertaken by the zoo. Written by the theme park entertainment team in conjunction with the zoo's education staff, the theatre performance was aimed at children aged three-nine years old. The theatre performance lasted 15 minutes and was performed twice daily. During the study period (March–October, 2015), the estimated audience was 14,500 children and 16,100 adults.

As the performance was intended for a young audience messages were kept simple. The aim of the production was to convey basic animal facts and inform visitors that the zoo was undertaking conservation work in Tanzania (planting trees, educating local people and, researching animals) and onsite through captive breeding programmes (including researching flamingo breeding). The production team decided not to convey any conservation actions for visitors within the performance. This research intended to indicate whether or not, and to what extent, information could be conveyed to young audiences. The findings were also intended to inform future productions with a greater focus on conservation actions. The intended outcomes of the theatre performance were for the audience to be able to:

a. Describe features and behaviours of flamingos, meerkats, and lemurs (chosen for ease of recognition from the zoo), specifically:

- Flamingos eat 'shrimp' (this simplistic message was designed to aid understanding for a young audience);
- Flamingos are born with grey feathers which turn pink from pigments in their food (i.e. shrimp);
- Meerkats live in the African desert and stand on two feet to keep watch; and
- Lemurs are primates from Madagascar and are endangered by hunting and logging.

b. State how the zoo helps conserve animals and habitats, including that Flamingo Land is:

- Doing conservation work in Africa (Tanzania) through the Udzungwa Forest Project (UFP); and
- Protecting animals and forests, educating people, and researching flamingo breeding.

The learning objectives focused on specific animal facts which were chosen to test whether family orientated theatre could convey biological and conservation information to adults and children during a leisure experience. The performance did not aim to convey conservation actions to visitors. However, understanding whether factual information can be conveyed through theatre has important implications for conveying pro-conservation behaviour messages in future productions.

The theatre performance included four actors, two dressed as meerkats and two with life-size puppets (a flamingo and a lemur) (Figure 1). A large digital backdrop displayed animal video footage, research photographs and maps. Screen display was timed to align with the script.

The script focused on two meerkats (Mia and Mylo, the Flamingo Land mascots) going on an adventure to meet new friends. On the way they met Francesca flamingo and Liana lemur. These



Figure 1. Photograph of the 'Mia and Mylo' theatre performance at Flamingo Land. The image shows; two actors dressed as meerkats, two actors with puppets dressed as animals and a digital backdrop. Source: Author

characters introduced themselves explaining their general features, what they eat, where they live and the threats they face in the wild. Each animal then sang a song about themselves and their adaptations. The animals then said they were going to explore the zoo. At this point they discussed the conservation work of the zoo and its work in Tanzania researching the animals and plants that live there, teaching local people about how to protect the rainforest and planting new areas of forest. The characters also spoke about the zoo's onsite conservation team who were researching captive breeding.

Over half (52%) of the script was sung to the tune of contemporary popular songs, including Meghan Trainor's 'All About that Bass' and Mark Ronson's 'Uptown Funk'. Lyrics were changed to reinforce a message, for example, the line 'all about the bass, the bass, no treble' was changed to 'all about the shrimp, the shrimp, no salmon' as a memorable way of expressing flamingo diet. The songs used were all upbeat; between 110 and 170 beats per minute. For most songs the altered lyrics were displayed on screen and the audience encouraged to sing along. To ensure consistency between performances the theatre content was pre-recorded with actors miming the words.

Methods

Evaluating theatre

We designed evaluation questionnaires based on the intended outcomes of the theatre performance. These tested whether the theatre performance had successfully conveyed its messages. The intended learning outcomes were focused on knowledge based objectives. These learning outcomes were specified by the zoo education team at the time of the study. Whilst knowledge based outcomes are unlikely to impact conservation action, positive learning outcomes of factual information could potentially have positive effects if conservation messages were included.

Adult and child respondents were questioned at baseline (pre-performance) and directly after the theatre performance (post-performance). A quasi-experimental approach was taken comparing unpaired responses from visitors pre- (n = 81 adult, n = 120 child) and post- (n = 77 adult, n = 124 child) performance. A sample of individuals were repeat tested (i.e. tested at both preand post-time points) (n = 15 adult, n = 29 child) in order to provide a paired control and to directly track knowledge changes. This experimental research method was chosen as it is more reliable than purely cross-sectional studies (e.g. Skibins and Powell 2013, which run the risk of potential differences being due to sampling rather than actual knowledge or opinion change). This can be particularly problematic where post-samples are collected on site as response bias is likely. By sampling paired and unpaired responses, we are able to reduce this error whilst still maintaining sample sizes.

The questionnaires pre- and post-performance were identical in appearance and content. Two types of self-complete questionnaire were handed out; a picture based questionnaire suitable for all ages was given to children and a text based questionnaire was given to adults. Children's questionnaires had strict instructions for accompanying adults that questions should be read exactly as they were written and if any help was given in the form of clarification, or if a child was perceived not to have understood the question this should be clearly indicated on the questionnaire. Where a child was deemed not to have understood a question, their response to that question was removed from the analysis. Responses to other questions were, however, included in the analysis. Where an adult stated that they had helped the child (139 questions assisted pre-performance and 184 questions post-performance) responses to these questions were included in the analysis but 'adult help' was included as a variable to ensure that this did not skew the results.

We purposefully chose to test an unpaired sample pre- and post-performance as this removed the chance that individuals would be primed by the first survey and look for answers during the performance. However, in order to alleviate concerns that an unpaired sample does not allow for knowledge change tracking and that the samples may differ in characteristics we included a paired control. As with any paired sample there was a risk of priming and looking for answers in the performance. By including both unpaired and paired samples we feel that we have minimised these limitations.

Pre-performance questionnaires were distributed to all families within 30 m of the stage 15 min prior to the performance. Audience members aged 2–17 were given the child's questionnaire and those over 18 years of age given the adult questionnaire. Whilst this represents a wide range of children's ages the average age was 8 years old. We included children across the whole range of ages as we wanted to capture the views of all individuals watching the performance. Questionnaires were designed to be simple enough for even the youngest audience members to understand providing an adult read the question to them. Whilst we acknowledge that the youngest individuals may not have a complete understanding of concepts, trial surveys established that even 2 year olds were able to repeat facts and select the correct picture response from a group of pictures.

Completed questionnaires were collected five minutes before the performance began. Those families who arrived immediately before the start could not be included in the pre-performance sample as they had no time to complete a pre-performance questionnaire.

Post-performance questionnaires were distributed to every 4th family immediately after the performance. If a respondent had completed a questionnaire both pre- and post-performance their responses were paired. The sampling method used meant there was a high proportion of unpaired respondents. Families who arrived during the performance were not asked to complete questionnaires as they may have missed relevant information. Demographic categories were compared between pre- and post-groups to ensure that the two samples were similar (Table 1).

Although motive for visit was not analysed, all individuals surveyed were visiting families and not part of a school group or field course. The audience can be assumed, therefore, to not have had a predetermined objective to learn.

Child questionnaires

Questions were designed to be child-friendly for completion with minimal adult assistance. A combination of open, closed and multiple-choice picture-based questions were used to maximise responses from children of all ages. Open questions were used for more complicated concepts such as meerkat behaviour, and the role of zoos. These questions were more suited to older children and allowed us to test whether these concepts had been conveyed without prompting answers.

To determine potential covariation and bias, information about the child's age, gender and prior viewing of the performance was collected, and also the accompanying adult's income and education levels. A small token of appreciation (a medal and certificate) was given to all children who participated.

Adult questionnaires

Adult questionnaires were comprised of open-ended questions about information covered in the performance and closed demographic information questions. All adults in each family were given the adult questionnaire. Not all adults completed these questionnaires (91.1% response, n = 14 refusals) as they were helping their children read and complete a child questionnaire. Adult questionnaires were distributed first to assess what they, as accompanying adults, had learned from the theatre performance and second, to encourage adults to focus on their own questions and not to influence children's responses.

Table 1. Sample groups p	re- and post-performance f	or adult and child data gathe	red for the Flamingo Land 'I	Mia and Mylo' theatre perfor	mance.	
	Adult pre-unpaired	Adult post-unpaired	Adult paired	Child pre-unpaired	Child post-unpaired	Child paired
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	(cf JC) 9C	40 (40 45)				Î L V
Kespondent age in	38 (35–42)	40 (40-45)	43 (30-49)	8 (8-9)	8 (7-8)	(/
years intean						
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		lent (323)	ucor vi equiva- lent (20)	ucor of equiva- lent (22)	lent (22-1)	ucur ul equiva- lant (31)
individuals)					1111 (22.1)	
Number of female	40 (60.6)	46 (74.2)	13 (86.7)	41 (45.1)	61 (64.2)	19 (65.5)
respondents (%)						
Number (%) who	29 (43.9)	29 (46.8)	6 (40.0)	33 (36.3)	24 (25.3)	13 (44.8)
had visited site in						
previous						
12 months						
Number (%) who	15 (22.7)	15 (24.2)	1 (6.7)	31 (34.1)	23 (24.2)	12 (41.4)
had seen the the-						
atre perform-						
ance before						
Mean number of	Ι	Ι	I	1.3 (0.7–2.1)	0.8 (0.4–1.4)	0.7 (0.3–1.1)
days since seeing						
the theatre						
performance						
Mean number of	45 (40–49)	40 (34–45)	37 (32–42)	42 (39–46)	42 (40–45)	37 (32–42)
adults viewing						
the performance						
Mean number of	I	I	I	39 (35–43)	46 (42–48)	37 (32–43)
children viewing						
the performance						

Data analysis

Adult and child responses were coded as correct (1) or incorrect (0) based on a pre-agreed coding table. If an open response included one of the pre-agreed accepted response words, the answer was marked as correct. Adult questions about flamingo adaptations and behaviours were marked out of four based on a pre-agreed coding scheme. Overall correct answers were calculated as a sum of the number of answers correct and not as the number correct minus the number incorrect. The latter method has the potential of revealing more misconceptions; however, the cumulative method was deemed sufficient for comparing the number of correct answers between the pre- and post-performance groups. Two researchers coded the data, blind to the test condition (pre- or post-performance). Both researchers coded 60% of the data to check inter-coder reliability. This was found to be good (kappa = 0.87). The remaining 40% were then coded independently. Disagreements were resolved by discussion whilst still blind to test condition.

Statistical analysis was performed using R version 64: 3.2.3 (CRAN 2014). Log transformations were applied to variables 'the number of children viewing the performance' and 'number of adults viewing the performance' to remove skew and heteroscedasticity. Predictor variables were tested for inter-correlation which can negatively affect regression modelling; where Pearson's coefficient exceeded r = 0.7 and variance inflation factors were >2 these variables were not included in the same model (Zuur et al. 2010).

For each question, binomial generalised linear models (GLMs) were used to evaluate the relationships between the dependent variable (whether the question was answered correctly or incorrectly) and independent variables (Children's response: age of respondent, gender, theatre seen, adult's help given, adult's income, number of children viewing (log), number of days since last viewing theatre performance. Adults' response: theatre seen, age, gender, highest level of education achieved, household income, number of adults viewing (log), whether respondent had visited Flamingo Land within the last 12 months, and whether they had seen the theatre performance before). Poisson GLMs were used to compare the total number of correct answers overall and for responses to questions on flamingo adaptations as answers were given a score rather than being correct or incorrect. Where data was over dispersed (e.g. unpaired overall correct answers) a quasi-Poisson model was used.

Minimum adequate models were produced using backwards-forwards stepwise selection and checked to ensure no deviance was lost (Murtaugh 2009). Where the most relevant independent variable to our research question ('theatre seen', i.e. whether the respondent was answering questions pre- or post-performance), was not preserved in the minimum adequate model, univariate GLMs were used to specifically model this variable against the dependent variable.

For each significant independent variable a percentage deviance was calculated (%D). This explained the impact of each independent variable on the dependant variable (response). A high percentage deviance (the maximum being 100%) meant that the variable had a major influence on the response, whilst a low percentage deviance indicated that other factors were additionally responsible. Highly significant but low deviance explained variables were possible and vice versa. This was because a variable may accurately predict a very small percentage of the responses and other, potentially untested, variables explain the rest of the deviance.

In addition, we tested the difference between the total responses (combined paired and unpaired) pre- and post-performance using Wilcoxon signed rank tests. This allowed for non-normally distributed data, for example, where unbalanced samples were used either because of being in unpaired pre-post-groups or where a child's responses had been excluded. Effect size was calculated based on the total number of correct answers using Cohens' *d* with a pooled standard deviation (Field 2013; Higgins et al. 2013). This explained the effect of the theatre performance on overall 'knowledge' (total number of correct answers given). An effect size of below 0.01 was seen to have no effect on learning, 0.02–0.18 a low effect, 0.19–0.44 moderate, 0.45–0.69 high and above 0.70 a very high effect (Higgins et al. 2013)

Adjustment using False Discovery Rate (α FDR) was applied to all tests to reduce Type 1 error risk (Garcia 2004) and 95% bootstrapped confidence were calculated using 10,000 iterations.

Ethics

All participants were informed that data were being collected as part of visitor experience research. Participants were informed that completion of the questionnaire constituted consent to be included in the study. Only children with accompanying adults were given the questionnaire and verbal consent from the accompanying adult was received before the child participated in the research. The study was granted approval by the University of York, Environment Department, Ethics Committee.

Results

Learning in children

Wilcoxon signed rank tests found that the overall number of children's correct responses significantly increased from pre- to post-performance (22.1% increase, w = 4403, $p \le 0.001$). Seeing the theatre performance had a strong effect on children's 'knowledge', i.e. the total number of correct responses given (effect size d = 0.76, mean score pre-performance = 2.2 (95% Cl 1.87–2.47), n = 120, mean score post-performance = 3.5 (95% Cl 3.17–3.80), n = 124; combined unpaired and paired responses) (Figure 2), and was the main predictor of overall correct answers (Table 2).

Seeing the theatre performance was also the main predictor of correct responses for both unpaired and paired groups for questions on flamingo diet and where Flamingo Land works outside the United Kingdom (Table 2).

Age was only found to be significant in two of the question areas (where meerkats are found in the wild and, where Flamingo Land works outside of the UK), adults help was only significant for the questions 'where are meerkats found in the wild' and 'what does Flamingo Land do there



Question asked

Figure 2. Number of correct children's responses (%) given for questions relating to content from the 'Mia and Mylo' theatre performance; comparison between paired pre-performance (white bars) and post-performance (black bars) (n = 29) and unpaired pre-performance (n = 91) (pale grey bars) and unpaired post-performance (n = 95) (dark grey bars).

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otherwise stated]	on uness	Significant variable [and model] statistics
Q1: Where are meerkats found in the wild?	Paired	No. of children viewing[log] (+) $\%D = 16.6$, p = 0.004; [AIC = 53.62, $%D = 22.04$, $n = 50, \alpha_{res} = 0.021$
	Unpaired	Gender [male] $(+)\%D = 2.90, p = 0.009;$ Age $(+)$ $\%D = 1.01, p \le 0.001;$ Adult's help given $(+)$ %D = 2.40, p = 0.002; [AIC = 186.68, $\%D = 13.68, p = 168, \alpha_{EDP} = 0.03)$]
Q2: Why do meerkats stand on two feet?	Paired	No significant variables [AIC = 58.31, % D = 24.75, n = 52 α_{EDR} =0.01]
	Unpaired	No significant variables [AIC = 160.62, $\%D = 20.60, n = 163, \alpha_{\text{FDR}} = 0.008$]
Q3: What colour are baby flamingos?	Paired	Theatre seen (+) % $D = 31.53$, $p = 0.009$; [AIC = 48.47, % $D = 31.53$, $n = 52$, $\alpha_{FDR} = 0.01$]
	Unpaired	No significant variables [AIC = 210.46, % D = 4.93, n = 175, α_{FDR} = 0.01]
Q4: What do flamingos eat?	Paired	Theatre seen (+) % $D = 19.12$, $p \le 0.001$; [AIC = 59.32, % $D = 40.2$, $n = 53$, $\alpha_{FDR} = 0.007$]
	Unpaired	Theatre seen (+) % $D = 23.27$, $p = <0.001$; Adult's income[< \pm 7000](+) % $D = 0.87$, $p = <0.00$; [AlC = 184.11,% $D = 34.90$, $n = 175$, $\alpha_{EDP} = 0.005$]
Q5: Where does Flamingo Land work outside of the United Kingdom?	Paired	Theatre seen (+) $\%D = 12.23$, $p = 0.019$; Age(+) %D = 12.78, $p = 0.019[AIC = 48.52, \%D = 21.30, n = 39, \alpha_{\text{EDP}} = 0.05]$
	Unpaired	Theatre seen $(+)$ % $D = 5.27$, $p = 0.002$; [AIC = 175.75,% $D = 8.92$, $n = 138$, $\alpha_{\text{FDR}} = 0.02$]
Q6: What do they do there?	Paired	No significant variables [AIC = 30.29, % D = 76.72, $n = 39$, $\alpha_{EDR} = 0.006$]
	Unpaired	Theatre seen (+) $\%D = 1.12$, $p = <0.001$; Adult's help given (+) $\%D = 0.0$, $p = 0.001$; [AIC = 181.95, $\%D = 8.0$, $n = 138$, $\alpha_{EDR} = 0.05$]
Overall number of correct answers [Poisson]	Paired	Theatre seen (+) $\%D = 17.6$, $p = <0.001$; Gender [Male] (+) $\%D = 2.4$, $p = 0.010$; Adult's help given (+) $\%D = 0.4$, $p = 0.002$ [AIC = 221.22, $\%D = 49.3$, $n = 58$, $\alpha_{\text{FDR}} = 0.03$]
	Unpaired	Theatre seen (+) $\%D = 7$, $p = <0.001$; Age (+) %D = 3.9, $p = 0.004$; Income (+) $%D = 8.2[<\pounds7000] p = <0.001, [\pounds7001-\pounds14,000]p = <0.001 [\pounds35,001-\pounds42,000] p = 0.004, [AIC =732, \%D = 25.2, n = 186, \alpha_{FDR} = 0.03]$

Table 2. A summary of children's increased awareness following an educational theatre production.

Significant predictors of children's correct responses to questions regarding animal information are shown, resulting from stepwise reduced generalised linear models (GLMs). Results are shown for two methods (unpaired respondents, n = 91-95; paired respondents, n = 29). Where not significant in multivariate GLMs, the variable 'theatre seen' is also presented as the central variable to the research question.

+/-=positive/negative relationship; AIC = Akaike Information Criterion; %D=percentage deviance explained (significant variables only).

[in its work outside the UK]'. This suggests that despite the wide ranging age groups, spanning several Piagetian levels (Piaget 1998), age was not a significant factor in the increase in correct answers post-performance compared to pre-performance. This supports the finding that seeing the performance was the main factor in correct response and therefore was responsible for child-ren's learning about animal facts and the conservation role of the zoo.

There was no significant change in children's knowledge about meerkat habitat or behaviour post-performance compared to pre-performance. In both cases children demonstrated a relatively high level of baseline awareness pre-performance (Figure 2).

Adult learning

Seeing the theatre performance had a strong effect on adult knowledge, i.e. the total number of correct answers given (effect size d = 0.71, mean score pre-performance = 2.27 (95% CI

1.88–2.68), n = 81, mean score post-performance = 3.69 (95% CI 3.21–4.17), n = 77; combined paired and unpaired responses). Significantly more correct answers overall were given post-performance compared to pre-performance (18% increase, w = 1931.5, $p \le 0.001$) (Figure 3) and seeing the theatre performance was the main predictor of overall correct response (Table 3).

Seeing the theatre performance also significantly predicted correct responses across both unpaired and paired groups for questions relating to where Flamingo Land works outside the United Kingdom and what it does there (Table 3). However, the theatre production had no effect on adult's awareness of flamingo adaptations. As this question was open ended, it is possible that visitors knew more about this species than they wrote down and this could explain why no improvement was seen on this question.

Although there were differences between paired and unpaired groups in responses to specific questions, there was little discernible difference when overall correct answers were compared (adult responses paired vs. unpaired w = 388.5, p = 0.2498, children's responses paired vs. unpaired w = 1359, p = 0.914). This suggests that large sample, unpaired pre-post-groups can indicate trends in the data in the absence of repeat testing.

Discussion

Our results show that educational zoo theatre performances effectively deliver information about animal facts and the conservation work of zoos to visitors. Although the theatre performance we tested was designed primarily for a young audience, the accompanying adults were also able to gain new animal knowledge and awareness about the zoos' conservation work. If learning can be achieved in an entertainment-driven combined theme park and zoo setting, conventional zoos can potentially achieve a similar, or greater, level of learning.

Success of the production was determined by positive gains in knowledge post-performance compared to pre- and confirmed by a large effect size. Visitors were unlikely to have visited the zoo with the intention of learning the specific objectives of the performance. Therefore, the finding that there were significant increases in visitors' knowledge regarding these specific facts and whilst on a leisure visit is important.





Figure 3. Number of correct adult responses (%) given for questions relating to content from the 'Mia and Mylo' theatre performance. White bars = pre-performance paired (n = 15), black = post-performance paired (n = 15), pale grey = pre-performance unpaired (n = 66) dark grey = post-performance unpaired (n = 62).*indicates where 'theatre seen' was a significant predictor of correct response.

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Model (and variables)

Table 3. A summar	v of adult's increased	awareness following	an educational	theatre production.
	,			

[Binomial distribution unless otherwise stated]		Significant variable [and model] statistics	
What is a lemur?	Paired	No significant variables [AIC = 32, $\%D$ = <0.001, n = 15, α_{EDP} =0.05)]	
	Paired 'theatre seen'	Theatre seen $(+)\%D = 28.9$, $p = 0.003$	
	Unpaired	Theatre seen $(+)\%D = 14.8$, $p = 0.028$; No. of adults viewing[log](-) $\%D = 0.0$, $p = 0.012$ [AIC = 194.08, $\%D = 16.5$, $n = 128$, $\alpha_{EDP} = 0.05$]	
What threats do lemur face in the wild?	Paired	No significant variables [AIC = 32, % D = <0.00, n = 15, α_{FDR} =0.05]	
	Unpaired	Theatre seen (+)% D = 6.65, p = 0.013; [AIC = 193.61, % D = 17.7, n = 128, α_{FDR} =0.05]	
Where does Flamingo Land work outside the UK?	Paired	Theatre seen (+)% $D = 35.4$, $p = 0.009$; [AIC = 45.0, % $D = 68.6$ $n = 15$, $\alpha_{\text{FDR}} = 0.02$]	
	Unpaired	Theatre seen (+)% $D = 7.3$, $p = 0.001$; [AIC = 174.16, % $D = 24.0$ $n = 128$, $\alpha_{FDR} = 0.01$]	
What does Flamingo Land do there?	Paired	Theatre seen (+)% $D = 35.4$, $p = 0.003$ [AIC = 45.0, % $D = 68.6$, $n = 15$, $\alpha_{FDR} = 0.003$]	
	Unpaired	Theatre seen(+)% $D = 15.6$, $p \le 0.001$; Theatre seen previously (+)% $D = 2.7$, p = 0.010; [AIC = 161.54, % $D = 33.3$ $n = 128$, $\alpha_{FDR} = 0.03$]	
What features or adaptations help	Paired	No significant variables	
flamingos survive in the wild?	[Poisson]	$[AIC = 84.6, \ \%D = 84.79 \ n = 15, \ \alpha_{FDR} = 0.05]$	
	Unpaired [Poisson]	No significant variables [AIC = 390.4, %D = 18.4 $n = 128, \%_{EDP} = 0.05]$	
Overall number of correct answers	Paired [Poisson]	Theatre seen (+)% $D = 29.1$, $p \le 0.001$; Education (+)% $D = 10.3$ [no formal qualifica- tions] $p = 0.010$ [A-level or equivalent] p = 0.007, [undergraduate degree] $p = 0.004[AIC = 124.0, %D = 71.3, n = 15, \alpha_{FDR} = 0.02]$	
	Unpaired [Quasi-Poisson]	Theatre seen (+)% $D = 16.5$, $p = 0.001$ [AIC = NA, % $D = 22.4$ $n = 128$, $\alpha_{FDR} = 0.05$]	

Significant predictors of adult's correct responses to questions regarding animal information are shown, resulting from stepwise reduced generalised linear models (GLMs). Results are shown for two methods (unpaired respondents, n = 128, paired respondents, n = 15). Where not significant in multivariate GLMs, the variable 'theatre seen' is also presented as the central variable to the research question.

+/-= positive/negative relationship; AIC = Akaike Information Criterion; D= percentage deviance explained (significant variables only).

Learning in children

Our finding that children gave more correct answers after watching educational theatre aligns with similar studies in museums (Baum and Hughes 2001; Jackson and Rees Leahy 2005) and reinforces the conclusions of previous zoo research on this topic (Penn 2009).

Seeing the theatre was the main predictor of correct responses overall, suggesting that theatre is an effective medium for conveying factual information. As responses were compared immediately before and after the performance other influencing factors such as exposure to information around the zoo site can be excluded. The theatre performance was particularly effective at conveying information on flamingo diet. This was a key objective of the performance, demonstrating that theatre can effectively convey its objectives. However, we acknowledge that conveying animal facts may have less impact on conservation than conveying practical conservation actions or emotional connections to species. Knowledge alone is insufficient to prompt proenvironmental behaviour change (Hines et al. 1987, Jacobson et al. 2006). We therefore suggest that future performances should set action or emotion focused objectives in order to provide impactful environmental education.

Whilst knowledge increased across most question areas, knowledge about meerkats remained unchanged. Pre-performance knowledge about meerkats was much higher than for other question areas (Figure 2) which could explain why the magnitude of change for meerkat related questions was minimal. This may be due to the popularity of meerkats as a species and their prevalence across television documentaries. Wagoner and Jensen's (2010) study also found that similarly aged children (age 9–11) had a good level of knowledge about meerkats before visiting the zoo. Given that the theatre performance tested only provided basic knowledge about meerkat behaviour, such as 'standing on two feet', 'looking out for danger' and about where they lived, there may have been limited scope for delivering new information capable of increasing audience awareness about the species. This highlights the need to ensure theatre content is adequately pitched for its audience in order to provide appropriate challenge for learners. Learning experiences should move visitors from their existing knowledge to new understanding (Vygotsky 1978). Pitching theatre content at the right level is crucial. If content is too simplistic then little learning will occur (Dove and Byrne 2014; Penn 2009).

Adult learning

We found that accompanying adults increased their knowledge about animals and awareness of the conservation work of zoos while viewing theatre aimed at their children. This suggests that theatre can convey information to the whole family.

Seeing the theatre performance was the most important predictor of knowledge increase across all questions. The only other variables that were selected as having any influence were adult's education level, which had a positive correlation with correct response, and the number of adults viewing the performance, which had a negative correlation. These findings are important as they demonstrate that adults are clearly able to learn from a theatre performance designed for the children that they accompany and that, even though they may not be as engaged in the show as their children, they are able to recall key messages from it. This has implications on planning future theatre performances as it suggests that theatre targeted at children could also include some elements or messages targeted at the accompanying adults. Targeting messages at both adults and children is particularly important when conveying environmental issues as they will have consequences across the generations. Whilst it is key that we inspire the future generation to be conservation aware, it is adults who will be able to make immediate lifestyle changes. If children are exposed to a conservation focused lifestyle at home, endorsed by their parents or caregivers, they are increasingly likely to continue these behaviours into their own adult lives.

Theatre as an educational device

When zoo visitors are repeatedly presented with concepts across a range of presentation styles, they are more likely to remember them (Weiler and Smith 2009). The production we tested used a combination of spoken word, up-beat songs with altered lyrics and onscreen information. Although the individual elements of the production are impossible to separate, the combination of all elements has been shown to be effective at increasing awareness in adults and children.

Catering for different learning styles using a combined presentation technique is not a new idea. Kolb suggested that educational impact could be increased by presenting information in different ways e.g. visually, kinaesthetically or through audio as this targets different areas of the brain thereby speeding up learning (Bates 2016; Jacobson et al. 2006; Kolb et al., 2011). This additionally supports Gardiner and Armstrong's theory of multiple intelligence which suggests that

some individuals are better at certain aspects of learning compared to others and therefore information needs to be targeted at multiple learning needs (Bates 2016; Jacobson et al. 2006). The very nature of learning outside the classroom in an environment such as a zoo caters for these multiple needs as individuals can select aspects of the experience to suit them. It is therefore appropriate that educational presentations within this learning environment present across multiple dimensions.

Language studies have demonstrated that the spoken word is important for overall comprehension with songs aiding in the recall of facts (Calvert 2001). Songs are known to help in information recall and effects are strongest when familiar tunes are used (Rainey and Larsen 2002). We found that awareness of flamingo diet was an area where the greatest difference between pre- and post-knowledge was seen. This information was presented through speech and as small chunks of pop songs with altered lyrics. As popular songs are known to play a role in memory (Hyman et al. 2013; Murphey 1990), it is possible that the song clips aided in recall.

Without comparing the anthropomorphic animals in the theatre tested against a production using people we cannot know whether puppets and costumed characters are more effective than actors for family learning. However, marketing campaigns have successfully demonstrated that anthropomorphic characters can make products more memorable and develop strong audience emotions (Balmford et al. 2002; Fournier 1998; Patterson et al. 2013). Using animal characters with human characteristics may help visitors understand environmental issues as they can present information using language and gestures that humans understand. This potentially has more impact than using live animals which are unable to communicate directly. According to Proffit (2013) and Hawkey (2003) audiences can find puppets easier to relate to than actors as puppets can present sensitive issues in a non-threatening way. Audiences can bond with an anthropomorphic character whilst still acknowledging that it is an exaggerated reality. Therefore using puppets and anthropomorphic animal characters has the potential to inform public audiences about environmental issues in a way which they can comprehend and avoids live animals performing unnatural behaviours for human benefit.

In order for messages to become embedded into our deep learning we must have repeated and varied exposure and be engaged (Bixler et al. 2011). As visitors self-select to view a theatre production within their leisure time we assume they have some degree of enjoyment and therefore are engaging with the information presented. Theatre is not the traditional way of conveying serious conservation concerns and therefore can provide an important addition and potentially target new audiences. We cannot control what exposure visitors have beyond their zoo experience, however, through interpretation such as theatre we can create varied exposure and encourage engagement through entertaining and emotive experiences.

When considering environmental education from an animal rights and deep ecology perspective the use of anthropomorphic characters has great potential. It is important to open up a dialogue about environmental issues rather than prescribing solutions (Kopnina and Gjerris 2015). Humans can forget that they too are animals and are intrinsically connected to nature (Spannring 2017). Therefore, by presenting anthropomorphic characters audiences can hear the animals' perspective from their own voice. Listening to environmental concerns from a nonhuman perspective can be important for helping individuals to value nature in different ways (Spannring 2017). This is important because individuals often make conservation decisions based on what they see as valuable, consequently if a species is deemed 'useless' to humans it may miss out on conservation support (Kopnina and Gjerris 2015).

With conservation issues becoming more pressing, it may seem frivolous to focus zoo education provision on theatre productions. It is true that messages delivered in zoos do need to focus on conservation actions in order to help visitors find environmental solutions relevant to their lives. However, visitors come to zoos during their leisure time and are looking to be entertained as well as educated. Therefore, using instruments such as theatre, messages can be conveyed in a way that is appealing to the whole family and which does not intrude on the overall leisure experience.

Implications

The information conveyed by this theatre performance was fact-based. This has limited value for extending visitor understanding beyond information recall. Although the performance effectively delivered these facts, we suggest that the theatre could have gone further to convey more complex messages, for example, pertaining to environmental actions or prompting discussions on climate change. This is particularly important for zoos to consider as most people are unaware of how their actions connect to wider, global problems (Okur-Berberoglu et al. 2014). Some zoos have been highly successful at instilling conservation actions amongst their visitors. Australian zoos in particular have used eco-friendly on-site practice and large scale campaigns to raise the profile of conservation actions (Pearson et al. 2014; Smith et al. 2010, 2012). Successful campaigns include avoiding palm oil and using recycled toilet paper (Pearson et al. 2014).

Our experimental approach of using both paired and unpaired pre- and post-samples has both advantages and disadvantages. We acknowledge that the unpaired sample prevents tracking knowledge change in individuals yet it avoids issues of priming. The reverse can be said for the paired samples. As neither approach can tackle both issues there will always be an element of limitation to the study design. However, we believe that this combined approach allows impact to be assessed from both aspects.

Our methods focused on testing knowledge change of specific animal and conservation facts pre- and post-performance. We acknowledge that factual awareness about animals is only a small aspect of environmental education. Creating positive and memorable emotional connections is another way of increasing conservation caring (Clayton et al. 2017). Whilst we did not test visitors' emotional response to the theatre performance we were anecdotally aware that visitors enjoyed the performance. Future work could include eye tracking and facial recognition analysis to test the impact of theatre on emotional response and conservation concern. Crucially, in order to justify investment in conservation theatre over other forms of zoo interpretation, comparative research is required to establish which forms of interpretation have greatest impact on visitors.

Conclusions

Theatre can enable a complete emersion of a visitor into a new environment which they could not otherwise access (Jackson and Rees Leahy 2005) and has the potential to convey complex topics such as climate change (Wasserman and Friedman-Young 2013). Whilst the theatre performance tested successfully conveyed its objectives, we note that it primarily encouraged information recall about animal facts and the zoo's conservation efforts. Raising awareness of the zoo's role may be beneficial for public relations, however, it has restricted value in meeting the overall zoo mission or the Aichi biodiversity targets (CBD 2011). We suggest that zoos should prioritise conveying information which raises biodiversity awareness and crucially encouraging conservation actions in order to engage visitors in solutions to environmental problems directly. Our findings demonstrate that information can be effectively recalled from family focused theatre. Therefore, using this method to convey conservation actions or encourage environmental actions could be highly successful.

This study indicates that theatre can successfully engage and educate family audiences without using live animals. This has important implications as live animal shows are often criticised due to welfare concerns. Theatre has the benefit of creating anthropomorphised animal 1246 👄 S. L. SPOONER ET AL.

characters which people can relate to and communicate with, whilst avoiding the risk of presenting animals as tame or as performing for the benefit of humans.

We acknowledge that this is a small study, based at a single zoo site. However, research into zoo-based theatre is limited. Therefore, this study in conjunction with research undertaken in museums and other zoo settings confirms the value of theatre in engaging and educating visiting families. Future research in this field would benefit from comparative studies across many sites and investigating whether theatre can influence conservation actions. Additionally there is a need to compare theatre with live animal shows to test whether it would be an adequate replacement.

Most importantly, zoos should consider what information they aim to impart to visitors. The theatre performance we tested successfully conveyed basic information about animals and the conservation work of the zoo. This raised awareness has a value in increasing support for species and of the zoo but is of limited use for conservation. Zoos should use theatre to engage family audiences with environmental issues and encourage them to develop personalised solutions. As childhood experiences can shape adult views, well designed, family-orientated theatre has the potential to help inspire future conservation action.

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