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Research article

Assessing the effect of zoo exhibit design on visitor engagement and attitudes towards conservation

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Abstract

Modern zoos claim to be a platform for conservation education and attempt to educate visitors using textual interpretation, public talks and engaging exhibit design. Walk-through exhibits aim to maximise the educational potential of a zoo visit by providing a unique, immersive experience that can enhance visitor connection with a species. This study assesses visitor engagement with walk-through zoo exhibits in comparison to traditional exhibits, and explores the role that educators and volunteers play in encouraging visitor engagement. Covert visitor observations were used to quantify dwell times and categorise conversational data at different exhibits. Species at walk-through exhibits elicited more comments related to surface level and deeper level information when compared to species at traditional exhibits ($P<0.001$). Similarly, a higher number of surface level and deeper level comments were made when a visitor had engaged with an educator or volunteer ($P<0.001$). Dwell times were over six times longer at walk-through exhibits; higher dwell times were significantly related to higher numbers of surface level comments ($R^2 =0.433$) and deeper level comments ($R^2 =0.361$). By conducting visitor surveys pre-visit and post-visit to a walk-through exhibit, some significant changes in visitor attitudes towards pro-conservation themes were revealed, but little evidence that visitors had learned something new from the exhibit. Overall, walk-through exhibits that utilise educators or volunteers can enhance visitor engagement with a species, although further research into additional interventions is necessary to determine how this engagement could be developed into pro-conservation knowledge and actions.

Introduction

The well-documented biodiversity crisis is now recognised primarily as a social problem rather than a biological one, with people and the choices they make being the predominant issue (Bennett et al. 2017; Balmford and Cowling 2006). Despite significant conservation efforts from governmental and non-governmental organisations, species declines continue to accelerate (St. John et al. 2010). Human activities such as excessive hunting, over-fishing and large-scale habitat destruction pose the largest threats to biodiversity (Maxwell et al. 2016). Therefore, to understand how behaviour change can be achieved (St. John et al. 2010), conservation scientists must utilise social science methods to understand the motives that drive such behaviours. Education is commonly considered as a vital and globally acceptable tool to aid conservation initiatives, as it can be used to influence people and their decisions (Esson and Moss 2016). Even international treaties, such as the Convention on Biological Diversity, which are dedicated to conserving the Earth's biodiversity, recognise that in order to successfully conserve species, people must be made aware of the value of biodiversity and the role they play in sustaining it—namely, Aichi Biodiversity Target 1 (https://www.cbd.int/sp/targets/). Zoos and aquariums have the potential to play a major role in supporting such global conservation efforts; with over 700 million visits made to world zoos and aquariums annually (Gusset and Dick 2011), they are in a powerful position to not only relay conservation messages to a very large and demographically diverse audience, but also to try and catalyse visitors to personally adopt more pro-conservation behaviours into their lifestyles (Barongi et al. 2015).

The vast majority of today's zoos portray themselves as institutions of biodiversity conservation and conservation education (Hutchins and Smith 2003). For some time now,

zoos have begun to recognise that providing public education is vital to achieving their conservation mission (Conway 1969). More recently, a mission statement analysis by Patrick et al. (2007) highlighted this by revealing that out of the 136 zoo mission statements analysed, 131 mentioned the theme of education. By contrast, only 118 directly mentioned conservation. This theme is echoed by Barongi et al. (2015) who refers to the education role of zoos as an "unrivalled platform to engage the general public in conservation" (p.6).

Education within a zoo setting often occurs through self-directed, free-choice learning (Ballantyne et al. 2007). This could include observing live animals, reading signage at animal exhibits, attending a public talk or interacting with zoo volunteers and staff members (Tofield et al. 2003). However, it is important to recognise that while many visitors do have some kind of learning agenda, the primary motivation for a zoo visit is to see animals and new enclosures (Roe and McConney 2015), which is principally a leisure activity. Such findings jar against the idea that modern zoos can operate as centres of conservation education. Consequently, the educational value of zoos is under the constant scrutiny of critics who claim that zoos are unable to demonstrate that they are centres of conservation education (Hyson 2004; Marino et al. 2010). It is worth noting that in many countries (including all those in the European Union) there is a legal requirement for zoos to provide education to their visitors (EU directive 1999/22/EC). The challenge that zoos face in proving themselves as educational institutions only emphasises the need for further research into their methods of communicating conservation messaging to their visitors. In recent years, research has been undertaken within zoos to address the basis for these criticisms. Moss et al. (2015) used repeated-measures surveys to show that visitors' biodiversity understanding, and knowledge of actions to protect biodiversity, were both significantly increased after a zoo visit. A similar study by Jensen et al. (2017) confirmed these findings, and found that visitor understanding of both variables was still significantly higher even two years after the zoo visit, indicating that zoos have the ability to leave a lasting impression on biodiversity related knowledge. Undoubtedly, the ability to demonstrate long-term gains in visitor biodiversity related knowledge supports the idea that zoos are able to make a significant contribution towards achieving global conservation goals.

In the struggle to define themselves as centres of conservation education, zoos must continually think of new ways to engage visitors with conservation messages. One method by which they attempt to achieve this is by ensuring that exhibits are designed in a way that facilitates and inspires visitor engagement (Ross and Gillespie 2009; Davey 2005). In the last century, zoo exhibits have evolved through different 'generations' (Coe 1996) with increasingly naturalistic designs that promote normal animal behaviours (Yilmaz et al. 2017). Initially, zoo animals were housed in first generation exhibits, which were usually small cages or concrete pits that lacked natural materials, and contained a variety of species (Moss et al. 2008). Second generation exhibits attempt to consider animal welfare to some extent. These exhibits are larger and more naturalistic, but still have many artificial elements (Yilmaz et al. 2017, Moss et al. 2010). Since then, zoos have attempted to develop immersive, third generation exhibits, that attempt to replicate an animal's natural habitat (Moss et al. 2010). The aim is to make the visitor feel fully immersed in these exhibits by concealing any obvious barriers between visitors and animals (Coe 1987). Appropriate educational materials are used at these exhibits to inform visitors of animal or conservation knowledge and engage them with the species (Tofield et al. 2003). These immersive-style exhibits are claimed to be most beneficial to visitor learning, as they can encompass both a positive entertainment experience and an educational experience (Ross and Gillespie 2009).

One step further than immersive exhibits are walk-through exhibits. These are immersive-style exhibits in which the visitor can enter, with no physical barrier between themselves and the animal, offering a unique opportunity to get close to animals and experience their natural environment and behaviour (Mun et al. 2013). While these types of exhibit are becoming more common in modern zoos, to date, there is minimal research into the educational benefit of walk-through exhibits. Despite this, there is a consistent overarching theme about walk-through exhibits in general; visitors appreciate being in close proximity to animals more than anything else (Mun et al. 2013; Woods 2002). The idea that people appreciate close interaction with animals is further supported by the fact that many zoos, including the site studied here (Chester Zoo, UK), offer experiences in which you can pay to interact with and feed a select few species (NEZS 2018a). Given that visitors appreciate being close to animals, walk-through exhibits that allow for close proximity to animals may provide the visitor with the most positive zoo experience, which may instil a greater appreciation for that species and a greater interest in its conservation (Lukas and Ross 2014). As such, walk-through exhibits that can provide entertainment and effortlessly encompass learning may provide direction for enhancing the educational potential of the zoo visit and in helping zoos to support their conservation goals.

Previous research employing a range of social research methods to investigate visitor engagement with immersive zoo exhibits has yielded conflicting findings. Bridges (2017) observed visitors at Chester Zoo to study how visitor engagement changed when second generation exhibits were replaced with immersive third generation exhibits; she found that visitors were less likely to stop to look at immersive exhibits in comparison to the older, more traditional exhibits, and conversation analysis showed that visitor engagement with immersive exhibits was only of a basic level. In contrast, observations made at Chester Zoo by Moss et al. (2010) were more promising; here it was found that visitors spent more time viewing the newer third generation exhibit and had higher interaction levels with different exhibit elements, when compared to the second generation exhibit that had previously housed the same species. Further afield, visitors were found to have longer dwell times at more naturalistic, third generation exhibits, and had more positive perceptions of the animals housed within them when compared to more traditional exhibits (Ross et al. 2012; Nakamichi 2007).

Although there has been visitor research at immersive third generation exhibits, there has been little research that seeks to understand visitor engagement with walk-through exhibits, and their potential to aid the development of pro-conservation knowledge and actions amongst visitors. Until now, there has been an assumption that close proximity to animals, such as that experienced in a walk-through exhibit, will ultimately lead to a greater appreciation for animals and a greater general support for animal conservation (Clayton et al. 2008; Skibins and Powell 2013), but research to support this claim is lacking. With critics claiming that walk-through exhibits may be detrimental to animal welfare (Morgan and Tromborg 2007), it is essential that the assumed potential of walk-though exhibits in connecting visitors to animals and further promoting pro-conservation attitudes is formally assessed. The main aim of this research is to evaluate the level of visitor engagement with species in walk-through exhibits in comparison to traditional 'stand and stare' exhibits, housing similar species. For this, a combination of visitor observation and survey methods were used. As all walk-through exhibits at the study site (Chester Zoo, UK) are supervised by educators and/or volunteers, a supplementary aim was to assess how these staff or volunteers may contribute (or otherwise) to visitor engagement.

Materials and methods

Exhibits

Data were collected at four of Chester Zoo's walk-through exhibits, and at three of Chester Zoo's traditional 'stand and stare' style exhibits. The walk-through exhibits observed were 'Fruit Bat Forest' (*Carollia perspicillata* and *Pteropus rodricensis*), 'the Butterfly Journey' (various Lepidoptera), the two-toed sloth exhibit (*Choloepus didactylus*) and the Bali aviary (*Lonchura oryzivora, Leucopsar rothschildi, Ducula bicolor*), while the traditional exhibits observed were the Sulawesi crested macaque (*Macaca nigra*), Malaysian jungle nymph (*Heteropteryx dilatata*) and the Visayan hornbill (*Penelopides panini*). Visitors can enter the walk-through exhibits with no physical barrier between themselves and the animals. Traditional exhibits are those where the visitor is able to view the animal, but is physically separated from the animal by an obstruction such as a glass window or a mesh.

Procedure

Unobtrusive, covert visitor observations were used at each of the seven exhibits. Visitor groups were randomly selected for observation as they approached the entrance to the walk-through exhibit, or the viewing area of the traditional exhibit. Once a group had been selected for observation, obvious demographic data including the group type (family, couple, adult group or lone visitor) as well as the approximate age and gender of the leading group member were recorded. The leading group member was defined as the first person in the group to enter the exhibit or viewing area. Leading group members were only selected if it was reasonable to assume that they were over the age of 16, as demographic data could not be collected for children. This method of visitor selection has been adapted from Moss and Esson (2010). A timing and tracking style of observation was used to closely observe the selected group as they passed through the exhibit (Yalowitz and Bronnenkant 2009). School groups were excluded from observations, as their visit is unlikely to reflect a typical zoo visit. All data were recorded into an Excel spreadsheet using a tablet computer. The staff member conducting the observations wore 'plain clothes' and a name badge rather than a uniform while conducting the observations in order to avoid attracting visitor attention (Moss and Esson 2010). If a visitor approached the researcher, the visitor was informed of the nature of the study and observation of that visitor was terminated. Observations were only made when the animal/s in the exhibit were clearly visible, regardless of where the animal/s were located within the exhibit.

Visitor engagement was measured by dwell time (seconds) at the exhibit and by conducting a broad conversation analysis. Conversation analysis included all members of the group selected for observation, regardless of age, while they were inside the exhibit or viewing area. The conversation categories used were

Table 1. Comment categories used to analyse visitor conversations.

Conversation Category	Definition
No response	Visitor does not give any kind of verbal response while in the exhibit i.e. stays silent
Social	Discussion of topics not related to the animal or the exhibit e.g. talking about work
Management	Giving instructions or organising the group e.g. planning lunch time
Naming	Either stating what animal it is e.g. bat; naming the species or giving the animal a personal name e.g. Boris
Anatomy	Discussion of the anatomical features of species, e.g. wings
Number	Comments related to the size of the animal group or the number of individual animals
Animal location	Comments on where the animal is or whether it is visible e.g. physically pointing at the animal
Exhibit	Commenting on the design of the exhibit, including comments about objects placed within the exhibit such as foliage or water features. This did not include comments about educational signage within the exhibit.
Behaviour	Commenting on the behaviour of the animals within the exhibit e.g. feeding behaviour
Mimicry	Visitor attempts to mimic sound of the animal in the exhibit
Wild habitat	Comments on the wild habitat of the animal e.g. what its predators are in the wild or what country it is found in
Conservation	Discussion of topics, such as species IUCN status, threats to the species, extinction and conservation efforts
Question and answer	Visitor asks a question and another visitor or member of staff answers. Comments in this category will also fall into at least one of the other categories. For example if a visitor asked "does this animal eat bananas in the wild too?" this would be categorised as a question and answer comment, a behaviour comment and a wild habitat comment
Emotive	Comments that show an emotional response or appreciation for the animal being viewed e.g. "Aw aren't they so cute. I want one". Shock and fear responses were also included, as these were deemed to also be responses that showed deeper engagement with an animal
Interaction with animal	Visitor attempts to verbally or physically interact with the animal by talking to it or waving at it e.g. "Bye-bye bats"
Photo	Visitor takes photograph of the animal or exhibit
Integral species	Visitors discuss a species that is part of the exhibit, but is not the main species. For example, two of the mammal exhibits also contained fish species in aquaria. Comments related to fish were therefore categorised here.
Other	Animal related conversation that does not fit into any of the above categories. For example "I once saw a bat born" or "I once saw a huge caterpillar". These comments are still related to the species, but do not directly relate to the individual/s being viewed or the exhibit itself, and so do not fit into any of the above categories

Table 2. Visitor conversation categories subdivided into three broader categories.

Surface level engagement	Deeper level engagement	Other responses
Animal location	Behaviour	Social
Anatomy	Exhibit	Management
Number	Emotive	Integral species
Naming	Mimicry	
	Habitat	
	Conservation	
	Question and answer	
	Interaction with animal	
	Photo	

adapted from Bridges (2017). A list of the categories and their explanations can be seen in Table 1. A tally was made for each comment in each category and all comments made by all group members were categorised. The conversational categories (Table 1) were organised into three different response types for ease of analysis; surface level responses, deeper level responses and other responses (Table 2). Surface level responses were basic, descriptive responses that could be made by taking only a brief glance at the exhibit. They are primarily descriptive rather than investigative responses. Deeper level responses required further thought about the animal or exhibit and showed a further level of engagement rather than just basic descriptions. This could include asking questions, displaying an emotional response to the animal or discussing the animal in-situ. Taking a photograph of the animal/exhibit was also included in this response type, as it was assumed that photos were taken to create lasting memories to look back at in the future. The final category comprised all other responses that were unrelated to the individual/s being viewed or the exhibit (Bridges, 2017). The researcher also recorded whether or not any group members engaged with educational signage and for how long (mm:ss). Engagement with signage was defined as obviously looking at the signage for more than two seconds. If there was an education staff member, otherwise known as a 'zoo ranger', or volunteer at the exhibit, the researcher recorded whether or not the group engaged with the staff member/volunteer. Data collection continued when visitors engaged with staff member/volunteer, although comments made by the staff member/volunteer were not recorded. All data collected during the observations remained confidential and anonymous and was only recorded for the purpose of data analysis.

In addition to visitor observations, surveys pre and post walk-through exhibit visit were used to evaluate visitors' attitude changes towards conservation related themes, and to explore self-reported gains of knowledge. Participants were selected to take part on a similar basis as the observations; when one group had completed the survey the next available approaching group was asked to take part. Only one member of each group completed the survey. Quantitative survey items were mainly measured using Likert-type scales in relation to statements developed from previous research at Chester Zoo (Moss et al. 2017). Open-ended questions were included to measure self-reported learning as well as visitor attitudes towards the exhibits. For the open-ended question that asked 'What did you like most about this exhibit?' answers were categorised in order to highlight the most common themes. Some initial expected themes such as 'seeing the animals', 'closeness to animals' and 'learning new things' were used as baseline categories (Mun et al. 2013; Woods 2002), although subsequent categories were added upon during analysis to account for all participant answers.

Statistical analysis

Data from the observations and the surveys were analysed using SPSS. Conversational data were grouped by category. Mann-Whitney tests were used to explore differences in conversational categories between the two exhibit types and between visitors who engaged with a staff member or volunteer or not. Linear regression was used to explore the relationship between conversational categories and visitor dwell time in exhibits. The quantitative survey data were analysed using independent t-tests to uncover any differences in attitude in visitors to walk-through exhibits, compared to those that hadn't visited walk-through exhibits. Open-ended survey data were investigated using a thematic qualitative analysis. All figures were created in SPSS.

This study received ethical approval by Chester Zoo's internal, but independent, ethical review process, and in accordance with Chester Zoo's human research ethics framework.

Participants

During the data collection period a total of 1892 visitor observations (1183=walk-through exhibits, 709=traditional exhibits) and 468 surveys were collected (239=pre-visit to a walk through exhibit, 229=post-visit to a walk-through exhibit). These data were used to perform statistical analysis.

Results

Conversational responses at walk-through and traditional exhibits

A Mann-Whitney test was performed on the three different response categories across the two enclosure styles (walk-through and traditional) to determine whether conversational responses differed significantly between enclosure styles. Surface level responses ($U=145202.5$, $df=1460$, $P<0.001$), deeper level responses ($U=74753$, $df=1185$, $P<0.001$) and other responses ($U=39309.5$, $df=998$, $P<0.001$) were all significantly higher at walk through exhibits when compared to traditional exhibits (Figure 1).

Interaction with staff members and volunteers

To determine whether interaction with a staff member or volunteer was able to enhance visitor engagement with an exhibit, a Mann-Whitney test was performed on the three conversational response categories for visitors who did or did not engage with a staff member or volunteer. The number of surface level responses ($U=63154$, $df=1460$, $P<0.001$) deeper level responses ($U=45047$, $df=1185$, $P<0.001$) and other responses 4($U=6676.5$, $df=998$, $P<0.001$) were all significantly higher when the group under observation had engaged with a staff member or volunteer. The results can be seen in Figure 2.

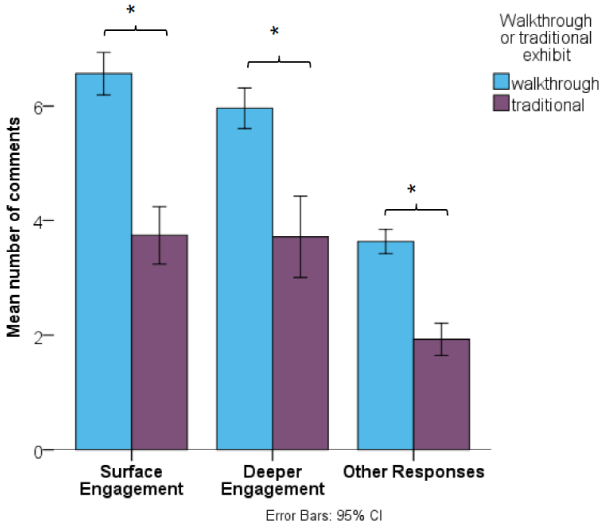

Figure 1. Mean number of comments for each type of visitor engagement category at walk-through and traditional exhibits. Error bars depict 95% confidence intervals. *denotes significant difference, P<0.05.

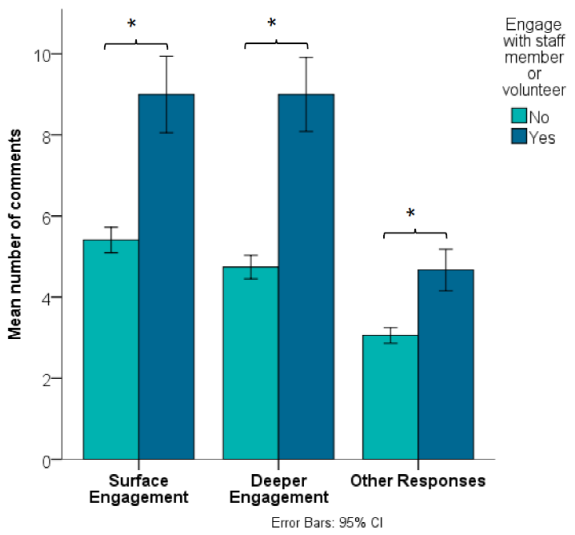

Figure 2. Mean number of responses for each visitor engagement category when visitors did or did not speak to an educational member of staff or volunteer. Error bars depict 95% confidence intervals. *denotes significant difference, P<0.05.

Conversational responses and dwell time

Visitor dwell times were recorded for each observation as one proxy for visitor engagement. The median dwell time at walk through exhibits was 161 seconds, while the median dwell time at traditional exhibits was 24 seconds. Following this finding, three linear regression analyses were performed to explore the relationship between dwell time and each of the three response categories. A strong positive relationship was revealed between dwell time and surface level responses ($F(1, 1458)=1115.96$, df=1, 1458, $P<0.001$, $R^2=0.433$ $\beta=0.658$). A moderate positive relationship was found between dwell time and deeper level responses ($F(1, 1183)=667.81$; $P<0.001$; $R^2=0.361$; $\beta=0.601$) and a weak positive relationship was found between dwell time and other responses ($F(1, 993)=323.56$, $P<0.001$; $R^2=0.246$; $\beta=0.496$). The results can be seen in Figure 3.

Changes in visitor attitudes pre- and post-visit to a walk-through exhibit

Some significant changes were found in visitor attitudes towards conservation/wildlife when comparing responses pre- and post-visit to a walk-through exhibit (Figure 4). Independent t-tests were used to compare pre- and post-visit responses to four Likert-scale statements. No significant differences were noted between pre- and post-visit responses for the statements, 'There is nothing I can do personally to help protect animal species' ($t=0.360$, df=455, $P>0.05$) and 'I feel connected to wildlife' ($t=-1.717$, df=456, $P>0.05$). The statement 'Some species are just meant to die out' had significantly lower support post-visit to a walk-through exhibit ($t=2.049$, df=453, $P<0.05$), and the statement 'I would like to do more to help wildlife', had significantly higher support post-visit to a walk-through exhibit ($t= -2.293$, df=455, $P<0.05$).

Visitor feedback of walk-through exhibits

To capture what visitors most appreciated about walk-through exhibits, visitors were asked, 'What did you like most about this exhibit?' A total of 187 answers were given and these were categorised into eight themes that emerged from the data. These themes were: Everything, Closeness to animals, Free flying or freely moving animals, Aesthetically pleasing e.g. "Beautiful and peaceful", The animal, Exhibit features or overall design, High visibility of animals, Comments related to feelings e.g. "Loved it". Comments that did not fit into any of the above categories were placed in an 'other' category. Some answers contained comments that fit into more than one category, so in total there were 201 categorised comments. The three most commonly mentioned themes accounted for 56% of the answers were:

Theme one: Free flying or freely moving animals.

These answers were related to the idea that animals could fly or move around freely without restriction.

"free flying bats" and "the freedom they have" were among some of the answers.

Theme two: Exhibit features or overall design.

These answers were related to either the overall exhibit design or a specific physical feature of the exhibit. Answers included, "plants and how they grow" and "the high ropes enabling me to see the sloths in slow movement".

Theme three: Closeness to animals.

These answers stated that being close to the animals was what they liked most about this exhibit. Answers included, "the feeling of being close with the bats" and "close to the birds".

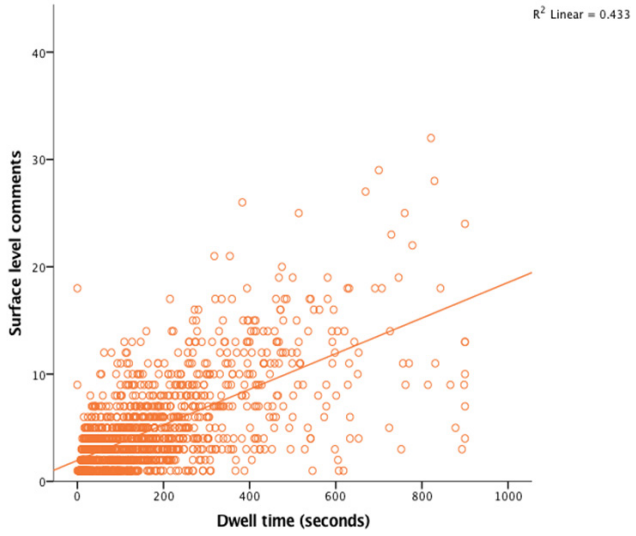

Figure 3a. The relationship between visitors dwell time and the number of surface level comments (F(1, 1458)=1115.96, P<0.001, R^2=0.433 β=0.658).

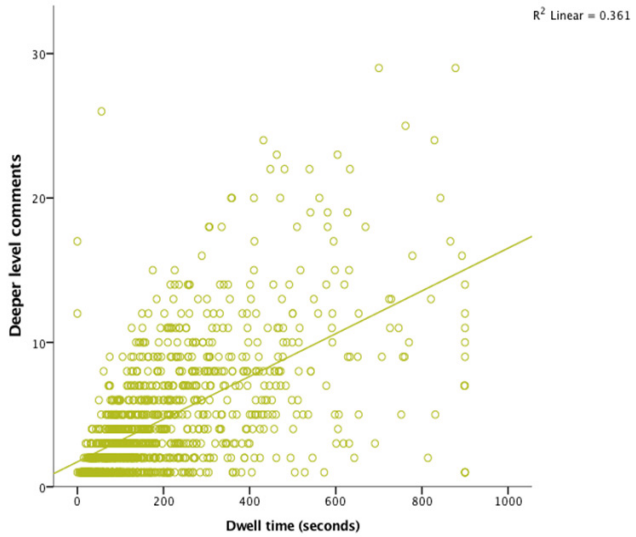

Figure 3b. The relationship between visitors dwell time and the number of deeper level comments (F(1, 1183)=667.81; P<0.001; R^2=0.361; β=0.601).

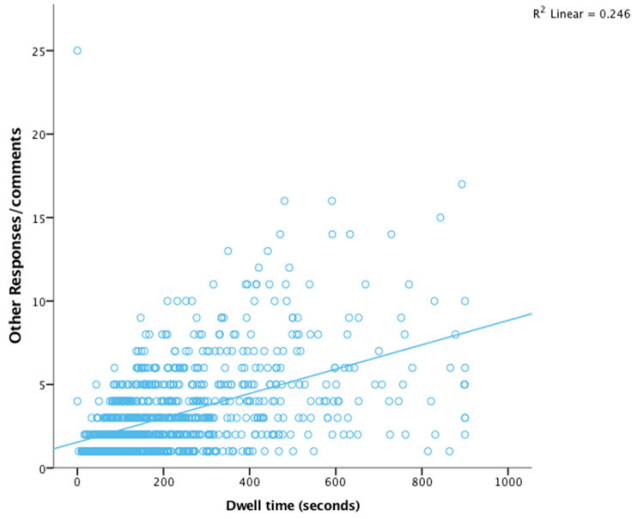

Figure 3c. The relationship between visitors dwell time and the number of other responses (F(1, 993)=323.56, P<0.001; R^2=0.246; β = 0.496).

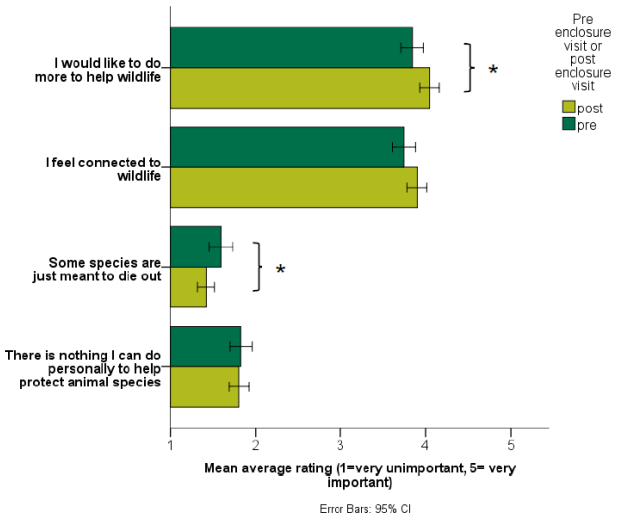

Figure 4. Mean visitor responses to attitude statements pre- and post-visit to a walk-through exhibit. Statements were measured using a 5-point Likert-type scale from 1 – Strongly disagree to 5 – Strongly agree. Error bars depict 95% confidence intervals. * denotes significant difference, p<0.05.

Self-reported learning at walk-through exhibits

During the post-visit surveys visitors were asked, 'Did you learn anything new from the exhibit?' 55.9% (n=119) responded 'yes' and 44.1% (n=94) responded 'no'. Visitors were then asked to provide a descriptive answer about what they had learned. Of those that responded 'yes' to the previous question, 68.9% (n=82) provided an answer about what they had learned.

On closer review of those answers, it was found that only 23.2% (n=19) could provide a truly factual statement about what they had learned, whilst 76.8% (n=63) gave answers that did not demonstrate a definite gain of knowledge. For example, 'that the butterflies have different chrysalis' would be considered as a factual statement that could demonstrate a true gain in knowledge. Answers such as 'names of birds' were not considered as factual statements.

Discussion

This research reveals some essential findings in relation to the way that zoo visitors engage with walk-through exhibits. Chiefly, that exhibit style has a significant impact on visitor engagement with a species, with visitors showing increased engagement with species housed in walk-through exhibits. Visitors elicited significantly higher numbers of surface level, deeper level and other comments at walk-through exhibits, when compared to visitors to traditional 'stand and stare' exhibits. The walk-through exhibits used in the study were considerably more immersive than the traditional exhibits, due to the fact that visitors were able to physically enter the animal's habitat rather than view the animal through a barrier. The findings here reinforce the ideas suggested by Ross and Gillespie (2009) that immersive exhibits, in this case walk-through exhibits, are able to elicit the greatest level of visitor

engagement. Ideally, the greatest mean increase in the number of comments would have been for the deeper level comments, as these comments demonstrate a stronger connection to a species (Bridges 2017). However, it was found that the greatest increase was in the number of basic, surface level comments. It is worth noting that this is perhaps because the walk-through exhibits generally house higher numbers of individual animals, resulting in increased numbers of animal location comments at walk-through exhibits. With regard to deeper level comments, it was found that visitors asked more questions, made more comments about animal behaviour and demonstrated a more emotional response to species in the walk-through exhibits.

However, referring back to two of the aims of the modern zoo—conservation and conservation education—if visitors are displaying a deeper level of engagement with species at walk-through exhibits, it may be expected that they would have a greater interest in the conservation of those species (Lukas and Ross 2014). However, conversation analysis revealed that visitor comments relating to conservation were made in only 2.3% of observations. Findings such as this do little to refute the idea that zoos are ultimately failing to define themselves as conservation education institutions (Hyson 2004; Marino et al. 2010). A more promising finding is that 93% of those conservation comments were made at walk-through exhibits, again reinforcing the conclusion that visitor engagement is greater with walk-through exhibits than traditional exhibits.

Unsurprisingly, dwell times were much higher at walk-through exhibits. This could simply be because the viewing area of a traditional exhibit is generally much smaller than the footpath area of a walk-through exhibit, as it was not possible to control for visitor floor area in this study. However, previous work by Moss et al. (2010), which did control for visitor floor area, similarly found that visitor dwell times were longer at more immersive exhibit styles, and suggested that there was a link between increased dwell time at an exhibit and visitor engagement with different exhibit aspects. Analysis of the relationship between dwell time and the number of comments visitors made revealed a significant positive relationship between dwell time and the three comment categories, adding support to the claim that longer dwell times may be linked to increased visitor engagement. As visitors tend to spend longer in walk-through exhibits, this may suggest that visitor engagement is higher at walk-through exhibits. This finding is one that could be applied to the future management of zoos; namely, if zoos can create 'time-consuming' areas or exhibits, as has been done with the walk-through exhibits, there is potential to increase visitor engagement with that aspect of the zoo visit experience. This does not just apply to the building of new animal exhibits, but could also include creating areas that showcase zoo campaigns or conservation work.

The study also demonstrated that educational staff members and volunteers play a role in increasing visitor engagement. Visitors, who spoke to either, made significantly more surface level, deeper level and other comments. The main roles of volunteers and zoo educators are to relay knowledge about animals and conservation to zoo visitors, as well as providing organised educational activities or events (Bixler et al. 2014; NEZS 2018b). With these roles in mind, it is not surprising to find that engaging with a zoo volunteer or educator is able to significantly alter the course of visitor conversations. The most promising finding here is that engagement with a zoo educator or volunteer had the greatest impact on the number of deeper level comments. This suggests that staff members and volunteers may be crucial in ensuring that visitors begin to discuss deeper level topics such as conservation; almost 70% of the comments made about conservation were made when a visitor had spoken to a volunteer or educator. However, it should be highlighted that the topic of conservation was still amongst the least frequently discussed topics, when compared to other topics such as animal names, behaviours and anatomy for example. Previous research investigating communication between volunteers and visitors yielded similar findings; they found that conversations between volunteers and visitors were often limited to discussion of animal names, diets, behaviours etc. rather than communication of conservation messages (Mony and Heimlich 2008).

It is also worth taking into account the idea that visitors who willingly choose to engage with a staff member or volunteer may already have an inherently greater interest in the animal being viewed, making it difficult to conclude that speaking to an educator or volunteer directly resulted in increased visitor engagement with the animal.

A limitation to this part of the study was that, during data collection, staff members and volunteers were not distinguished. Had this been done, it may have been possible to gain a better insight into the exact roles that education staff and volunteers play in enhancing visitor engagement. With particular regard to volunteers, the role that they played seemed to vary depending on personal traits, as some volunteers would confidently approach visitors to provide information, while other volunteers were more reserved. The variety of approaches that different volunteers had towards interaction with visitors could possibly alter the effect that they are able to have on increasing visitor engagement with the species, although this was not something that this study was able to evaluate. Future research might seek to further explore the way in which volunteers are utilised by zoo visitors, as well as determining any potential actions to help volunteers actively communicate conservation messages to a wider audience.

The survey tool used here revealed findings about the positive impact that walk-through exhibits have on visitor attitudes towards conservation. Respondents' attitudes towards all four statements relating to nature and conservation were found to change positively when comparing pre- and post-exhibit responses. Respondents agreed less with the negative statements about nature/conservation, and agreed more with the positive statements about nature/conservation after visiting a walk-through exhibit, although only two of these changes were significant. One of the statements that respondents agreed significantly more with post-exhibit visit was, "I would like to do more to help wildlife". Interestingly, this was the only statement that relates to intention to change behaviour. As previous research has identified, it is virtually impossible to directly measure visitor behaviour or commitment to change behaviour, as many studies into behaviour change are reliant on self-reports rather than direct observation (Swanagan 2000; Esson and Moss 2014).

Nevertheless, respondents showing a significant increase in their desire to adopt pro-conservation behaviours is a promising outcome for zoos. The challenge that still exists is to then ensure that this broad sense of commitment to conservation actually develops into changing their everyday actions (Ballantyne et al. 2007). When considering these attitude statements, it must be considered that it is not possible to directly attribute any attitudinal changes to a walk-through exhibit, as respondents may have visited many zoo exhibits prior to visiting the walk-through exhibit. As such, it is more appropriate to conclude that the attitude changes seen here were as a result of the zoo visit as a whole.

When respondents were asked what they liked most about the walk-through exhibit, three common themes emerged. These were the free-flight aspect, the exhibit design and the ability to be close to the animals, themes that are echoed in previous research into walk-through exhibits (Mun et al. 2013; Woods 2002). It is worth noting that the free-flight aspect and the feeling of close proximity to animals would be difficult to achieve at a traditional exhibit. The

findings conclude that a positive visitor engagement experience is being achieved at walk-through exhibits. However, our survey findings suggest that this is not translating into wholesale embedded learning (Ross and Gillespie 2009). Respondents were asked to self-report if they had learned anything new from the walk-through exhibit. While over half of the respondents felt that they had learned something new, further questioning revealed that only very few respondents had learned anything that was considered factual, or showed a substantial gain of knowledge. These findings therefore highlight that the educational potential of these exhibits, at least in relation to knowledge gain, is not yet being fully realised.

Conclusions

Overall, the findings of this study offer several suggestions about visitor engagement with walk-through exhibits. When compared with traditional 'stand and stare exhibits', walk-through exhibits are significantly more successful in engaging visitors with a species. The extent of visitor engagement increased further when a visitor interacted with a member of educational staff or a volunteer, especially with regards to increasing numbers of deeper level comments. However, it was found that visitors rarely discussed topics such as conservation or wild habitats; a finding that gives pause for thought, given that a core aim of zoos is to provide conservation education. Although visitors clearly showed a deeper level of engagement with walk-through exhibits, it appears that there is still some disconnect between entertainment and education; very few visitors demonstrated any substantial learning about animals or conservation during their visit to the exhibit, despite being engaged with the species. In agreement with what has been suggested by Bridges (2017), the immersive approach to conservation education may not be the most effective, and perhaps a more direct form of conservation education is necessary in addition to immersive exhibit design. If zoos are to uphold their claims as conservation education institutions, it is crucial that they continue to consider how conservation education can be best delivered, while maintaining a positive entertainment experience.

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