JZAR JOURNAL OF ZOO AND AQUARIUM RESEARCH
www.jzar.org

Research article

The effects of human-zoo ambassador animal interactions on millennial populations

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Keywords: education, human-animal interactions, millennial, welfare, zoo animals

Article history:
Received: 03 Oct 2022
Accepted: 08 Jul 2024
Published online: 31 Jul 2024

Abstract
Zoos and aquariums offer unique opportunities for their visitors to engage with a variety of animals, including many nonnative species. These human–non-human animal interactions may also occur outside of the zoo, as some institutions have ambassador animals that travel to locations for educational purposes. Shifting attitudes towards animals in professional care including ambassador animals has been identified in millennial populations, who are considered drivers of social change. The objective of this series of preliminary studies was to evaluate the impact of live ambassador animals on millennials' knowledge gain as well as changes in attitudes towards zoos, species conservation and animal welfare. Experiments were conducted using a pre-/post-test methodology with treatment groups consisting of live animals during educational messaging versus control groups with no animal present (n=65; n=34, respectively). The human-zoo animal interaction for each experiment's treatment group was simply the presence of the animal—no touching was allowed. Results suggest that the use of a live zoo ambassador animal during educational experiences increases positive attitudes towards some species (P=0.02) and enhances perceptions of zoo animal welfare (P=0.02). These studies contribute to critical evaluation of the use of zoo ambassador animals as well as aid in the objective measurement of the effectiveness of these interactions.

Introduction

Interactions between human and non-human animals (HAI) have served as an educational tool for many decades and with a variety of population ages (King 2004; Lairmore and Ilkiw 2015; Pinto and Foulkes 2015). While the most precise terminology would be human–non-human animal interactions, for clarity these occurrences are referred to as human-animal interactions (HAI). Many of these interactions take place in traditional classroom settings and involve small companion animal species (Gee et al. 2017; Pinto and Foulkes 2015). These HAI may include classroom pets, animal involvement in educational lessons and targeted, animal-assisted interventions. Studies suggest these interactions can improve cognitive learning, empathy and intrinsic motivation (Hergovich et al. 2002; Hummel and Randler 2012; Krull et al. 2015), reduce aggressive behaviours (Hergovich et al. 2002) and improve engagement and self-regulation (Gee et al. 2017). At the university level, agricultural/animal science and veterinary medicine programmes primarily involve use of domestic livestock species in classroom HAI (King 2004; Lairmore and Ilkiw 2015) for hands-on educational experiences and to enhance student knowledge gain and

retention (George and Cole 2018). HAI educational experiences can expand to include native wildlife and exotic animals, typically through rehabilitation centres and zoos (Ballantyne et al. 2007; Spooner et al. 2021a,b).

As zoological institutions have evolved from menageries to centres of conservation, education and science (Beer et al. 2023; Greenwell et al. 2023; Rabb and Saunders 2005), this shift has included offering opportunities for HAI (D'Cruze and Grove 2024). This aligns with the goal of modern zoos to highlight the animals in their care as ambassadors for conservation and education (Ogden and Heimlich 2009). HAI are a common feature in zoos and aquariums around the world, with 75% of institutions surveyed across Europe, North America, Asia, Oceania, South America and Africa advertising at least one type of HAI and North America and Oceania advertising the most interactions (D'Cruze et al. 2019). These interactions can be indirect, which may include live shows/demonstrations, walk/swim-through activities or passively observing animals in their habitats. They can also be direct interactions, including touching, hand feeding or riding an animal (D'Cruze et al. 2019; D'Cruze and Grove 2024). In addition to HAI, zoos offer educational signage at exhibits and expert talks from animal care staff and volunteers (Roe et al. 2014). Some zoos also offer outreach programming, often known as ambassador animal programmes, which may include transporting animals to locations outside of zoo property for HAI. The educational value of live animal encounters is commonly highlighted as a benefit to these interactions (Miller et al. 2013; Spooner et al. 2021b; Wünschmann et al. 2017), though previous studies evaluating the impact of educational opportunities often occur in zoological settings (D'Cruze and Grove 2024; Luebke 2018; Miller et al. 2020; Spooner et al. 2021a). Additional research on impacts of HAI outside of the zoo is needed. Based on the ethical considerations for these interactions, the zoological industry has adopted the position that all HAI, including ambassador animals, must include careful consideration of both benefits to human participants and welfare of the animals involved (Perdue and Maple 2024; WAZA 2020).

This question of ethics around interactions with animals has been at the forefront of shifting societal views towards animals in professional care and zoos and aquariums (George et al. 2016; Kleespies et al. 2021; Manfredo et al. 2020). Public concern for the welfare of animals in zoos and aquariums has been consistently demonstrated around the world (Davey 2007; Gurusamy et al. 2015; Jiang et al. 2007; Naylor and Parsons 2019; Reade and Waran 1996). This concern extends to ambassador animals, with several recent studies aiming to evaluate the welfare of animals in these roles (Baird et al. 2016; Fischer et al. 2021; Powell et al. 2020; Spooner et al. 2021a). An individual's concern for ambassador animals can be traced to their beliefs and value orientations. Two frameworks which have evolved to evaluate attitudes towards animals and zoological institutions are Wildlife Value Orientations (WVO) and Identity-Related Visitor Motivations (IRVM). WVO is a conceptual framework to guide understanding of beliefs and attitudes towards wildlife, resulting in placement into one of two main value orientations, domination or mutualism. The domination value orientation uses a utilitarian approach to considering wildlife, while mutualism uses an egalitarian approach (Fulton et al. 1996; Teel and Manfredo 2009). The IRVM framework uses a standard set of survey items to group visitors into identity-based categories based on their motivations for visiting a particular institution (Falk 2006). Through continued science-based advancement, there is tremendous opportunity for zoos and aquariums to be positive influences in their human and animal communities, though it will require consideration of changing societal perspectives (Greenwell et al. 2023).

Currently, one of the populations significantly influencing social change, including impact to zoos and aquariums, is the millennial generation born between 1981 and 1996 (Dimock 2019; Schewe and Meredith 2004). Although not entirely a monolith, this generation is shaped by a suite of common characteristics (Debevec et al. 2013; Leask et al. 2013; Schewe and Noble 2000), including being social-cause oriented (Debevec et al. 2013) and engaging with and contributing to causes to help others rather than strengthen institutions (Feldman 2015). Millennials desire opportunities for connections and up-close interactions with nature (Douglas et al. 2022) but show concern for ethical experiences during interactions with animals (Bucic et al. 2012; Douglas et al. 2022). Also noted is their awareness of animal welfare issues, especially for animals in professional care (Marinova and Fox 2019). This interest in animal welfare coupled with shifting attitudes towards zoos leads to the need to evaluate this generation's response to zoo ambassador animal programmes as educational opportunities. Although not exclusively responsible for these shifting attitudes towards animals and HAI (Alba et al. 2023; Carles et al. 2023; Dimock 2019), millennials have grown up with HAI in zoos and are now of the age to bring their children (generation Alpha) to zoos and potentially participate in HAI (McCrindle 2024; Sterbenz 2015). As societal views on animal issues continue to evolve, shifting in part due to the millennial generation, it is necessary to understand the value and impact of HAI.

The lack of a clear understanding of the presence (or absence) of a cause-and-effect relationship between HAI and outcomes for the human participants (e.g., attitude change, knowledge gain, behaviour change) has identified a need for experimental studies to further explore this link (Sherwen and Fernandez 2024). Given this gap in literature and the role of the millennial generation, this series of studies was designed to investigate the use of live ambassador animals during educational experiences with millennial populations. Building on previous work by George and Cole (2018), the first experiment in this series was designed to measure the effect on knowledge gain using a traditional zoo environment. The second experiment was designed to measure the effect on attitudes toward species, zoos and zoo animal welfare using a novel environment. It was hypothesised that the use of a live zoo ambassador animal during educational experiences would influence knowledge gain, as well as attitudes towards the species and towards zoo animal welfare. These studies contribute to the growing field of science exploring live zoo ambassador animals to help guide this practice in the future.

Materials and methods

The populations in these studies included millennials born between the years of 1981 and 1996 living in greater Columbus, Ohio. Experiments were approved by The Ohio State University's Institutional Review Board, all participants completed consent forms and participant information was anonymised before each experiment began. Both studies followed a pre-/post-test survey methodology, commonly employed to measure knowledge gain, attitudes and behaviour change (Campbell and Stanley 1966). Surveys were administered electronically via Qualtrics software (Qualtrics, Provo, UT). All animals were part of the Columbus Zoo and Aquarium's ambassador animal collection with involvement limited to participation in existing educational programs, leading to exemption from the university's Institutional Animal Care & Use Committee (IACUC) review. Participants were not able to approach or touch the animals, animals were simply present with zoo staff during the educational messaging. The duration of each program was consistent across both experiments and was limited to 15-20 minutes.

Table 1. Study population, location and treatment and control groups for each experiment

Experiment	Location	Treatment groups	Number of people
Experiment One	Auditorium at Zoo, Columbus OH	Live presentation with live animal present (T1)	21
		Recorded presentation with live animal present (T2)	23
		Recorded presentation with no animal present (control)	21
Experiment Two	Public park, Columbus OH	Live presentation with live animal present	21
		Live presentation with no animal present (control)	13

Experiment One

This experiment's sample population consisted of 65 college students of various disciplines attending The Ohio State University, in Columbus, Ohio. The study took place in an auditorium at the Columbus Zoo and Aquarium, on December 2nd, 2015. All participants were bussed from the university to the zoo. The environment and speaker were controlled by use of the same room and representative from the zoo for each presentation. Two ambassador animals were used, the African black-footed penguin *Spheniscus demersus* and African cheetah *Acinonyx jubatus.*

Students were randomly assigned to one of three groups to account for internal validity (Table 1). Treatment one (T1) included a live presentation with both animals present at different times during the presentation (n=21), treatment two (T2) a recorded presentation with the same animals present at separate times during the recording (n=23) and the control group the same recorded presentation with no animals present during the presentation (n=21). First, T1 was tested and the presentation was recorded for use in the T2 and control groups. All participants had access to water before their respective presentation and were held in a separate waiting room until their group was called. For each of the treatment groups, as information was presented about the focal species, an animal representing that species was presented in front of the group.

Participants completed the pre-test before splitting into their respective groups. The post-test was independently completed immediately after each presentation and students had the opportunity to walk around the zoo after completion. To account for a potential priming effect on the post-test, only half of the participants in each group completed the knowledge pre-test (T1 n=13; T2 n=11; control n=10). To measure knowledge gain, the pre- and post-tests included multiple choice questions about each species, the answers to which were stated during the educational messaging by zoo staff. Information presented included animal physiology, reproduction, social structure, diet/nutrition and terminology for each species. Demographic information was also collected during the pre-test, including student majors, number of visits to a zoo within the last 12 months and agricultural experience.

Experiment Two

The sample population included millennials recruited via flyers posted in public locations in Columbus, Ohio and surrounding areas (n=34). A boxed dinner was offered as an incentive to participate in the study. Presentations took place on 4 and 7 October 2017 at the shelter house of a public park in central Columbus, Ohio, allowing for a novel location and animal presence. Blind random selection into the treatment and control groups occurred by participants choosing which date to attend without knowledge of the group assignment. An ID was selected for each participant to connect pre- and post-test data without identifying the individual. The environment was controlled through use of the same location within the park on both nights. To ensure consistent messaging across treatment groups, the same speaker presented to both groups and the presentation was recorded on the first night. The speaker reviewed the presentation recording for replication to the best of their abilities on the second night.

The treatment group consisted of 21 participants and the control group 13 participants (Table 1). The treatment group included four ambassador animals, the African black-footed penguin, African cheetah, two-toed sloth *Choloepus hoffmanni* and radiated tortoise *Astrochelys radiata,* with a live presenter. The control group included the same presenter with no animals present. Educational messaging for both groups included basic life history traits of each species, the care they received at the zoo and their conservation status. At the time of this study, all ambassador animals regardless of their species were permitted to travel outside of the zoo for educational programming. Since the time of this study, new regulations in the US prohibit one of the participant species (cheetah) from traveling as an ambassador animal (H.R.263 - BCPSA 2022). As a result, the participating zoo no longer permits the use of cheetahs off-site.

Participants completed the pre-test after scanning the QR code on the recruitment flyer and the post-test immediately following the educational presentation they attended. Questions included in both surveys were designed to measure attitudes toward zoo animal welfare and zoos in general not covered in Experiment One (Table 2). Attitudes towards and knowledge of the species involved were evaluated using seven- and five-point Likert scales with positive scores on the lower end of each scale (like a great deal–dislike a great deal; extremely knowledgeable–not knowledgeable at all).

Demographic information was expanded to include participants' wildlife values and motivation when visiting a zoo using the WVO and VIRM frameworks. WVO have been validated to evaluate attitudes towards wildlife and explore impacts of societal values on animal management and conservation (Alba et al. 2023; Manfredo et al. 2020; Teel and Manfredo 2009). VIRM has been

validated for zoo and aquarium visitors, to understand motivations to visit and the role of these institutions in their communities (Falk et al. 2007, 2008). Participants were also asked to select identity(s) as 1) animal rights advocate, 2) hunter, 3) environmentalist, 4) conservationist and/or 5) farmer/rancher.

Statistical analysis

Data were recorded and analysed using SPSS for Windows v26.0 (SPSS Inc., Chicago, IL, USA). The relationship between participants' demographic information and pre-test scores were examined using Pearson correlations for both experiments. All data were non-parametric and therefore pre-/post-test scores were averaged within each group and differences in knowledge gain and attitudes towards animal welfare in zoos and the species presented compared using the Mann-Whitney U test.

Experiment One

Mann-Whitney U tests were employed to determine the influence of a live animal on the level of knowledge gained between the pre- and post-test. Student majors and agricultural experience were compared to pre-test scores using Pearson correlations. Descriptive statistics were used to determine the percentage of participants that visited a zoo in the last 12 months.

Experiment Two

Influence of the presence of a live animal on attitude towards zoos and study animals was examined using Mann-Whitney U tests. The effects of participants' history of zoo visits were examined using Pearson correlations. WVO questions were categorised into mutualistic or dominionistic using Principal Component Analysis. Appropriateness of the correlation matrix was determined using Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy. Descriptive statistics were used to determine participants' identity(s) as well as motivations for visiting a zoo.

Results

Experiment One

Agricultural experience (r^2=0.43, P=0.01) and living on a farm (r^2=0.39, P=0.03) were found to be positively correlated with average pre-test scores of participants. Notably, these two demographic factors were also positively correlated with one another (r^2=0.51, P<0.01). No other demographic factors (gender, number of previous zoo visits, companion animal in household) were correlated with average pre-test scores. Most of the population (n=49) were enrolled in animal-related majors: Animal Sciences, Zoology and Wildlife. Additionally, almost 80% of the participants had visited a zoo within the last 12 months (0 visits 22.4%, 1–2 visits 61.2%, 3–4 visits 10.4%, 5+ visits 6%).

Average knowledge gained did not differ between groups, although the largest increases occurred in treatments one (27%) and two (27%) compared to the control (16%). Average knowledge gained for individual questions across groups are described in Table 3. For treatment one (live presentation and live animal), participants had a 63% knowledge gain when asked how long the gestation period was for the cheetah and a 62% knowledge gain when asked what the common term was for a group of cheetahs (Table 3). In treatment two (recorded presenter and live animal), knowledge of the social structure of the cheetah increased 73% and of the length of the penguin's incubation period increased 63% (Table 3). Finally, within the control group, knowledge of the penguin's social structure increased 71%, while that of the penguin's incubation period increased 56% (Table 3).

Experiment Two

Participants were found to be consistent in their wildlife values and align with the mutualistic value orientation compared to domination. All statements within the mutualism orientation were positively correlated with the first principal component (PCA1),

Table 2. Survey questions that measured attitudes towards animal welfare in zoos and zoos in general. Level of importance measured on a five-point Likert scale (extremely important–not at all important) and level of agreement on a seven-point Likert scale (strongly agree–strongly disagree)

Survey questions that measured participants' attitudes towards animal welfare in zoos
What level of importance do you think zoos place on the following: species conservation; public education; entertainment; scientific research; animal wellbeing
Zoo animals' welfare is compromised due to captivity.
Animal welfare is a focus of the zoo.
Zoo animals should exhibit all the same behaviour as their wild counterparts.
Zoo animals have the ability to adapt to their human-created environments.
Zoos conduct scientific research to assess their animals' welfare in order to continually improve conditions for their animals.
Zoo animals suffer stress due to their environment.
Zoos value human entertainment above animal welfare.
Zoos create spaces for their animals that allow the expression of natural behaviours.
Zoo animals' welfare is better than their wild counterparts due to consistent food and water.
Zoo animals' welfare is better than their wild counterparts due to protection from predation.

Journal of Zoo and Aquarium Research 12(3) 2024
http://doi/org/10.19227/jzar.v12i3.719

while all domination statements were negatively correlated with PCA1. Scores for the mutualism statements (mean=1.47 to 2.75) corresponded with the agreement portion of the seven-point Likert scale, while the domination statements (mean=3.35 to 6.10) corresponded with the neutral to disagreement portion of the seven-point Likert scale. The WVO correlation matrix was deemed appropriate following Bartlett's Test of Sphericity ($\chi 2(55)=294.39$, $P<0.01$) and Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO=0.84).

For identity, 30% of participants identified as an animal rights advocate, 2% identified as a hunter, 35% as an environmentalist, 31% as a conservationist and 2% as a farmer/rancher. After grouping questions on the motivation to visit a zoo, individuals viewed exploring as being most important (2.12±0.35), then seeking experience (2.5±0.75), connecting spiritually (2.5±0.38), being the facilitator (2.56±1.45) and lastly identifying as a professional/hobbyist (3.15±0.62; Figure 1).

Responses to questions on the frequency of zoo visits revealed that most millennial participants had been to a zoo as both a child and an adult and planned to visit a zoo within the next few months. For visits to the zoo as a child, 14.8% answered that they visited rarely, 51.9% visited sometimes, 24% frequently and 9.3% very frequently. As an adult, only 5.6% of respondents answered that they had never been to a zoo, 18.5% responded rarely, 53.7% visited sometimes, 14.8% frequently and 7.4% very frequently. Regarding plans to visit a zoo within the next six months, 13% said they would visit zero times, 66.7% 1–2 times and 20.3% responded that they planned to visit 3–4 times. Visits to the zoo was also found to be correlated with the statements "zoo animal welfare is compromised due to captivity," "animal welfare is a focus of the zoo," "knowledge of the two-toed sloth," and "attitude about the cheetah" (Table 4).

No difference of knowledge gained between groups was observed. Increased positive attitudes towards cheetahs ($U=64.5$, $P=0.02$) and penguins ($U=64.5$, $P=0.02$) were observed in the treatment group compared to the control but no difference of sloth or radiated tortoise was found (Figure 2).

Differences between the treatment and control group were found for three animal welfare statements with stronger agreement in the treatment group (Figure 3). Statements included "animal welfare is a focus of the zoo" ($U=63.00$, $P=0.02$), "zoo animals have the ability to adapt to their human-created environments" ($U=45.00$, $P<0.01$), and "zoos create spaces for their animals that allow the expression of natural behaviours" ($U=60.00$, $P=0.02$).

No differences between groups were observed for level of importance zoos placed on conservation, education, entertainment, scientific research and animal wellbeing. All responses showed perception of high importance across groups in both the pre- and post-test (Table 5). For the pre-test, ranks averaged 1.19–2.33 with conservation being the most important. Post-test responses averaged 1.11–2.47 with animal wellbeing showing the highest importance.

Discussion

The objectives of this series of studies were met by the distribution of pre- and post-test surveys to measure the impact of a live animal during educational messaging on knowledge gained (Experiment One), as well as changes in attitudes towards zoos, species conservation, animal welfare and zoos (Experiment Two). The hypothesis was not fully upheld as no influence on knowledge gain was found, although more positive attitudes towards species and animal welfare in zoos occurred in the live animal treatment group compared to the control group in Experiment Two. The findings contribute to the growing body of literature around the use of ambassador animals in and outside of zoological settings, demonstrating the positive impacts these animals have on conservation for their species.

Table 3. Average knowledge gained for multiple choice questions across treatment and control groups

Questions	T1 (%)	T2 (%)	Control (%)
The social structure of a cheetah is which of the following	50	73	6
The typical number of offspring for a cheetah is	9	8	-5
The newborn cheetah is referred to as	22	3	0
The common term for a group of cheetahs is called	62	42	51
A cheetah's gestation period is typically	63	9	27
A cheetah's digestive system is classified as	41	19	30
The common term for a group of penguins is called	45	43	8
A penguin's digestive system is classified as	27	57	30
The typical number of offspring for a penguin is	-17	0	-10
The social structure of a penguin is which of the following	-53	-3	71
A penguin's incubation period is typically	39	63	56
A newborn penguin is referred to as	35	16	16

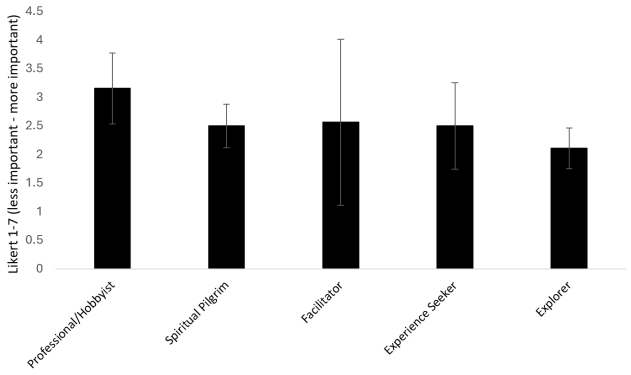

Figure 1. Average±SD motivation for visiting a zoo by participant identity. Identity questions were grouped and averaged using descriptive statistics based on the Visitor-Identity Motivation framework

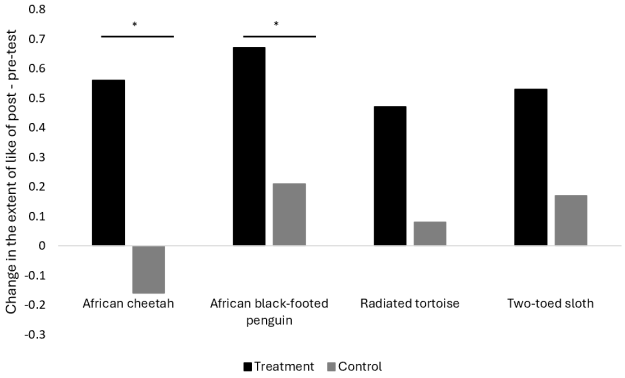

Figure 2. Influence of live animal on positive attitude towards species used in educational presentation. Participants ranked their attitude using a seven-point Likert scale (like a great deal–dislike a great deal). Differences in positive attitude found for the cheetah (P=0.02) and black-footed penguin (P=0.02). The treatment and control groups were compared using Mann-Whitney U tests. * indicates P<0.05.

Although no overall difference in knowledge gained between the treatment and control groups was found in Experiment One, several survey questions showed over 50% knowledge gained when comparing post-test scores to the pre-test (Table 3). These findings differ from a previous study that evaluated a cheetah ambassador programme, finding the least amount of knowledge gained within the cheetah encounter group compared to a guided tour. Authors concluded that participants were distracted by the up-close presence of the animal (Whitehouse-Tedd et al. 2022), in contrast to this study demonstrating the greatest amount of knowledge gained for the cheetah questions in treatment groups.

One explanation for the lack of difference in knowledge

Table 4. Pearson correlations of number of visits to a zoo with pre-survey questions of attitudes toward animal welfare in zoos and ambassador animals

Pre-survey questions	Demographic visits to the zoo questions		
	Number of visits to the zoo as a child 1-5 rating (rarely–very frequently)	Number of visits to the zoo as an adult 1-6 (never–very frequently)	Visits to a zoo in the next six months 1-3 (0, 1-2, 3-4)
Zoo animals' welfare is compromised due to captivity 1–7 (strongly agree–strongly disagree)	P=0.01 r^2=0.37	P=0.02 r^2=0.34	P=0.01 r^2=0.37
Animal welfare is a focus of the zoo 1–7 (strongly agree–strongly disagree)	P=0.98 r2<-0.01	P<0.01 r^2=-0.45	P<0.01 r^2=-0.48
Level of knowledge of two-toed sloth 1–5 (extremely knowledgeable–not knowledgeable at all)	P=0.03 r^2=-0.31	P=0.39 r^2=-0.13	P=0.4 r^2=-0.12
Level of like or dislike of the cheetah 1–7 (like a great deal–dislike a great deal)	P=0.72 r^2=-0.05	P<0.01 r^2=-0.39	P=0.21 r^2=0.27

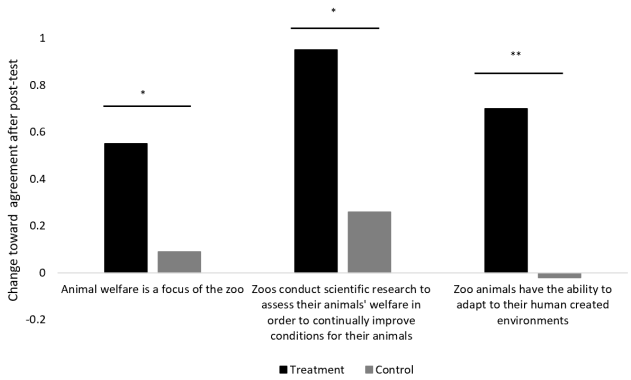

Figure 3. Influence of live animal on level of agreeance with animal welfare statements. Level of agreeance was determined using 7-Point Likert scale (strongly agree – strongly disagree). Differences between the treatment and control groups were determined using Mann-Whitney U tests. * indicates P<0.05, ** indicates P<0.01.

gain may be due to the false learning phenomenon, in which participants report misconceptions or misinterpreted information following animal encounters (Spooner et al. 2021b). Additionally, the findings of no difference in knowledge gain may be attributed to bias or prior knowledge within the study population, as most students were animal-related majors. Notably, this study only evaluated knowledge gain not retention, with post-tests distributed immediately after educational sessions. A previous study by the research team implemented a retention test methodology, and although no difference was found overall, a 12% increase in knowledge retention occurred when exotic animals were present during an education session (George and Cole 2018).

Previous studies suggest that the presence of live animals in educational settings may increase both knowledge gain and retention (Gee et al. 2015; George and Cole 2018; Hummel and Randler 2012), although it is important to recognise that not all studies include a control group. Several studies also investigated the impact of live animal presence and demonstrations on increasing zoo visitors' knowledge, again contrasting to what was found in this study. The impact of watching a live polar bear training session versus watching a video of the same session found greater knowledge gain, positive emotional experience and pro-conservation behaviours in the group that viewed the session live compared to the group that watched the video. Authors noted that the poor quality of the polar bear training session recording may have contributed to the difference in knowledge gain, and absence of a knowledge retention test to measure long-term impacts was a limitation of their study (Miller et al. 2020). Visitors to an Australian zoo also demonstrated a gain in knowledge following a live seal encounter, although this study did not contain a control group (Blandford et al. 2023).

The millennial population contained mostly individuals with a mutualistic value orientation, consistent with evidence that societal views are shifting towards a more mutualist approach to wildlife (Manfredo et al. 2020; McCoy et al. 2016). Societal shifts are partially driven by younger generations, such as mutualism-oriented millennials, being mutualism-oriented compared to dominionistic older generations (Alba et al. 2023). Additionally, the findings support millennials' concern for the wellbeing of others including animals (Debevec et al. 2013; Douglas et al. 2022; Marinova and Fox 2019).

All five identity-related motivations were present in the study population with professional/hobbyist and facilitator being most common (Figure 1). While previous studies evaluating visitors' identity-related motivations across zoos and aquariums found facilitators and explorers to be the most common (Falk et al. 2008), members of the current study population volunteered to participate in a zoo-related study. Thus, the higher proportion

Table 5. Experiment two mean ±SD pre-/posttest scores for question "what level of importance participants believe zoos place on the following?" Responses ranked using 7-Point Likert scale (extremely important - not at all important).

Categories	Treatment Group Pre-test	Treatment Group Post-Test	Control Group Pre-Test	Control Group Post-Test
Conservation	1.19 ±0.48	1.16 ±0.38	1.33 ±0.57	1.33 ±0.49
Education	1.41 ±0.69	1.47 ±0.61	1.39 ±0.72	1.33 ±0.49
Entertainment	2.33 ±1	2.47 ±0.96	2.29 ±1.12	2.25 ±1.06
Scientific Research	1.67 ±0.88	1.37 ±0.6	1.71 ±0.86	1.75 ±0.87
Animal Well-being	1.26 ±0.53	1.11 ±0.32	1.58 ±1.14	1.42 ±0.67

of professionals/hobbyists in the population is not surprising. While not a perfect framework (Dawson and Jenson 2011), when combined with other frameworks examined in this study, the findings contribute to better understanding zoo visitors' motivations and how these may influence their behaviour while at the zoo.

Although differences between the treatment and control groups did not occur, overall participants' perceptions of the zoo's high importance for conservation, well-being, education and scientific research are noteworthy (Table 5). As zoos have traditionally based their mission statements around the pillars of conservation, science and education (Gusset and Dick 2010; Rabb and Saunders 2005) and more recently animal wellbeing, it is necessary to ensure those aims are achieved and that information is effectively conveyed to the public (Spooner et al. 2023). Visitors' perceptions should continue to be assessed as zoos and aquariums contribute millions of dollars towards conservation each year.

Increased positive attitudes towards penguins and cheetahs, but not sloths or tortoises, were found in the treatment group when compared to the control group (Figure 2). This finding aligns with Miller et al. (2020), finding an increased positive emotional experience and empathy when comparing a live presentation to a video. It is also notable that animals that are active during interactions elicit more engagement and positive attitudes from visitors, supported by the visitor attraction model (Godinez et al. 2013; Learmonth et al. 2021; Margulis et al. 2003).

It is well established that attitudes towards animals can be highly species-dependent, supporting the finding of no difference of attitude towards the tortoise and sloth. Americans generally have more positive attitudes towards mammals and birds than reptiles and invertebrates, except for historically stigmatised species such as rats and vultures (George et al. 2016). This can be further explained by the complex factors that shape people's attitudes towards certain species, including past experiences, media depictions and cultural or religious beliefs known as speciesism (Herzog and Burghardt 1988; Horta and Albersmeier 2020). These factors may have also influenced the findings of the relationship between visits to a zoo and several of the pre-test questions, as increased number of visits was found to correlate with positive perceptions of zoo animal welfare (Table 4).

The live animal demonstration increased agreement with the statements that animal welfare is a focus of the zoo, zoos actively conduct scientific research to improve their animals' welfare and that zoo animals can adapt to human-created environments. Additional studies also found active, up-close demonstrations with animals to increase positive perceptions about the animals' welfare, compared to passive viewing or no presence of the animal (Anderson et al. 2003; Learmonth et al. 2021; Miller et al. 2020). A study of elephant encounters found that 95% of participants scored the elephants' welfare as a 10/10 (Lacinak 2024).

In order to maintain a social license to operate (Demuijnck and Fasterling 2016), zoological institutions must understand the shifting societal values and attitudes of their millennial visitors (Hampton and Teh-White 2019) and effectively translate their work to the public. In terms of an individual's decision of how and where to spend time and resources, and whether that includes zoos, it is helpful to consider millennials' economic position. Millennials account for a large share of the consumer market (Berger 2018), although a portion of this generation is financially insecure (Dueño 2014). Consequently, although millennials may be socially conscious and willing to use their resources to support causes, potentially including zoological conservation, resources may be limited and therefore used selectively. Evidence suggests that although millennials self-report a passion for enacting positive change, consistent follow-through may not occur (Bateman and Phippen 2016; Sandfort and Haworth 2002; Zloch 2015). For zoos and aquariums to continue receiving support from this generation through visits, participation in HAI and donating to support their missions, attitudes of millennials should continue to be evaluated in the future.

In considering future directions of this work, it is important to recognise the inherent limitations of self-reported, survey-based assessments. It is well established that awareness of participation in research can influence participants' behaviour, which may have influenced the results. Known generally as the Hawthorne effect, the precise impacts of research participation are challenging to identify (McCambridge et al. 2014). Specifically, there is potential for social desirability bias in self-reported surveys, leading to participants' responses aligning with social norms or socially desirable attitudes or beliefs (Nederhof 1985). Future studies should investigate new ways to measure the impacts of HAI outside of traditional, self-reported surveys. Innovative assessment tools fulfilling educational and entertainment motivations, as found in this study, may lead to higher response rates and differences in findings. Additionally, future research should evaluate the impacts of HAI on other generations, such as Generation Z, to assess if attitudes of even younger generations are influenced by ambassador animal programmes.

Although the studies discussed here focus on the effects of such interactions on the human participant, it is imperative that future research continues to evaluate the effects of such interactions on the animals and their welfare. While there is some evidence that interactions with humans in these contexts can have positive impacts on animal welfare (Bloomfield et al. 2015; Mehrkam and Dorey 2014; Sherwen and Hemsworth 2019), there is also the risk of harm, which must be avoided (Learmonth and Hemsworth 2024; Williams et al. 2023). These studies have shaped the ways HAI involving ambassador animals occur today, including opportunities for choice and control during interactions (Hartell-DeNardo et al. 2022), ensuring selected animals are suitable for specific interactions and utilising positive reinforcement training (Martin et al. 2024). Although the inability to touch an animal during an encounter has been cited as the least-liked aspect of the experience (Lacinak 2024), some zoos have made changes to eliminate direct contact with animals to improve animal welfare (Saiyed et al. 2019). Continued shifts towards human and animal-focused HAI will promote positive experiences for the human participants and prioritise positive welfare of the animals involved (Learmonth 2020; Perdue and Maple 2024; Spooner et al. 2021b).

Conclusion

The impact of ambassador animals to aid in conservation and education messaging should continue to be examined in the future. The series of studies presented here contribute to the growing literature that aims to better understand the effects of human-animal interactions. Results from this study suggest that presence of ambassador animals increase visitor perceptions of animal welfare and that participants believe animals can cope appropriately in professional care. These findings are especially important for millennial populations who show increased positive attitudes towards animals as well as heightened concern for animal welfare. The results, albeit based on small sample sizes, partially support the claim that direct interactions have a positive effect on attitudes towards species which are encountered (cheetah and penguin). Additionally, these studies show that positive human-zoo ambassador animal interactions increase attitudes towards essential elements of zoos' missions, such as emphasis placed on conservation and animal wellbeing. Finally, the use of the millennial population in these studies offers insights into the current zoo-going population, better understanding their relationship with zoos.

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