Kinecting with Orangutans: Zoo Visitors' Empathetic Responses to Animals' Use of Interactive Technology

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ABSTRACT

Animal conservation organisations occasionally harness depictions of animals using digital technology to inspire interest in, and concern for animals. To better understand the forms of empathy experienced by people observing animal-computer interaction, we designed and studied an interactive installation for orangutans at a zoo. Through collaborative design we established an understanding of zoos' objectives and strategies related to empathy in the zoo context. We deployed a prototype installation, and observed and interviewed visitors who watched orangutans use the installation. Analysis of observations and interviews revealed that visitors responded with *cognitive, affective* and *motor* empathy for the animals. We propose that these empathetic responses are prompted by the visibility of orangutans' bodily movements, by the 'anthropic frame' provided by digital technology, and by prompting reflection on animals' cognitive processes and affective states. This paper contributes new evidence and understanding of people's empathetic responses to observing animal-computer interaction and confirms the value of designing for empathy in its various forms.

Author Keywords

Empathy; zoos; primates; conservation; animal-computer interaction.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Modern zoos aim to inspire visitors' concern for animals and conservation through engaging encounters with other species [23,48]. Zoos' presentations of animals are not simply educational, but also aim to be enjoyable and memorable. As part of this work, zoos draw on and reinforce emotional responses to animals and foster a sense of "connection" with them [15].

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Figure 1. Interactive projections powered by a Microsoft Kinect in use by Dewi (6).

Zoos use a range of strategies to create emotionally engaging experiences which motivate people to care about the natural world [16:111]. Many such strategies aim to elicit empathy, in various forms, towards animals. For example, naturalistic enclosures and enrichment (stimulating activities, habitats and toys) allow observation of natural behaviours at close proximity [25], fostering interest in animals' thoughts and feelings. Interpretive presentations often make connections between animals' and humans' behaviours, encouraging a sense of "shared identity" [15].

Several conservation organisations have identified the public appeal of animals using digital technology. Highly-publicised initiatives show animals using iPads [53,57], touchscreens built into zoo enclosures [47], motion sensitive cameras [12], and portable video cameras [59]. Though motivated by animal wellbeing (see, for example, [11,14,64]) or research objectives (for example, [41,50]), such initiatives have considerable potential to support visitor engagement. On the other hand, digital technology for animals could potentially attract controversy, in the context of shifting social attitudes towards animal displays [2], and critical voices which challenge more broadly zoos' animal-keeping practices (see, for example [37]).

Despite this, the impacts of animal-computer interaction on perceptions of animals have received little academic attention. This paper explores responses to animals' use of digital technology through a study of zoo visitors' perceptions of orangutans using an interactive installation which enables them to interact with digital games projected into their enclosure. We report on a trial of this installation conducted at the orangutan exhibit on several occasions over a period of one month.

The primary contribution of this paper is an understanding of zoo visitors' empathetic responses to orangutans which emerge in their reflections on the animals' use of interactive technology. Through visitor interviews we identify several forms of empathy for the animals. These findings indicate that digital technology could play a role in promoting zoo visitors' empathetic connections with animals. We conclude with insights on designing for empathy towards animals.

BACKGROUND

Conceptions of Empathy

Empathy has been broadly defined as "an emotional reaction in an observer to the affective state of another individual" [9:699]. However, research into empathy has been a site of considerable debate. Some have sought an explanation of empathy as a single mechanism which results in a range of psychological states and behaviours (including, for example, sympathy and prosocial behaviours) [52]. Others contend that the term *empathy* is used to refer to numerous separable, but allied psychological phenomena [4,9].

Throughout these debates, it has been commonplace to make distinctions between cognitive and emotional dimensions of empathy [9,19,52]. *Cognitive empathy* has been described as an intellectual response which allows one to understand others' points of view, or imagine the thoughts and feelings of others [4,9]. It is thus a concept closely related to *Theory of Mind*: the ability to conceive of others' thoughts, intentions, knowledge and affective states [9]. *Emotional empathy* includes affective responses to others' emotional states, which may result in the related phenomenon of *emotional contagion* [9]. Emotional empathy is also understood by many to include concepts such as *sympathy*, or compassionate responses to others' suffering [52].

Recent developments in neuroscience have resulted in increasing attention to a third major category of empathetic response: *Motor Empathy* [9,10]. The term *motor empathy* has been used to denote the response that leads people to mimic or represent internally others' movements, postures and facial expressions. The discovery of the Mirror Neuron System (MNS), neural systems which are activated not only when performing but also when observing an action [9,28,56], provides new foundations for understanding empathetic responses to others' movements and observable emotions. These insights also provide new scientific foundations for related concepts such as *embodied empathy* (a "body-oriented perspective" understanding of human interactions, emerging from psychotherapy [20]), and *kinaesthetic empathy* (an understanding of observers' bodily experience of others' movements developed in dance studies [24]). The relevance of these concepts to interaction design has been signalled by a small body of research (e.g. [17,24,26]). It has also been demonstrated that this form of response is elicited by observing non-human entities, such as robots performing complex actions [28]. However, to date HCI has failed to engage with the potential power of interactive technology to evoke bodily empathy in people observing system users.

Empathy for Animals

Empathy for animals has been studied primarily in terms of its impacts on attitudes and behaviours relevant to animal welfare [30,51], and its association with empathy for humans [18,49,58]. Such studies have focused on emotional components of empathy, particularly sympathy for animals in distress. It has been argued that interspecies empathy is a foundation of concern for animals' wellbeing [51:47]. In some studies, such as [30], *empathy for animals* is taken to be equivalent with attitudes to animal welfare.

Cognitive dimensions of empathy for animals have to a lesser extent been explored in research into the effects of *belief in animal mind* (BAM) - "beliefs about the extent to which animals have awareness, thoughts, and feelings" [31] - as a factor in people's attitude to animal use and welfare [34]. Belief in animal minds has been found to be a strong predictor of attitudes towards animals [34], and to have some association with empathy for animals (though this association is moderated by other factors) [31]. It should be noted that the concept of BAM does not assume the existence (or non-existence) of animal minds, but rather investigates people's attitudes on this matter, as one dimension of people's perceptions of animals.

The *perceived similarity* of animals to humans has also been found to predispose people to empathetic responses towards animals [13,31]. Several researchers and organisations have shown that people's empathy for animals, and support for animal rights and animal welfare, can be engendered through initiatives that anthropomorphise animals, for example by emphasising the human-like characteristics of animals through language or anecdotes [13].

Empathy in Human-Computer Interaction

In the field of human-computer interaction, empathy is considered primarily in the sense of *empathetic design,* as a resource to understand stakeholders and motivate design (see for example [65]). However, some researchers have turned their attention to the potential for digital technology to support empathy for others. Belman and Flanagan examine video games which aim to foster empathy between social groups, identifying guiding principles for design of such games [5]. The authors propose, for example, that

games need to engage both cognitive and emotional empathy to impact on players' understanding of the world. Others have proposed mechanisms to support empathy between remote collaborators, for example through configuring systems to improve visibility of body language [46], or incorporating computational detection of others' facial expressions [42]. Huck and colleagues consider how empathy between members of a community can be enhanced through design which draws on and represents practices associated with church rituals [32]. In this paper however, we extend these approaches by arguing for increased attention to opportunities for designing interactive systems which foster *observers'* empathy for the users.

Empathy and Animal-Computer Interaction

The field of animal-computer interaction (ACI) maintains a keen focus on issues of animal wellbeing and ethics [38]. Animal-centred design work confronts the challenge of viewing the problem situation, and potential solutions, from the animal's perspective [38]. Interaction design approaches aiming to include the voice of the animal in the design process include the development of personas representing animals [27], and human-animal play (e.g. [33,62]). In this design project, we draw extensively on the knowledge and expertise of human participants (orangutan keepers) with close, long-standing relationships with individual animals in a specific context, an approach previously adopted in ACI research and design work (for example [39,40,54]).

Much ACI work attends to contexts in which human empathy for animals may play an important role in enabling communication and effective cooperation. For example, ACI research has investigated dog handlers' relationships with service dogs [54] and cancer detection dogs [39]. Other ACI interventions have sought to collect and present data representing animals' behaviour, aiming to increase people's ability to interpret animals' internal states and intentions, in initiatives that could support cognitive empathy. This approach has been applied to support adoption of shelter animals [1] and help owners' to understand their pets' needs [45]. However, some researchers have cautioned against quantification initiatives, highlighting the potential risks to animal welfare and human-animal relationships [35].

Other researchers have examined playful approaches to promoting people's affective responses and sense of connection with animals. For example, *Playing with Pigs* [22] presents a system which provides touchscreen installation for pigs at a farm, which people can interact with remotely. However, much research remains to be done to understand both the potential role of ACI in fostering empathy, and observers' empathetic responses to animals' use of interactive technology.

Empathy in Connections with Zoo Animals

To shape community conservation attitudes and behaviours, modern zoos build on visitors' desire to connect with animals [15], fostering visitors' *sense of connection* with animals through engaging encounters [15,23]. Visitors' emotional responses to animals are seen as an important dimension of conservation education which can lead to the formation of enduring memories [2,3]. The field of conservation education pays growing attention to the concepts of perceived similarity, BAM, empathy and related affective responses towards animals [7,16,55] as potentially significant mechanisms in conservation education and developing environmental attitudes [6,8,16]. In the context of the zoo, Myers et al. [43] explore three forms of response to animals which overlap with emotional and cognitive dimensions of empathy: the ability to imagine what it is like to be the animal; wondering about an animal's thoughts or feelings; and caring about saving the animal.

Digital Technology for Zoo Encounters

Zoos are beginning to make use of interactive technology, including screens to display digital media which can extend and augment the animal encounter; interactive systems to support educational experiences; and technology-based animal enrichment [61].

Of particular interest to zoos is the opportunity for technology to support educational, engaging encounters between animals and groups of visitors, while ensuring animal wellbeing and visitor safety. Indeed, any intervention in the zoo setting needs to take account of potential impacts on zoo visitors. Despite this, little is known about the effects of watching animals using digital technology. A study of touchscreen enrichment for orangutans at Zoo Atlanta found that seeing the screen in use increased visitors' perceptions that orangutans might benefit from using technology, and had no negative impacts impact on the visitor experience [50]. Viewers of a BBC documentary 'filmed' by chimpanzees at Edinburgh Zoo felt that they had learned about chimpanzee cognition and enrichment needs through the film [29]. Together, these studies suggest that such interventions might draw observers' attention to the animals' cognitive abilities and the implications for animal welfare, thereby contributing to empathy for animals.

Depictions of animals using digital technology have considerable appeal, and have been deployed by a number of conservation organisations to engage the public. The *Apps for Apes* program, which has provided iPads for orangutans at numerous zoos, aims at public engagement as well as cognitive enrichment for orangutans [57]. The international mainstream press regularly covers stories such as penguins' use of iPads [53] and animals taking 'selfies' [12]. The public engagement power of these depictions is evidenced by their popularity in online news and media aggregation platforms. Despite the apparent impact of these depictions on the viewer's curiosity and emotional responses towards the animals, these effects are not well understood. To investigate this phenomenon, this paper presents a novel interactive installation designed to explore

zoo visitors' empathetic responses to orangutan technology use.

DESIGNING FOR EMPATHY AT THE ZOO

This research was conducted at Melbourne Zoo, Australia ("the Zoo"), in collaboration with its parent organisation Zoos Victoria. Melbourne Zoo houses six orangutans: an infant female (Dewi), her mother (Maimunah) and father (Santan) housed as a family group, an adolescent male (Malu), an older adult female (Kiani) and her adult daughter (Gabby).

We developed contextual understandings of the Zoo, and of the role of empathy in visitors' encounters with animals, through meetings and workshops with Zoo personnel (staff with responsibilities for animal welfare, animal keeping and visitor experience), and contextual inquiry with keepers at the orangutan enclosure. We also drew on observations and interviews researching digital technology at Melbourne Zoo (reported in [61]). Design concepts emerging from workshops were developed into visual prototypes which were refined with Zoo personnel. The Zoo's animal welfare specialist took a leading role in the collaboration, ensuring that the wellbeing and enrichment of the orangutans remained central to the project's objectives and methods.

Generating Empathy at the Zoo

Our initial investigations at Melbourne Zoo revealed the important role of empathy in the zoo visit, and how emotional responses to animal encounters responses are generated and managed. Like many long-established zoos, Melbourne Zoo has seen significant transformations in the keeping of animals. Consistent with broader trends, the Zoo has moved away from the focus on entertainment and reinvented itself as a conservation organisation, a change which has largely been driven by shifts in public attitudes towards animal welfare and use of animals [2]. The continuing popularity of the zoo visit means that Zoos Victoria, along with other modern zoos worldwide, has great potential to make significant contributions to conservation awareness in the community at large [2].

To achieve these conservation outcomes, the Zoo aims to encourage a connection between humans and animals, drawing on understandings that a zoo visit can result in an emotional connection to particular species, and that this connection can promote empathy and concern for the species' wellbeing [2,15]. These connections are facilitated in a range of settings, including 'close encounter' or 'behind the scenes' experiences, which allow visitors to meet the animals and talk with their keepers.

At Melbourne Zoo, animals' natural behaviours and capabilities are showcased through presenting enrichment or training. Enrichment is designed principally to provide animals with stimulation and variation in their environment and give them opportunities to express motivated behaviours, with the ultimate aim of enhancing animal welfare. Enrichment for orangutans, for example, often includes ropes to swing on, poles to climb and food puzzles to exercise cognitive abilities. Guided by Zoos Victoria's '*Connect, Understand, Act*' model for conservation education [36], scheduled presentations are delivered at animal enclosures, providing engaging explanations of animals' behaviours and traits, as well as conservation messages. Presenters aim to elicit emotional and empathetic connections with animals through techniques such as including personal narratives about individual animals, or encouraging visitors' playful mimicry of animals' behaviours. However, the Zoo aims to ensure that these presentations focus on an the animals' natural behaviour.

Empathetic Foundations for Design

In this work, we have adopted an conceptual frame of empathy for animals which seeks to integrate notions of cognitive and emotional empathy with zoos' techniques for eliciting visitor empathy. Accordingly, we consider *cognitive empathy* for animals (imagining how the animals would feel and think, and reflection on animal minds) as well as *emotional empathy* (evidence of emotional contagion, sympathy, concern about animals' welfare, or affective responses to observing the animals' state). As part of these, we also consider *perceived similarity* between animals and humans, (identifying similarities and differences, as well as drawing links between human behaviour and that of non-human species). This frame provided a foundation for design of an interactive installation aiming to foster visitor empathy for animals.

KINECTING WITH ORANGUTANS

In order to further explore how the use of digital technology by animals can generate empathetic responses in visitors we designed, developed and deployed a novel digital enrichment system for the orangutans at Melbourne Zoo. The development of this system followed an in-depth collaborative design process with a variety of stakeholders, and included several prototypes.

As part of the *Apps for Apes* program, the orangutans at Melbourne had prior experience with tablet computers. Observations of their use of the tablets during the design process highlighted their interest in digital sensory enrichment, but for safety reasons their access to the technology was very limited. Zoo keepers held the tablet such that the orangutan could only reach the device with their fingertips, stretched through metal bars. This was an extremely un-orangutan way to interact with something; affording only limited movements and investigations, and constricting play.

Our new system used a Microsoft Kinect sensor and projector to create a large 'touchscreen' style interface on the floor of the orangutan enclosure (see Figure 1). To afford the orangutans the ability to interact the way they wanted to, we developed our own touch-detection software, building on the approach of Wilson et al. [63], which was responsive to the variety of ways orangutans 'touch'; with whole hands, feet, faces and with objects. Both the data

projector and the Kinect sensor operated through a glass wall of the orangutan enclosure. This design placed hardware outside of the animal enclosure, significantly reducing safety risk, and allowing the orangutans as much freedom as possible in their interactions. The installation was positioned at a glass corner of the orangutans' enclosure, so as to be readily visible to visitors entering the exhibit area.

Designing for Empathetic Responses

Through our design workshops we had identified three specific strategies for evoking empathetic responses:
(1) enable visitors to observe animals' natural behaviours at close proximity; (2) make visible to visitors the orangutans' cognitive capabilities; and (3) allow visitors to observe differences between individual animals' behaviours and preferences.

Using these strategies, we developed four applications that utilized our Kinect system in response to orangutans' existing enrichment and to foster empathetic responses. *Burst* (Figure 1) and *Sweep* (coloured tiles that disappear when touched) were highly responsive designs which introduced the interactivity of the system to the orangutans through visually interesting movement. They encouraged the natural, playful behaviour of sweeping, and allowed for a wide variety of interaction strategies, revealing cognitive capabilities such as using objects as tools for interaction.

In addition, two more complex applications, *Painting* and *Gallery*, were developed. *Painting* (Figure 2) replicated the experience of painting with a brush on a canvas (a regularly used form of enrichment). Touches left coloured marks, and five buttons on the side allowed the active colour to be changed. *Gallery* presented six images or videos, and when touched ('selected'), the content expanded to fill much of the projection. Videos played for 15 seconds. Orangutans could interact with the content creating a water-ripple effect. Both of these applications attempt to make visible the differences between the orangutans, in terms of their creativity (*Painting*) and preference towards content (*Gallery*). Simultaneously, these applications highlight their relevant cognitive capabilities, desires and intentions. An anecdote often recounted in live presentations at Melbourne Zoo refers to orangutan Kiani's love of photos of herself, and her habit of displaying visible preference when shown images on a tablet computer. *Gallery* attempts to make visible these kinds of individual preferences, but also the cognitive capability of the orangutans to recognise themselves in photographs (and display a preference towards them), as well as the other orangutans and their keepers.

RESEARCH METHOD

The system was installed at the orangutan enclosure on several occasions (for periods of 2-3 hours) over the course of 4 weeks. Orangutans' behaviour in the enclosure was video recorded while the system was active, from a static camera and a handheld camera. Debriefing meetings were conducted by researchers with the orangutan keepers and animal welfare specialist to support iterative refinement of the applications.

Figure 2. Gabby (35) using the *Painting* application.

Semi-structured interviews were conducted with 25 visitors who observed the system in use. We approached adult visitors who were at the orangutan exhibit for at least 30 seconds while the installation was in place, and were seen to have observed the system in use. Interviews were conducted at the orangutan enclosure. Though our protocol allowed for interviewing groups of visitors (including children accompanied by adults), respondents all chose to take part in interviews individually. Participants were representative of adult visitors to the Zoo in terms of age distribution, and the majority were accompanied by young children. We developed a semi-structured interview protocol in which visitors were prompted to talk about:

- any interaction with the orangutans, or opportunities to view them up close;
- what they had learned at the orangutan exhibit that day;
- how the visit had affected their perceptions of orangutans;
- what they thought of the orangutan enclosure;
- what they thought of the installation, and what they thought its purpose was.

Interview numbers were constrained by the fact that the Zoo also wanted to capitalize on the potential of the installation to engage wider audiences through mass media: some sessions were therefore closed to the public to allow for professional filming.

Data Analysis

Recordings of meetings and visitor interviews were transcribed and analysed. Videos of animals' use of the system were reviewed by researchers, and memos created noting animals' salient behaviours and observable responses from visitors, where visible in the field of view. We reviewed these alongside memos from debriefing meetings, researchers' observations on orangutans' use of the system, and visitors' reactions to the installation. Through an iterative coding process, key concepts related to emotive responses to the animals and the technology were identified and categorised. In this analysis, we sought to identify the forms of empathy experienced by visitors who watched orangutans using the installation. Accordingly, in our development of codes we drew on the concepts of empathy for animals outlined above: cognitive empathy, including reflections on animals thoughts, intentions and desires; emotional empathy, including compassion and concern about animal welfare; and perceived similarity of orangutans to humans. This process resulted in the themes presented below.

RESULTS

In this section we describe the kinds of empathy experienced by visitors in response to orangutans' varied forms of engagement with the installation. We show how these forms of use were reflected in visitors' consideration of animals' cognitive processes and intentions, their affective states and their welfare needs.

Cognitive Empathy

An important aim of our system, consistent with the Zoo's goal of inspiring visitors' admiration for animals, was to make orangutans' cognitive capabilities visible to visitors. Watching the orangutans use the installation, many visitors' responses indicated close reflection on orangutans' mental states, including their intentions, desires and learning processes.

Reflections on Intentions

From the outset, orangutans approached and interacted with the installation directly, without encouragement from keepers. This was apparent to visitors, prompting them to reflect on the animals' intentions and the ways in which they were attracted by the installation. Several visitors observed that the orangutans were using the technology voluntarily [P04, P09, P12]. Some described how the orangutans were "*curious*" [P09] and wanted to "*explore*" [P13] the technology. This was seen as a positive aspect of the system, and one which had implications for reflections on animal wellbeing, discussed below. One respondent affirmed:

"*they're not being rewarded for interacting with the technology. So in that way it's a good thing because it's more free exploration, not sort of training to use it*" [P09].

This exploratory, unstructured use of the system seemed to lead visitors to reflect on the animals' intentions, concluding that they were determining for themselves what they wanted to achieve. One visitor noted how the installation was "*letting him* [adolescent orangutan] *explore what he can do with the computer*" [P13], while another described how the young female orangtan was "*trying to catch the patterns*" [P04].

Other participants attributed specific goals or intentions to the animals, and appraised the animals' use of the system accordingly:

"*I think he's struggling to choose the colours, get the concept - but I think he'll get the hang of it over time*." [P11].

These assessments of orangutans' ability or inability to perform specific tasks were recorded principally when orangutans were using the *Painting* application.

Reflections on Desires

Initially, many of the orangutans explored the interface with their mouth and nose. Some of the orangutans seemed to attend more to the play of the lights from the projector on their body than to the projected images on the floor. On several occasions, orangutans positioned themselves in the light from the projector, moving limbs and body parts slowly as they watched the coloured light on their fur or skin. When interacting with the projections on the floor, the orangutans generally adopted forms of bodily interaction which were not consistent with human use of a touchscreen. For example, they commonly used the backs of their hands, forearms or other body parts to interact with the projections. Visitors interpreted these interactions as exploratory, and saw them as indicators of the orangutans' desire to engage with the system, commenting for example:

"What's really interesting is that they're using the back of their hands to play with the patterns and she's obviously intrigued" [P04].

Orangutans' more active engagement with the system included rolling and spinning on the projections. The two younger orangutans both made use of blankets or cloths to interact with the projections on the floor while swinging from the bars overhead. The combination of the Kinect sensor with projection display allowed orangutans to integrate their interactions with their habitual forms of play and whole-body movements. This seemed to contribute to visitors' sense that interacting with the system was a positive experience for the orangutans.

"*they seem to enjoy it*" [P01].

"*I think it's pretty impressive, yeah, just seeing them react and all that yeah, it's really impressive*" [P03].

Reflections on Learning and Intelligence

Several visitors commented on the orangutans' use of the system as a learning process:

"*it worked out - it was doing it with the sheet at first - and then thought, no I can actually do it with my feet and hands*." [P05].

During the course of interviews, many respondents explicitly described how their perceptions of the orangutans had been impacted by seeing them using the installation. Many of the visitors stated that the experience confirmed their perception of the animals as intelligent, although some of these comments were very brief in nature. Several visitors commented that seeing the orangutans use the technology increased their appreciation of the animals' abilities:

"*Maybe they're smarter than I thought that they were*" [P15].

"*They can do a lot more than I thought, especially I didn't think they could do things with technology*." [P11].

"*It reminds me that they're probably a lot more intelligent than the general public think they are and yeah, just, yeah just reminds me that there's more to animals than we think, which is pretty exciting*" [P16].

Over time, the orangutans seemed to gain familiarity with the system: keepers reported that the animals quickly learned what the installation could do and how to use it. This was noticed by some visitors:

"*I was interested to know how quickly they would get used to the software and it would just become another thing in there, just like 'aah, whatever' and it seems to be a bit like that, so it's another toy*." [P06].

Several visitors felt it was likely that orangutans would rapidly habituate to the games provided, and novel stimulation and more challenging activities would need to be continually devised for them.

"*the challenge of the program is trying to work out a variety of things, they'll always have to be reviewing this, because I would say, with most animals, if they can solve certain problems they will be able to get to a level and once they get there they'll get bored*" [P12].

These comments indicate a thoughtful, reflective engagement with the animals, and an interest in the animals' inner world. For some visitors, this seemed to go deeper than the forms of wonderment and respect for animals' impressive abilities that zoos aim to inspire.

Perceptions of Orangutans' Similarity to Humans

People's perception of animals' similarity to humans plays an important role in empathy for animals. Reflecting on the animals' use of the technology, over half of the respondents mentioned the similarity between orangutans and humans, or drew comparisons between orangutans and human children.

Many respondents drew on their knowledge of children to interpret orangutans' cognitive engagement with the interactive technology. When assessing the potential benefits of technology for animals, some drew on their experience of keeping young children entertained:

"*I know trying to entertain a toddler,[…] anything that can distract or stimulate or keep concentration for a little while, it's brilliant*" [P01].

One interviewee drew on her knowledge of teaching children to conclude that the games needed to be made more challenging in order to maintain the orangutans' interest [P12]. A few explicitly considered children's engagement with technology when evaluating the technology:

"*'Well they seem to enjoy it, so I don't think there's anything wrong with it. I mean it's like having a toddler and people say, 'oh you shouldn't give them technology', but why not, it's just what we do now, so yeah. If my toddler gets to play with an iPad then I don't see why not*" [P01].

Emotional Empathy

Visitors' positive emotional responses to orangutans were evident in many of the interviews. There were some indications that these attitudes towards the animals contributed to, and were reinforced by, people's perceptions of the technology and its potential benefits for the orangutans:

"*I'm a bit in love with them anyway. So, anything that is provided that can help them and improve them and make their lives interesting, I think is fascinating.*" [P04].

Consideration of Animal Welfare

Concern for animal welfare is an important dimension of emotional empathy for animals, and this theme was salient in visitor interviews. Prominent in many visitors' responses was close consideration of animal wellbeing, and the potential impacts of the installation for animal welfare. When asked about their perceptions of the installation, most visitors gave primary consideration to the potential impact on orangutans' wellbeing. A majority deemed that innovative use of technology could be stimulating for the animals.

Visitors who made similar assessments described the installation as "*exciting*" [P05] or "*a clever concept*" [P18], with one stating that he would be happy to pay more to support this form of animal enrichment [P06].

Other visitors were more hesitant in their assessment of the potential benefits for orangutans' wellbeing. For some, the fact that orangutans were not encouraged or rewarded for using the installation was an important factor. Sited in the corner of one of the orangutans' indoor enclosures, the installation allowed orangutans to engage casually, as they moved around the enclosure. As part of their habitual patterns of movement through the space, orangutans regularly entered and left the area where the installation was located. This was noted favourably by visitors:

"*if they don't want to… but if they want some space they can move away, and yeah it's up to them*" [P10].

However, the interviewer recorded that one observer, who declined to participate formally in the research, expressed strong negative opinions on digital technology for zoo animals.

It is noted that our findings related to animal welfare attitudes entail a risk of social desirability bias, in that zoo visitors speaking with researchers may be likely to emphasise their interest in animal welfare and conservation. Therefore, we consider that the zoo context itself might be a factor which directs visitors' attention to questions of animal wellbeing.

In contrast to the attention given to animal wellbeing impacts, only 5 of the 25 respondents mentioned visitor education and engagement when evaluating the installation. observing for example that the intervention could be "*good for the kids, to let them see what [the orangutans] are capable of*" [P14]. It had been anticipated that visitors would give more attention to matters of visitor education and entertainment, particularly because most respondents were accompanied by small children. Despite this, visitors indicated that the installation provided good visibility of the orangutans and their behaviours.

"*The idea is really good, I think it's different* […] *and the setup is good so we can see*," [P10].

"*It's been really… it's been amazing because they've all come up. Like we've actually seen more than we would on a normal day*" [P01].

This indicates that the installation design, as well as the siting and configuration of components, played a role in enabling visitors to closely observe, and reflect on orangutans' use of the system.

Motor Empathy

As the findings above suggest, visitors' engagement with the installation seemed to be enhanced not only by the visibility and dynamic nature of the installation itself, but also by the visibility and dynamic nature of orangutans' interactions. This seemed to allow for observers to respond directly to the physical movements of the orangutans. Many visitors commented on their goal-oriented movements:

"*I was at both windows and watching them hit, I saw two of them hit the dots for a while, so that was pretty impressive*" [P03].

"*she's trying to catch the patterns and in fact seeing an 18 month old child observing he's probably wanting to do the same sort of thing.*" [P04].

As this comment suggests, many children responded to the orangutans' movements and interactions in ways which suggested that they were attracted to these movements and interpreted them as forms of play. Some children were seen running, bouncing or crouching at the glass wall which separated them from the orangutans and the installation. (Figure 3).

Figure 3. The system was configured to allow visitors to observe the orangutans' use in close proximity. Many respondents drew comparisons between the play of Dewi (6), and similar aged human children.

DISCUSSION

Responding to zoos' interest in engaging audiences through depictions of animal-computer interaction, we have explored observers' empathetic responses to animals using an interactive technology. *Kinecting with Orangutans* has allowed us to study zoo visitors' responses to orangutans' use of an interactive installation. In this work, we have adopted a broad understanding of empathy for animals which incorporates cognitive and emotive dimensions, attending to perceived similarity between animals and humans, and the potential role of motor empathy.

Interviews with zoo visitors reveal responses consistent with empathy for animals, in accordance with our design strategies and theories of empathy. Visitors considered orangutan's cognitive abilities and affective states, were prompted to consider the similarities (and fine-grained differences) between humans and orangutans, and attended to the installation's impact on animal wellbeing.

In the following discussion we interrogate these findings further to explore how empathy can be evoked by watching animals using interactive technology. We explore the anthropic framing effects of digital technology, the role of interactivity in prompting reflection on animal minds, and motor empathy responses to watching animals' physical movements. We conclude by discussing the contributions of this work to animal-computer interaction and HCI more broadly, noting limitations of the study and proposing avenues for future research.

Anthropic Framing

Despite long-standing use of digital technology for primate research (see, for example [60]), computers are generally thought of, by the public at large, as tools used by humans alone. Seeing animals using interactive technology therefore creates a human frame of reference. It invites the observer to interpret the animals' behaviours through the lens of what one knows about one's own (or other people's) behaviour and cognition. This 'anthropic framing' effect is seen in interviewees' comments refering to the orangutans' similarities to humans. As previously discussed, this effect of emphasising orangutans' similarity to humans may contribute to empathy towards the animals [13].

On the other hand, an installation which exactly replicated technology designed for humans would perhaps not have been well received. Visitors' tendency to evaluate the installation in terms of its benefit to animals' wellbeing reflects a rejection of exhibits in which animals perform human-like behaviours for entertainment (consistent with prior work which reports zoo visitors' attention to matters of animal welfare and exploitation [2]). In addition, visitors noted approvingly that the *Kinecting with Orangutans* installation allowed for orangutans' preferred forms of interaction (such as using the back of the hand, feet, and objects), rather than requiring the animals to adopt human forms of interaction. Visitors' positive appraisal of the installation as appropriate for orangutans might in fact depend on the fact that neither the applications or interface look *quite* like any system they have seen used by humans.

Previous technology-based interventions for orangutans have made use of familiar technology designed for humans, notably iPads [57]. In contrast, *Kinecting with Orangutans* depends on a novel configuration of hardware. This prevented visitors from making assumptions about 'correct' forms of interaction. Visitors' observations were largely characterised by an attitude of curiosity, rather than appraisal. On the other hand, the *Paint* application replicated conventions which might have been familiar from drawing applications for touchscreen devices: this prompted two visitors to voice assumptions about the way that orangutans would want to use the application, leading them to believe the animal had failed in its attempt.

These findings have important implications for addressing concerns that providing digital enrichment might be seen as exploitative, in encouraging animals to perform 'human' activities. Our study suggests that technology which provides a familiar, anthropic frame encourages observers to perceive animals' similarities to humans, which has the potential to contribute to empathy for animals [13]. However, it also indicates that use of familiar conventions in the design of the technology should be balanced with (a) visitors' expectations that zoo enrichment should prioritise animals' natural behaviours, rather than coercing animals to perform for entertainment, and (b) the risk of prompting visitors to view animals' behaviours in terms of an ability (or failure) to replicate human interactions.

Revealing Animal Minds

Visitors' reflections on the orangutans' use of the installation indicated that a majority of respondents attributed thoughts and feelings to the orangutans. This indicates a belief in animal minds, which has demonstrated links with empathy for animals [31,34]. Our observations suggest that visitors' ability to watch and make sense of the animals' actions, and make inferences about the animals' intentions and cognitive processes depended on several related features of the installation. The capacity for full-body interaction enabled by the Kinect sensor, the relatively large dimensions of the projection area, and the use of brightly coloured, dynamic game interfaces contributed to the visibility of the installation itself and of orangutans' interactions with the system.

The recognisable appearance of the installation, discussed above in terms of its impact on perceptions of similarity, also allowed observers to draw on their own experience of using comparable systems (such as touchscreen displays), or prior observation of other people using such systems. This enabled them to assess the level of complexity involved, and to make inferences about the learning processes and potential difficulties faced by the orangutans. Observers' prior knowledge of comparable tasks provided a basis for people to be impressed by orangutans' ability to use interactive technology, but also enabled them to take the perspective of the orangutan user.

The visibility of the installation and the familiar frame of reference in which to interpret usage also enabled visitors to notice differences in the way individual orangutans interact with the system. By allowing orangutans to interact in a wide variety of ways, the installation revealed the animals' individual preferences and interests in a form which visitors could readily interpret to draw inferences about animal personalities.

This demonstrates some success in our design strategies of making visible to visitors the animals' natural behaviours, their cognitive capabilities and individual preferences. However the challenges of this approach are revealed by that fact that some interviewees' responses were limited to relatively superficial observations, such as comments about the "intelligence" of orangutans.

Motor Empathy

In addition to cognitive and emotional forms of empathy, there were also indications in our observations of visitors' responses which might be categorised as *motor empathy* or *kinaesthetic empathy*. Physical responses and bodily experience evoked by the physical movements of the orangutans were particularly evident in children's playful reactions to the installation, which were observed by researchers and evidenced by visitors' comments regarding children's desire to "do the same sort of thing" as the

orangutans. Children's physical responses to orangutans' use of the installation is consistent with the tendency for young zoo visitors to play at the orangutan enclosure windows, mirroring and responding to the behaviours of the infant orangutan in particular (e.g. Figure 3).

This finding provides further support for the approach of enabling orangutans to explore and use their preferred forms of interaction, and catering to full-body movement. It also points to opportunities for interactive technology to support zoos' strategy of encouraging people to act out animals' behaviours in order to build connections with wildlife. This indication of the potential role of motor empathy in visitors' responses also suggests the need for further HCI attention to observers' felt, bodily experience of watching others use interactive systems [24].

Together, these understandings of people's responses to watching bodily movements provide a resource for animal-computer interaction design which has not been exploited to date. Furthermore, this points to the power of watching others use technology, and the potential for HCI to respond to this in the design of social and persuasive systems. More research is needed to understand the role of motor empathy in observing technology use by both animals and humans.

Limitations

These findings must be interpreted with some caution. Firstly, it seems reasonable to assume that zoo visitors' responses may be affected by a social desirability bias; in particular, this phenomenon might have increased respondents' consideration of animal wellbeing. This possibility is supported by studies of family zoo visits which have found that visitors' behaviours involve elements of performance enacted for other members of the public [21]. Secondly, despite the surprising depth of consideration given by many respondents to orangutans' cognitive processes, several visitors showed relatively superficial engagement with the animals, with comments limited to brief observations that orangutans are "intelligent". Thirdly, this study has been conducted with orangutans, the species considered to be humans' closest living relatives, and which are readily anthropomorphised. It is unclear how these findings might generalize to species which are less similar to humans or have less charismatic appeal, such as snakes [44]. Finally, further work is required to validate the impacts of specific design choices on zoo visitors' empathetic responses to animals.

Contributions and Future Work

The findings of this study provide a basis to further investigate how digital technology for animals can support emotionally engaging encounters with humans. This work suggests an important role for animal-computer interaction in the care and presentation of animals in zoos, which, despite critiques from some academic and public spheres, maintain broad popularity and a position of social and cultural significance in many countries. We find that observing animals using technology evokes responses commensurate with a 'close encounter' with an animal. These findings suggest a role for interactive installations in promoting empathetic encounters with animals in captive and non-captive settings. Further research is in progress to validate the impacts of digital enrichment in terms of animal wellbeing.

The above discussion provides new insights into the anthropic framing effects of digital technology, and design tactics relevant to specific forms of empathy. This work suggests opportunities for HCI to engage with the empathetic potential of watching others' use of technology as a resource for design, and as a resource for understanding the impacts of technology in social contexts.

CONCLUSION

This paper explores the forms of empathy experienced by people observing orangutans' use of a novel interactive system. Our study responds to representations of zoo animals using interactive technology, publicised by zoos to foster people's interest in wildlife. In collaboration with zoo personnel we investigated the zoo context, and developed an interactive installation for orangutans, drawing on zoos' tactics for fostering empathetic responses to animals. Visitor interviews conducted during trials of the installation indicate that observers responded to the animals with *cognitive empathy*, including reflections on animals' intentions, desires and perceptions of similarity to humans; *emotional empathy*, such as consideration of animals' wellbeing and needs; and revealed some responses consistent with *motor empathy*. We contend that digital technology establishes an anthropic frame in which to interpret animals' interactions, but that it may be important to moderate this through design which caters to species-specific behaviours, and to avoid replicating familiar human computer interfaces. We also find that animals' cognitive states and intentions are made apparent by a system which allows full-body interactions and is to some extent familiar to human observers. Finally, the indication that motor empathy may be evoked by watching physical forms of interaction has important implications for both ACI and HCI research and design. Overall, this study contributes new understanding of designing computer interactions to engender observers' empathy for animals and highlights the potential value of designing for empathy.

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