Exploring methods for interaction design with animals: a case-study with Valli

Conference Item

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ABSTRACT
This case study describes our progress towards the goal of providing technology-enhanced enrichment for an Asian elephant so that she can exercise choice and control. We offer guidelines for developers to show how interaction design with a captive elephant might be approached.

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Interaction design; animal computer interaction; control; choice; environmental enrichment; elephant; participatory design.

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INTRODUCTION
When humans keep animals in captivity for any reason, it is then a duty of care enshrined in law [1] to ensure that their well-being is maintained. As well as keeping the animals physically healthy and psychologically as free from distress as possible, this responsibility also includes ensuring that they have the freedom to express their normal (non-captive) behaviours. To this end, animal keepers and carers often provide environmental enrichment for their captive animals, aimed at enhancing their well-being by encouraging them to behave as naturally as possible within the confines of their enclosures.

Enrichment can take many forms. Typically, the provision of food is seen as an enrichment opportunity - for example by scattering fruit or grain for foragers so they need to search and collect it as they would in the wild, as opposed to offering an immediate dish. This kind of enrichment gives the animals something meaningful to do with their time as well as exercising their sensory, cognitive and physical apparatus. In fact, food enrichment is common in the UK for many zoo-housed species [2].

There are other potential forms of enrichment that emphasise, for example, physical exercise, social experiences or sensory and cognitive stimulation. Some of these possibilities are under-explored, and we aim to demonstrate how technology can help us to deliver new enrichment opportunities. While this idea has been explored with various species, for example, marmosets [3], pigs [4], orangutans [5], dogs [6,7], lions [8] and cats [9], our work focuses on elephants.

In particular, we have been working with Valli, an Asian elephant who has been brought up by human carers in a rural environment in Wales. This case study explains the background to the work, describes some of the design challenges encountered and how they were tackled, as well as offering suggestions for a methodological approach that could be applied to a similar scenario. Overall, the purpose of this research is to design and develop some novel enrichment opportunities for captive elephants, using technology in two distinct ways - to facilitate the design and to enable the solutions that are built.

BACKGROUND
Whitham and Wielebnowski's report on zoo animal welfare [10] recommends to: "*Provide animals with stimulating opportunities to overcome challenges, make choices, and have some level of control over their environments*." There are many ways to approach such a challenge, and while we have initially been investigating different kinds of elephant-friendly interfaces, our ultimate goal is to provide playful interactive experiences for Valli in the form of *toys* with *acoustic* properties.

There are a number of reasons for exploring acoustic enrichment, including: (i) wild elephants experience the diverse calls of the herd and have complex audio interactions [11]; (ii) recent research suggests that elephants might engage with a system that has tangible and acoustic properties [12]; (iii) acoustic enrichment for zoo-housed elephants is minimal; (iv) acoustic output can be created dynamically and can be programmed to be highly responsive. At the same time, playful enrichment has the potential to enhance welfare, as well as being in itself an indicator of good welfare [2,13], as it shows that an animal is relatively free from stress and therefore willing to embrace the uncertainty inherent in playful situations [14]. Thus, a playful interactive system (smart toy) could be both

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empowering and cognitively enriching for an animal [15], engaging them into making choices that enable them to control an aspect of their environment.

Figure 1: Valli plays with a stick during a walk at Skanda Vale

Play interactions can be enabled by either games or toy. They differ, in that games are formal systems with logic and rules that partially determine how play is realised, whereas toys are "props for play" [16]. They provide a focal point (Fig.1) but avoid the pre-defined objectives common to games. Although an elephant might be able to learn how to interact with a simple game, our emphasis is on involving them in a process of co-designing a toy that also affords them opportunities for creative expression.

Approaches to designing interactive toys for animals have recently been proposed by Pons et al [25] and Zamansky and Wirman [26]. Both emphasise the need to start by investigating species-specific behaviour and both recognize that the self-rewarding nature of play makes an interactive toy an ideal vehicle for exploring ACI. While Pons et al. envisage an intelligent, reactive environment that adapts according to the emotional state of the animal, Zamansky and Wirman characterise the loop of input and output that exists when an animal interacts playfully with a system. But in both cases, the authors' focus is on how technology can be used to create playful interactions. Conversely, our research has been guided by a fundamental principle of environmental enrichment, which is that every intervention must have a clear enrichment goal. Consequently, each prototype has been developed with clearly defined goals specifically related to enrichment, usability, technical challenge, playfulness and education. We furthermore sought to achieve these goals with Valli's participation, by taking an empirical approach to the research.

According to Sicart [16], when toys are explicitly designed, there are two distinct characteristics to consider: their filtering properties (how they support play) and their manifestation (how they are experienced via our senses). The same characteristics have been associated with the development of prototypes by Lim et al. [17] in the context of research through design using physical objects. Artefacts embody the choices made by designers [18] and also act as catalysts for future ideas. From the perspective of the researcher, the act of designing both drives and enriches knowledge. This perspective has influenced our work, whereby a significant part of the research has involved designing, manufacturing, testing and analyzing physical prototypes with Valli. The very process of making objects for an elephant has produced valuable insights - for example, imagining how a trunk might manipulate a control mechanism and what sensory details could be of interest.

The following section describes some of the design challenges we faced and how we approached them.

DESIGN CHALLENGES

The project at the time of writing has focused on developing suitable controls for an elephant to use.

Our design questions have included trying to find out what Valli is physically capable of doing with her trunk and attempting to determine her preferences with regard to interfaces. We also needed to assess her level of understanding of the experimental control mechanisms, to see if she could make the connection between interacting with a manufactured object and perceiving the associated output. In doing this, we are aware that there can be tension when technology is discussed in the context of environmental enrichment, which we discuss below.

Technology is not natural

The goal of enrichment is to give captive animals a more natural experience – but technology is not part of an elephant's habitat in the wild. On the other hand, living in a restricted enclosure is not a natural state for any animal. Because of the complexities of animal management, schedules are imposed and captive animals have fewer choices to make than their wild counterparts.

In this work, technology has been used to make the link between the animal input (making choices and using controls) and the system output (sensory stimulation). It also enables the sensors that detect input and the actuators that provide output, offering both cognitive and sensory enrichment. Mancini et al [6] endorse the use of technology for supporting the lives of captive animals, explaining how it can be used to personalise experiences and create adaptive systems to emulate key elements of the experiences that animals might have in a natural context.

Indeed, through technology, we have been able to design systems that Valli can control independently if she wishes, testing different sensors and outputs. We have attempted to evaluate which kinds of interfaces are most successful, both in terms of their ease of use for an Asian elephant and of their intrinsic appeal for Valli. At the same time, we have also aimed to design solutions featuring properties that might be valuable for and appeal to other species.

Participatory design

We elected to attempt a participatory design (PD) approach in order to include our user, Valli, and her carers in the design process. We aimed to share ownership of the designs and take advantage of the skills and knowledge that Valli's carers can offer to the project.

PD with animals has been attempted before [19,20], with mixed success. Lawson et al. [20] are sceptical of the notion of PD with animals, based on studies conducted with dogs and their owners. They point out that the power balance is never shifted in favour of the dog and that animals' lack of language means that they are unable to offer useful analyses of their experiences. Jorgensen and Wirman [15] also highlight how difficult it is to understand an animal's point of view, but offer a play-oriented approach to PD, whereby human designer and non-human animal user engage with each other in a playful scenario that aims to bridge the communication gap between the species, enabling the users to become true participants in the design process. This method was appropriate in the context of captive orang-utans, since the designers were trying to design a toy that enabled cross-species play; however, the majority of zoo-housed elephants in UK live in a regime of "PC" (protected contact) which means that direct interactions with humans are avoided. Therefore playing together to test ideas was not a suitable method for prototyping with Valli. Instead, we have tried to offer her systems that she could use by herself while her reactions were monitored.

As we did not know what types of controls an elephant was capable of using, nor what kinds of output held interest for her, it was vital to obtain feedback from Valli during the design process. This led us to prototype iteratively until a useful solution was reached. We could not ask Valli about interfaces directly, so we used a variety of methods to determine her reaction to our interventions: (i) observational data and video recordings to show how she interacted with a novel interface; (ii) data from the system to show whether the design was functional or not; (iii) expert opinions of her keepers who could evaluate her response by observing her body language.

Supersize practicalities

From a practical perspective, building elephant-friendly objects is time-consuming and expensive. Construction has to be sufficiently robust, yet systems must be portable so that they can be handled and installed by a couple of keepers. These constraints have informed the designs, which were all built from recycled materials in London then transported to Skanda Vale in Wales.

One of the problems with rapid prototyping is the lower production values of the devices being tested. The reality is that Valli has trashed several of our systems when she has been left unattended. While the systematic destruction of a novel object in the enclosure also provides her with cognitive and sensory enrichment, the effect is transient and leaves little scope for progress. Interestingly, she has not attempted to destroy the controls themselves, but has targeted the wires and pipes that facilitate the deployment of a shower system. To address these issues, we have selected particular places to locate the controls, where they are at trunk-tip reach so that Valli cannot use her full strength to destroy them immediately. The enclosure has a conveniently placed metal grid under a balcony rail, where buttons can be bolted (Fig. 2).

Figure 2: Shower buttons mounted on balcony

Self-rewarding experiences

One consequence of the focus on play is that we believe the enrichment should not be associated with food. We are interested in discovering other potential motivators. This choice is supported by Clark [23], in her investigation of what promotes the psychological well-being of large-brained mammals in captivity. She found that non-food rewards could be highly motivating for chimpanzees and dolphins when they were engaged in cognitive challenges. Play is characterized as autotelic, a spontaneous and voluntary activity, undertaken for pleasure. [21,16,22] The reward is inherent, not an action performed in order to receive another banana. In addition, there exists a prevalence of food enrichment and food is often used as a reward in shaping and training exercises.

By the same token, a toy should invoke curiosity; it may come with challenges, but it is not a training exercise and ideally the animal should be able to engage with it without prior training. Melfi [24] presents training as an activity that is not inherently cognitively enriching, but which can facilitate conventional environmental enrichment if it affords learning opportunities or results in a subsequent enriching experience. Keepers at Skanda Vale have suggested that Valli could easily be trained to use any kind of device, but we have been trying to find out what kinds of controls are intuitive for an elephant (Fig. 3: with / without banana).

Aesthetics

Intuitive controls are ones whose affordances map to our natural way of interacting with the world, meaning that they are easy to use and ideally require no explanation. In this regard, we had been focusing on an elephant's tactile and acoustic senses for button designs, but it became obvious that the controls also needed to be visible in order to stimulate Valli's curiosity. When we located the buttons behind a browse hole or on the ceiling outside her enclosure, she had trouble finding them without an olfactory cue (banana), which inevitably became associated with the device.

Figure 3: Banana training v shower control

As inveterate button-pushers faced with an enormous new user, we were seduced by the idea of enormous push-buttons. Eventually we realised that Valli's natural behaviour was to explore a new object carefully with her trunk, not to push it, so we used hidden sensors to detect the exploratory movements of her trunk around the buttons and tried to make the buttons more interesting and enticing from a tactile perspective. Rope and hessian were used to knit textured button pads that she spent several minutes investigating. While it was impossible to gauge Valli's reaction to the acoustic feedback we offered, she responded positively to the haptic feedback given by vibro-motors. We will investigate this further in future trials.

Concept mapping

In some well-understood designs, the input from the user, the output from the system and the feedback supplied by the control mechanism are three distinct features; the haptic sensation of the click from a switch is completely separate from the effect of illumination, although it is consistently associated with such an effect. Humans are also capable of understanding that the same control can implement different effects and that subtle differences in the position of a switch can indicate whether the switch is on or off. We take this for granted because we are surrounded by technology and learn how to use it from an early age. However, we cannot expect an animal to easily make the same connections between an abstract interface and the system it controls. Therefore, our approach has been to initially simplify the buttons (Fig. 2) so that they activate only one easy-to-perceive effect, i.e. a water supply. This has also made it easier to assess whether Valli was capable of using them.

How to enable Valli to activate the ON/OFF functionalities was another interesting problem with a number of possible solutions. To begin with, we programmed buttons to only activate an effect while they were being touched, which had the benefit of allowing us to measure for how long Valli kept her trunk on the control.

Finally, the need for iterative prototyping has meant that working buttons were recycled to try out different systems; improved buttons were substituted to failing versions that controlled the same effects. However, this meant that the new, improved buttons were now activating the functionalities previously activated by the old buttons. This lack of consistency could be a major problem when it comes to enabling Valli to develop a conceptual map of the system she is interacting with. We hope to address this issue by altering the position or texture of the controls to help Valli clearly distinguish them.

GUIDELINES FOR DEVELOPMENT

Based on our studies so far, we offer six guidelines for developers attempting to design controls for an animal to use without explicit training or without using food as a motivator, allowing the animal to learn through experience ways to interact with new technology in their environment.

Define goals

With enrichment goals clearly defined, it becomes easier for system designers to work with animal carers, as there is a shared objective and measureable output. Usability and technical goals can be used as basic milestones, while playfulness and education goals will depend on the purpose of the system and the research interests of the design team. .Our enrichment goals were generated from perceived gaps in the experience of captive versus wild elephants [12].

Research user characteristics and preferences

As with HCI, it is critical to investigate the sensory apparatus and natural behaviours of prospective users. Elephants are naturally curious - they like investigating new things – and we can use this natural behaviour to our advantage when designing and developing novel enrichment opportunities. For many animals, a novel object placed in their environment is an enriching experience [2].

Consider aesthetics

Although animals can be trained to use different mechanisms, one should aim to provide an interface that is intuitive and encourages natural behaviour, so that the emphasis for enrichment is on being able to make choices about how to control the output, rather than solve a problem about what to do physically with a button. Boxed rope and wood buttons worked well for our elephant. A pulley or similar robust device might have been another successful mechanism, but there were limitations (safety, expense, resources, manufacturing challenges) that prevented us from exploring this possibility.

Empowerment

To avoid the need for training, it is important to allow the animal to discover the functionality of the system independently. This makes it easier to assess whether goals have been met, because the animal's behaviour is not being affected by keeper expectations or the promise of a treat.

Tap test

We suggest using water as the initial feedback/output for a novel control system. Water is natural, desirable, familiar, it maintains life, it has tactile and acoustic and taste/smell properties, and it is empowering for an animal to be able to access fresh water whenever it wants. Valli discovered that she could choose between a strong jet or a fine mist of water, showing preference for the latter. By using water as the output, it is possible to test a range of different input mechanisms prior to installing a complete system that offers different sensory feedback.

Research through Design

Brainstorming and concept work is great fun, but the physicality of the experience can lead to useful insights, as constructing objects can aid reflection on how the target species might interact with the design. [17,18]. We took a "hands on" approach, moving from concept development to making in order to better appreciate the qualities of the materials used in the design. For our purpose, it became clear that the most usable controls combined hidden sensors with an organic tactile interface adapted to an elephant.

CONCLUSIONS AND FUTURE DIRECTIONS

Our goals were to design and develop a device that encouraged playful behaviour, offered cognitive and sensory enrichment, enabled control over an aspect of the environment, was intrinsically motivating and was easy to use. This case-study describes our progress towards these goals and offers some guidelines for those interested in developing interactive systems for animals. Our future work will investigate haptic feedback in more depth and explore the use of acoustic toys that afford elephants control over the sound that is produced. We will use lessons learnt from the shower controls to inform the design of a different system.

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REFERENCES

1. Animal Welfare Act, 2006: http://www.legislation.gov.uk/ukpga/2006/45/crossheading/promotion-of-welfare
2. Young, R. 2003. Environmental enrichment for captive animals, Oxford, UK ; Malden, MA: Blackwell Science.
3. H. Buchanan-Smith & I. Badihi. 2012. The psychology of control: Effects of control over supplementary light on welfare of marmosets. Applied Animal Behaviour Science, 137(3-4), pp.166–174.
4. K. Alfrink, I. van Peer & H Lagerweij. 2012. Pig Chase. Playing with Pigs project. www.playingwithpigs.nl.
5. Wirman, H. 2014. Games for/with strangers – Captive orangutan (pongo pygmaeus) touch screen play. Antennae: The Journal of Nature in Visual Culture, 30, pp.103–112.
6. C. Mancini, J. van der Linden, G. Kortuem, G. Dewsbury, D. Mills and P. Boyden. 2014. UbiComp for animal welfare: envisioning smart environments for kenneled dogs. Proc.ACM UbiComp '14, ACM Press, New York, NY, USA, 117-128.
7. Hirskyj-Douglas, I., Read, J.C. 2014. Who Is Really In The Center Of Dog Computer Design? Proc. ACE '14 Workshops, ACM Press, New York, NY, USA.
8. M. Kingston-Jones, H. Buchanan-Smith & R. Marno. 2005. Novel feeding and hunting enrichment for large captive felids: the lionrover and responsive hanging prey. Proc.7th Symposium on Zoo Research, Twycross Zoo, UK, 7-8th Jul.
9. Westerlaken, M., Gualeni, S. 2014. Felino: The Philosophical Practice of Making an Interspecies Videogame. Proc. The Philosophy of Computer Games Conference, Istanbul.
10. Whitham, J., Wielebnowski, N. 2013. New directions for zoo animal welfare science. Applied Animal Behaviour Science,147 (3-4), p.247-260.
11. J.H. Poole & P. Granli. 2008. Mind and Movement: Meeting the Interests of Elephants. An Elephant in the Room: the Science and Well Being of Elephants in Captivity, 69, p.73.
12. French, F., Mancini, C., Sharp, H. 2015. Designing Interactive Toys for Elephants. Proc. ACM CHI PLAY '15. ACM Press, New York, NY, USA.
13. A.F.S. Oliveira et al. 2010. Play behaviour in nonhuman animals and the animal welfare issue. Journal of Ethology, 28(1), pp.1–5.
14. Costikyan, G. 2013. Uncertainty in Games. The MIT Press.
15. Hammeleff Jorgensen, I.K., Wirman, H. 2016. Multispecies methods, technologies for play. Digital Creativity 27 (1).
16. Sicart, M. 2014. Play Matters. MIT Press.
17. Lim, Y.K., Stolterman, E., Tenenberg, J. 2008. The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. ACM ToCHI, 15 (2).
18. Hengeveld, B., Frens, J., Deckers, E. 2016. Artefact Matters. The Design Journal 19 (2).
19. C.L. Robinson et al. 2014. Canine-centered interface design: supporting the work of diabetes alert dogs. Proc. ACM CHI'14, ACM Press, pp. 3757–3766.
20. Lawson, S., Kirman, B., Linehan, C. 2016. Power, participation and the dog internet. In Frameworks for ACI: Animals as stakeholders in the design process. Eds: North, S., Mancini, C. ACM Interactions July-August.
21. J. Huizinga. 2012. Homo ludens, Madrid: Alianza Editorial.
22. Chen, J. 2007. Flow in games (and everything else). Commun. ACM, 50 (4), pp.31–34.
23. F.E. Clark. 2013. Can cognitive challenges enhance the well-being of Marine Mammals in Zoos and Aquariums? Journal of Zoo and Aquarium Research, 1(1).
24. Melfi, V. 2013. Is training zoo animals enriching? Applied Animal Behaviour Science, 147(3-4), p. 299-305.
25. Zamansky, A., Wirman. H. 2016. Toward characterization of playful ACI. In Frameworks for ACI: Animals as stakeholders in the design process. Eds: North, S., Mancini, C. ACM Interactions July-August
26. Pons, P., Jaén, J., Catalá, A. 2015. Envisioning Future Playful Interactive Environments for Animals. In A. Nijholt, ed., More Playful User Interfaces: Interfaces that Invite Social and Physical Interaction, pp. 121-150, Springer.