SoundJam 2018: Acoustic Design For Auditory Enrichment

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Abstract
This workshop was designed to offer participants an opportunity to explore different kinds of auditory enrichment for a range of animals in different environments. Teams of participants worked together on a small set of briefs provided by domain experts, brainstorming ideas and developing concepts into well-designed blueprints for prototype devices. The day was organized along the lines of a traditional game jam.

Author Keywords
ACI, audition, environmental enrichment, auditory enrichment, acoustic design, game jam, workshop, physical computing.

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

Introduction
Animals have evolved forms of communication (signaling) that work in a species-specific environmental context – gestures that can be observed from a range of distances, olfactory cues that can be "posted" and remain until they dissipate, vocalisations and other acoustic signals that act immediately but in some cases with great range, enabling remote contact with conspecifics. Without humans contributing to the

Cross-category enrichment

Fig 1: Puzzle feeder
Capuchin explores pocket filled with ice and strawberries, Lakefield Monkey Sanctuary, 2014.
Courtesy Fiona French.

Fig 2: Suspended straw
Asian elephant family browsing at Dublin Zoo, 2016.
Courtesy Fiona French

soundscape, their auditory perception and associated cognitive abilities would have evolved in relation to what was audible in the surrounding ecosystem.

As human populations expand over the globe, these "natural-sounding" places are slowly disappearing. People use sound insulating techniques to protect their homes and working environments from sound pollution, but animals living in urban and confined spaces must or indeed our proximity, it can be argued that we have a duty to consider their acoustic well-being as part of our attention to their welfare and environment.

On the other hand, many non-human animals also *make* a considerable amount of noise, particularly those living in social groups. Since natural behaviour includes demonstrating the ability to both make signals and interpret others' signals, it is important that an animal has both the opportunity and the motivation to perform this behaviour. It follows that if a social species is housed independently or with a smaller number of conspecifics than would naturally occur in the wild, it is possible that their acoustic repertoire will be diminished, along with the cognitive processing required to discriminate between a range of sounds.

As a consequence of these issues, auditory enrichment for animals in captivity can take two distinct forms – negative, whereby noise levels are reduced, dampened or masked in order to protect animals from intrusive sounds (which could be of human origin or generated by a nearby predator species), and positive, when animals are offered acoustic experiences in order to give them sensory, cognitive or social stimulation.

The workshop will focus on the design of auditory enrichment for a small selection of different animals.

Motivation

Animals living in manmade environments may need protecting from anthropophonic noise. Current research in this area includes passive acoustic monitoring where soundscapes are captured and analysed to infer environmental parameters (Figs 3 & 4) [13], as well as animal behavioural studies [10].

Sensory enrichment uses devices which generate visual, olfactory, tactile and acoustic stimuli. Depending on the type of device, environmental enrichment can encompass different categories – thus, a puzzle feeder (Fig. 1) might simultaneously provide cognitive, food, olfactory and tactile enrichment; a suspended straw bale (Fig. 2) could offer food (foraging), exercise and social opportunities.

Many examples of auditory enrichment involve keepers (and researchers) selecting and playing sounds to the animals in their care. Captive gorillas have shown preference for natural sounds over either silence or music (rock or classical) [12], while captive chimpanzees preferred silence to music [15], as did captive moloch gibbons [14]. On the other hand, Vivaldi (classical) had an observable calming effect on zebrafish [6], "classical music" seemed to reduce stereotypic behaviour in zoo-housed elephants [16], while soft rock and reggae has been documented as reducing stress in kennel-housed dogs [2].

There are many studies in which the purpose of the enrichment is to calm an animal, in which case it makes However, a device designed for auditory enrichment

Technology supporting auditory enrichment

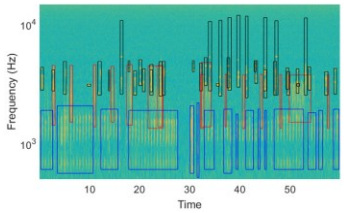

Fig 3 and 4: Songmeter and annotated soundscape
Installed at Mersey Gateway.
Courtesy Paul Kendrick

Fig 5: Grey parrot toy
Courtesy Reinhard Gupfinger

could have the potential to stimulate cognitive activity if the target species was offered a control mechanism that enabled interactivity. This could have the additional benefit of enabling designers to learn more about user preferences.

Several ACI researchers are making progress in this direction. For example, Gupfinger and Kaltenbrunner have developed interactive acoustic devices for captive grey parrots (Fig. 5), which allow the birds to make choices about generating sounds and music, with the aim of gaining insight into how grey parrots perceive and respond to different auditory stimuli [5]. Pons et al. have focused on an exploration of orangutan behaviour in relation to tangible objects with sound-controlling properties [9]. This is specifically in order to offer control and choice to the orangutans using moveable objects that they freely manipulate as part of their normal behaviour.

Biological salience is mentioned by Mancini and Lehtonen [7] as a key factor in ACI design, and this feature is reinforced by Ritvo and Allison [11] who claim that ACI systems should be designed to mimic and augment the user species' natural behavioural tendencies. These examples also showcase the importance of volition and choice when designing sonic enrichment, factors emphasised by Mancini and Lehtonen. We believe that research in this area opens up the possibility for redefining aesthetics so that it is possible to take a more species-centric approach to ACI design.

Call for participation

This workshop aims to bring together expertise from different disciplines, enabling participants to network and move towards designing and developing exciting new auditory enrichment experiences for a range of animals.

The structure will follow the format of previous years' ZooJam and FarmJam workshops [4] [3], which generated a broad range of innovative enrichment concepts in a relatively short time period. The game jam format shapes the design process by offering both accelerated and constrained design [6] [8] with different rewards for different participants – some focused on outcomes, others on creativity, some on having learning opportunities, others on networking and finding potential research collaborators. To facilitate this, the workshop outputs will be shared publicly.

We invite participants from a wide range of communities, including but not limited to game design, computer science, engineering, education, HCI and ACI, acoustic engineering, animal behaviour and environmental enrichment. This is an opportunity for those with an interest in animal welfare to share ideas and explore the potential of using acoustic technology to enhance enrichment.

We would like prospective participants to contact workshop organizing committee to express their interest.

Workshop aims

The workshop aims to:

- Raise awareness of the value of auditory enrichment amongst the ACI community and beyond.

During the workshop

Fig 6: Brainstorming

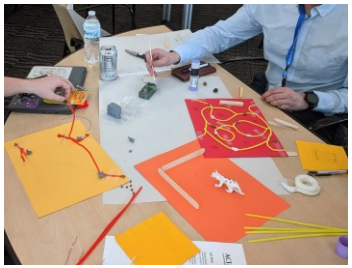

Fig 7: Crafting
Making a model of the design for a serval enclosure

Fig 8: Presenting ideas

- Provide opportunities for networking and creative teamwork.
- Investigate novels ways of using technology to support auditory enrichment.
- Examine briefs (challenges) relating to different species.
- Generate novel acoustic designs in response to briefs.
- Produce and present design documentation.

Activities

The workshop was facilitated in person by Fiona French and Valerie Hare, while Reinhard Gupfinger participated remotely as the expert on parrot behaviour.

Overview
The following activities were undertaken during the event:

- Short introductions for participants and members of organizing committee; participants received briefs.
- Structured workshop activities enabling people from different backgrounds to meet and discuss specific challenges in the field of auditory enrichment – starting with brainstorming sessions where participants worked together to imagine concepts in response to the briefs (Fig. 6).
- Discussion of initial ideas with feedback from species experts - leading to the formation of small teams focusing on collaborative design briefs and creating early phase concepts.
- Team crafting session (Fig. 7), when participants were tasked with creating a physical prototype pf their concept using a variety of simple resources.
- Opportunity to present final designs and answer questions (Fig. 8).
- The outcomes of the workshop are shared online in a repository of ideas to support future collaborations by keeping a record of participants' skills and interests. There is a website dedicated to the workshop.

www.zoojam.org/soundjam

Briefs
Challenges for participants were provided in the form of four briefs relating to auditory enrichment for four different species – parrots, chimpanzees, servals and elephants. In this paper, we use the brief for parrots as an exemplar of the type of challenge and the associated outputs/feedback. Reinhard Gupfinger provided the brief for parrots and communicated with the teams during the event.

"While parrots are known for their complex cognitive and communicative abilities, they need enrichment and attention in captivity or they can become distressed. Behavioral disorders like feather plucking is a common symptom. Parrots are along with others the most intelligent birds and have become popular pets due to

parrot species show specific auditory skills such as "entrainment". Spontaneous entrainment in animals is unusual and involves the ability to align their movements to a musical beat. This ability has been found in grey parrots and cockatoos and has thus disproved the claim that entrainment to music is unique to humans. Building on this, providing appropriated auditory enrichment could provide new opportunities for improving the quality of life for parrots living in captivity.

"Recent research in the field of cognitive biology has focused on the role of animals listening to human music as a concept of enrichment. Since most of the music is selected by humans, this can lead to anthropomorphic biases. Therefore, the music should be attuned to the animals' auditory skills. In addition, it has been found that animals prefer sounds and musical arrangements that are biologically relevant for them.

"Challenge**:** Design a playful musical instrument for parrots, which is based on traditional design metaphors such as string or percussion instruments. Consider the particular physical interaction patterns of grey parrots, which are mostly performed with the parrot beak. Design a collaborative instrument, to stimulate the birds' interest in discovering things together, since grey parrots usually live in long-term couple relationships. What kind of sound should the instrument produce and discuss if the sound could be biological relevant to the parrots?" (Reinhard Gupfinger)

Brainstorming and Feedback
After the first brainstorming round, Reinhard discussed the teams' early ideas; he was able to contribute feedback via Skype.

"The brainstorming round brought a lot of promising ideas we could discuss (Fig. 9). Many of the proposals of the three teams had overlaps and we tried to classify them as well as discussing the possibilities for development. We analysed the different forms of interaction, possible auditory feedback, use of materials and considerations for positioning the instruments in the aviary. The feedback round was followed team formation with a focus on the development of prototype auditory enrichment for parrots.

"The team agreed to work on a system that could be installed in an aviary and that allowed the parrots to interact in different places and to individually or collaboratively generate sound and music. One proposed idea was to have a stand where sensors measured the pressure to find out where the parrots were located, then to add some rods equipped with sensors such that the parrots could pull or push to play notes of some sorts. The sonic feedback would come directly from a speaker placed behind the device. There was also the idea of adding some light for visual feedback to let the parrots clearly know whether the devices were active or not, to support the idea of hearing and seeing what the parrots were doing.

"A further concept was to enrich the aviary with multiple interactive swings equipped with sensors to detect if parrots were on the swings. The swings would be equipped with different sounds - for example, one with beats and another with single notes that could be triggered by rocking the swings. The swings could allow several parrots to play music together at the same time." (Reinhard Gupginger)

Parrot auditory enrichment development

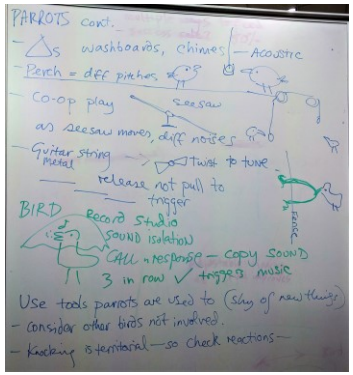

Fig 9: Parrot concepts
Some of the collection of ideas from participants shared on whiteboard.

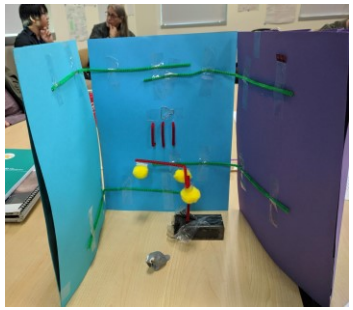

Fig 10: Parrot crafting
Mock-up of enrichment station by Larry Freil (Georgia Tech) and Shogo Yamashita (University of Tokyo).

Author Reflections

Reinhard

Although I was unable to attend the workshop in person, I had the opportunity to participate as an expert via Skype video sessions. I discussed the brief and provided a handout with detailed information on parrot cognitive and physical skills and preferences. The aim was to explain some of the outstanding abilities of parrots, such as entrainment, so that participants could include these abilities in their design concepts for auditory enrichment. In addition, participants were confronted with more concrete questions, as described in the brief for parrots.

The finale prototypes were presented at the end of the workshop and were also made available on an online video platform. The multitude of promising ideas proposed by the participants was very positive and the two final concepts for auditory enrichment environments are partly already in practical application such as the rope swing test station [5] that was developed for testing the sonic abilities for grey parrots."

The experience of participating in the workshop via Skype was new to me. The drawbacks were: (i) to make it not easy for me to obtain an overview of the presented ideas; (ii) to not be able to clarify problems during the brainstorming and development process of the workshop. From my experience as a participant in the last ACI "FarmJam" workshop, this process and discussion was especially enriching for me. However, the remote participation in the "SoundJam" workshop was a very positive experience that I would not have wanted to miss.

Paul

The brainstorm session (for chimpanzees) produced a marble run system where sounds could be assigned to particular marbles which would then trigger audio at particular points in a marble run. Chimps could assign individual sounds to their marbles and interact with the sequence. This seems a simple yet intuitive idea.

It was interesting to that the control of the system was physical and avoided the use of touch screen technology, which perhaps may make the proposed ideas more appealing to the animals, and therefore more affective at enrichment. Perhaps the chimps could control the volume of the sounds by adjusting the gradient of the ramps and hence the speed and repetition rate of the sounds.

Fiona

SoundJam 2018 was successful in meeting its aims of promoting cross-disciplinary collaboration and generating novel concepts in the area of auditory enrichment. We were very fortunate that Valerie Hare, an expert in environmental enrichment, was able to support the workshop, facilitating activities and providing valuable feedback on ideas throughout the event.

For me, one of the clear revelations was how the crafting session helped participants to refine and share their ideas (Fig. 10). We have always supplied craft materials during ZooJams, but this year we stipulated that teams would have to make a small physical prototype during the afternoon session. For some people, this proved to be an excellent way to communicate their ideas and aided the transition from thought to concrete example, as well as highlighting

Acknowledgements

Special thanks to Valerie J Hare from The Shape of Enrichment [17], for supporting and helping to facilitate this event.

practical considerations that need to be considered when developing for animals in a captive setting.

We look forward to running further events such as these and welcome proposals for collaboration from the wider community.

Biographies

Fiona French is a senior lecturer in the School of Computing and Digital Media at London Metropolitan University. She is course leader for BSc Computer Games Programming and has organised several game jams and other play related public events. Her research interests include Animal Computer Interaction, physical computing and toy and game design and development. Fiona is currently investigating the design of playful interactive systems for elephants, as part of a PhD in the Animal Computer Interaction Lab at The Open University.

Reinhard Gupfinger is a university assistant and PhD candidate researcher at the Tangible Music Lab at the University for Art and Design Linz, Austria. He is undertaking a study in the context of Animal Computer Interaction (ACI) by designing musical instruments for grey parrots.

Paul Kendrick is an acoustic engineer, with a research focus in AI (machine audition). He has been researching how to use acoustic signals to better understand animals and the environment, focusing in particular on analysis of soundscapes to assess biodiversity.

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