A Report on the First International Workshop on Research Methods in Animal-Computer Interaction

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Abstract
Animal-Computer Interaction (ACI) is a new and quickly developing discipline, which is closely related to HCI and is making reference to some of its theoretical frameworks and research methodologies. The first edition of the Workshop on Research Methods in ACI (RM4ACI) was co-located with the Third International Conference on Animal-Computer Interaction, which took place in Milton-Keynes, UK in November 2016. This paper presents an overview of the workshop, including insights from discussions on some of the challenges faced by the ACI community as it works to develop ACI as a discipline, and on important opportunities for cross-fertilization between HCI and ACI that the HCI community could consider.

Author Keywords
Animal-computer interaction; workshop summary; research methods.

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

Introduction
Animal-Computer Interaction (ACI) is an emerging discipline aiming to develop user-centric interactions

between animals and technology. Exploring such interactions contributes to our understanding of animal behavior and has important applications, e.g., for the development of technologies that can support the activities of working dogs during training and deployment 43], or that can provide environmental and cognitive enrichment for animals in captivity through various forms of positive stimulation and entertainment [38]; or for the design of technologies for conservation and other animal research that can minimize the impact of human interventions on the animals involved [33]. Furthermore, a previous alt.CHI contribution [21] argued how the emerging discipline of ACI has the potential to significantly expand the boundaries of HCI under broader theoretical and methodological frameworks, by focusing on users who require interfaces that do not assume what we call 'language', and whose cognitive characteristics and natural behavior place hard methodological constraints on the design and evaluation of such interfaces. Indeed, in an effort to develop animal-centric interactions, researchers have systematically explored the extent to which HCI principles can be applied to the design of animal interfaces as well as the extent to which such principles may require adaptation or even reinvention [33,24,43,30].

Five years after the publication of Mancini's "Animal-Computer Interaction – a manifesto" [20], calling for the development of ACI as a scientific discipline through synergies between HCI and animal studies, the field has grown significantly. This is evidenced by numerous publications and scientific events, culminating this year in the Third International Conference on Animal-Computer Interaction (ACI2016), held for the first time as an independent event, in co-operation with the ACM. A reflection was thus particularly timely on the achievements to date of ACI as a scientific field, the identity of the ACI community, ways of shaping it in the future, and crucially what the development of ACI might mean for HCI. To this end, the RM4ACI workshop brought together leading ACI researchers from different backgrounds to discuss the toolbox of research methods relevant for the ACI community, and their relations to frameworks and methodologies from HCI, animal studies, ethology and other disciplines.

The interdisciplinary partnership of the workshop organizers, Anna Zamansky and Amanda Roshier, coming from computing and animal science backgrounds respectively, provided a setting of shared perspectives in the design and execution of the workshop. The workshop program consisted of two parts: two sessions of invited talks by leading ACI researchers, who shared their experiences and reflections regarding the use of a range of research methods to design interactive systems for nonhuman users, followed by a discussion. This paper presents a report on the workshop, including a summary of the invited talks and insights arising from the discussions among participants to draw lessons for the ACI and HCI communities more broadly.

Chronological Summary

Clara Mancini, head of the Animal-Computer Interaction Lab at The Open University, UK, started by presenting methods used over the years within the ACI Lab's research projects. These included *ethological observation and measure*, which the team are using to develop a framework to inform the design of wearer-centered biotelemetry interventions [33]), and which

involves the observation and measurement of specific behavioral parameters to assess animal's responses to tracking devices. It also included the use of *multispecies ethnography* [25,23], which integrates researchers' observations of animal behavior, corroborated by expert advice, with accounts provided by the animals' human companions, acting as mediators; such observations paid particular attention to contextual associations that the animals might use to attribute meaning and respond to technological interventions. Moreover, the team had used *iterative physical prototyping* to elicit canine requirements [25], when designing an interface for alert dogs, enabling them to express their design preferences; they had also used the method for gauging interest and finding preferences of captive elephants towards different designs of interactive toys for cognitive enrichment [6]. The species-specific analysis and implementation of core interaction design principles had also been used by the team to inform the design of interactive environments that could better support canine users tasked with assisting humans with disabilities. *Focus groups and role play* had finally helped the team think outside the 'human box' and enable them to better understand animals' needs [4]. Clara's final message was that animal-centered research and design are extremely hard due to more or less obvious interspecies differences and communication barriers. Yet one should not despair: design (whether for human or nonhuman animals) is never perfect nor finished; instead, it is an iterative process that progresses by incremental approximations to the best possible solutions; thus, carefully attending to the process in ACI is perhaps more important than focusing on achieving one final outcome.

Hanna Wirman, head of the Game Development Stream at the School of Design of the Hong Kong Polytechnic University, discussed research methods used in the TOUCH project [41], a research effort between several institutions to develop digital enrichment for Bornean orangutans in rescue centers in Indonesia. Her toolbox of methods mainly comes from cultural and media studies and game design. Hanna pointed out how using user-centered design, adopted from HCI and interaction design, for animals – not as objects of technology, but active users, poses considerable challenges. For instance, the focus on `user' assumes a clear task (or functionality) at hand, which is not always the case for animals. Furthermore, there is a fundamental difference, or otherness between the designer and user, which is further enhanced by the fact that the designer cannot just ask the user what he wants, as one would do with humans. In addition, testing designs can be extremely challenging for animals, especially those kept in captivity. Hanna also pointed out that since orangutans have no previous history as users of digital technology, the design process of her team was a pure "play exploration". For instance, poking was recognized through observation as a common, pleasant play activity. Further, such exploration revealed that a stick has many affordances for orangutans, and could have multiple uses in the context of play. Wirman concluded that due to the challenges posed by the unique environment of the project, research becomes pragmatically cross-disciplinary, an eclectic mixture of methods. One must also accept the fact that sometimes there are no clear methods to apply, but one needs to explore and experiment instead. Finally, in our choice of methods we must always respect the difference between us and animals.

Describing her role at the University of Nottingham's School of Veterinary Medicine and Science, Amanda Roshier discussed training veterinary students on the topics of animal behaviour and welfare. These topics are also essential to ACI, particularly where an understanding of both the species and individual is a key component of the design and evaluation process [8]. Her experiences of research methods included qualitative methods of surveys and interviews [31], ethological methods of observing and interpreting animal behaviour; and quantitative methods in biomedical engineering to evaluate injury mechanisms [18]. Her introduction to the discipline of ACI stemmed from a collaborative project developing a horse automated behaviour interaction tool [26]. Amanda emphasized the need to develop partnerships with relevant stakeholders, and in particular she had discovered that many ACI projects appear to lack input from those with animal science/welfare expertise. Such guidance is invaluable for the successful implementation and evaluation of many ACI projects; but most importantly to support animal welfare.

Shaun Lawson, an HCI researcher at Northumbria University, became interested in ACI around 15 years ago when working with trainers of seizure alert dogs. Shaun frequently works with animal behavioural scientists to explore the opportunities at the interfaces between HCI, ubicomp and companion animal understandings. Ethical concerns and challenges of ACI were illustrated through examples of his research. One project applied speculative design to explore technologies for pet owners: several prototypes were developed and included tracking the animal's movement, a collar to interpret emotions, and a device to analyse cat excrement to identify health issues and track hunting behaviour [16]. This project emphasised the concern that technology industries push animal technology to unwary (human) consumers when this may be useless or even dangerous. Another project asked how dogs would design the internet [17], illustrating that animals must be involved in the design process or else we just design on top of them. Shaun believes that borrowing user-centred design, co-design and participatory design methods from HCI does not seem the way forward, and that to design new technology with and for animals will need some radical new methods – and thinking. Shaun commented how cross-disciplinarity is still lacking; where most ACI work seems to be delivered by HCI researchers, lacking collaboration with animal behaviourists or welfare experts, and those who might provide breakthroughs through more theoretical or philosophical debate or provocation.

Carol Hall from Nottingham Trent University focuses in her research on equine behaviour as a means of improving horse management, training, and welfare. Although the examples presented were equine specific, the principles discussed were applicable to all animal species. Although not usually referred to as such within animal science, ACI is increasingly used as a means of monitoring the health, behaviour and well-being of animals, and contributes to enriching their managed environments. In particular, the use of augmented reality technology to provide surrogate companionship to horses seems particularly promising due to indications of responses of horses to images of con-specifics [9,10]. Such technology will allow the development of responsive surrogate companions in addition to other options that will enable an animal to make choices about its environment. To evaluate the

impact of such technology, ACI methods must incorporate the expertise of those involved in assessing animal behaviour and welfare. Behavioural observation and the interpretation of this behaviour (using quantitative and qualitative methods: ethograms, physiological parameters, qualitative behavioural assessment) is a key element in the development of ACI. Hall concluded that the development of relevant technology within ACI requires careful consideration of the animal. Factors to consider include: species-specific features, individual differences, perceptual worlds and the salience of associated stimuli. The ecological niche of the species will in part determine the response of an animal to novel technology. For example, the horse, as a prey species is a neo-phobic animal that flees from potential danger and has a strong flight / fight response. Care must be taken to introduce any new technology in an animal-friendly way. The potential fear of the human element should also not be forgotten, particularly when dealing with animals that are unfamiliar with human interaction.

Steve North from the Mixed Reality Laboratory at the University of Nottingham started his talk with 'our commitment to non-human animals: build only what they want or need'. The thing to avoid is researcher self-deception, also known as the unconscious projection of personal design priorities and enthusiasms onto 'voiceless' co-designers. Things to embrace: methodologies that genuinely elicit animals' requirements and their responses to our technological solutions. North's work is mainly based on using quantitative, ethology-based approaches for the analysis of interactions and behaviours (in both single species and multispecies contexts). The commonalities between his recent projects are: video analysis and the use of ethograms [26,27,28]. North went on to pose the question: how do we build only what non-humans want or need? First, we need to embrace the 'otherness' of animals and apply techniques to enhance empathy with animals by putting ourselves in their place. As a technique to do that, he described the use of 'design fiction', in the early stages of requirement elicitation. He showed examples of design fiction, from a publication currently under preparation. In addition, he presented a video, featuring a 'real world' example [5]. Another thing to consider are techniques that challenge: human exceptionalism / supremacy and the pigeon-holing of ACI as an 'outsider activity'. As an example of such techniques, North questioned the assumption that the ACI field is a niche subclass of HCI. He presented a thought experiment: 'A taxonomy tree of computer interaction things', asking, "is ACI a part of HCI, or vice versa?". In this, he argued that (when presumptions about human exceptionalism are put aside) HCI (concerned with human-animals) should actually be considered a subclass of ACI (concerned with *all* animals). He went on to introduce a new hybrid approach: representing the interdisciplinary nature of ACI. He described amalgamating quantitative (ethology) and qualitative (ethnography) methods into what he termed 'ethographology' (describing *and* studying the fundamental behaviour of a species. Challenging anthropocentric assumptions and the hybrid methodology may help us to avoid unconsciously projecting our personal design priorities and enthusiasms onto users. North concluded that lessons learned about user-centred design for 'unaware interactors' may be transferable to HCI domain, working with vulnerable / neurodiverse human animals.

Melody Jackson, director of BrainLab at Georgia Tech, combines her professional experience as a dog trainer with her expertise in ubiquitous computing and HCI. She described her research project "FIDO: facilitating interactions for dogs with occupations" [10,12,42]. In this project devices are developed that enable assistance dogs, military dogs, and search and rescue dogs to communicate with their handlers by pulling a string on a special vest equipped with sensors. This project has recently received funding from Google and NSF. Jackson summarised the process of designing the technology, the value of seeking input from animal behaviourists and trainers, the iterations, discoveries, evaluation of the product, and future expectations of this research. She stressed the importance of developing performance metrics for evaluating technology for dogs. In her work on FIDO she used criteria such as dog accuracy, sensor accuracy and reachability, etc. She warned that the training process of animals is influenced by human errors and mentioned the potential role of automated training to remove the human from this equation. However, she also cautioned overlooking the human component, where studies indicate human delivery can actually influence how rewarding something actually is for a dog.

A discussion on research methods in ACI

Reflecting upon what had been presented, participants then revisited the questions that had been raised at the beginning of the workshop. Below are the main points and issues arising from these discussions.

Concerning the toolbox of methods needed for ACI, most participants agreed that the ACI community should try to remain open to the vast number of methodologies that different fields of research could offer. However, it would be desirable to see a more structured and systematic application of behavioral, animal science and ethological approaches, as well as theoretical work on the basic differences between humans and animals with respect to the use of technology. Some examples of recent ACI works that take the former direction and use video analysis and ethograms are [26,27,28,1,2]

Despite the inherent multi-disciplinarity of ACI, the current situation is that most research approaches and methods employed in ACI are borrowed from HCI, such as user-centric design, participatory design, etc. However, these need to be appropriately adapted to the context of ACI, taking into account interspecies differences and communication barriers. In order for HCI methods to be usefully applied, it is important that animals are enabled to express their needs and wants; this implies not only the possibility of freely providing feedback to what human designers might propose, but also crucially the possibility of 'suggesting' design solutions of their own. In this context ideas from affective computing [36,35] and social signal processing [40] seem particularly promising, as in these approaches non-verbal behavioral cues are used as physical, machine detectable evidence of emotions and social relational attitudes, respectively. In this context the discussion touched upon existing challenges in the Human-Robot Interaction (HRI) community. There too, the inherent multi-disciplinarity of HRI has meant that at present the field does not have a coherent framework around which its methodologies are based (e.g.,[1]). ACI researchers could draw from the developments that are currently taking place within the field of HRI, using as a model, when addressing the

issue of methodological incoherence and inconsistencies in the novel field of ACI and thus develop a more structured and coherent methodological approach.

From the perspective of behavioral science, it is important to take full account of the ecological niche and innate behavioural tendencies, perceptual abilities, and social needs of the species in question, and the impact that past human interactions (and other experiences) may have on an individual animal. In addition, the size and shape (anatomy) of the species and the age of the individual animal must be taken into account. Technological advances have resulted in the use of interactive screens (and computers) in animal visual learning studies (see, e.g. [10]). However, the consideration of optimal stimulus placement, general visibility of stimuli, features of the test area, and the relevance of the trial / test to the species concerned are among the factors that will impact on performance and therefore on any conclusions that can be drawn from the results. Designing animal-friendly trials is also of prime importance to ensure the well-being (and motivation) of the animal concerned. Presenting an animal with a task that it cannot complete because it does not have the physical and/or perceptual capability will lead to inaccurate conclusions and will be detrimental from an animal welfare perspective. ACI needs to consider apparatus and experimental design from the animal's point of view.

Ethical principles in ACI were another issue that generated discussion. Participants agreed that although some work has been done on ethical principles for ACI (see, e.g. [22,39]) there is currently no widely agreed upon set of ethical guidelines. Moreover, views were expressed that as ACI researchers, we have a moral obligation to develop only what "animals want and need". But what are these needs, and who makes these decisions? Animal welfare surely plays a crucial role, but are there also other factors? For example, the majority of production animal husbandry systems compromise welfare under economic pressures. Despite this deviation from an ideal animal-friendly environment, ACI nevertheless has the potential to significantly improve the welfare of production animals [19]. A suggestion was made to use a Delphi method [19], when developing technologies intended for animals, relying on opinions of a group of experts, including experts in animal welfare, animal behaviorists, ACI researchers, as well as potentially also representatives of other disciplines.

A further concern raised in the discussion was developing a discourse between ACI researchers and people working with animals who are not academics, but are often stakeholders in the process of designing for animals. For instance, in designing interactive toys for elephants [6] or a computer game for orangutans [42], zoo keepers and handlers can provide important insights that inform the design of the artefacts. There is therefore a need to develop a balanced approach, supplementing data gathered by ACI researchers with insights from professionals working with animals (and assisting when conflicting approaches can complicate best-case solutions), as well as from individuals looking for solutions for their animals.

Summary

It seems that the field of ACI has reached the level of maturity at which a critical look at the research methods used is needed. The workshop provided an

excellent opportunity to begin a discourse on this topic. Issues of scientific self-identification and relations between ACI and HCI are themes that kept reoccurring in the discussion. While some participants viewed ACI as part of HCI, and others argued for the opposite (see, e.g., the points raised above by Steve North), all agreed that ACI is closely related to HCI and is using or making reference to some of its theoretical frameworks and research methodologies. On the other hand, the adaptation of such frameworks and methods to the context of working with animals has the potential to push the boundaries of HCI itself [21]. For one example, the need to adapt current self-reporting data-gathering methods (e.g. surveys, interviews) for participants who do not use 'language' could stimulate the development of equivalent methods that could be used with very young or neuro-diverse human participants. For another example, the need to develop effective tools for the interpretation of behavioural measure in animals could lead to improvements in the interpretation of similar behavioural measure in HCI to assess humans' responses to technological interventions. These and other examples emerged during the discussion. In brief, we believe that a constructive dialogue between ACI and HCI communities will enhance the cross-fertilization between these disciplines.

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