Animal-Computer Interaction: a Manifesto (2011) and sections from Towards an Animal-Centred Ethics for Animal-Computer Interaction (2016)

Book Section

Animal-Computer Interaction: a Manfesto (2011) and sections from Towards an Animal-Centred Ethics for Animal-Computer Interaction (2016)

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Animal–computer interaction: a manifesto[1]

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Animals[2] have been involved in machine interactions for many decades. Skinner's famous operant conditioning chamber, used in behavioral experiments since the early 1930s,[3] provided output devices, such as lights or sounds, and input devices, such as levers or buttons, and would dispense food or water if, for example, a rat or a pigeon completed a given sequence of tasks correctly. These systems have gradually evolved into sophisticated computerized environments affording complex interactivity. Other interaction systems, such as computer games currently employed in more advanced primate cognition studies, provide, for example, on- screen animations that can be controlled via joystick (Gill 2011).

Within agricultural engineering, interactive computing devices have also been developed, for example, to optimize milk production in the farming industry, with the introduction of the first automatic milking systems in dairy farms emerging in the early 1990s (Rossing et al. 1997). These systems have rapidly developed into cutting-edge applications of pervasive and ubiquitous computing technology, enabling cows to independently engage in voluntary milking and express intelligent and social behavior never previously observed in constraining farming environments (Brennan 2005).

Examples of a different kind of interaction are provided by tracking and telemetric sensor devices, which have been used in conservation studies since the early 1970s and which have now become commonplace. For example, radio collars allowed researchers to uncover the elusive behavior and territorial needs of snow leopards for the first time (Jackson and Ahlborn 1989), and satellite collars enabled conservation efforts to start mapping the movements of elephants (Lindeque and Lindeque 1991). Tracking devices have also been introduced to the pet market, while various telemetric technologies are used in laboratory settings to monitor, for example, dogs' physiological parameters during pre-clinical trials (Emka Technologies n.d.).[4]

In short, animal–computer interactions have a long history and can be found in many areas in which human activity involves other species.

The elephant in the room

In spite of its history, the study of the interactions between animals and computing technology has never entered mainstream computer science, and the animal perspective has seldom informed the design of animal computing applications, whose development has so far been driven by academic disciplines other than computer science or by other industrial sectors. The design of these technologies remains fundamentally human cent[e]red, and the study of how they are adopted by or affect their users remains fundamentally outside the remit of user-computer interaction research.

The negative effects of this lack of animal perspective become obvious when, for example, the behaviour and welfare of seals fitted with bio-logging tags and satellite transmitters are

significantly affected and data gathered during costly conservation studies risks invalidation (Hazekamp et al. 2009), or when cows who do not engage with milking systems are culled and farmers suffer capital losses (Brennan 2005). But risk mitigation aside, what about the things we could gain from a shift in perspective? What would it allow us to learn about and achieve with interactive technology? How would it influence our reflection on usability, adaptation, appropriation, methodology, and ethics, to name but a few aspects? Studies in interspecies computer interaction have started making appearances at HCI venues (Lee et al. 2006, McGrath 2009, Noz and An 2011, Weilenmann and Juhlin 2011), but the remarkably marginal position this research still occupies in the HCI community and its research agenda is an indicator that its significance has not yet been recognized. For some reason, animal–computer interaction (ACI) is, quite literally, the elephant in the room of user-computer interaction research. The time has come to acknowledge the elephant, to start talking about ACI as a discipline in its own right, and to start working toward its systematic development.

The right moment

Advances in our understanding of animal and comparative cognition, as well as those in computing technology, make the development of ACI as a discipline both possible and timely, while pressing environmental, economic, and cultural changes make it desirable.

From long-held training experiences, we know that several species can use interactive devices of one kind or another, sometimes appropriating them in interesting and unexpected ways. More generally, though, we now know that many species have sensory faculties superior to ours (Willis et al. 2004), possess sophisticated cognitive abilities, engage in advanced problem solving, use purpose-built tools for complex tasks (Emery and Clayton 2004), communicate through articulated languages, experience a range of emotions, form complex social relationships, make moral judgments (Bekoff 2004), and hand down cultures through generations (Rendell and Whitehead 2001). This has progressively made us more aware of the similarities between humans and other species, more appreciative of other species, and more attentive toward the significance of our relationships with them and the fragile environment we all share (Hurn 2011).

At the same time, the interaction modes afforded by computing technology have expanded well beyond those provided by keyboard and mouse. Tangible, embodied, and proxemic*s* interactions, for example, have brought physicality back into computing by engaging the whole body through contact and movement. Sensor technology has become more agile, robust, and sensitive, better able to read the changes coming from within and around us. In general, developments in pervasive, ubiquitous, and ambient computing are enabling technology to adapt to our spontaneous behaviours and to the contexts that these continuously produce and modify. Not only do these advances make computing technology more accessible to humans but they also make it far more accessible to other species. ***Aims and approach*** ACI aims to understand the interaction between animals and computing technology within the contexts in which animals habitually live, are active, and socialize with members of the same or other species, including humans. Contexts, activities, and relationships will differ considerably between species, and between wild, domestic, working, farm, or laboratory animals. In each particular case, the inter- play between animal, technology, and contextual elements is of interest to the ACI researcher. ACI aims to influence the development of interactive technology to:

- improve animals' life expectancy and quality by facilitating the fulfilment of their physiological and psychological needs (technology that encourages healthy feeding habits in domestic animals or allows them to modify their housing conditions at leisure might be consistent with this aim);
- support animals in the legal functions in which they are involved by minimizing any

negative effects and maximizing any positive effects of those functions on the animals' life expectancy and quality (technology that gives farm animals control over the processes in which they are involved, produces no side effects on the animals involved in conservation studies, or helps working animals communicate with their assisted humans might be consistent with this aim); and

- foster the relationship between humans and animals by enabling communication and promoting understanding between them (technology that allows companion animals to play entertaining games with their guardians or enables guardians to understand and respond to the emotions of their companion animals might be consistent with this aim).

ACI aims to develop a user cent[e]red approach, informed by the best available knowledge of animals' needs and preferences, to the design of technology meant for animal use. It also appropriately regards humans and other species alike as legitimate stakeholders throughout all the phases of the development process.

Ethical Principles

ACI: A manifesto 57 ACI takes a non-speciesist approach to research (Dunayer 2004), and researchers have a responsibility to:

- acknowledge and respect the characteristics of all species participating in the research without discriminating against any of them;
- treat both human and nonhuman participants as individuals equally deserving of consideration, respect, and care according to their needs;
- choose to work with a species only if the intent is to advance knowledge or develop technology that is beneficial or otherwise relevant to that particular species;
- protect both human and nonhuman participants from physiological or psychological harm at all times by employing research methods that are non- invasive, non-oppressive, and non-depriving;
- afford both human and nonhuman participants the possibility to withdraw from the interaction at any time, either temporarily or permanently; and
- obtain informed consent to the involvement of both human and animal participants, either from the participants themselves (for example, for adult humans) or from those who are legally responsible for them (for animals).

Widespread benefits

The development of ACI as a discipline could have many benefits for both animals and humans. For example, it could have important effects on our interspecies relationships by informing the design of technology that enables the animals we live and sometimes work with to effectively communicate with us, increase their participation in our interactions, and constructively influence our environments. These developments could give us a better understanding of those we share our lives with and help us build safer, richer, longer, and more productive relationships with them. ACI could also lead to further insights into animal cognition – for example, by informing the design of interactive technology for behavioural studies that affords optimal usability and creative appropriation for the animals. Or it could support conservation efforts – for example, by informing the design of monitoring devices that minimize the impact on the animals while maximizing the quality and reliability of the data gathered through them. Moreover, ACI could improve the economic and ethical sustainability of food production – for example, by informing the design of technology that affords farm animals more freedom and autonomy, enabling them to live less unnatural lives, reducing their stress levels and susceptibility to illness without recourse to drugs, increasing their productivity, and improving the quality of their produce. Finally, ACI could expand the horizon of user-computer interaction

research by pushing our imagination beyond the boundaries of human-computer interaction. For example, it could help us discover new ways of eliciting requirements from those who cannot communicate with us through natural language or abstract concepts. It could help us explore new modes of interaction for those who do not have hands, cannot decipher the patterns emitted by a screen, or have limited attention spans. Or it could help us find new ways of understanding and evaluating the impact of technology on individuals and social groups – perhaps shedding new light on issues such as identity, privacy, or trust, and contributing to our understanding of what it means to be human and who we are in relation to other species.

A research agenda

Of course, whether ACI can yield the benefits outlined above depends on our ability to tackle some challenging questions. For example, how do we elicit requirements from a nonhuman participant? How do we involve them in the design process? How do we evaluate the technology we develop for them? How do we investigate the interplay between nonhuman participants, technology, and contextual factors? In other words, how on Earth are we going to develop a user-centered design process for animals? Here is a possible roadmap:

- First, we could look at what has been done in other areas, what knowledge about animal behavior and psychology is available, and what data has already been collected about animal-computer interactions. We could look at how all that maps onto what we know about user-computer interactions and how it might contribute to ACI as a discipline and design practice.
- Second, we could form collaborations with researchers from disciplines such as ethology, behavioral medicine, animal psychology, and veterinary, agricultural, and environmental engineering to help us with this mapping effort. Similarly, the expertise and experience of professionals and practitioners who work with animals in environments where animal-computer interactions take place would be important.
- Third, we could study in-the-wild cases of whatever technology is already in use or might be developed in order to understand those domains and contexts, their users and stakeholders, so that we can begin to develop or adapt relevant ACI concepts and models.
- Fourth, we could look at human-centered interaction design protocols and methods in order to assess which ones may or may not be relevant to an animal-centered design process, which might be adapted, which might be borrowed from other disciplines, and which might need to be developed from scratch.
- Fifth, we could start adapting, developing, and integrating animal-centered interaction design protocols and methods—for example, for requirements elicitation, participatory design, and contextual evaluation, in a loop between empirical work and theoretical reflection.
- Sixth, we could start developing theoretical models of animal-computer interaction, which would then drive further research. These would take into account pre-ACI research on animals and would be informed by ACI empirical research with animals.

An Invitation

Because of the questions it raises and the challenges it poses, ACI is arguably the next frontier in the study and development of interactive technology. Those who are keen on joining in the exploration of this new territory are warmly invited to sign the ACI Manifesto and join our animal-computer interaction group at: http://www.open.ac.uk/blogs/ACI/

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Selection from 'towards an animal-centered ethics for animal–computer interaction'[5]

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Ethical implications of user-centered design for and with animals

In contrast to the above, I argue that, in order to be consistent with a user-centered perspective, ACI's ethical approach to research needs to meet different criteria. First, it is not the animal characteristics that provide grounds for their treatment but rather their role as users and research participants. Thus, giving all animals involved in ACI research equal protection and care (according to their individual needs) is the most appropriate way to ensure that their requirements as users can emerge during the process and can therefore be designed for with their active participation. On the other hand, precisely because user characteristics are so central to the design process, animals cannot be viewed as the substitutable components of an experimental set- up. Therefore, it is only appropriate to involve an animal in research if this is directly relevant to them. Furthermore, if one recognizes that maintaining good welfare at all times is an important individual requirement, in order to be consistent with user- centered design ACI research needs to be compatible with the welfare of both end users and research participants. Protecting the welfare of animals used in research is the aim of related institutional directives, protocols and guidelines. But what are the specific implications of ACI's animal-centered perspective in this regard?

A welfare-centred ethics

What constitutes good welfare for animals is the object of on-going research (Fraser *et al*. 1997, Fraser 2008) some notions of animal welfare assuming more than others that animals are capable of conscious and sentient experience. Because it bypasses the thorny issue of consciousness and sentience, and is there- fore relevant to all animals, the notion of welfare proposed by Stamp Dawkins (2012) is particularly useful here. For Stamp Dawkins, animal welfare presupposes the fulfilment of two fundamental conditions: That an animal is healthy and that they have what they want. The author's rationale is that animals have evolved adaptations for coping with environmental conditions (e.g. a thick coat), for exploiting available resources (e.g. specific hunting techniques or a specialized digestive system) and for recovering from injury (e.g. mounting an immune response), in order to maintain good health thus maximizing their chances of survival and reproduction. However, [as] Stamp Dawkins points out, animals have also evolved adaptations for preventing the occurrence of conditions that could compromise their survival in the first place, adaptations which result in the animals wanting certain things: for example, wanting to search for prey that might be hiding in the ground, or wanting to burrow to hide from potential predators. For Stamp Dawkins, the animal being healthy and having what they want are inter- dependent conditions or requirements (e.g. a captive animal whose exploratory behavior is constantly frustrated may develop harmful stereotypies) which need to be satisfied at the same time (e.g. giving an animal free access to food needs to be compatible with maintaining their optimal weight). If only one of the two conditions is satisfied, welfare is compromised.

It follows that ACI research should never threaten the health of the animals involved and never deny them what they want, unless denying or limiting what they want is necessary to preserve their health. More specifically, the welfare requirement that an animal is healthy means that ACI

research should never entail practices or procedures that interfere with the evolutionary adaptations that sup- port the animal's health (e.g. through genetic manipulations), or threaten the animal's health by compromising their physiological or psychological integrity (e.g. through invasive, aversive, or otherwise injurious manipulations). On the other hand, the welfare requirement that animals have what they want means that ACI research should never entail practices or procedures which prevent animals from expressing spontaneous behavior (e.g. through restriction or constriction), or con- fine animals within settings that are not those for which they have evolved (e.g. through caging). The only cases in which such practices or procedures would ever be appropriate in connection with ACI research is in the unlikely event that they needed to be carried out for the direct benefit of the individual animal in question (e.g. through therapeutic surgery or confinement).

Stamp Dawkins (2012) notes how generally the death of an animal is not in itself considered a welfare issue on the grounds that a dead animal cannot suffer, from which would follow that the killing of an animal upon completion of a research procedure, an accepted practice by current legislation, does not impact on their welfare unless it causes the animal to suffer in the process. However, such a position seems to be at odds with the very evolutionary definition of animal welfare. If an animal has evolved certain adaptations precisely because these allow him to stay alive, and if violations to the animal's adaptations impact on his welfare, then interventions that lead to the animal's death arguably pose a welfare issue on the grounds that they are incompatible with the very function that has allowed those adaptations to evolve. Bekoff (2010) argues how the struggle of an animal who is under attack indicates that his life matters to him; this point is arguably valid whether the animal is or is not aware of the attack, or even whether he is or is not aware of being alive. As Stamp Dawkins (2012) points out, struggling (e.g. to break free from confinement) is an evolutionary adaptation ultimately aimed at keeping the animal alive and well. Whether the threat to an animal's life is delivered overtly in a form that the animal is able to recognize as a threat (e.g. strangulation) and thus respond to (e.g. struggling), or covertly in a form that the animal is unable to recognize (e.g. lethal injection during sedation) and thus respond to (e.g. hiding), the fact remains that such a threat opposes the very function of the animal's life-preserving adaptations. In this respect, it could be argued that killing can never be compatible with animal welfare, except when the mechanisms whose function is to keep the animal alive and well are so irretrievably compromised (e.g. because of illness) that there is no hope for his health and contentment to be restored to balance. Thus, on welfare grounds, the killing of participating animals at the end of research procedures is incompatible with ACI's animal-centered perspective.

Instead, consistent with Stamp Dawkins' definition of welfare (2012) researchers should always endeavor to respect the animal's identity and safeguard her integrity, both physiological and psychological, at all times. This means that researchers should work in contexts that are habitual for and thus familiar to the animal; they should endeavor to be as unobtrusive and undisruptive of the animal's daily life patterns and routines as possible; they should give the animal space for expression and control over the research process; and they should use only forms of interaction which are respectful of and responsive to the animal's needs and wants at all times. In animal-centered research, the interests of individual participants should 'prevail over the interests of science and society, where there is conflict' (Medical Research Council 2004) and any potential risks to individual participants should outweigh any potential benefit to others. Therefore any cost-benefit analysis of the research should be carried out from the perspective of what, at the best of the researchers' knowledge, are the animal's best interests. In user-centered design this is both and ethical imperative, as recognized by ethics frameworks regulating the involvement of humans in HCI research (Association for Computing Machinery 1992) and a methodological necessity, as argued by Ritvo and Allison in their discussion of research methodologies applicable to ACI (Ritvo and Allison 2014). But how can researchers ensure that, in the case of animals, the interests and requirements of users and research participants are appropriately represented and thus prioritized?

The issue of consent

Existing frameworks motivate the need to minimize the impact of research procedures on the welfare of the animals involved, on the grounds that they are capable of suffering whilst being incapable of consenting. This implies the ability to comprehend the immediate and wider implications of one's involvement (Faden and Beauchamp 1986), but of course interspecies cognitive differences and communication barriers make conveying the welfare implications of a research procedure to other animals practically impossible. Nevertheless, consent arguably marks an important difference between participation and subjection, thus in user-centered research the animals' consent needs to somehow be sought.

Of course, one approach to the issue is seeking consent for animals via media- tors who are capable of comprehending the implications of the research in relation to the animals' welfare requirements and who have the legal authority to consent on their behalf. To ensure that consent is provided from a user-centered perspective, such agents should also have a vested interest in prioritizing the welfare of the animals concerned. Furthermore, since in user-centered research participants are not merely representatives of a category or substitutable components of an experimental apparatus but individuals, consent should to be sought on an individual basis. In this regard, Mancini et al. (2012) highlighted the complementary role of the animals' daily carers, on the one hand, and animal welfare experts, on the other hand: The former hold critical contextual knowledge about an individual's characteristic patterns and circumstances, while the latter hold essential expertise to assess those characteristic patterns and circumstances in relation to established animal welfare knowledge (Väätäjä and Pesonen 2013). Thus, overall mediated consent should imply the following:

- the capacity to comprehend the immediate and wider welfare implications of a procedure,
- a vested interest in prioritizing the welfare of individual animals,
- familiarity with the individual's characteristic patterns and circumstances,
- animal welfare expertise relevant to the individual, and
- the legal authority to consent on behalf of the animal.

Whether all or part of these competences are distributed across different individuals (e.g. the animal's human companion who is also her legal guardian and an independent animal welfare expert) or are found within one individual (e.g. if the human companion and legal guardian is also an animal welfare expert), they should all be represented in the consenting process. Additionally, an independent authority, such as the animal welfare review bodies envisaged by the European Directive, should ensure that the above conditions are met in compliance with ACI's research ethics framework as well as existing legislation.

On the other hand, voluntary engagement is a fundamental aspect of con- sent (Faden and Beauchamp 1986); however, clearly it would not be realistic to assume that mediators know what the animal they represent wants in specific contingencies. Thus mediation does not eliminate the need to obtain some form of contingent consent from the animals themselves. While animals might not be able to assess the welfare or wider implications of a procedure, they are nevertheless able to respond to specific conditions (Stamp Dawkins 2012), provided they are afforded the freedom to make relevant choices, including the choice not to engage or withdraw altogether. Ritvo and Allison (2014) propose that participant- controlled procedures are best suited to enable animals' preferences to emerge in ACI research; these may entail dichotomous-choice protocols, whereby participants choose whether or not to be exposed to a stimulus, or multi-stimulus protocols, whereby participants can choose between different stimuli as well as the length of stimulus exposure. If a participant is enabled to choose the pace and modality of their engagement with, or withdrawal from, the research process at any time,

then their response can provide a measure of their consent to engaging with a specific research set-up. Of course, any contextual variations during a procedure might affect the participant's assessment of the situation and thus their amenability to participate, so whether participants are able to assess the situation is an important consideration.

Luger and Rodden (2013) argue that, as ubiquitous computing systems become more complex and seamless, and support an increasing range of daily activities, the data that drives their functionalities is increasingly abstracted from its original context; this makes it impossible for (human) users to understand the implications of their interactions with such systems and thus provide informed consent to the use of data they divulge during the course of those interactions. In this respect, the authors emphasize the dynamic nature of consent and the importance of enabling effective withdrawal at any time; they also stress the importance of giving users visibility over data flows within systems and the ability to easily interrogate the system to evaluate the cost-benefit trade-offs of engaging or withdrawing. In a more concrete sense, these are similarly useful considerations when designing ACI research procedures. Thus, overall contingent consent should imply the following:

- procedural set-ups that enable the animal to assess the situation as much as possible (e.g. allowing the animal to freely explore his surroundings or any research equipment as appropriate prior to starting a procedure, and at regular intervals during the procedure),
- opportunities for the animal to make relevant choices between alternative forms of engagement (e.g. between different forms of input or output in an interface; between reward mechanisms based on food or play), and
- the possibility for the animal to effectively withdraw or withhold engagement (e.g. plenty of escape routes or rest corners as appropriate).

Importantly, in order to monitor levels of consent over time, researchers should be able to continually and expertly monitor variations in the participant's response to a procedure against their welfare requirements, as highlighted by Väätäjä and Pesonen (2013), and dynamically and promptly make any appropriate adjustments, including suspending a procedure.

Researchers who work with non-competent or non-linguistic humans (Medical Research Council 2004, 2007) are well familiar with notions of mediated and contingent consent, its dynamic and transient nature (e.g. consent as a process rather than as a one-off occurrence [Medical Research Council 2007]), and the critical importance of monitoring and responding to signs of dissent (e.g. a young child becoming upset [Medical Research Council 2004]). They are also aware of the necessary complementarity of the two forms of consent (Medical Research Council 2004, 2007), whereby those who can see the wider implications of a participant's involvement lend their insight in the participant's best interest, while the participant themselves is the only one who can assess the contingent, directly experiential implications. Consistent with the implications of user- centered research, the very ethical perspective underpinning these notions is just as relevant here.

Notes

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2 The term animal(s) is loosely used throughout to refer to nonhuman animals.

3 Operant conditioning chamber; http://en.wikipedia.org/wiki/Operant_conditioning_ chamber

4 [Since original publication this resource is no longer available. See http://www.emka.fr/produit/emkapack4g/ [Accessed 15 May 2016] for a more up to date link.]

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