Digitally Complemented Zoomorphism: a Theoretical Foundation for Human-Animal Interaction Design

Michelle Westerlaken
NHTV University of
Applied Sciences
Mgr. Hopmanstraat 1
4817 JT Breda
(The Netherlands)
michellewesterlaken@gmail.com

Stefano Gualeni
NHTV University of
Applied Sciences
Mgr. Hopmanstraat 1
4817 JT Breda
(The Netherlands)
gualeni.s@nhtv.nl

Abstract

From an interspecies perspective, we advocate for a theoretical foundation aimed at facilitating further research towards digitally mediated human-animal interaction. The proposed framework follows an approach we call '*digitally complemented zoomorphism*' and recognizes 'play' as a free and voluntary activity that is shared by both animals and humans. As a result, three initial design guidelines will emerge. Our work is pursued in order to provide animals with stimulations which stem from a closer understanding of their needs and preferences and are not solely designed around human subjectivity.

Author Keywords

Human-animal interaction; technology; play; design; user experience.

ACM Classification Keywords

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

General Terms

Design; Theory; Human Factors.

Introduction

The values of Western culture are conducive to spending a considerable amount of resources on the development of technological artefacts which mediate the relationships between humans and animals[1]. The amount of physical products as well as software applications dedicated to human-animal interaction available on the market, such as remote human-animal interaction [4,9,14,19], and the growing amount of industry-sponsored applied research projects [15,16] are symptomatic of an increasing commercial interest in deepening the understanding of relationships between animals and humans as well as their technological mediators.

The research area for technically mediated human-animal interaction is still exploratory. However, the increased relevance of the relationships human beings establish with animals, as well as the importance of improving the animal welfare in society encouraged new research and fostered technical innovation. This is exemplified by research in agricultural fields [1,18,10] and domestic animal markets [12, 21].

This paper will propose a novel theoretical foundation to approach the design of physical products as well as software applications capable of providing a more compromising bodily and mental stimulation for the animals who share anthropic environments and social practices with humans. The user-analysis methodologies and design guidelines that will follow from the establishment of such a theoretical foundation are expected to guide the practical design of artefacts that will more closely embrace the actual needs and preferences of animals.

Within the structure of this paper, a critical review of the existing applied research in the area of digital technology intended for animal use will first and foremost demonstrate the lack of an examined and shared theoretical framework.

We will then propose a '*zoomorphic*' approach as a more desirable alternative in which the free and voluntary activity of '*play*' is understood as a form of interaction in which the mutual constitution and co-shaping of relationships is already naturally occurring in both animals and humans.

The three initial design guidelines that stem from this framework could be more exhaustively expressed as a '*digitally complemented zoomorphism*'. The descriptor '*digitally complemented*' indicates that a necessary portion of our embodied analysis of the human-animal relationship will not rely on human subjectivity, but will be performed digitally. The latter will consist of the tracking and the collation of biometric data that objectively quantify the changes of the animals' bodily dimensions during specific technically-mediated activities.

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[1] The term 'technological artefacts' is used as a reference to all mediators designed by human beings that interfere in human-animal interaction. The term is specifically employed in order to take an objective distance from what animal scientist Ruth C. Newberry describes as vague notions that are used inconsistently throughout literature and might contain anthropomorphic notions, including terms like environment enrichment or toys [13].

Related work

A reading of the recent, existing literature in the field reveals an understanding of human-animal interaction that, despite its fundamental, structuring role, is never openly discussed or justified. As a consequence, all the existing works can be criticized for being assertoric (possibly true but unproven) and for relying on what could be labelled – following Daniel Dennett's insights – as '*folk animal psychology*' [6].

In the following section we will demonstrate that a solid theoretical foundation is not present or problematized in the existing literature. This led to two methodological issues:

1. First of all, the absence of a systematic approach resulted in the design of experiments, products and applications that are tentative and could not work towards the structuring of a shared design methodology.

2. Secondly, the benefits of technologically mediated animal interaction are currently focused on the perception of animal needs, based on subjective human judgements and the human end of the animal-human relationship. This unquestioned acceptance of superficial forms of anthropomorphism (see side bar on the next page) necessarily results in an unbalanced and prejudicial understanding of the relationship itself which is likely to result in the production of suggestive conclusions.

Tentative Research
The existing literature in the field of technical artefacts for human-animal interaction often includes the proposal of a concrete concept for a technical artefact.

The proposed mediators are subsequently evaluated by pet owners in the form of focus groups, interviews and/or prototype based experiments [14,15,16,22]. Even though these trial-and-error-based approaches might provide valuable insights on the human pole of the relationship in terms of expectations and preferences, the concept proposals face usability problems on the animal end such as the inability to reliably measure the physical wellbeing of the animal [16] and the creation of fully functional prototypes [15,22].

For example, Paldanius et al. proposed three different concepts as explorative studies aimed at gaining a better insight into the experiences and expectations of dog owners in order to inform the design of successful digital human-dog interaction technology [16]. This approach was revelatory of a fundamental methodological problem: the assumption that the analysis of the human engagement in the relationship will lead to practical design objectives and approaches which will improve the wellbeing of the dog. In another research example, a digital application intended for cats was examined [14]. Similar to the research mentioned above, the design was informed and based on a tentative design strategy (influenced by human perceptions of animal preferences and enjoyment) with the purpose of providing a game application for cats, without relying on or constructively proposing a design methodology or set of guidelines.

Anthropomorphism
According to Human-Computer Interaction researcher Clara Mancini the current design of existing technologies intended for animal use is fundamentally anthropomorphic [11]. A human focus is also overtly

Anthropomorphism

Anthropomorphism - the attribution of human characteristics to non-human entities [20] - is the essential background to the way in which human beings understand animals, their behaviour and their interaction with them.

We argue that an unquestioned anthropomorphic perspective on human-animal interaction leads to suggestive conclusions and does not effectively focus on meeting and satisfying the needs and preferences of animals. Rather, it gravitates around the human pole of the interaction.

We concede, however, that a degree of anthropomorphism is patently inevitable when human beings design and manufacture technological artefacts intended for animal interaction.

detectable in existing research towards technological artefacts aimed at the mediation of the relationships between humans and animals [14,15,16,21,22]. In the mentioned articles, user studies performed on human participants are pursued and utilized to guide the design of mediating artefacts. This could logically be embraced as an appropriate component of a design methodology if the pet owners themselves were the intended end-users of the technology. The declared scope of the existing research and the technological concepts that were prototyped as a result, however, is that of engaging the pet as well as improving the wellbeing of the animal and the relationship with its owner.

Next to the digitally mediated human-animal interaction research mentioned in this section, the risk for anthropomorphism and a failed recognition of the animal needs and behaviour exists in research towards other (non-digital) mediators in human-animal interaction such as toys and environment enrichment. According to animal scientist Ruth C. Newberry, concepts like 'animal welfare', 'stress', and 'environment enrichment' are vague notions and are used inconsistently in literature. Currently, no standardised methods or criteria allow the assessment of whether actual enrichment occurred. The current research approaches have produced inefficient, trial-and-error research and incorrect interpretation of the results [13]. Next to this, 'enrichment attempts often give the impression that they are based more on human feelings and perspectives and on convenience than on biological relevance and functional utility of the animals' [13].

Assessing the shortcomings of the current research towards technologies intended for animal interaction, Mancini observed that it might be helpful to start regarding animal-computer interaction as a discipline in its own right. She also suggested moving away from pursuing practical research and, instead, investing time and resources more constructively into working towards a systematic development of the field [11]. In a later article, Mancini et al. raised the same issues proposes questioning what technologically-mediated human-animal interaction might mean for both the humans and the animals in terms of interpretational mechanisms and the way it affects the animal [12].

In order to make technological artefacts useful in providing more meaningful and balanced interactions with animals that are more balanced and meaningful, we agree with Mancini that a more systematic research approach is preferable at this point over continuing with exploratory and fragmented applied research without a shared theoretical framework.

Theoretical Foundation
This paper proposes a theoretical foundation with the purpose of structuring a methodological approach to the design of technological artefacts that have animals as their intended users. We raise the question: could we have a better, more examined, less anthropomorphic understanding of what we are trying to accomplish with technological artefacts intended for human-animal interaction?

The Centric Animal and Play
We advocate for a theoretical foundation to human-animal interaction based on the embodied, voluntary and free interaction in 'play'. This activity will be

Helmut Plessner's theory of positionality

Plessner's theory of positionality accounts for the dissimilarities between plants, animals, and human beings in terms of spatial organization and independence from the environment:

Plant: a plant has no awareness or consciousness of itself or its environment. It does not have a centre of experience and cannot relate to its external boundaries;

Animal: animals have an experiential centre and a degree of self-awareness (centric positionality). The animal is, to a degree, self-conscious and independent from its surroundings;

Human: the human being has a centric positionality but can also form a cognitive relationship with its very experiential centre (eccentricity). As such, it is fully capable of self-reflection and of making decisions which are fully independent from its environment [17].

understood and analysed on the basis of Helmut Plessner's theory of positionality and Jos De Mul's notion of '*going-along*' in interspecies interaction.

In his 1938 book, historian Johan Huizinga proposed a vision stating that the fact that animals, similarly to human beings, naturally engage in play demonstrates that they must be more than merely mechanical systems [8]. In other words, if animals are somehow aware of the fact that they are playing, which is a deliberate activity and includes a degree of separation from reality, they must be more than merely instinctual beings univocally engaged with the practicalities of their surroundings.

Animal scientist Marc Bekoff and philosopher Colin Allen explained that play is a tractable, evolved behavioural phenotype that lends itself to further research, and social play (including interaction with another living creature) occurs in a wide range of species and involves issues of communication, meaning, role-playing and cooperation. Furthermore, in a way that is not dissimilar from Huizinga, they raise questions on the availability of self-conception that, to some extent, seems to be forthcoming in animals during play [2].

Bekoff and Allen propose a more encompassing vision on animal cognition, observing that an animal may have specific cognitive abilities related to particular states or intentions of other creatures, without having the general ability to reason or form specific deliberate content as a response to the interaction [2]. In other words, an event such as play may involve behaviour that resembles eccentric activities, even though neither participant has a general conception of this behaviour.

In this matter, it becomes clear that centric animals (see side bar) seem to experience play as something different than eccentric human beings, because their experiential structure is organized in a different way. Centric animals might not have the full ability for self-reflection and the experience and perception of their environment is different from our human experience and perception. However, when focusing on play in animals that human beings share certain characteristics with, a mutual understanding and response to signs, cues, and behaviour emerges. This bodily conception (which will be described as '*going-along*' later in this paper) of each other can be explained, according to a more gradient understanding of Plessner's theory of positionality, by the fact that – during play - animals and humans have analogously eccentric positionalities.

The similarity in the structuring of human and animal cognitive activity during play indicates that play itself can form a specifically suitable context wherein to start developing a theory about inter-species understanding. In this respect, this study currently has a general focus on 'higher' animal species that have relatively advanced abilities, share certain characteristics in life with human beings, and are suitable for human-animal interaction (including for example non-human primates, higher domestic animals such as cats and dogs, and other placental mammals with cognitive abilities that are familiar to those of human beings).

Furthermore play, as an activity that is characteristically voluntary and free, naturally provides a shared context in which the animal is not forced or artificially involved in the interaction.

A clear and workable definition of the term '*play*' in the present work is necessary in order to clarify how our theoretical framework can be used to analyse the playful interspecies interaction with technological artefacts. According to Burghardt, there are innumerable ways of characterizing and defining play. However, he argues that many of these definitions provide nothing more than a list of factors involved in play, while what he considers necessary is an approach that allows systematic analysis in order to separate '*play*' from other behaviours with which it may be confused [3]. Burghardt therefore provides a definition of animal play according to five criteria, following an ethological approach (see side bar).

Although some of the concepts proposed in this set of criteria are inevitably bound to the way humans understand animal behaviours and needs, the general definition is set up in such a way that the availability of all five criteria helps us distinguish playful behaviour from non-playful behaviour.

Digitally Complemented Zoomorphism

The understanding of positionality in animals in physical play lays the foundation for a theoretical approach and a more aware and compromising form of anthropomorphism. This zoomorphic approach relocates the focus from the human perspective towards a better understanding of the needs and preferences of the animal. Besides its intrinsic theoretical value, in our intentions such a perspective is supposed to open the way for further research towards the design of technological artefacts that mediate the relationships between humans and animals. We propose the term '*digitally complemented zoomorphism*' as an approach

that stems from this foundation and provide three initial design guidelines:

1. The use of external stimuli in the form of technological artefacts;

2. Analysing animal behaviour through '*going along*' in a common embodied praxis (such as play);

3. The digital tracking and collation of objective biometric data about the animal experience.

1. Technological artefacts as external stimuli
This paper proposes that the natural curiosity of animals and their explorative behaviour could be exploited to stimulate their engagement with interactive technological artefacts in a research setting.

According to Burghardt, most animals show explorative and investigating behaviour when new objects appear in their environment. These activities are linked to play and can show overlapping types of behaviour (such as playful body signals), but are different in context, bodily dimensions, and function [3]. In this case, the most useful insight is that exploratory behaviour and curiosity are often visible before play, and thus effectively promote playful behaviour in the animal [3].

In combination with the focus on actual play, this means that the technological artefacts we design for playful human-animal interaction have a function in facilitating environmental stimuli that motivate the animal to play and engage in voluntary human-animal interaction.

2. Going-Along: a Mutual Understanding

As already mentioned, play facilitates a mutual understanding due to the shared interaction and response to bodily cues. According to philosopher Jos De Mul, common traits in the way bodily signals are produced and interpreted allow specific species to understand other species to a certain degree. In particular, he argues that the dimensions that constitute the human world enable us not only to meaningfully relate to other human beings, but up to a certain degree to understand animal life as well [5]. In other words, a closer insight into the intentions of an animal could be achieved by '*going-along*' in a common embodied praxis such as play.

The objective of this shared activity with the animal is not attributed *a priori*, but unfolds itself intuitively in the course of the interaction. An example includes the elementary understanding of the intentions of a dog while playing with a human being.

Mancini et al. recently published an article in which they proposed the exchange of indexical semiotics through which humans and dogs could *coevolve* [12]. This article describes how one of the three kinds of communication signs ('*symbols*', '*icons*', and '*indices*') is specifically suitable for trans-species interaction. Where '*symbols*' and '*icons*' are merely abstract signs and require linguistic abilities, '*indices*' are instead directly and physically grounded in a bodily relationship with the world and other beings and thus neither preclude nor require shared mental abilities [12].

In other words, if we are able to interpret a dog's semiotic processes on the level of understanding their indexical signs, we can connect meaning to them in the context of human-animal interaction.

The work of Mancini et al. provides a first structured approach regarding research in the area of digitally mediated human-animal interaction. However, this work continues to rely on a subjective understanding of the animal (since it focuses solely on human interpretations), and does not stem from an articulated theoretical framework. Instead, our work proposes the possibility to structure an objective framework for human-animal interaction which initially focuses on the interspecies understanding that naturally occurs in the activity of play and is complemented by the use of objective bodily measurements during the interaction. This will be proposed in the form of biometric observations in the next section of this text.

This new approach could provide a more thorough, interactive and balanced comprehension of the animal, its behaviour and its intentions.

3. Biometric Research

Despite the understanding of the animal through an embodied and shared interaction and the avoidance of superficial forms of anthropomorphism, the zoomorphic approach proposed in this study still stems from a rather subjective human perception of animal needs and behaviour. In order to complement this human subjectivity, biometric research could offer valuable insights. This includes the digital tracking and collation of biometric data to uncover changes in the animals' bodily dimensions and/or movements. In other words, by objectively measuring psychophysiological changes in the body of the animal (such as heart rate, respiration, or body temperature), or by digitally

measuring changes in the movement patterns of the animal (such as pacing, position, or types of interaction with technological artefacts) we can observe how it reacts to certain stimuli or experiences [11].

According to Burghardt, biometric measurements of pleasurable states during play have not yet been carried out, but, for example, heart rate measurement in horses when they were confronted with novel stimulus showed that their heart rate was reduced, which is often found when the animal's attention is focused. Therefore, studying heart rate changes during free play sessions might be useful in assessing the experience of horses during play [3].

However, according to Goodenough et al. biometric data is subject to high levels of variability [7]. In addition, the application of sensors and electrodes on animals causes difficulties in both receiving accurate measurements (for example due to sudden animal movements) and in that it interferes with the normal behaviour of the animal (for example when the animal tries to remove the sensors or is restricted in its movements).

Therefore, in order to avoid the limitations of measuring valuable psychophysiological data, we suggest to start with a focus on the digital tracking and analysis of external biometric measurements through computation of videotaped observations. The tracking of data through external sensors can provide objective and more thorough insights in the interaction with both the technological artefact and the human being involved in it without having to apply sensors on the animal's body (see side bar for examples).

On this basis, a combined interpretation of videos of the interaction with the animals, reports by the humans involved in the activity and the tracking of the animals' biometric dimensions or behaviours during the interaction is likely to provide a more solid, balanced and sustainable understanding of the involvement and the level of enjoyment of both poles of the relationship.

Conclusion

Our research argues that the existing applied studies aimed at the creation of technological artefacts for human-animal interaction are often exploratory, have a marked human focus, and draw conclusions based on superficial anthropomorphic statements. This approach resulted in the design of methodologies that are tentative, and do not respond to or accommodate the current needs and behaviour of the animal.

The understanding of positionality in animals in physical play constructs a novel theoretical framework that provides a basis for further research in the field of animal-oriented user studies and human-animal interaction that is based on a more compromising and balanced form of anthropomorphism. In relation to this we propose the term '*digitally complemented zoomorphism*' and provide three initial design guidelines. We recommend:

1. The use of external stimuli in the form of technological artefacts to motivate the animal to play and engage in human-animal interaction in a research setting.

2. The pursuing of a closer understanding of the animal, its behaviour and its intentions by 'going-along'

in the embodied praxis of play with animals we share certain characteristics with in life.

3. The complementation of the above with the digital tracking and collation of biometric data in which the changes of the animals' bodily dimensions during specific technically-mediated activities can be monitored and understood.

We believe these guidelines will lead to the realization of technical mediators that will more closely align to the actual needs and preferences of the animals, and are not solely designed around human subjectivity.

The limitations in measuring valuable and accurate biometric data in animals could be overcome by concentrating on the use of external biometric measurements. Such data will provide the researchers with a more objective and quantifiable complementation of the insights in the behaviour of animals in addition to the more subjective bodily understanding of the interaction through 'going along' in the shared activity of play.

Acknowledgments

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