Grounded Zoomorphism: An Evaluation Methodology for ACI Design

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ABSTRACT

This paper proposes and evaluates a novel method for the analysis and the refinement of products and designs that participate in playful, digitally-mediated human-animal interactions. The proposed method relies on a Grounded Theory approach and aims at guiding design and research in the field of Animal Computer Interaction in a way that is better focused on the experience and needs of the animals interacting with playful, digital artefacts. In order to validate the proposed techniques, we designed a video game (*Felino*) in which cats and humans play together on a single tablet. *Felino* was then tested together with cats (N=19). Guidelines for the refinement of the game itself emerged from the process, and are presented as exemplary outputs of the proposed method at the end of this study.

ACM Classification Keywords
H5.m. Information interfaces and presentation.

General Terms
Design

Author Keywords
Animal Computer Interaction; Play; Method; Grounded Theory; User; Experience; Zoomorphism

1. INTRODUCTION

Throughout the last century, animals have been involved in machine-driven interactions in several ways in a number of different contexts, such as agriculture, scientific research, animal welfare, military applications et cetera. From the 1930s onwards, Skinner conducted experiments on animals using operant conditioning methodologies, among which the training of pigeons to peck at a target inside the nose of a missile in order to steer it in the desired direction [9].

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http://dx.doi.org/10.1145/2693787.2693796

Since then, technological advancements and the development of new interaction possibilities facilitated a number of research projects and commercial enterprises aimed at establishing interactive relationships between animals and computers. However, as discussed by Mancini [5], and Westerlaken and Gualeni [12] the design of these systems is in general centred on human aspirations and perceptions, thus failing to include the animal in the design and research process. In 2011, Animal-Computer-Interaction (ACI) was introduced in the larger context of academic disciplines involved in Human-Computer-Interaction (HCI) [5]. As a research field, ACI advocates for a user-centred approach informed by the best available knowledge of animals' needs and preferences [5]. Our research proposes a systematic design method and contributes to the discussion of user-centred design with a playful, digital application (Felino, discussed in detail later in this paper). Our experimental game design project also functions as the benchmark to demonstrate and evaluate the proposed method.

2. EXISTING METHODOLOGIES

Even though the research field of ACI is still exploratory, a few more fundamental methodological approaches to design and research have been presented during the last few years. These include insights coming from a variety of disciplines and perspectives including those of ethnography, semiotics, and digitally-complemented zoomorphism.

2.1 Ethnography

In 2011, Weilenmann and Juhlin argued that research in the field of ACI could be significantly enhanced by the adoption of an ethnomethodological perspective on ACI [11]. According to Weilenmann and Juhlin, since we cannot avoid human subjectivity in understanding the behaviour of animals, we could resort to a more sophisticated form of anthropomorphism by trying to include the understanding of the natural habitat and behaviour of the animals in our assessment of their interaction with computers. Using this ethnographical study as an example, Mancini et al. later wrote that even though the approach of Weilenmann and Juhlin focused on the immediate context of the interaction, the interaction itself might be defined by a broader relational context, which includes both the animal and the human [6].

2.2 Semiotics

Haraway described how we can start to understand other animals and the relationships we form with them by engaging with their material semiotics, even if they are not fully accessible by humans

[3]. On this basis, Mancini et al. proposed an approach in which the semiotic exchange constitutes the basis for the understanding of the relationships between animals, humans and technology [6]. If we are able to interpret an animal's semiotic process on the level of understanding their indexical signs (posture, movement, alert calls, et cetera), we can connect meaning to them in the context of digitally mediated human-animal interaction [6]. A familiar example of this approach can be experienced on an everyday basis when playing with a dog. Through certain indexical signs (such as body movement and playful signalling), both the dog and the human understand that they are playing.

2.3 Digitally Complemented Zoomorphism

Based on the understanding of 'play' as a free and voluntary activity, Westerlaken and Gualeni argued for a more informed and compromising form of anthropomorphism that relocates the focus from the human perspective to the animals'. From this framework, the following three guidelines emerged and form the basis of this study:

1. It recommends the use of external stimuli in the form of technological artefacts: the natural curiosity of animals and their explorative behaviour can be used to stimulate their engagement with interactive technological artefacts in a research setting. This means that the animal is motivated by the artefact to engage in natural and voluntary play;

2. It analyses animal behaviour through 'going along' in a common praxis: the understanding of indexical semiotics and common traits in the way bodily signals are produced and interpreted allows specific species to understand others to a certain degree. This 'going along' could be achieved in a common and free praxis such as play. This objective unfolds itself intuitively in the course of the interaction;

3. It advises to digitally track metric and/or biometric data concerning the animal experience: In order to complement the subjective human approach that results from the first two guidelines, metric and/or biometric research can offer additional insights in the experiences of the animals that are studied. This includes methods that can provide a quantifiable analysis of the interaction with the artefact [12].

As an additional method for analysing the data that is obtained in this study, we follow a Grounded Theory (GT) approach. In GT, rather than performing data analysis starting from hypotheses and preconceptions, the data itself guides the analysis and steers the research in directions that were not planned out from its onset. This approach seemed to us to be particularly desirable as it aligns with the shifting of design control and research direction away from the human pole of the human-animal interaction that we proposed in our zoomorphic perspective [12]. Moreover, we consider such an approach to be particularly desirable for the tentative steps that we are taking, both as designers and as researchers, in a field that still lacks a tradition and a systematic organization of methodologies and theories. The GT method typically includes the collection of data through interviews and video observations which are examined and coded with the objective of identifying patterns and their interrelationships [2].

3. MEANINGFUL PLAY

Play is considered a pre-cultural and voluntary activity that can provide pleasure or enjoyment and is shared between species [4]. These characteristics of play form a specifically suitable and safe context from where we can start designing and user-testing digitally mediated interactions [12]. In many animals, including the domestic cat, humans have found a series of behavioural characteristics that enable us to separate playful behaviour from other behaviour with which it might be confused [1]. These criteria provide a helpful checklist that can be used in analysing the behaviour of the playful and non-playful cats during the user-testing. The types of play that will be applied in this research can be defined as 'object' and (inter-species) 'social' play [1]. The object serves as a digital mediator and the playful interaction will be taking place between the mediator, the cat, and the human.

According to Salen and Zimmerman, successful game design is dependent on the extent to which meaningful play can be created which includes the process by which a player takes action within the designed system of a game and the system responds to the action [8]. We argue, however, that meaningful play does not only emerge from the relationship between players and the game system (or their actions in connection with the game outcomes), but that it is also relative to how the game system and its mediators shape and regulate the playful interactions AMONG the players (or, in our case, between the human and cat players). Therefore, rather than implementing for example strict rules, time pressure, winning/losing conditions, or scoring systems, we designed a digital mediator that embraces play in a wider and less structured form. This perspective eventually led to the creation of a game that functions as a digital toy and aims at stimulating the human and the animal to playfully 'go-along' with one another.

4. THE GAME: *FELINO*

Felino is designed to specifically afford a gameplay structure that allows both cat and human to have a relevant role during the playful interaction (see Figure 1). Thereby we intended to provide the human and the animal with the possibility to 'go-along' in the shared activity of play. *Felino* therefore invites the human and cat to play together, and provides the human with options to adjust in-game elements according to the human's interpretation of the interaction.

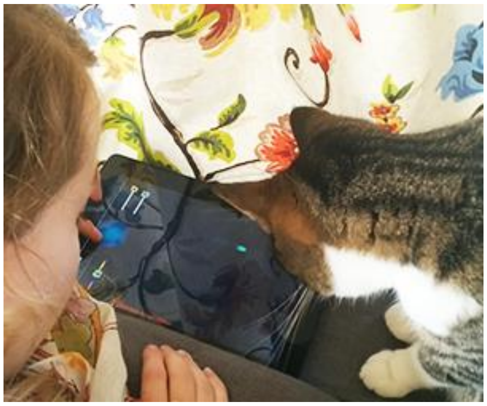

Figure 1: human and cat playing together with *Felino*.

As human developers, we tried to design a game that adheres to the sensory perceptions and playful behaviour of the cat. This means that we avoided including conventional mechanics such as time pressure, high scores, or game-over states, and we based our design decisions on our interpretation of available animal research regarding, for example, the eyesight, colour perception, and playful behaviour, of cats.

The game takes place in an aquarium seen from above in which fish and other sea creatures can be caught by the cat. By using virtual controls placed in the bottom section of the screen, the human player can alter game attributes, such as the size and speed of the fish, and regulate the movements of in-game objects in order to align the game to the reactions and interpreted preferences of the cat during gameplay (see Figure 2). One specific virtual control that the human can use consists of a small joystick that regulates the movement of a crab that is always present in the aquarium. With this crab, the human player can collect spheres that are released whenever the cat catches a fish. By collecting these spheres, other small crabs will be created behind the main one, generating a trail that the cat will be able to interact with.

Figure 2: a screenshot of *Felino.*

5. METHOD

A total of 19 domestic cats joined our user-tests. Most of these cats (15) were temporarily living in the *Animal Shelter Breda*, the Netherlands. The other 4 participants were tested in their home environment. The cats were a mix of gender (10 female) and age (average 5,4 years old). During the testing, existing ethical guidelines for HCI studies that include animals in their research project were taken into account [10].

The complete audio and video data pertaining to each of the testing sessions were recorded for the purpose of the analysis. The length of each recording varied depending on the interest manifested by the cat. On average the sessions lasted 5 minutes and 51 seconds. The shortest session was 57 seconds and the longest session lasted for 15 minutes and 54 seconds.

The data was then analysed using the *Elan* software [7]. The audio/video recordings were coded according to six different categories: Cat Behaviour, Human Behaviour, Game State, External Distractions, Unclear Video Information, and Talking (see Figure 3). After our initial data analysis, we decided to add two more categories of annotations including Cat Taps, and Extra Interest. This resulted in a total of 1666 annotations. This systematic analysis uncovered the interactions with the artefact as well as the interactions of the human and cat. We coded the behaviour of the cat to analyse movement patterns and playful signals. Human behaviour was coded to analyse their interaction with both the cat and the game. Additionally, we coded game content to analyse what happens in the game at certain points of interest. The other categories were used to mark distractions and external factors.

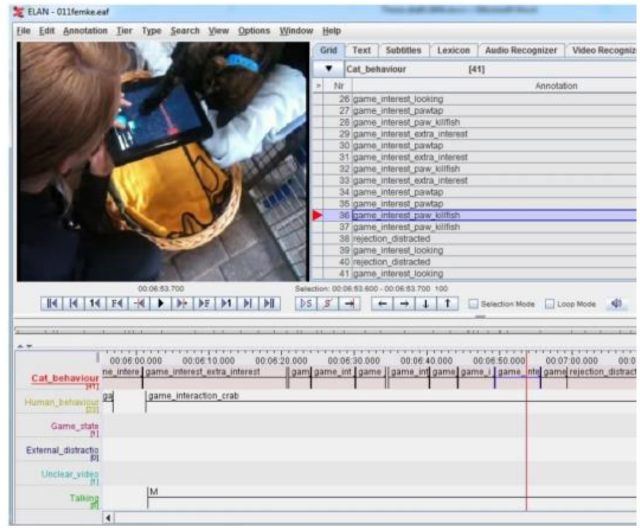

Figure 3: video annotations example in Elan v4.7.2.

6. RESULTS

Our findings have a distinct focus on informing design iterations of the tablet game *Felino* that will be discussed in the following section. In order to reflect upon the behaviour of the cats we have grouped them into different segments including 'rejection', 'interest', and 'extra interest' (see Table 1). With the use of these segments we further analysed our data and derived 7 core results that we found valuable for further iterations on the game.

Table 1: segments grouped from cat behaviour annotations.

Rejection	Looking away, walking away, grooming, being distracted, self-petting, and falling asleep.
Interest	Looking, sniffing, looking at the side of the tablet, and changing position while looking.
Extra Interest	Looking at the game while following specific objects, tapping with the paws, killing fish, walking on top of the tablet, sitting on top of the tablet, walking on top of the tablet while playing, and controlling the interface.

6.1 All the cats that were tested showed an interest in the game at some point during the session and five cats showed playful behaviour.

Evaluating the annotations from all participants, we derived that all cats showed an interest in the game at some point. Furthermore, in 5 cats playful behaviour was recognized by observing their behaviour in the video recordings according to the characteristics of animal play defined by Burghardt (see Meaningful Play).

6.2 The cats generally showed more interest in the different fish than in the crab.

Observations of the video recordings suggested that the cats were generally more interested in the fish than the crabs. Furthermore, a coding of in-game objects that were tapped by the cat shows a clear difference in killings of the fish versus the crab. Even though both objects were continuously on screen, the fish were killed a total of 63 times and the crab only 11 times.

6.3 The physical interaction of the human with the tablet often generated interest from the cat.

Observations of the video recordings suggested that the physical behaviour of the human influenced the interest of the cat in the game in a positive way. Table 2 shows an overview of the percentage to which the cat showed an interest, extra interest, or rejection towards the game while the human performed different types of physical interactions. This graph shows that the cat mostly reacted positively towards these physical interactions. Only petting the cat seemed to generate more rejection than interest. This seems to be quite logical, because whenever the human player started petting, the cat mostly moved its attention away from the tablet towards the human.

Table 2: the percentage to which the cat showed an interest, extra interest, or rejection towards the game while the human was performing a certain physical interaction with the artefact or cat.

	Interest or Extra Interest	Rejection
Tapping the fish	69,3%	10,2%
Tapping the water	50,7%	16,0%
Moving the tablet	46,2%	7,7%
Playing with the hands	36,8%	0%
Ticking on the tablet	33,9%	14,3%
Petting the cat	16,7%	22,5%

6.4 The digital sounds that were generated by tapping the fish and the water caused extra interest in the game from the cat.

The physical human interactions including tapping the fish and tapping the water might create interest in the game from the cat because of the digital sounds that they trigger. Through observations of the video recordings it was noted that some cats directly looked at the side of the tablet containing the speaker (see Table 4).

6.5 The cats all accepted the human presence. They remained calm and sometimes showed affectionate behaviour towards the human.

The cats generally seemed to accept the presence of the human being. Some of the cats did not show any continuous interest in the tablet or walked away from the game, but none of the cats showed any aggression, anxiety, or severe stress related body signals. Furthermore, some of the cats showed affectionate behaviour before, during, or after the test sessions such as rubbing their body against the human or purring while appearing in a calm state.

6.6 The speed control slider had the highest impact on the cat compared to the sliders for size, colour, and brightness.

When comparing the interaction with the four control buttons for changing the speed, size, brightness, and colour of the fish, it was found that the speed slider had the highest impact (both positive and negative), generated the most interest/extra interest, and the lowest rejection (see Table 3).

Table 3: the behaviour of the cat while the human changed a specific type of control slider that adjusted the in-game elements (fish). The total impact refers to the percentage in which there was any behavioural reaction from the cat at all and the other two columns shows the percentage of the behaviour that was segmented as interest/extra interest or rejection.

Control Slider Type	Total Impact	Interest/ Extra Interest	Rejection
Speed	73,9%	63,0%	10,9%
Colour	66,7%	48,5%	18,2%
Size	66,7%	40,5%	19,2%
Brightness	65,4%	46,2%	26,2%

6.7 The cats often showed extra interest in the game or the side of the tablet whenever a fish would swim outside of the screen.

Table 4 shows what happened on the screen of the tablet or in the environment whenever a cat showed extra interest in the game. This table indicates that the cat showed extra interest specifically when the fish moved off the screen. They often looked at the side of the tablet until the fish came back or until they focused their interest on other elements inside or outside the game.

Table 4: the activity on the screen or in the environment while the cat showed extra interest in the interaction.

Annotation	Occurrences
Crab moves	10
Fish move	30
Fish moves off-screen	103
Fish moves onscreen	29
Follow specific fish	13
Interest in human hands	29
Interest in speaker side	17
Interest in tablet side	28

7. DESIGN ITERATIONS

The design iterations for the tablet game *Felino* that can be derived from the results are interpreted from a designer's perspective. This means that this interpretation is not the single outcome of this research, but rather a suggestion informed by a better understanding of the animals' preferences that can be used to refine the game. The design iterations that we derived from our data are as follows:

7.1 Stimulate more playful behaviour

Even though all cats showed interest in the game at some point during the testing session, only 5 cats actually showed playful behaviour. The game could therefore be more engaging for the cat if certain elements elicit more playful reactions from the cat. This could be done by giving the human more control over the in-game elements so that the human gets a bigger role in encouraging the cat to start playing.

7.2 Change the behaviour and control the crab

Since the fish generated more interest than the crab, the behaviour of the crab should be closer aligned to that of the fish. This means, for example, that the crab could be faster, its animation could be bigger, and it could go outside of the screen. The physical interaction of the human with the tablet could be further explored by implementing more human interaction into the control of the crab. Instead of a virtual joystick, the crab could be moved by tilting the entire tablet, tapping on the screen, or sliding the crab to different locations (see Figure 4).

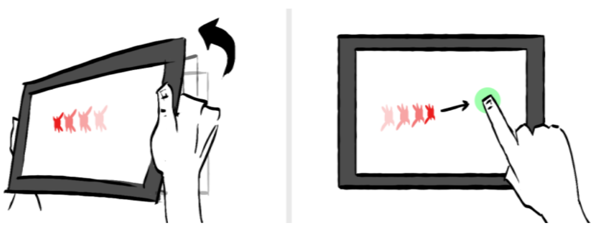

Figure 4: possible iterations for the control of the crab.

7.3 Encourage human-artefact interaction

In the current prototype, the screen is divided into a human-area and cat-area. However, the cats often showed interest in the game when the human tapped the fish or the water in the cat-area. This means that instead of strictly dividing the screen in two areas, the human-area should be opened up and the human should be encouraged to tap elements in the cat-area rather than be restricted to its own side (see Figure 5).

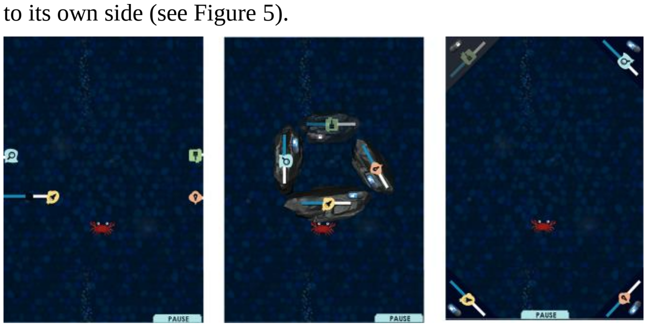

Figure 5: possible iterations for the human interface.

7.4 Implement different types of audio

Since the cats often seemed to notice the sound that was generated by tapping the fish and the water, sounds could be further generated at different moments in the game or a sound button could put the human in control of generating these sounds.

7.5 Evaluate the impact of the variation in speed of certain game elements

The control slider that changes the speed of the fish had the biggest impact compared to the control sliders for size, colour, and brightness. It might therefore be interesting to evaluate the impact of the variation in speed of certain game elements throughout the rest of the game. Perhaps the fish and/or crab could get more interesting for the cat if their behaviours were more varied in terms of speed.

7.6 Evaluate the possibilities of the tablet-side

The cats often showed extra interest in the game and specifically the side of the tablet whenever a fish swam outside of the screen. By implementing more variety in the behaviour of the fish when they swim outside of the screen (for example longer/shorter disappearances, short/long come-backs, slow/fast swimming near the side of the tablet), it could be further tested if the fish become more interesting for the cat. Furthermore, it could be interesting to explore how physical components on the side of the tablet could help to stimulate more playful behaviour.

8. CONCLUSION

In this study we proposed a new method for the analysis and refinement of products and designs for playful, digitally-mediated human-animal interactions. We used a GT approach in addition to 'going-along' in the common embodied praxis of play with the animal. In order to evaluate our method, we designed a playful artefact that was used as an external stimulus to facilitate voluntary interaction and meaningful play between humans and cats. We believe that, even though a degree of subjectivity is inevitably involved in the data analysis of GT, our method could provide a valuable approach to make better informed choices as designers and work towards a more balanced inclusion of the animal's experience in the design process.

The study could have gained an additional layer of objectivity had it been paired with the digital tracking of metric as well as biometric data. However, the valuable use of these methods is strongly related to the type of artefact, the type of measurement, the ethical considerations, and the type of animal included in the study. Given the specific focus on one distinct artefact, further research will need to be performed in order to investigate the wider implications of this study and to make our framework more viable and usable in different contexts and for different animals.

9. Acknowledgements

The authors wish to thank the *Animal Shelter Breda* (The Netherlands) and the other cat owners for their participation in this study. We also thank Alex Camilleri and Simon Niedenthal for their valuable feedback.

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