

Ethics and Power Dynamics in Playful Technology for Animals

Using speculative design to provoke reflection

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ABSTRACT

Technology (digital or otherwise) is a great enabler; it bridges gaps and opens doors and, in the process, alters the reality within which it and its users exist. As technology aimed at non-human animals is becoming commonplace, questions about its efficacy and the ethical implications of its use are becoming ever more pertinent. To explore these issues, we conducted a workshop in which speculative design was used as a means of debating ways through which play, a widespread phenomenon across animal species, can be used as a tool for enabling interspecies communication. We describe the context for this discussion, the methods used, and present a set of speculative designs that illustrate aspects of ethics, equality, and appropriate play in order to provoke further reflection and discussion.

CCS CONCEPTS

• Social and professional topics - User characteristics • Human-centered computing - Interaction design – Interaction design theory, concepts and paradigms

KEYWORDS

Animal-Computer Interaction, ethics, power dynamics, speculative design, co-design, participatory speculation

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1 Introduction

Technology aimed at non-human animals is becoming commonplace, heightening the discussion around the ethics and other implications of designing such systems. In this paper, we focus on the design of *playful systems* because play, in all its contexts and across species, is widely recognised as a voluntary behaviour with intrinsic reward [27, 67, 23]. Between participants, play becomes a vehicle for expression. It is therefore a phenomenon that enables friendly communication across species, transcending language through its reliance on a common understanding of rules and non-verbal signals.

Interspecies play is manifest in human relationships with domesticated dogs, where it is evidence of a mutual ability to read each other's signals [34, 73]. Play also occurs between humans and other domesticated species, such as cats [55] and horses [65], while playful experiences have been observed between various non-human species, including primates [74], dogs with horses [46] and dolphins with whales [16]. As noted in our earlier work [23]:

'*Social play is therefore an important aspect of communication not only within species, but also creates opportunities to encourage and enhance interspecies communication ... and fosters a deeper understanding of the play partner's intentions, reactions, and behaviour.*' Thus, we propose that playful technology has the potential to facilitate an exchange of signals between species, by acting as mediating device, facilitator or participant (interlocutor).

Interaction with technology has been described as having a metaphorical conversation with a system via an interface [78] [3,59]. This terminology for conversation is used because the system reacts to user input and provides feedback that the user perceives; in turn, this offers the user an opportunity to react to the system, and so forth. Although adaptive systems and interfaces might use algorithms to modify their responses to users, conceptually all computer systems originate from human designers, who seek to understand how their users communicate, as well as their cognitive and physical capabilities. It could therefore be argued that the human designers are also part of the conversation, because they have defined how the system will respond. We therefore seek to analyse the systems we design for animals, in order to reflect on the nature of the conversations we stimulate.

Devices for non-human animals either *pick up signals* that can be interpreted as having underlying meaning relating to the animal's health, state of mind and intention (physical, psychological, emotional, cognitive) or *deliver signals* that facilitate communication between the animal and a system or another living being. Sometimes, the animal's interaction is intentional, and the ensuing conversation can be dynamic; at other times, the animal may not be aware of perceiving or sending signals, nor of the device that is tracking or responding to its user. As noted by North [61], humans can only speculate about where non-human animal perception falls within the spectrum of awareness. In this context, several issues have been raised regarding the ethical consequences of the systems being used [48, 49]. These have included disruptions to usual behaviour [85], questions of who has power and control [44,11], long-term effects [82,28], privacy [39] and potential dependency [13].

Human Computer Interaction (HCI) has focused on the needs of humans as they are the core user base of any technology. In consequence, frameworks have been developed to support designers in creating computer systems. These may relate to the psychology of interaction design, aesthetic features, functionality, ergonomics, or ethics. By contrast, designers of systems for non-human animals have fewer guidelines. These designers work in diverse ethnographies, have wide-ranging objectives, come from multidisciplinary backgrounds and typically have many different perspectives. Designers also may have a range of goals, such as animal welfare, human interest, or a combination of both.

The Animal-Computer Interaction (ACI) community deeply invests in design work that enriches the lives of animals, as well as enlightening the humans who do the ideation and associated craft. To this end, we ran a one-day workshop during the ACI'2020 conference [23] to explore how ethics and power dynamics are manifest in the technological systems we design for non-human

animals, particularly in regard to playful concepts that enable or facilitate interspecies communication. Ultimately, our goal was to investigate the challenges and opportunities associated with designing such technology, thereby revealing the underlying ethical questions. By bringing these into focus in this paper, we hope to share our ideas with future designers and shape the discussion moving forward.

2 Context and Motivation

Humans have long been fascinated by the idea of speaking with other animal species. Between the 1950s and 1980s, psychologists ventured into multi-year projects to train various great ape species to learn and use human verbal [29], sign [25], and symbolic languages [77]. However, at that time the interest was primarily about discovering the evolutionary basis of human language and cognition through the comparison with other primates' brains. Hence, early attempts at human-animal communication had a human-centred focus that failed to understand animals' species-specific traits.

However, the quest to communicate with animals has not halted and has assumed more interactional connotations [39]. Research with companion animals, especially dogs, has taken an interest in understanding animals' thoughts and behaviour, in order to prevent or correct interspecific misunderstanding and strengthen human-pet bonding. Human-animal communication research has subsequently shifted direction from animal-utterance projects and the imposition of human languages towards a more respectful engagement with non-human animals, one that recognises the animals' species communication uniqueness, perspective, and capabilities. Across the animal kingdom, body postures, visual, acoustic, and chemical signals are widespread modalities of both intra- and interspecific communication which evolved in social and agonistic contexts. For example, African wild dogs (*Lycaon pictus*) produce a wide variety of vocalisations that serve various pack dynamics functions such as greeting each other, displaying distress and submission, seeking contact, and playing [72]. In hunting situations, studies suggest that wild dogs can also recognise Thomson's gazelles' ability to outrun them. This is done by dogs interpreting gazelles' stotting behaviour (i.e. bounding high in the air while running), which the gazelles typically use to convey their stamina and therefore discourage predators from chasing them [21].

Investigating these ways of communication within the same and across diverse species is one of the gateways for understanding, managing, and even enhancing encounters in human-made settings, where domesticated, captive, wild urban and human animals meet. To this end, automated systems can be helpful. For example, eye-tracking technology has been used to monitor gaze of rhesus macaques while watching social videos (of conspecifics) and non-social videos (nature documentaries) to see what they were more interested in [7]. The researchers found that the macaques looked longer at the social videos than at the non-social ones. This technology could be used further to check what specific social interaction was of interest and what type of communication was

supporting it. An example of technology supporting research into cognition and modes of expression is the program at Lincoln Park Zoo where scientists installed touchscreens for chimpanzees and Western-lowland gorillas to give them choices and some control over their environment [19]. As a result, researchers were able to better understand the primates' cognitive abilities and assess and improve their welfare. In addition, zoo visitors were allowed to observe the animal-touchscreen interactions and ask questions, thus supporting the zoo's educational goals. Touchscreen computers have proved to be a popular technology, widely used with a variety of captive non-human animals in zoos and wildlife centres - examples include grey parrots [68], black bears [83] and tortoises [57]. They have also been deployed in research facilities to test cognitive abilities and prosocial behaviours - examples include keas [62], pigeons [36], kune kune pigs [86], and wolves [14].

Meanwhile, ACI scholars have embarked on the unique challenge of creating *human-animal relational interactions* by designing technology-mediated interfaces that are ethically and cognitively appropriate for both interactors. For example, Pons [70] proposed a remote playful environment where hospitalised children and in-daycare-facility dogs could interact by means of a mobile application controlling a robotic ball, therefore providing physical and mental stimulation to both players, even though we note the dogs had no control over the system. North [60] developed human-wearable robotic horse ears to explore the possibility of using them to express intentions and emotions to real horses. Ko et al. [40] designed an interactive tank enabling fish-keepers to deliver positive stimuli to guppies through the generation of bubbles into the aquarium, therefore increasing people's sense of caring and fostering bonding with fish pets. However, as most of these examples demonstrate, often only the human is in control of the system.

To explore interspecies communication further from an ethical perspective required an imaginative leap into an impersonal future, rather than a critique of established practice. Prior work has suggested that speculative design is useful both to ACI [61,45, 32] and within the context of playful systems [23]. We therefore concluded that playful systems would be the most suitable vehicles for a speculative design challenge since play offers a universal open gateway for engagement and interaction. The improvisation and joy associated with play [9] are easy to recognize but hard to define. However, most researchers agree that social, object or locomotor play [4, 8, 77] is an activity that is practiced for the thrill of the experience, without an obvious function or immediate benefit to the player [6]. Thus, play fighting which may appear aggressive and competitive does not involve the injury or loss of social status associated with contests; players have agency, they choose to become involved and the stronger player may self-handicap so that the game can continue [69]. There is clearly an intrinsic reward for playing. A cat who plays with a rat, allowing it to get away before catching it again, sees its prey during play as a toy, rather than as food to be eaten; this is an example of both object and locomotor play, but not social play, since the rat has not agreed to participate.

Since inter- and intraspecies play requires a shared understanding of the situation, including the transmission of signals that indicate willingness and trust, the design of such systems became one of the first exercises in the workshop, described in the Method section that follows.

3 Method

The virtual workshop at ACI'2020, 'Designing Technologies for Playful Interspecies Communication', comprised twelve participants who had familiarity with animals and experience building ACI technologies. Using the World Cafè method [87], which has previously shown to be viable in ACI contexts [32], participants were tasked with creating speculative designs, to elicit reflection and provoke engagement with the theme. The Miro board included a set of animal cards (face-down), from which participants randomly picked two species for group ideation on future playful scenarios. This aspect of the workshop was framed by considering the following questions:

- [1] What might the animals want to communicate via technology?
- [2] How would animals normally express themselves using signals?
- [3] How could technology support the design of playful systems that would engage both species?

To help participants collaborate and ideate on these tasks online, a combination of Zoom [90] and Miro [56] was used. Miro is an online multi-user whiteboard (Fig.1). In this workshop space, participants worked in teams around virtual tables with access to drawing materials and media uploading. The event was facilitated and documented by participants and facilitators throughout the day using Miro's digital post-it notes.

Following the World Cafè method, participants gathered in randomly allocated small groups around tables (in the Miro virtual space) and worked on the proposed context for that table. After a specific amount of time (12 minutes), all participants except one on each table were asked to move on to the next table. The remaining participant welcomed the newcomers to that table and explained the discussion held in the former round, as well as clarifying the ideas and notes left on the table. The new group on each table then started elaborating on previous concepts or creating new ideas. In this way, all participants shared in the ideation process.

Following the ideation period, and drawing from their discussions, participants shared their thoughts about the opportunities and challenges afforded through tech-enabled playful communication systems. This was achieved by inviting members of the workshop to contribute using the Mentimeter app [54], which enabled simultaneous anonymous feedback from the group presented the results as a word cloud (Fig. 9 & 10), so that everyone had an instant overview of the collective response.



Figure 1: Screenshot from Miro Board used as workshop space

The next part of the workshop involved reflecting on these themes in relation to the co-created designs. It became clear that ethics were of paramount importance, rather than technological provision, and that both opportunities and challenges were strongly connected to power and autonomy. We focused on these topics during a group discussion, by addressing the following questions:

- How can we design for **equality** with two animals whose play is mediated through technology?
- What does **appropriate play** look like for two animals using computer systems?
- What are the key **ethical issues** that come up when we build systems to support interspecies play?

The outputs of the discussions are explained in 4.2. *Looking Forward: Topics for Reflection.*

4 Workshop Outputs and Discussion

This section describes the speculative outputs arising from the ideation session and discusses the reflective outputs collected from participants during the event.

We present seven speculative designs, created by small teams in response to the brief they were given – to imagine a future playful scenario that would engage two different species to interact with each other (4.1). At the time of creating the speculative designs, during the event, no constraints were used in the ideation, so the designs could be provocative and controversial. These designs were subsequently shared with all the participants and used to provoke insights during the reflective discourse that followed (4.2).

4.1 Speculative Designs



Figure 2: #1 Chase-Prey, with calf and wolf cub.

#1 Chase-Prey consists of a vest and collar combo worn by a cow and a collar worn by a wolf. The wearables facilitate the animals to play chase together. Designed to be used by young cows and wolf cubs, this technology senses when a cub catches a calf, with the vest providing protection to the caught prey. The wolf collars warn the wolves if they are biting too hard, while the cow collars protect the cows' necks. This technology can also be used with adult animals but only if they are habituated with each other. The goal of this technology is to facilitate social learning and playing.



Figure 3: #2 Flutter-Catch, with butterfly and dog.

#2 Flutter-Catch consists of a vest for a dog with brightly lit, coloured flowers on the external surface and corresponding haptic feedback actuators on the inside next to the dog’s body. A butterfly has to seek the flowers and steal the nectar, which causes the vest to vibrate under the flowers and the dog to ‘lose a point’. The aim of the game is for the dog to keep as many points as possible by protecting the flowers, while the butterfly aims to steal their loot.



Figure 4: #3 Parrot-and-Dog-Seek, with parrot and dog.

#3 Parrot-and-Dog-Seek is an augmented reality game such that a parrot’s whistles are remotely signaled to a dog, to help direct the dog to hidden toys and food items in their vicinity. The dog can remotely see the parrot in AR and the parrot has access to a soundboard in case she wants to use sounds she cannot produce. The aim of the game is to cooperate in finding all the hidden items together remotely but collaboratively.

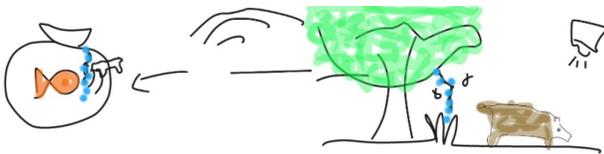


Figure 5: #2 Chains-of-Joy, with goldfish and wild boar.

#4 Chains-of-Joy invited a fish in a bowl and a wild boar to play with each other through remotely wiggling a chain. When either animal wiggles their chain to start the interaction, the movement triggers an augmented reality image (e.g. hologram) of the other animal (captured through cameras). It also triggers the other animal’s chain to wiggle back, allowing for a tug and movement game.



Figure 6: #5 Bionic-Tail, with dog and kitten.

#5 Bionic-Tail facilitates play between an adult dog and a kitten. It is inspired by the natural behaviour of cats who attack moving objects and sometimes play with real tails belonging to real dogs, without understanding the possible injury that can occur. The wearable Bionic-Tail allows the dog to play with the cat without experiencing stress or pain and is controlled via a non-invasive brain-computer interface. In consideration of the different energy levels of the participants, the Bionic-Tail comes with a setting to autonomously mimic play/prey behaviour that can operate when the dog is taking a nap. These autonomous movements start off fast-paced and incrementally slow down based on the number of contacts with the cat.

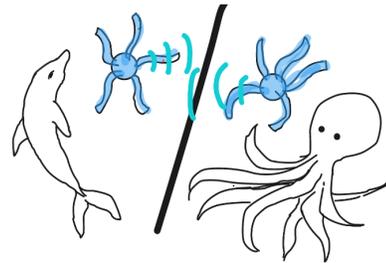


Figure 7: #6 Capture-the-Ball, with dolphin and octopus.

#6 Capture-the-Ball is based on the game ‘capture the flag’, since both species are involved in object play - with dolphins having been observed playing tag with seaweed [38, 79]. There are two identical objects, one placed within each tank, and players are rewarded with food treats for scoring points. They achieve this by quickly reaching the ball and carrying it towards a designated goal post. The animals compete against one another, although play involves no physical contact between the players, to avoid aggression. The paired robotic balls contain accelerometer and GPS sensors which wirelessly direct the motor of the paired ball to relocate.

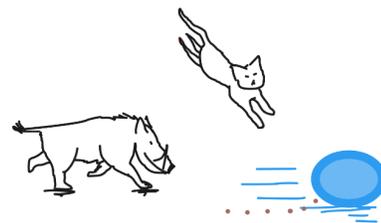


Figure 8: #7 Rolling-Ball, with wild boar and feral cat.

#7 Rolling-Ball: This is a foraging and hunting game that takes advantage of both species’ tendency to hunt rodents and participate in play hunting as juveniles. Through a built-in camera and facial recognition software, the ball autonomously travels through the city, seeking out feral boars and cats. Once they are identified, it entices them to approach by releasing food pellets, then rolls away to encourage playful chasing behaviour. Similar to hunting, the objective of the game is to catch the ball. Once contact is made

(through attacking), the ball will release more food pellets and continue to attempt to ‘escape’. This will go on until all the food is depleted. Additionally, with a built-in GPS, the ball can decrease human-to-wildlife conflict through redirecting wildlife found within high-human traffic areas towards predetermined sites.

4.2 Looking Forward: Topics for Reflection

As a starting point for reflection around our theme, we attempted to categorise technology-supported communication between animals into distinct types. Intent was initially an important aspect of the categorisation, because it is dependent on whether the animal (human or non-human) understands the full context of the scenario. However, the complexities of real-life communication with or without technology meant that it was impossible to configure discrete types that fitted every situation. In reality, when signals are transmitted intentionally, others may also be transmitted unintentionally – for example, amongst humans, body language and pheromones can communicate information that participants in a conversation acquire unconsciously.



Figure 9: Motivations for animal-to-animal communication.

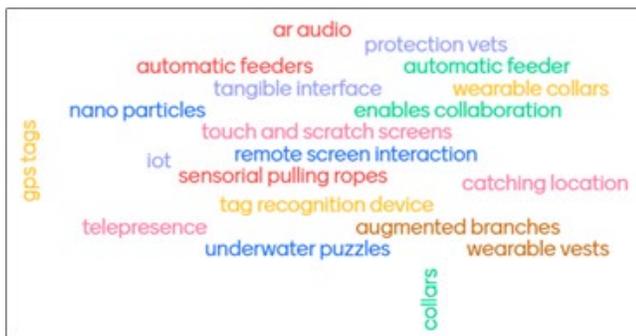


Figure 10: Ways in which technology supported animal-to-animal speculative designs.

The sample designs featured in the previous section give an indication of the types of random challenges presented and the ensuing concepts. In response to the Mentimeter questions asked after the World Café design session during the workshop, food and

play were conceived as the most common motivators for signaling (see Fig. 9), while the range of technologies required for enabling play was broad and varied (see Fig. 10).

In some cases, technology was used to enable and enhance the communicative aspect, which was part of a deliberate exchange between the species. In other cases, the conversational aspect was omitted, and the focus was on how playful behaviour might facilitate a different form of communication, via a technology bridge. This highlights an aspect of interspecies play requiring clarification – the relative cognizance of the participants.

One-way communication involves a signal being transmitted by one animal and perceived by another but initiates no response from the perceiver. Tracking devices on animals, for example, collect data that is transmitted (in real time or periodically) to a human, but the animal has no knowledge of this transaction. The human, who initiated the communication in the first place by attaching and starting the device, does not reply. The same tracking device may inadvertently be sending a visual signal which differentiates the wearer from other individuals [47, 64]. Depending on the species involved and on the device design, this may alter social interactions, attract predators or alter the wearer’s movements.

Similarly, humans may send signals without realising or intending to do so, and sometimes these involve the use of technology. For example, the sound, smell and vibration of an approaching vehicle is a clear signal to any animals in the vicinity – perhaps indicating danger to a hedgehog or a deer. The smell from a camping stove, on the other hand, might alert possums to the nearby availability of human food. Humans also deliberately design systems that send signals to animals, such as electric fences to ward off intruders. A more friendly example is a tag embedded in a cat’s collar, which triggers her cat-flap to open when she approaches. We note there is no conversation here, even though the flap responds to the tag. The cat is merely attending to her business and the flap opens, sending a signal that the route is clear.

Two-way communication is a form of conversation that requires transmission, perception and response from both participants. An example of this is the situation where a farmer uses a whistle to instruct a working sheepdog. Both parties are engaged in the exchange – the dog responds to the farmer physically and is perceived visually, while the farmer responds to the dog with an audio signal that she can hear. This is a conversation with clear intent from both parties. Moreover, both farmer and dog are aware of the landscape and the sheep, albeit from different perspectives. By contrast, in a domestic situation where someone is playing with a companion animal, such as a cat, with a laser pointer device, the device signal (moving light) is geographically distanced from the device controller (human) and the animal may be unaware of human participation. In this case, the response (chase and pounce) is intended by the animal for the device, but it is really the human who replies, by controlling the light for the animal.

Yet another dimension might be if a human were to be a hidden participant in an exchange between two non-human animals, observing and collecting data. In a captive situation, when novel enrichment devices are introduced into shared enclosures, members

of the same species may interact with each other and the device - for example, orangutans at Melbourne Zoo played together with a Kinect-enabled projected interface and their interactions were monitored by human researchers [85]. There has been less exploration of how communication could be mediated between *different* non-human species through using technology.

We suggest that in all these technology-enabled situations, a human is necessarily one of the participants (as sender or perceiver of signals, as designer or controller of technology) [71]. In our co-created examples, the human was the designer, and potentially also a perceiver, observing the results. The following sub-sections discuss the issues surrounding ethics and power dynamics relating to the technology-enabled interactions that were examined during our discourse.

4.2.1 Equality

What does equality look like in the context of two animals playing together? Is it possible to offer similar experiences, shared goals, equal opportunities? Does a shared sense of trust combined with guaranteed safety mean that a relationship is equal? Or is it about agency and having an equal amount of control? Rather than providing answers, our speculations gave rise to questions.

The answers to these questions may depend on context, such as whether the play occurs between members of the same or different species. Within the same species, there will always be inequalities, for example due to age, experience or position in a hierarchy. However, players are already able to communicate because they have evolved the same communication structures to understand each other, and restraint is often shown by stronger players so that the game can continue, suggesting that play is more rewarding than dominance during a game [67]. Our focus was on issues pertaining to *interspecies* communication, using play as the motivator for signal exchange between participants. There are many examples of species that have evolved to understand other animals' signals; the dogs and gazelles mentioned earlier are a case in point. Evolutionary game theory (EGT) [51] explains the development of such interspecies communication strategies as evolved responses to the challenge of maintaining healthy populations within a conflict situation.

The predator-prey scenario, #1 Chase-Prey, generated concerns regarding power dynamics. It was felt that the prey species in the pair would always be at a psychological disadvantage. Even with protection, the presence of the wolf would be threatening, and the calf would respond instinctively to the wolf's smell. It was not clear whether a winning strategy could ever be adopted by the calf - rather than mediating play through the technology, the design seemed to evoke an intense hunting experience. In #2 Flutter-Catch, the situation differs. Although the dog is a natural predator, butterflies are not its natural prey and they also inhabit a different realm most of the time (in the air). It was presumed that the butterflies would interact primarily with the jacket, as a mobile food source, while involuntarily providing visual signals to the dog. Meanwhile, the dog might bark at them, which would be a clear signal to which they might respond, but it would have no

control over providing the nectar as this is an intrinsic part of the jacket, determined by the human designer. In many ways, the experience of the dog in the jacket is similar to that of the calf, lacking agency and constantly under attack (albeit from butterflies not wolves).

Power can be represented as having control in a situation - the ability to make choices and enact them. A hallmark of playful behaviour is the *consent* given by players, who willingly enter the game while simultaneously knowing they can choose to leave at any point [35, 66]. But how can we understand the volition of another species? For example, do companion dogs really want to play fetch, or are they just trying to please their human carers? Who is *in control* of this game? What *agency* does the dog have, other than to run in the direction of the ball (thrown by the human) and bring it back? As in #1 Chase-Prey, there is usually a clear *hierarchy* of power, with the human in charge, as they choose when to start or stop the game.

Another example of a game with an obvious hierarchical structure is #3 Parrot-and-Dog-Seek. As it is said (and variously attributed), 'knowledge is power'. In this design, the parrot has access to *hidden knowledge* and uses audio signals to modify the dog's behaviour. The dog has agency on the ground and relies on support from the parrot. It seems as if the parrot is in charge here, while the dog must be both *reliant and obedient* in order to obtain any rewards. In relationships between humans and other animals, humans are usually the ones with the most comprehensive knowledge, even when depending on the skills and perceptions of animals in a working partnership.

Summary

Equality: *Power dynamics; Predator-prey conflict; Having personal control (enacting choice); Consent; Possession of knowledge; Hierarchy - being in charge.*

4.2.2 Appropriate Play

We have explained how consent, agency, shared knowledge and understanding of hierarchy amongst players can contribute to an equitable playing experience. However, we felt that there are other dimensions of play that should be addressed in the context of animals, relating to the non-human species' experiences of pleasure, their motivations and their behavioural tendencies [63, 30].

Linked to the principle of consent is the *intrinsic reward* associated with play; playful behaviour continues because of the *pleasure* associated with the experience [22]. There are many reasons why play might be a rewarding experience, some of which are explored in our designs. Design #4 Chains-of-Joy describes a scenario where technology facilitates sending signals from one species to another, enabling different but essentially equal experiences. We do not know whether a boar and a fish could comprehend each other in reality, far less augmented reality, since they inhabit different ecosystems. It seems likely that there is no concept 'boar' for a fish. Nonetheless, in each case, the animal is playing with a chain that provides acoustic, tactile and visual

feedback. The advantage of playing together, even if they are unaware of the fact, is that the chain movement is not programmed to a schedule nor randomly activated, but instead linked to the behaviour of the other player. Therefore, it is probable, if not assured, that a wiggle will receive a response. Moreover, the toy moves independently as well as being flexible, thus offering *exciting performative aesthetics* such that ‘*action enables sensory perception and sensory perception informs action*’ [24].

Both #6 Capture-the-Ball and #7 Rolling-Ball include technology that offers kinaesthetic feedback through the use of autonomous robots. Design #6 Capture-the-Ball is presented as a *competitive* game, but with no physical contact between players, since the designers have anticipated that the game might lead to aggressive behaviour. Competition is a strong motivator in human games, but we are usually able to restrain ourselves and adhere to rules that frame symbolic wins and defeats. Rough and tumble games amongst non-human animals often follow similar patterns, avoiding conflict and promoting *social behaviour*, which is widely acknowledged to be beneficial to animal welfare [67]. Design #5 Bionic-Tail promotes natural behaviour in the kitten player through its mobility, although it undermines the usual dynamics in a situation where a cat attacks a dog, by not only permitting but actively encouraging the cat to pounce. This behaviour may be instinctive and natural for a cat, but should we be facilitating *aggression*, and to what end? As we have suggested earlier, a similar problem occurs between players of #1 Chase-Prey, although the suggested technology is static and does not in itself exhibit aesthetic properties pertaining to kinaesthetic feedback.

It should be noted that there can be negative consequences to repeatedly having a pleasurable stimulus. As with humans, *addictive behaviour* has been documented in non-human animals in relation to specific drugs, such as heroin and cocaine [41, 52]. But humans are also susceptible to behavioural addiction – for example, gambling, which offers the potential for a reward with every risk taken. In 2018, the World Health Organisation (WHO) recognised ‘gaming disorder’ as a serious medical condition for humans [88].

As a case in point, the autonomous ball that drops food pellets in #7 Rolling-Ball could easily become a focal point for the wild animals. Food is a very strong motivator for wild animals, having a direct link to fitness. The design might achieve its aim of easing the conflict with other inhabitants in a city designed as human living space, but at what cost to the feral boars and cats? They might lose their natural foraging and hunting skills to the detriment of their health outside the city. They might also be distracted by chasing the ball such that they are more prone to predation from other feral animals. Moreover, the competition for resources associated with #7 Rolling-Ball could easily lead to aggressive behaviour, which is not appropriate in play.

There is another potentially negative outcome of competition, involving the emotional responses of the players. Emotions are as much a part of a playful experience as physical capabilities and cognition, yet it is hard to understand psychological motivations and emotions in other humans, far less other species. Companion

animals might be the exception, because dogs (for example) are very adept at letting humans know their feelings, since we have co-evolved as species. However, not all animals have this ability, nor are humans necessarily able to make appropriate judgements. Consider design #6 Capture-the-Ball, which pits a dolphin against an octopus. They inhabit the same medium, and can see each other, but presumably have no olfactory perception of each other since their enclosures are separated. This game also specifies food as a reward for beating the opponent, so we might expect the pressure to win to be stressful, since food is critical for survival. Losing the game multiple times could cause negative emotions such as shame, resentment, sadness, anger and despair [5].

By contrast, the *cooperation* described in #3 Parrot-and-Dog-Seek suggests that this game would be a positive example of interspecies communication being used to fulfil a shared goal. Games can therefore be appropriate vehicles for engendering a *sense of purpose*, as the goals are small and regular. Animals maintained in human care may understandably find themselves lacking purpose compared to their wild counterparts, who spend their time concentrating on survival.

The parrot and dog scenario also highlights another component of games - namely, the *mechanisms* that enable play to take place. How might the dog and the parrot learn the rules in order to play effectively? *Learning* in itself is a highly motivating and unavoidable attribute of any playful experience. It is advantageous to players to be learning new skills and gaining knowledge about other players. There are two distinctly different paradigms: (i) learning via *training*; (ii) learning through experimentation - trial and error. One school of thought considers that training (by humans) is the most efficient way to enable the animals to achieve their aims and thereby benefit from the rewards offered by the intended experience. Moreover, successful training (for example, with working animals) is an example of interspecies communication, when the human manages to teach the non-human to understand their signals. The other perspective is that learning independently, for example through exploration or by copying peers, although usually much slower, is empowering, fosters confidence, and perhaps enables a deeper understanding of a complex system. Both methods have advantages and can be deployed to enable playful technology.

The idea that learning can be an important part of enrichment is implicitly included in Coe’s recent five ‘Cs’ proposal [12], which complements the Five Domains model (nutrition, environment, health, behaviour and state of mind) developed to assess welfare in 1994 [53]. The five Cs are control, choice, challenge, change and competency, in recognition of the need to give animals agency, cognitive stimulation, variety and a sense of *personal* achievement.

Having a personal response to a situation reminds us that animals are *individuals*, with preferences and competencies that differ from being to being, not just from species to species. A one-size-fits-all approach to technology fails to address the multiple variations within an intended user group, exemplified by the popularity of customisable game design elements in games for

humans - e.g. ability to alter characters, to control features or to adjust difficulty.

One of the possible disadvantages of designs that use an interface between participants, such as #Parrot-and-Dog-Seek, #4 Chains-of-Joy and #6 Capture-the-Ball, is that immediately a critical sense of perception is lost - the *sense of smell*. Olfactory signals have been described as the most honest ones [89] because they cannot be faked - all animals unintentionally exude smells, and scent is one of the clearest ways that aspects of fitness (health, mating potential) are communicated between individuals, including responses such as stress.

Summary

Appropriate play: *Intrinsic reward (not food); Pleasure - aesthetics, sensory modalities; Competition v. cooperation; Social behaviour; Aggression; Addiction; Distraction; Emotions; Cognition and learning - new skills, acquiring knowledge, gaining achievements, in-game goals; Individual preferences.*

4.2.3 Ethical Issues

We have suggested which factors of play might be most appropriate for humans to target in their designs, and which might be better avoided. Our speculative designs also highlighted other aspects of technology-supported systems for animals that deserve the consideration of future designers.

A pertinent consideration is the inclusion of a points system within the #2 Flutter-Catch game, which seems to be an example of anthropomorphic design. Are the points really for the insects to collect, or are they a way to gamify spectator sports for humans? How could the butterflies possibly understand? In a similar fashion, #6 Capture-the-Ball imposes a human predilection (balls to goals) on octopuses. Godfrey-Smith states that ‘the minds of cephalopods are the most other of all’ [26], explaining how their nervous system is distributed throughout their body and arms, rather than located in a single brain organ. As such, the octopus might be an excellent example of embodied cognition – the idea that the intelligence of the animal comes through its physicality within its environment. There is little doubt that an octopus is physically capable of manipulating a ball to a target, but at present, the perspective of the cephalopod remains mysterious.

There is an argument that all these human devices aimed at non-human animals are at best frivolous and at worst, meddling with natural behaviour. Enrichment programs for captive animals should always specify clear goals for any intervention, as specified in the S.P.I.D.E.R. framework [1], and those goals should be to enhance the animal’s welfare by facilitating the expression of natural behaviours. However, the use of computers to enhance this endeavor has recently been endorsed by animal experts, since technology can supersede natural features as a way to stimulate natural behaviour in a captive setting [13, 50].

As mentioned, there are guidelines for the management and welfare of zoo-housed animals; indeed, AZA Accreditation [2] exists to ensure high standards within participating institutions. Moreover, in some countries, there are animal protection

regulations in place that target specific groups of animals in our care [e.g., 18, 20, 80, 81]. Excluding farmed animals, the animals arguably the most at risk from poor caregiving are companion animals, whose living arrangements are rarely supervised. There is an increasing interest and trend to invent touchscreen devices for human caregivers’ homes to occupy companion dogs, by challenging their mental capabilities [58] or communicating remotely with them when the caregivers are not at home. This field is a mixed blessing, since it is tempting to communicate with a beloved pet while away, but on the other hand, the devices could mislead caregivers into believing that it is acceptable to leave their pets home alone for long time periods. The design #5 Bionic-Tail came under scrutiny in case it was intended as a home-alone entertainment device and brought the challenge of regulating ‘pets and their caregivers’ into focus.

To return to farmed animals, we appreciate that the challenges to welfare are currently hard to solve due to financial restrictions and growing demand from consumers, who show conflicting perspectives towards intensive farming. Although many farmers are willing to enrich the experiences of their livestock, this has to be done with sustainable effort and cost. However, there does seem to be a gradual cultural shift towards animal welfare and alternative forms of farming, which brings hope for progress in this area.

Summary

Ethics: *Anthropomorphism; Enrichment goals; Natural behaviours; Legislation and regulations; Categories of animals – companion, farmed, zoo and refuge, working, wild.*

5 Conclusions

In our workshop, play was chosen as the paradigm for exploring interspecies communication because it seemed to be both innocuous and apt – non-threatening, voluntary, autotelic – a universal barrier-breaking phenomenon. Speculative Design proved to be a useful tool for provoking ideas and framing discussions around this theme, which revealed some of the underlying dynamics in tech-enabled ‘playful’ exchanges, as well as highlighting the importance of existing work on ethics. Our discussions broadly encompassed three areas – equality, appropriate play and ethical issues.

In respect to **equality** (Section 4.2.1), the predator-prey game #1 Chase-Prey became a metaphor for the relationships that humans currently have with non-human animals, directly and indirectly (via technology). Humans are always the top predator in every engagement, and this knowledge, whether conscious or not, underpins every transaction that takes place between humans and other species. It may therefore be difficult to form equitable relationships with non-human animals, should we wish to do so. Nevertheless, we argue that as part of a duty of care to the under-represented and under-privileged in our world (in this context, non-human animals), humans should start *listening* a bit more.

One intriguing outcome of interspecies communication research is the possibility to develop ‘translating’ devices that enable humans to instantly interpret the meaning of animal signals

and behaviours, thus moving us into the role of listener. While some research is moving towards this possibility (e.g. CHAT, an underwater acoustic apparatus able to match dolphin whistles with corresponding English words [31]; interpretations of dog [75] and pig tail movement [10]), understanding how non-humans transmit and perceive signals, and crucially what those signals *mean*, remains a huge challenge. It is both a wicked problem (for how can we assess another being's subjective experience? [15, 17, 42]) and it is a fundamental step for any respectful interspecies engagement; in other words, engagement that takes into account the specific communicative modalities of the other species. Moreover, it is impossible to design playful technology that supports two different species to communicate without first having some understanding of each species' signaling behaviours and intentions.

Appropriate play (Section 4.2.2) highlighted the potential benefits associated with playful tech, and also some of the risks, such as aggressive or addictive behaviour, or experience of negative emotions.

Contemplating the speculative games underlined the importance of making informed design decisions, grounded in knowledge of species-specific characteristics and expected behavioural patterns. As an example, in #2 Flutter-Catch, both butterflies and dogs use their sense of smell. However, they have evolved to be aware of different scents, and there is a concern that a strong nectar odour might inhibit the dog's normal olfactory abilities. In future scenarios, we suggest that olfaction should be monitored by human moderators of designed interspecies games so they can ensure that all players are having an appropriate experience. We note that humans currently lack the ability to discern or interpret olfactory signals from other animals with sufficient understanding, making this an exciting area for future research.

As a general principle, we suggest that designers offer non-human animals engaging with their technologies a choice of modes, controllers, types of feedback etc., informed by their sensory preferences, and thereby discover more about the range of variance within a species.

Finally, regarding **ethical issues** (Section 4.2.3), we direct the reader to current legislation that aims to protect those we care for in our digital society. In regard to interaction design, the new UK Children's Code (age-appropriate design code) [26] falls under the UK Data Protection Act 2018. It aims: *'to ensure that children have a baseline of protection automatically by design and default, so that they are protected within the digital world rather than being protected from it.* Should all non-human animals everywhere be protected by legislation that ensures they are treated fairly in a technologically enhanced environment? How could this be framed so that it encompasses companion animals, farmed animals, laboratory animals, working animals and the range of captive animals we maintain in zoos, sanctuaries and wildlife centres? And what about the wild animals that are already affected by human technological interventions?

We look forward to future reflections and discussions on these and other associated topics. As we seek to learn more about other

species and support their welfare, in both wild and captive settings, investigating how to design species-specific technologies can bring us a step closer to understanding our non-human users. We hope this paper will inspire designers and researchers to consider some of the issues we have raised in relation to their projects.

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REFERENCES

- [1] Animal Enrichment. The S.P.I.D.E.R. Framework. Retrieved Jan 23, 2021 from <http://www.animalenrichment.org/spider>
- [2] Association of Zoos & Aquariums. <https://www.aza.org>
- [3] Simone D.J. Barbosa & Maira Greco de Paula. 2003, June. Designing and evaluating interaction as conversation: a modeling language based on semiotic engineering. In International Workshop on Design, Specification, and Verification of Interactive Systems (pp. 16-33). Springer, Berlin, Heidelberg.
- [4] Marc Bekoff. 1984. Social play behavior. *BioScience* 34, 4 (Apr, 1984), 228–233. DOI: <https://doi.org/10.2307/1309460>
- [5] Marc Bekoff. 2000. Animal Emotions: Exploring Passionate Natures: Current interdisciplinary research provides compelling evidence that many animals experience such emotions as joy, fear, love, despair, and grief—we are not alone. *BioScience* 50, 10 (Oct 2000), 861–870. DOI: [https://doi.org/10.1641/0006-3568\(2000\)050\[0861:AEEPN\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2000)050[0861:AEEPN]2.0.CO;2)
- [6] Marc Bekoff and John A. Byers (Eds.). 1998. *Animal play: evolutionary, comparative, and ecological perspectives* (1st. ed.). Cambridge University Press, Cambridge, UK.
- [7] Eliza Bliss-Moreau, Anthony C. Santistevan and Christopher J. Machado, C. (2021). Monkeys prefer reality television. *PsyArXiv*, 12 Jan. 2021. Preprint DOI: <https://doi.org/10.31234/osf.io/7drpt>
- [8] Gordon M. Burghardt. 1999. Play. In Greenberg A, Haraway M (Eds.) *Comparative psychology: a handbook* (1st. ed.). Garland, New York, pp 725–735.
- [9] Roger Caillois. 1961. *Man, Play, and Games* (1st. ed.). University of Illinois Press.
- [10] Irene Camerlink, Winanda W. Ursinus. 2020. Tail postures and tail motion in pigs: A review. *Applied Animal Behaviour Science*, Volume 230, 2020, 105079, ISSN 0168-1591. <https://doi.org/10.1016/j.applanim.2020.105079>.
- [11] Yoram Chisik & Clara Mancini. 2019. "P for Politics D for Dialogue: Reflections on Participatory Design with Children and Animals." Proceedings of the Sixth

- International Conference on Animal-Computer Interaction.
- [12] John Coe, J.C. Embedding environmental enrichment into zoo animal facility design. In Proceedings of the Zoo Design 2017 Conference, Wroclaw, Poland, 5–7 April 2017; pp. 20–32.
- [13] John Coe and Julia Hoy. 2020. Choice, control and computers: Empowering wildlife in human care. *Multimodal Technol. Interact.* 4, 4 (Dec, 2020), 92. DOI: <https://doi.org/10.3390/mti4040092>
- [14] Rachel Dale, Sylvain Palma-Jacinto, Sarah Marshall-Pescini and Friederike Range. 2019. Wolves, but not dogs, are prosocial in a touch screen task. *PLoS One* 14, 5 (May, 2019), e0215444. DOI: <https://doi.org/10.1371/journal.pone.0215444>
- [15] Marion Dawkins. 2006. Through animal eyes: what behaviour tells us. *Appl. Anim. Behav. Sci.*, 100 (2006), pp. 4-10.
- [16] Mark H. Deakos, Brian K. Branstetter, Lori Mazzuca, Dagmar Fertl, Joseph R. Mobley Jr. 2010. Two Unusual Interactions Between a Bottlenose Dolphin (*Tursiops truncatus*) and a Humpback Whale (*Megaptera novaeangliae*) in Hawaiian Waters. *Aquatic Mammals*, 36(2).
- [17] Frank De Waal. 2011. What is an animal emotion? *Ann. N. Y. Acad. Sci.*, 1224 (2011), pp. 191-206.
- [18] EC. 1998. Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes. *Official Journal of the European Communities* L 221, (Aug 8, 1998), 23–27, <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31998L0058>
- [19] Crystal L. Egelkamp, Lydia M. Hopper, Katherine A. Cronin, Sarah L. Jacobson and Stephen P. Ross. 2016. Using touchscreens to explore the welfare and cognition of zoo-housed primates. *PeerJ Preprints*, Jul 2016, No. e2312v1, DOI: <http://doi.org/10.7287/peerj.preprints.2312v1>
- [20] EU. 2010 Council Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes. *Official Journal of the European Union* L 276, (Oct 10, 2010), 33–79, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0063>
- [21] Clare D. FitzGibbon and J. H. Fanshawe. 1988. Stotting in Thomson's gazelles: an honest signal of condition. *Behav. Ecol. Sociobiol.* 23, 2, 69-74. DOI: <https://doi.org/10.1007/BF00299889>
- [22] Mary Flanagan. 2015. The Ludification of Culture & Playful Aesthetics. In Steffen P. Walz and Sebastian Deterding (Eds.), *Gameful World: Approaches, Issues, Application*. MIT Press, Cambridge, MA. DOI: <https://doi.org/10.7551/mitpress/9788.001.0001>
- [23] Fiona French., Ilyena Hirsky-Douglas, Heli Väättäjä. 2020. Designing Technologies for Playful Interspecies Communication (Virtual workshop). In Proceedings of the Seventh International conference on Animal-Computer Interaction; Article 20, p.1-6 (November 2020). DOI: <https://doi.org/10.1145/3446002.3446003>
- [24] Fiona French, Clara Mancini and Helen Sharp. 2020. More Than Human Aesthetics: Interactive Enrichment for Elephants. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*. pp. 1661–1672. DOI: <https://doi.org/10.1145/3357236.3395445>
- [25] R.A Gardner and B.T. Gardner. 1975. Early signs of language in child and chimpanzee. *Science* 187,4178 (Feb, 1975), 752-753. DOI: <https://doi.org/10.1126/science.187.4178.752>
- [26] Peter Godfrey-Smith. 2016. Other minds: The octopus, the sea, and the deep origins of consciousness. Farrar, Straus and Giroux, New York, NY
- [27] Peter Gray. 2013. Definitions of Play. *Scholarpedia* 8, 7, 30578. DOI: <https://doi.org/10.4249/scholarpedia.30578>
- [28] Katherine Grillaert & Samuel Camenzind. 2016. "Unleashed enthusiasm: ethical reflections on harms, benefits, and animal-centered aims of ACI." In Proceedings of the Third International Conference on Animal-Computer Interaction, pp. 1-5.
- [29] Keith J. Hayes and Catherine Hayes. 1952. Imitation in a home-raised chimpanzee. *Journal of Comparative and Physiological Psychology* 45, 5, 450–459. DOI: <https://doi.org/10.1037/h0053609>
- [30] Suzanne D.E. Held & Marek Špinko. 2011. Animal play and animal welfare. *Animal behaviour*, 81(5), 891-899.
- [31] Denise L. Herzing. 2016. Interfaces and keyboards for human-dolphin communication: what have we learned? *Animal Behavior and Cognition* 3, 4, 243-254. DOI: <https://doi.org/10.12966/abc.04.11.2016>
- [32] Ilyena Hirskyj-Douglas, and Andrés Lucero. 2019. On the Internet, Nobody Knows You're a Dog... Unless You're Another Dog. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, Paper no. 117, 1-12, DOI: <https://doi.org/10.1145/3290605.3300347>
- [33] Alan Hook. 2019. "Equine Eyes: A Speculative Design Project for Interspecies Understanding."
- [34] Alexandra Horowitz & Julie Hecht. 2016. Examining dog-human play: the characteristics, affect, and vocalizations of a unique interspecific interaction. *Animal cognition*, 19(4), 779-788.
- [35] Alexandra Horowitz. 2009. Attention to attention in domestic dog (*Canis familiaris*) dyadic play. *Animal Cognition*, 12(1), 107-118.
- [36] Ludwig Huber, Nils Heise, Christopher Zeman, Christian Palmers. 2015. The ALDB box: Automatic testing of cognitive performance in groups of aviary-housed pigeons. *Behav. Res. Methods* 47, 1 (Mar, 2015), 162-171. DOI: <https://doi.org/10.3758/s13428-014-0462-2>
- [37] Information Commissioner's Office (ICO), 2018. What is the Children's Code? Retrieved Jan 23, 2021 from

- <https://ico.org.uk/for-organisations/age-appropriate-design/additional-resources/what-is-the-children-s-code/>
- [38] Vincent M. Janik. 2015. Play in dolphins. *Curr. Biol.* 25, 1 (Jan, 2015), R7-R8. DOI: <https://doi.org/10.1016/j.cub.2014.09.010>
- [39] Chloe Kliman-Silver. 2020. "Examining The Animal-Human Bond Through The Lens Of Telepresence." In Proceedings of the Seventh International Conference on Animal-Computer Interaction, pp. 1-5. 2020.
- [40] Donghyeon Ko, Daye Kwon, Eunjin Kim and Woohun Lee. 2018. BubbleTalk: enriching experience with fish by supporting human behavior. In *Proc of DIS'18*. DOI: <https://doi.org/10.1145/3196709.3196720>
- [41] Lawrence Kolb and A. G. DuMez. 1931. Experimental Addiction of Animals to Opiates. *Public Health Reports (1896-1970)* 46, 13 (Mar 1931), 698-726. DOI: <https://doi.org/10.2307/4579992>
- [42] L. Kremer, SEJ Klein Holkenborg, I. Reimert, J. E. Bolhuis, and L. E. Webb. 2020. "The nuts and bolts of animal emotion." *Neuroscience & Biobehavioral Reviews* 113 (2020): 273-286.
- [43] Don Kulick. 2017. Human-Animal Communication. *Annu. Rev. Anthropol.* 46, (Oct, 2017) 357-378. DOI: <http://doi.org/10.1146/annurev-anthro-102116-041723>
- [44] Shaun Lawson, Ben Kirman, Conor Linehan. 2016. "Power, participation, and the dog internet." *interactions* 23.4 (2016): 37-41.
- [45] Shaun Lawson, Ben Kirman, Conor Linehan, Tom Feltwell, and Lisa Hopkins. 2015. "Problematising upstream technology through speculative design: the case of quantified cats and dogs." In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, pp. 2663-2672.
- [46] Veronica Maglieri, Filippo Bigozzi, Marco Germaine Riccobono, Elisabette Palagi. 2020. Levelling playing field: synchronization and rapid facial mimicry in dog-horse play. *Behavioural processes*, 174, 104104.
- [47] Clara Mancini, Janet van der Linden, Jon Bryan, and Andrew Stuart. 2012. Exploring interspecies sensemaking: dog tracking semiotics and multispecies ethnography. In Proceedings of the 2012 ACM Conference on Ubiquitous Computing (UbiComp '12). Association for Computing Machinery, New York, NY, USA, 143-152. DOI: <https://doi.org/10.1145/2370216.2370239>
- [48] Clara Mancini. 2017. "Towards an animal-centred ethics for Animal-Computer Interaction." *International Journal of Human-Computer Studies* 98 (2017): 221-233.
- [49] Clara Mancini, Shaun Lawson, and Oskar Juhlin. 2017. Animal-Computer Interaction: The emergence of a discipline. 129-134.
- [50] Cristopher F. Martin and Robert W. Shumaker. 2018. Computer tasks for great apes promote functional naturalism in a zoo setting. In *Proc.of ACI2018* Article n.7, pp. 1-5. DOI: <https://doi.org/10.1145/3295598.3295605>
- [51] J. Maynard Smith and G.R. Price, 1973. The Logic of Animal Conflict. *Nature* 246, (Nov, 1973), 15-18. DOI: <https://doi.org/10.1038/246015a0>
- [52] Nancy K. Mello. 1973. A review of methods to induce alcohol addiction in animals. *Pharmacol. Biochem. Behav.* 1, 1 (Jan-Feb, 1973), 89-101, DOI: [https://doi.org/10.1016/0091-3057\(73\)90061-0](https://doi.org/10.1016/0091-3057(73)90061-0)
- [53] D.J. Mellor and C.S.W. Reid.1994. Concepts of animal well-being and predicting the impact of procedures on experimental animals. In: Baker R, Jenkin G and Mellor DJ (Eds.) *Improving the Well-being of Animals in the Research Environment*, pp 3-18. Australian and New Zealand Council for the Care of Animals in Research and Teaching: Glen Osmond, SA, Australia
- [54] Mentimeter, 2021. Online polling software. Available at: <https://www.mentimeter.com/>
- [55] Claudia Mertens. 1991. Human-cat interactions in the home setting. *Anthrozoös*, 4(4), 214-231.
- [56] Miro, 2020. Interactive whiteboard cloud software. Available at <https://miro.com/>
- [57] Julia Mueller-Paul, Anna Wilkinson, Ulrike Aust, Micheal Steurer, Geoffrey Hall, G. and Ludwig Huber, L. 2014. Touchscreen performance and knowledge transfer in the red-footed tortoise (*Chelonoidis carbonaria*). *Behav. Processes* 106 (Jul, 2014), 187-192. DOI: <https://doi.org/10.1016/j.beproc.2014.06.003>
- [58] Corsin A. Müller, Kira, Schmitt, Anjuli L.A. Barber and Ludwig Huber. 2015. Dogs can discriminate emotional expressions of human faces. *Curr. Biol.* 25, 5 (May, 2015), 601-605. DOI: <https://doi.org/10.1016/j.cub.2014.12.055>
- [59] M.A. Norman & Peter J. Thomas. 1991. Informing HCI design through conversation analysis. *International journal of man-machine studies*, 35(2), 235-250.
- [60] Steve North. 2018. Umamimi robotic horse ears - using configurable code profiles to replicate individuality in equine animatronics. In *Proc. of ACI2018* Article n. 6, pp. 1-6. DOI: <https://doi.org/10.1145/3295598.3295606>
- [61] Steve North. 2017. Hey, where's my hay? design fictions in horse-computer interaction. In Proceedings of the Fourth International Conference on Animal-Computer Interaction, pp. 1-5. 2017.
- [62] Mark O'Hara, Ludwig Huber, Gyula Kopanny Gajdon .2015. The advantage of objects over images in discrimination and reversal learning by kea, *Nestor notabilis*. *Anim. Behav* 101 (Mar 2015), 51- 60. DOI: <https://doi.org/10.1016/j.anbehav.2014.12.022>
- [63] Ana Flora Sarti Oliveira, André Oliveira Rossi, Luana F.M. Silva, Michele Correa Lau, Rodrigo Egydio Barreto. 2010. Play behaviour in nonhuman animals and the animal welfare issue. *Journal of ethology*, 28(1), 1.
- [64] Patrizia Paci, Clara Mancini, Blaine Price. 2020, July. Understanding the Interaction Between Animals and

- Wearables: The Wearer Experience of Cats. In Proceedings of the 2020 ACM Designing Interactive Systems Conference (pp. 1701-1712).
- [65] Elyssa Payne, Jodi DeArango, Pauleen Bennett, Paul McGreevy. 2016. Exploring the existence and potential underpinnings of dog-human and horse-human attachment bonds. *Behavioural processes*, 125, 114-121.
- [66] Sergio Pellis & Vivien Pellis. 2009. *The Playful Brain*. Ch. 1, p.2. Oneworld Publications. ISBN: 978-1-85168-760-2
- [67] Sergio Pellis & Vivien Pellis. 2017. What is play fighting and what is it good for?. *Learning & Behavior* 45, 355-366. DOI: <https://doi.org/10.3758/s13420-017-0264-3>
- [68] Franck Péron, S. Houmady, N. Mauny and Dalia Bovet. 2012. Touch screen device and music as enrichments to captive housing conditions of African grey parrots. *Journal of Veterinary Behavior* 7, 6 (Nov-Dec 2012), e13. DOI: <https://doi.org/10.1016/j.jveb.2012.09.041>
- [69] Milada Petrů, Milada, Marek Špinko, Veronika Charvátová, and Stanislav Lhota. "Revisiting play elements and self-handicapping in play: a comparative ethogram of five Old World monkey species." *Journal of Comparative Psychology* 123, no. 3 (2009): 250.
- [70] Patricia Pons, Alicia Carrion-Plaza and Javier Jaén. 2019. Remote interspecies interactions: improving humans and animals' wellbeing through mobile playful spaces. *Pervasive Mob Comput* 52, (Jan 2019), 113-130. DOI: <https://doi.org/10.1016/j.pmcj.2018.12.003>
- [71] Patricia Pons Tomás, Javier Jaén, Alejandro Catalá. 2015. Envisioning Future Playful Interactive Environments for Animals. In *More Playful User Interfaces: Interfaces that Invite Social and Physical Interaction*. Springer. 121-150. doi:10.1007/978-981-287-546-4_6
- [72] Robert L. Robbins. 2000. Vocal communication in free-ranging African wild dogs (*Lycaon pictus*). *Behaviour* 137, 10 (Jan, 200), 1271-1298. DOI: <https://doi.org/10.1163/156853900501926>
- [73] Nicola J. Rooney, John W.S. Bradshaw, Ian H. Robinson. 2001. Do dogs respond to play signals given by humans? *Animal Behaviour*, 61(4), 715-722.
- [74] Michael D. Rose. 1977. Interspecific play between free ranging guerezas (*Colobus guereza*) and vervet monkeys (*Cercopithecus aethiops*). *Primates*, 18(4), 957-964.
- [75] Luisa Ruge, Elizabeth Cox, Clara Mancini, and Rachael Luck. 2018. User centered design approaches to measuring canine behavior: tail wagging as a measure of user experience" In *Proceedings of the Fifth International Conference on Animal-Computer Interaction*, pp. 1-12. 2018.
- [76] Duane M. Rumbaugh (Ed.). 1977. *Language learning by a chimpanzee: the Lana Project* (1st. ed.). New York Academic Press, New York. DOI: <https://doi.org/10.1016/C2013-0-11427-4>
- [77] Ivan Sazima. 2008. Playful birds: cormorants and herons play with objects and practice their skills. *Biota Neotrop* 8, 2, 259-264. DOI: <https://doi.org/10.1590/S1676-06032008000200025>
- [78] Hana Schank. 2012. UX Design as a Two-Way Conversation. (Apr 2012). Retrieved Jan 20, 2021 from <https://uxmag.com/articles/ux-design-as-two-way-conversation>
- [79] Racher Smolker, Andrew Richards, A., Richard Connor, Janet Mann and Per Berggren. 1997. Sponge carrying by dolphins (*Delphinidae*, *Tursiops* sp.): a foraging specialization involving tool use? *Ethology* 103, 6, 454-465. DOI: <https://doi.org/10.1111/j.1439-0310.1997.tb00160.x>
- [80] UK Government. 2007. The Welfare of Farmed Animals (England) Regulations 2007 (Jul 2007). Retrieved Jan 23, 2021 from <https://www.legislation.gov.uk/ukxi/2007/2078/contents/made>
- [81] Understanding Animal Research. 2020. The 3Rs and Animal Welfare (Jun 2020). Retrieved Jan 23, 2021 from <https://www.understandinganimalresearch.org.uk/animal/s/three-rs/>
- [82] Heli K Väättäjä & Emilia K. Pesonen. 2013. "Ethical issues and guidelines when conducting HCI studies with animals." CHI'13 Extended Abstracts on Human Factors in Computing Systems. 2159-2168.
- [83] Jennifer Vonk and Michael J. Beran. 2012. Bears "Count" Too: Quantity Estimation and Comparison in Black Bears (*Ursus Americanus*). *Anim Behav* 84, 1 (Jul, 2012), 231-238. DOI: <https://doi.org/10.1016/j.anbehav.2012.05.001>
- [84] Sarah Webber, Marcus Carter, Sally L. Sherwen, Wally Smith, Zaher Joukhadar, and Frank Vetere. 2017. Kinecting with Orangutans: Zoo Visitors' Empathetic Responses to Animals' Use of Interactive Technology. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* 6075-6088. DOI: <https://doi.org/10.1145/3025453.3025729>
- [85] Sarah Webber, Marcus Carter, Wally Smith, and Frank Vetere. 2017. "Interactive technology and human-animal encounters at the zoo." *International Journal of Human-Computer Studies* 98 (2017): 150-168.
- [86] Marianne Wondrak, Elin Conzelmann, Ariane Veit, Ludwig Huber. 2018. Pigs (*Sus scrofa domestica*) categorize pictures of human heads. *Appl. Anim. Behav. Sci.* 205 (Aug 2018), 19-27. DOI: <https://doi.org/10.1016/j.applanim.2018.05.009>
- [87] World Café. 2021. World Cafe Method. Last accessed Jan 20, 2021. <http://www.theworldcafe.com/key-concepts-resources/world-cafe-method/>
- [88] World Health Organization (WHO). 2018. Addictive behaviours: Gaming disorder (Sep, 2018). Retrieved Jan 22, 2021 from: <https://www.who.int/news-room/q-a-detail/addictive-behaviours-gaming-disorder>

- [89] Sarah M. Zala, Wayne K. Potts and Dustin J. Penn. 2004. Scent-marking displays provide honest signals of health and infection. *Behav. Ecol.* 15, 2 (Mar, 2004), 338–344. DOI: <https://doi.org/10.1093/beheco/arl022>
- [90] Zoom, 2020. Videoconferencing software. Available at <https://zoom.us/>