Animal Welfare as a Design Goal in Technology Mediated Human-Animal Interaction

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ABSTRACT
Designing technology mediated human-animal interaction with the animal welfare as a design goal calls for understanding of animal welfare issues. This paper discusses the notion of animal welfare and specifically focuses on domestic dogs (*canis familiaris*) as an example case. Strategies for mediating relatedness are discussed and an initial framework to support designing tactile interactions for human-animal interaction is presented. Paper builds its reasoning upon scientific research on human-animal interaction and welfare, and identifies issues for future work in this area.

Author Keywords
AHCI; human-animal; interaction; relatedness; haptics; tactile interaction; senses; touch; intimacy; framework.

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

INTRODUCTION

Relatedness - or related notions of connectedness, intimacy, love, belonging, closeness, and togetherness - and its expression in human-human relationships have been shown to influence health and well-being in humans [4, 22]. Studies on effect of human-animal interactions (HAI) on humans seem to indicate positive effects on human well-being. Reported impacts include positive effects on social interaction between humans and factors related to these interactions, anti-stress effects, anxiety and pain, as well as health (both physical and mental) [2]. For both humans and animals positive physiological effects have been identified as a consequence of human animal interaction, specifically in case of domestic dogs [10, 11].

These results, among others, suggest that mediating human-animal relationship with technology could potentially have opportunities to increase the welfare of both animals and their handlers or owners. However, some questions arise to be considered. Can the positive effects of human-animal interaction be mediated with technology over distance? What can be mediated and how? Can animal welfare be set as a design goal when developing systems for technology mediated human-animal interaction? If animal welfare is set as a design goal, how could we approach it?

In this paper the notion of interaction is approached as "*a mutual or reciprocal action or influence*" (MOT Collins English Dictionary) that is mediated by technology. Interactive system is a "*combination of hardware, software, and/or services that receives input from, and communicates output to users*" (ISO 9231-210:2010). In case of computer mediated human-animal interaction both humans and nonhuman animals are considered as users.

When considering the welfare of animals and setting welfare of animals as a design goal, this paper specifically focuses on domestic (pet) dogs. In addition to previous research findings on positive impacts of HAI on both humans and pet dogs, specific welfare related issues can be used as design goals. Different types of anxieties are among one of the key reasons for the lowered welfare of pet dogs [13, 14, 21 , 35, 38]. They are also an expressed concern of dog owners [32]. Research suggests that touch can have a calming effect on humans and animals [7, 18, 25, 50]. Touch is also an inherent part of human-animal interaction. Therefore, this paper focuses on haptic interaction as one of the possibilities to increase animal welfare, exemplified in case of domestic dogs (*canis familiaris*).

To support further research in the area of using animal welfare as a design goal, this paper discusses the notion of animal welfare, describes typical reasons for lowered welfare and behavior problems in the case of pet dogs. It discusses strategies for mediating relatedness and also explores issues related to using haptics in mediating human-animal interaction over distance when attempting to increase animal welfare with the solutions.

WHAT IS ANIMAL WELFARE?

A*nimal* is defined as any live dog, cat, monkey (nonhuman primate mammal), guinea pig, hamster, rabbit, or any other warm-blooded animal, which is being used, or is intended for use for research, testing, experimentation, or as a pet or

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domestic animal (adapted from AWA, Animal Welfare Act, Nov. 6, 2013).

Welfare of an animal includes its physical and mental state, i.e. fitness and a sense of well-being (FAWC, Farm Animal Welfare Committee). The Five Freedoms[1] outline originally the ideal states of animal welfare (Table 1). They are generalized to pets as well [28]. Today the Five Freedoms are interpreted as the minimal requirements for animal welfare, but they are not seen to characterize the notion of "a good life". However, they still provide a simple and generally accepted basis for discussing animal welfare.

Freedom	Elaboration
Freedom from Hunger and Thirst	Ready access to fresh water and a diet to maintain full health and vigor.
Freedom from Discomfort	An appropriate environment including shelter and a comfortable resting area.
Freedom from Pain, Injury or Disease	Prevention or rapid diagnosis and treatment.
Freedom to Express Normal Behaviour	Sufficient space, proper facilities and company of the animal's own kind.
Freedom from Fear and Distress	Conditions and treatment which avoid mental suffering.

Table 1. The Five Freedoms (source: FAWC).

Some research in the field of HCI explicitly mentions technology related welfare issues in animal related studies as exemplified next. For wearables, ergonomical issues are addressed by describing that the animal is able to move and act naturally [24] Natural human animal interaction related cues are supported by creating a natural sensation of stroking for the animal in case of poultry [20]. Enrichment of a hamster living in captivity is aimed to be supported by providing a possibility for natural behaviors [5].

The following subsection addresses the notions of stress and welfare generally and initially discusses designing for animal welfare.

On stress, distress and welfare

Stress is defined as a real or perceived perturbation to an organism's physiological or psychological well-being [6]. If animal experiences stress that is severe, prolonged or both, this leads to lowered welfare (distress) [6].

Any stimuli or event that causes a physiological or psychological reaction or change in an animal causes also stress. Either behavioral or physiological mechanisms are used to cope or adapt to the perturbation caused by a stressor [6]. These mechanisms include behavioral reactions, activation of the sympathetic nervous system and adrenal medulla, secretion of stress hormones (e.g. glucocloricoids and prolactin) and mobilization of the immune system [6].

Stress reactions are normal to any change in an environment. They have been separated to eustress (form of positive or physiological stress) and to negative stress (overstress and distress) (Selye, 1974 as cited by [27]). Beneficial stress can be related to exercise, for example, whereas negative stressors are exemplified by hunger and thirst. Stressor intensity, stressor duration and the capacity of an individual animal to respond and cope with stress affect when stress changes to distress. Minor perturbations may be momentarily stressful and they may momentarily negatively affect the emotional state [6]. However, they do not cause long-term behavioral or physiological changes and affect animal's welfare like severe or prolonged stressors or multiple cumulative stressful insults do. In addition, the predictability and controllability of environment from the point of view of the animal are important factors for attenuating the stress and effect of stressors.

Similar to humans, animals differ in their ability to cope or adapt to changes in their environment and experience. One individual may be quick to adapt to any changes, another may adapt slower to all or certain types of stressors, and a third one may be unable to cope with certain types of stressors at all. As an example of the inability to cope or adapt is fear caused by certain types of loud noises.

Challenge is that there exist currently no direct measures to assess the mental well-being of an animal directly. Understanding the normal behavior is the first step in being able to assess and recognize stress or distress (NRC). Furthermore, Duncan (2005, cited by [6] suggests that the most important consideration for assessing animal's welfare is its emotional state.

Designing for animal welfare

The five freedoms outlined previously can be used as the guiding principles as well as experience goals both in planning and conducting the studies with animals and when developing technology for animals [47]. As outlined in the following sections in case of pet dogs, many of their behavioral disorders are linked to problems in their welfare. Researchers who aim to design for dogs – or more generally for animals – need to also take into account that the developed technology may not only be beneficial from the point of view of animal welfare.

Introducing technology and various stimuli to animals can also cause behavioral disorders or increase negative stress levels in short or long-term use, for example. Therefore, when welfare is set as a design goal or when minimizing the negative effects of technology on welfare are aimed for, researchers should not only set welfare related goals. They can also consider the possible impacts, make a risk assessment, and ideally understand the species specific natural behaviors as well as consider the possible individual differences of the animals in their reactions and ability to adapt to the introduced technology [46]. A recommendable

[1] http://www.defra.gov.uk/fawc/about/five-freedoms/

approach is to carry out a cost-benefit analysis [17]. Technology that supports the welfare of the animals can focus on supporting natural behaviors or adapting to and coping with environmental changes or stressors, enriching animals' lives by providing appropriate stimulation, address the ergonomical issues related to the work of working dogs, and/or support the learning or work in a positive and safe way, for example.

In case of technology development and interventions when technology is tested and used, each of the freedoms should be considered in relation to how technology or the studies or interventions may affect the animal welfare. This requires also understanding and knowledge on species related specific aspects, such as the species typical natural behaviors in addition to the perceptual, cognitive and motor skills, for example.

Next section exemplifies animal welfare and typical behavior problems in case of pet dogs. The raised issues are used as a basis for exploring the use of haptics to increase animal welfare and more specifically in technology mediated human animal interaction.

DOG WELFARE AND TYPICAL BEHAVIOR PROBLEMS

This section uses the five freedoms as a basis for discussing the welfare issues and challenges of pet dogs.

Welfare of dogs and current challenges

The most commonly denied freedoms of pet dogs in USA are freedom from fear and distress, and freedom to express natural behaviors [14]. Usually pet dogs have adequate food and water and they are cared for diseases and in case of injury. However, training methods or tools, the physical abuse of dogs, and training related technology like electric shock collars may cause pain and/or fear in the dog..

Dogs' freedom to express natural behaviors is also often neglected in USA [14]. Natural behaviors include, 1) social intraspecies interaction as well as interaction with and presence of humans, 2) physical activity, 3) mental stimulation by problem solving and learning, 4) eating related species specific behaviors starting from the searching for the food (by using different senses: hearing, smell, vision) to actual eating behavior (chewing, tearing etc.), and 5) species or breed specific behaviors related to the original purpose of the dog as a working, companion or hunting dog, for example.

Severe or prolonged stress of dogs can be caused by several reasons, as exemplified in Table 2 (see [13, 14, 21, 35, 38]). Different types of fears, phobias and anxieties are most common reasons for lowered welfare in dogs. Possible stressors and reasons for lowered welfare should be acknowledged and understood in technology development for animals whether avoiding negative impacts of developed technology or aiming to prevent or ease lowered welfare or stress with technological solutions momentarily or in long term. Some of the behavior problems like fear for loud noises can also have a genetic background (Overall).

Fear of environmental stimuli in urban environments, such as vehicles and noises.	Fear or aggression caused by the used training methods and/or mistreatment (such as physical punishment).
Noise phobias.	Fear caused by the use of technologies or tools that create aversive stimuli (e.g. ultrasonic, citronella & electric collars).
Separation anxiety, which can be defined as a state of fear.	Confinement, such as crating dogs for long-periods of time (note laws and regulations).
Too many, prolonged or too strong environmental stressors.	Lacking environmental stimuli and possibility to express natural behaviors related to exercise, eating and social encounters with humans and conspecifics.
Unpredictable and uncontrollable aversive or attractive events.	Leaving alone for long periods of time.

Table 2. Reasons for lowered welfare in dogs (Houpt 2005, Houpt et al. 2007, Lindsay 2001, Rehn et al. 2011, Resner 2001, Rooney 2009).

Some examples when it can be appropriate to aim for easing dog's stress with technological solutions include the following, for example:

- Ease the various dog's fear, phobia, or other anxiety, such as fear of or anxiety caused by a postman, thunder, fireworks, or loud noises.
- Support as one intervention the other behavioral treatment of a dog that is coached by a professional animal behaviorist.
- Ease the anxiety when visiting a veterinary clinic or a foreign place for a short or longer term visit.
- Ease the anxiety while traveling, e.g., in a car or plane.
- Ease the stress and calm the dog when staying at a dog hotel when owners are traveling.

Similarly, many of these example cases apply for other species as well, such as horses, and cats.

Typical behavior problems in dogs

To approach dog welfare from another perspective we outline next some common behavior problems in dogs. By understanding the common behavior problems, it is at the same time possible to understand what should not be the effect and outcome of the technology intervention on dog's welfare and behavior or what kind of behaviors should be reduced due to the technology intervention. On the other hand, the common behavior problems provide appropriate design goals to tackle for enhancing the dog's welfare and prevent their forming.

Examples of typical behavior problems or disorders in dogs are presented in Table 3 ([13, 14, 21, 35, 38]). Many behaviors are natural for the species originally, but they may become excessive and signs of poor welfare due to stressful conditions.

The capability to cope with stressors is affected by the dog's personality [21, 40, 44]. Behavior problems can be caused by the owner or handler, by the circumstances that the dog lives in [13, 38, see also previous section) or even by a single fear- or pain related experience [13]. In addition, genetics can play a role when behavior problems occur, such as with tail-chasing [45]. In all cases the listed problem behaviors are signs of poor welfare of the dog.

Destructive chewing	Digging
Chasing (e.g. cats, cars, balls)	Phobias, fears
Barking or other hypervocalization	Aggression (towards humans and/or dogs)
Hyperactivity	Stereotypies or repetitive behaviors (such as tail-chasing in adult dogs)
Over-grooming (some part of the body)	Increased passiveness

Table 3. Typical behavior problems in dogs.

EFFECTS OF TACTILE HUMAN ANIMAL INTERACTION ON WELFARE

Human animal interaction with tactile activities seems to be beneficial for both dogs and owners alike. Stroking a dog has been shown to reduce blood pressure of both human and animal [30], for example. Recent experimental research on human-animal interaction that included stroking, petting and talking for 3 minutes with pet dogs (*canis familiaris*) shows positive physiological effects on both owners and dogs [10, 11]. Positive effects include the release of oxytocin both in dogs and owners with a peak in the oxytocin levels at 1-5 minutes after the interaction (ibid.). Oxytocin levels were shown to positively correlate with the quality of dog-owner relationship (ibid).

Furthermore, when studying the effect of 8-minute grooming on dog's heartrates with kenneled greyhounds and guide dogs, McGreevy et al. [25] found that grooming had a substantial effect on reducing heat rate of dogs. However, no difference was found in the heartrate when comparing what body part was groomed. Authors discuss that if a reduced heart rate is a sign of reduced stress, it can be assumed that non-invasive interventions that have this effect are reinforcing. They also point out that the extent to which all dogs are reinforced by physical contact depends on their socialization and familiarity of persons conducting the grooming.

Results indicate that haptics can provide opportunities to positively influence the welfare of dogs in technology mediated human animal interaction.

To support identifying the types of tactile activities between humans and dogs, McGreevy et al. [25] present a classification for dog-dog tactile interaction and their dog-human or human-dog counterparts. Tactile activities include activities related to allogrooming and resting as presented in Table 4. We added one human initiated behavior towards dogs that does not seem to have a counterpart – namely, hugging. In addition, a number of activities that involve various tactile activities in dog-dog interaction include different types of play and wrestling. Some of their counterparts can be found in play and wrestling between humans and dogs with somewhat different counterparts [15]. Play and wrestling related tactile activities in human-dog interaction needs further investigation. These described activities provide initial support for identifying tactile activities relevant when designing for human-dog interaction mediated by technology, specifically by haptics.

Dog-dog behavior	**Human-dog behavior**	**Dog-human behavior**
Grooming nibble	Brush/scratch	As dog-dog
Lick	Kiss/spongeing/wiping	As dog-dog
Mouth	Isolation and restraint of particular bodypart	As dog-dog
Nuzzle face/ears	Massage face/ears with fingers	As dog-dog
Resting in physical contact	Same behavior	As dog-dog
	Hugging	

Table 4. Classification of tactile activities based on observed behavior and extended with hugging (adapted from McGreevy et al.)

MEDIATING RELATEDNESS AND INTIMACY WITH TECHNOLOGY IN HAI

Being related to others is one important basic need of humans. Since relatedness is important for humans, mediating relatedness in intimate relationships with technology in human-human interaction has been of interest in the HCI community [12, 39].

A review of published artifacts (design concepts or technologies) for mediating relatedness and intimacy with technology between humans categorizes strategies to six categories [12]: awareness, expressivity, physicalness, gift giving, joint action, and memories. This categorization is used in discussing generally mediating relatedness and intimacy in HAI with technology, and also raises issues related to haptics in HAI.

Awareness is mediated by "artifacts that create a feeling of cognitive awareness and continuity by sharing different types of (ambient) information about current activities or

moods among partners (without conversation or doing anything together)" [12]. In HAI awareness takes place naturally when human and animal are co-located. Awareness of presence, activities, and mood when co-located can be sensed either by sight, smell, touch, and hearing, and in some cases possibly by tasting when animal's viewpoint is considered. In addition to these, other senses include temperature, kinesthetic, and pain, for example. However, animals can also possess a number of senses that are not reported for humans, such as sensing magnetic and electrical fields in case of birds, for example. There exist differences between species, in their sensory capabilities and therefore in their sensing of the world and awareness of others.

At least two things need to be considered when technology-mediated human-animal interaction is planned. There seems to be an imbalance between the current solutions in technology mediated HAI when awareness is considered in terms of the directionality of awareness. Solutions usually aim to support the human's awareness of animal's physical activities and, such as with activity tracking solutions for dogs [1, 19, 49], monitoring the activity of the animal remotely [32], commanding or training a dog remotely [3, 16, 36] or locating dogs and making inferences of their behavior [48]. However, awareness of how animals sense the world and how to support humans' awareness of this sensing calls for further work. In other fields of research computational models for visual sense and flying behavior of insects have been created [9] or lately herding behavior of dogs has been modelled 43]. In these cases the technology development is primarily aiming for smart autonomous vehicles or robots. The awareness of an animal of a human and his/her activities that is mediated by technology is largely nonexistent unless remote command or training is considered with the exception the developed solution for human-poultry interaction [20].

There are also specific challenges and issues that need to be studied in relation to technology mediated HAI such as: How do the animals understand mediated activities of a human, remote presence of a human, or mediated mood of a human? How does an animal experience, perceive, and react to these if they are mediated by technology? What kind of impact do these have on an animal and its welfare?

Expressivity is mediated by "artifacts that emphasize the affective and emotional aspect of intimacy. They enable partners to express their feelings and emotions in a wide variety of ways, such as developing an own language or to use language in an ambiguous way" [12]. When human and animal are co-located, expressivity can be sensed with any of the five basic senses, depending on the species. Tactile interactions are one of the commonly used ways to express affect in human animal relationship as exemplified in Table 4 for human-dog relationship.

One of the few artifacts developed for technology mediated human-animal interaction over remote connections supporting expressivity is the two-way haptic interface for human-poultry interaction 20In this case the expressivity is one directional from human to poultry, as the animal is not intentionaly expressing its feelings towards the human interacting with it. Similarly to awareness, expressivity raises questions for further study on the intentionality and directionality of the expressivity and whether this would be relevant and understandable from the point of view of the animal. For humans the expression of affect and emotions to an animal is understandable and can give pleasure when appropriately supported by technology and how this is designed. Can an animal and what species of animals get pleasure and to what extent understand expressing affect or emotions remotely – mediated by technology - to a human?

Physicalness covers artifacts that have as a strategy to mediate relatedness by "a feeling of physical intimacy. They simulate either secondary effects of physical proximity (e.g., body heat, heartbeat) or meaningful gestures (e.g. hugs, strokes)" [12]. As exemplified in the previous section in case of tactile activities of dogs, humans and dogs have various cues and activities for mediating relatedness when co-located (see Table 4). These can also be specific to a certain human-dog relationship and depend on the dog breed as well.

Gift giving is mediated by artifacts that "demonstrate caring and valuing the other person by gift giving" [12]. When co-located with humans, animals, such as cats and dogs, can bring game to their owner. Humans commonly give treats to animals, just for showing caring. Even stroking or giving attention to an animal can be considered as a gift, if it pleases the animal. On the other hand, an animal can also give a gift by some form of physical attention, such as licking or resting his head gently on a human. What is gift giving is largely dependent on how the receiver values the gift and experiences it and what is the motivation of the one giving the gift. A human is more conscious of giving a gift, but it seems that at least dogs and also cats as domesticated animals living with humans, can also perform this type of actions. More work is needed to consider and study these issues, and to investigate whether gift giving could be mediated by technology and what can be considered as gift giving in remote interactions of humans and animals, for example.

Joint action refers to artifacts that "allow for carrying out an action together, which usually requires being physically colocated" [12]. When considering joint action of humans and animals, we need to investigate the types of actions present. These are largely dependent on the species, but also on preferences of humans and needs of the animal in question. By understanding the existing joint action types, we can mediate them with technology or extend or develop completely new types of joint action either remotely or when co-located. For example, a mixed reality game enables a human to play with a hamster, which is able to carry out its natural behavior at the same time as part of the

human's gameplay [5]. This can be played either remotely or as a co-located game.

Memories are mediated by artifacts that "keep records of past activities and special moments of a relationship" [12]. Different types of activity and location tracking solutions aimed for dogs [1, 19, 49] or other animals, and social media and content sharing services provide a means to keep track of memories of the human animal relationship [8, 23, Mikkola, Marshall, Dimicco). From the point of view of the animal, these are not relevant. Animals can attribute feelings and experiences to places, events at certain places, humans, other animals, artifacts, smells, tastes, noises, visual or haptic cues, and so forth. However, it can be harder to separate these to specific memories and mediate this association in terms of similar temporal or physical context as perceived by a human. Animal cognition studies are bringing more understanding to these issues in relation to animals and their capabilities [41, 34]. On the other hand, this gives an interesting space to explore for mediation with technology.

As a summary, when considering the previous research on human-animal interaction in HCI, only a few of the studies so far focus on mediating relatedness and intimacy between humans and animals remotely [5, 20] beyond monitoring, tracking or remote command and training. Study by Cheok et al. with a hamster and a human playing a mixed reality game employs the strategy of *joint action*, although the awareness of the joint action is on the human side. For hamster the aim of the authors is to provide an opportunity to carry out natural behaviors for enrichment.

Lee et al. [20] report on a two-way haptic interface between humans and poultry. Authors aim to give positive feelings for poultry but also meet the humans' needs to be connected to their pets even when they are not physically present with them. The solution employs as technology mediated strategies *awareness and physicalness* of poultry's movements for the human. In this solution a combination of visualization and tactile sensations is used to mediate animal's actions (movements) to humans (ibid.). For poultry the solution employs *expressivity* of human's touch (stroking) via a tactile vest with haptic interface (vibrotactile sensors) to create a natural sensation of stroking. The findings from this study seem to support other research findings on that tactile sensations created by a vest equipped with tactile sensors, which is worn by poultry, are preferred by poultry over not wearing the vest.

TWO MOTIVATIONS FOR TECHNOLOGY MEDIATED HAI

All in all, there seems to be two main justifications that support the need for mediating relatedness and intimacy in human animal relationship with technology.

First, there seems to be a need for mediating relatedness and intimacy with technology when not co-located especially primarily based on humans' needs. Companionship is one of the main reasons for owning a pet in the Western world [42]. For owners being able to feel connected and close to their pets and care for them, as well as to feel related and even express relatedness can be important. This expression of relatedness and caring for an animal that is mediated by technology can potentially also lead to increased welfare of an animal. In addition, it may be possible that if technology is able to mediate relatedness in a form that is pleasurable to the animal in question, it can enjoy it as seems in the case of a solution for human-poultry interaction [20]. To this date, we do not have clear evidence or knowledge whether animals, such as dogs or cats, can understand expressing relatedness that is mediated by technology if they are not co-located with a human. There are also a number of species among animals that most likely do not share the feeling of relatedness with humans who care for them. They rather tolerate the presence and interaction due to the circumstances or get some benefit from the relationship, so the feeling of relatedness is not mutual or reciprocal.

Second, technology mediated human animal interaction can potentially contribute positively to animal welfare. For example, there is evidence that indicates that at least with certain species, tactile interaction with humans can be calming or rewarding for an animal, such as dogs, cats, poultry, and horses. These are all examples of domestic animals. In case of dogs, there are a number of reasons for lowered welfare as outlined previously. One of the most common reasons are anxieties, often related to fears and phobia. These could be eased or even treated with the aid of technology mediated HAI. While not being the only solution to solve these challenges and needs, technology based solutions could support these situations and be part of the therapeutic – including behavioral and medical - treatment of the animal.

FRAMEWORK FOR HAPTICS IN TECHNOLOGY MEDIATED HAI

Previous research indicates that touch can have a calming effect on animals. Technology mediated touch could therefore be used for calming of animals and reducing their anxiety. Relatedness and intimacy are inherent parts of human animal interaction in case of domestic animals and this relatedness can be mediated by tactile activities.

This section presents a framework to support considering the issues related to designing for haptics in technology mediated HAI. The same framework can be partly applicable for other senses as well.

Synchronicity – is the interaction synchronous or asynchronous? How fast should the interaction be to be considered synchronous? When is speed important?

Direction – is the interaction unidirectional (either human or animal creates input or receives output, but not both) or bidirectional (either human or animal creates input and receives output)?

Intentionality – is the interaction intentional (intentionally initiated) or unintentional (initiated unintentionally, automatically, or based on behavior, for example)?

Reciprocality – is the interaction consciously reciprocal or not? Can users learn based on using the solution that their input triggers some positive response or effect as output to themselves?

Awareness – are both users (human and animal) aware of each other if not co-located or do both of them need to be aware of the other partner of the interaction? Can users (human or animal) learn to become aware of each other to a certain level or fully when not co-located? Is a user (human or animal) aware that their action can trigger an output to another user or that the output they experience is created as an output by another user when not co-located?

Input and output – what is the input that triggers the interaction (e.g., is it touch, a tactile cue, or automated sensor based measuring behavior and changes in it)? What is the tactile stimuli like in terms of its naturalness, action, duration, velocity, abruptness, temperature, location, frequency, and extent of surface touched and place on the body? How is the stimuli captured (e.g., from natural tactile interaction) or designed to be mediated with technology?

CONCLUSIONS

Designing for animal welfare needs understanding of animal welfare. In addition, we need to consider what and how can be mediated with technology. Although the definition for interaction refers to mutuality or reciprocality, it does not seem necessary that human-animal interaction that is mediated by technology needs from both parties awareness. Neither does it require intentionality of the interaction, or intentionally initiated reciprocality, especially when considering animal in the interaction. Instead, the action or influence can be based on automatic feedback based on behavioral data, contextual data, or similar. Further work on designing for mediating relatedness and strategies to support it, and how to assess the impacts of interventions is needed.

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