Methodological considerations within ACI: Importance of canine participant selection

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ABSTRACT
This paper outlines work that critically evaluates usability study design within ACI, specifically in regard to canine participants. Usability studies are an established interaction design tool and considered an important part of the design process. Often, a specific element or elements of user interfaces may be examined in a lab environment to learn more about users' habits. However, when ACI practitioners desire to gain similar understanding of animal users, issues may arise; for example, experimental design leveraged in animal cognition research may not be appropriate due to a baseline of training required for many canine interfaces. On the other hand, end users are not always available for exploratory or more targeted testing. This work examines canine participant selection in an effort to understand issues and potential solutions to participant selection for usability testing with canine users.

Author Keywords
Animal Computer Interaction; Participatory Design; Theory; Methods; Human Computer Interaction

ACM Classification Keywords
1.2.1.5 Human-centered Computing: Interaction Design, Participatory Design

INTRODUCTION
Animal Computer Interaction (ACI) is a growing research area that continues to develop its own methodologies and processes, often borrowing and adapting from Human Computer Interaction (HCI). Within ACI, Canine Computer Interaction (CCI) involves designing technology for domestic dogs (both working and non-working) [4]. These technologies have aimed to support human-dog relationships [14, 15], support working dogs in their jobs [11, 12], and improve canine welfare [5, 13].

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It is widely accepted that user input is essential to good design. ACI practitioners, like user-centred design HCI practitioners, move from the assumption that the user should be involved in the design process. However, what this involvement looks like varies depending on the type of research. Many areas of CCI research call for usability testing with canine participants and exploration of different modes of interaction for different demographics of dogs. For example, researchers have explored touchscreens [16], bite-and-pull activation [11], button activation [7, 9, 12], and wearable interfaces [3, 6].

While exploratory studies are often important to identify potential applications of technology (and potential novel interaction modalities), on-going studies are also sometimes a necessary part of the design and evaluation process. As more systems continue to be developed for canine use, the usability of these canine interfaces and particular elements of their designs need to be tested in order to understand the ease of use for different groups of canine users. However, traditional experimental methods, so often leveraged in canine cognition research, may not always be appropriate in CCI. This is due to a baseline of training often being required for a dog to successfully interact with many canine interfaces. On the other hand, end users are not always available for exploratory or more targeted testing in CCI. Thus, there exists a tension between selecting participants from a population of dogs that is intended to actually use the resulting system, versus selecting from larger, more accessible pet dog populations.

This work thus examines canine participant selection in an effort to understand issues and potential solutions for studies involving development and testing of CCI systems. To do this, we briefly summarise participant selection in existing CCI work, noting where there has been a justification of the selection of specific participants. We then combine this survey of canine participant selection in existing literature with an initial methodological exploration conducted with professional dog trainers (n=4) and their dogs to further identify methods for CCI practitioners moving forward.

BACKGROUND
Here we review existing CCI work that has specific relevance to participant selection; either because the authors provide explanation or justification for their selection, or because they notably do not.

The first canine-computer system to move from a user-centred design perspective was Rover@Home, a two-way interactive "doggie webcam" that allowed human users to remotely dispense treats to a dog [10]. This work refers to usability testing as "clinical trials" and all canine participants had extensive clicker training backgrounds. However, the authors do not specifically address why this was the case, or indeed if this was necessary, such as a discussion of whether non-clicker trained dogs would be able to use the system.

Systems to Support Canine-Human Relationships

Later, a system called CAT (Canine Amusement and Training) created a multi-species game platform for dogs and humans. Here the authors provide brief reflection as to the participant choice: "Two canines participated in this evaluation and due to their sizes, were instrumented with two separate sensors." The authors did not specify whether they had intentionally selected differently size dogs or any other details as to the dogs' background or training [15]. In another system developed to support human-canine bonding, Baskin and Zamanksy [2], used two different canine participants of different size, age, and gender, but do not say if these differences were by design or simply due to participant availability. They do, however, give an explanation of the training given to the dogs prior to their participation in the usability testing (in preparation for the experiment, the dogs were trained to 'catch' moving virtual objects on the tablet screen using positive reinforcement with food reward). However, the canine participants' previous training backgrounds prior to the study are not described. Additionally, another project examined the use of a positioning system to study human-canine interaction, but made no mention of how the canine and human participants were screened or selected [14].

Systems to Support Working Canines

Most systems for canines with specialised jobs have had participants that were intended *end-users* for the application (that is, dogs that are part of the target demographic that the system was built for). For example, the FIDO project aimed to elicit requirements for wearable technology to support communication between working dogs and their handlers, thus selected trained assistance dogs as their participants (n=3). The work describes that the participants had already (prior to their involvement with the study) been trained with operant condition techniques, specifically shaping with positive reinforcement [6]. In another project to support working canines' communication with their handlers, Robinson et al. developed a specialised interface for Diabetes Alert Dogs, a contextualised interface that required working with end-users for its development [11]. As exploratory and ethnographic work, this study justifies its participant selection based on needing end-users of the system to be involved in the design process so as to identify where technological intervention should occur in the first place, and to then identify the best design for the particular problem that is being solved. Similarly, Mancini et al. [9] developed custom prototype button-switches for mobility assistance dogs and conducted an ethnographic study with 6 assistant dog trainers and their dogs as end-users (the work also included an additional case-study with one assistance dog and owner participant partnership that was in part selected because the owner worked within the research institution).

Zeagler et al. [16] conducted work towards designing a specialised touchscreen interface specifically for working dogs. Here, while the authors do not explain how the participants were recruited and selected, they do describe the backgrounds of the participants, describing that their first study included exclusively medium to large dogs, and that the dogs in their previous touchscreen studies were "pre-trained" with *targeting* (i.e., training that has resulted in the ability of a handler to ask a dog to direct pressure with a paw or nose to a specific object or target). In one phase of the study, a new participant dog trainer was added, so as to provide a "new pool" of participant dogs that had never seen the interface before.

Another project has designed novel interfaces for an additional kind of specialised canine worker: cancer detection dogs that are trained to examine cancer samples in a lab environment and determine the presence of cancer. Similar to other CCI exploratory work with domain-specific users, the particular subset of intended canine users had specialised knowledge and skillset, and again the researchers worked directly with actual end user canines and trainers (n=7, n=3) to explore the problem space and build a novel interface solution [9].

Other CCI Systems

Other work has explored touchscreen interfaces for dogs not to support them in working tasks, but rather to provide mental stimulation [13]. This work describes that a large number (n=265) of dogs and a smaller amount of wolves (n=20) were "trained to use the touchscreen in several different studies in several different labs." The work further describes that most of the dogs were "standard pet dogs", while 20 of the dogs were actually raised in a similar way to wolves. It does not go into any detail, however, why different dogs were chosen, and does not discuss any additional training that any of the dogs might have had.

Additional work has explored relationships between handlers and dogs through canine wearable trackers [14]. This study had 20 human users and 23 canine participants; the work described the range of participants, describing that there were varying human ages, lifestyles, and daily environments and as such the dogs' lifestyles varied accordingly. However, it was unclear if this variation was intentional or simply due to the natural variation of the participants that were available for the study.

Another study looked at leveraging mobile technology to increase adoption rates of shelter dogs [1]. The study had the selection criteria of dogs over 9 lbs (4.08 kg). This selection based on weight requirement was the result of the minimum

weight requirement to wear the commercial apparatus used in the study. Otherwise, the dogs (n=45) were selected only as they became available for adoption, due to the study specifically examining the effect of wearing the apparatus on a dog's long-term adoptability outlook.

CASE STUDY: DOGS AS INFORMANTS

To explore the potential for developing new methodologies for canine participant selection, we developed a new, exploratory approach as an exercise to help prepare a usability study. The usability study we used is one to compare different types of pressure-activated switch usability in dogs, so as to create a baseline understanding of different dogs' interaction experiences, both physical and cognitive, when working with pressure-activated interfaces. Rather than taking a common approach that has emerged in CCI, which is to select participants that are potential end-users of a contextualised technical application, we were interested in exploring new methods of how we could design a study and select participants. To this end, we collaborated with four dog trainers and their well-trained dogs, not to actually conduct usability testing on a specific system, but rather to help inform what sort of process could be efficient and effective for CCI researchers that need to bring in canine participants in non-contextualised, exploratory lab work with physical apparatuses. It was thus important that our participants had existing training that went beyond that of a pet dog, which is why we leveraged four local dog trainers.

Participants

In this context, by "well-trained" dog participants we mean more-than-normal pet training, whilst not being an actual professional working dog. Thus, we would expect some sort of extra, consistent training framework in place that would simply not be there for most pet dogs. Our dog trainers were available from existing collaborations and each trainer was asked to bring whichever of their dogs they would find most suitable or convenient for targeting work in lab setting. Three out of the informant four dogs (A, B, C) were trick trained, and three out of four dogs (B, C, D) were agility trained. Two were trained using verbal cues/markers (A, B) and two were trained using clicker training (C, D).

Process

We held co-located, unstructured workshops one at a time with each dog trainer and their dog. During these sessions, we discussed our study setup, primarily the environment and how it may affect canine participants. We also performed some initial "dry run" usability testing on different types of buttons (accessibility button-switches purchased off-the shelf). Our goal was not to collect data on the usability various switches, but rather to observe what was or wasn't effective about our setup and method.

We saw that all four dogs were able to interact with the switches, very likely due to their previous experience with target training. Additionally, since they already had a working relationship with their handler, most dogs either immediately, or very quickly after the session had started began *offering behaviours*, (that is, exploring their environment and looking to their handler for confirmation of what behaviour they might get rewarded for performing). In this sense, all four dogs were ideal participants for what we would want to be collecting data on (had they been there to actually collect data). However, that is not to say that there were not differences between the dogs and their interactions; there certainly were. But it did confirm that the baseline training the dogs already had meant they could "walk in the door" and immediately start performing specific usability tasks that pet dogs would simply not be able to.

Figure 1. Top: A canine participant is first exposed to a small button switch during a training session. The handler is pointing to the surface while giving the dog a (pre-trained) verbal command asking the dog to touch the button. Bottom: Another canine participant is requested to target the button, and uses both of her front paws to do so

Figure 2. A model of observed proportion of possible canine participants, with the top of the pyramid being the most helpful to researchers, and the bottom the least helpful, but also the most accessible.

DISCUSSION

We propose that based on these preliminary results, CCI practitioners could consider the following parameters when considering how they will design a CCI study, what sort of participants they will need access to, and over what time periods, starting from the primary question:

What is the context of our usability testing?

1. Are we hoping to identify a gap in technological assistance and determine the best modality or a new interactive system? *If so, using actual intended end-users as participants may be appropriate, if not necessary, even if it means a trade-off of having limited access or small participant numbers.*
2. Or, do we have a general system we already hope to implement but need to know how to select certain elements for it (for example, determine a particular material, size, shape, pressure, or other variable of an already-known baseline modality). *In this case, using participants that are not professional working dogs or end users may be appropriate, especially if large numbers of n are desired. Or, end users may be more appropriate, or a combination of the two.*
3. Or, do we already have a system we have developed, either because our requirements were well defined or because we are building off of other work, and we simply need to do usability testing to identify how effectively canine users are able to interact with our system, identify any problems or potential for improvements? *In this situation, context may be important (i.e., end-user canine and human participants may be necessary).*

From our preliminary work here, and survey of existing canine participant selection, we also posit that there is a 'sweet spot' that CCI practitioners should try to identify when it comes to participant selection in most (but not all) cases. This would involve optimising the accessibility of the canine participants as best as possible within the required skillset or training of the dogs.

Participant accessibility

As discussed, recruiting and using actual end-user dogs, or dogs with the same background and skillsets as intended end-users, is undoubtedly important in situations where work is being done to create novel designs and explore new applications. However, in some cases, it may be appropriate to 'start from scratch' with the training of non-expert canine participants, that is, recruit normal pet dogs with little or no specialised training, and teach them with a specific framework as part of the structure of an on-going study (this approach would not, however, be appropriate for studies that take place across only one or two sessions, as there potentially would not be enough time to train the dog participants, depending on the amount of baseline training required to participate).

While there may be more effort and time involved in training up non-specialised canine participants, it may be a good option or necessary option. This is because pet dogs, by comparison to specialised or certified working dogs, are significantly more plentiful and accessible. It is possible that even when a researcher has on-going access to specialised dogs such as K9-unit, search and rescue, and assistance dogs, there may still be more travel time involved and the time the dogs and their handlers spent in the research is directly taking away from time they are doing their current role, in contrast to pet dogs.

Modifying Existing Training

Another significant consideration, besides challenges of having access to canine workers and logistics outlined above, is protecting the training of existing working dogs. In terms of ethics, there are much greater implications of changing an active working dog's training (whose performance or lack thereof might put human lives at stake) as part of a study rather than a pet dog's. Thus, while in some circumstances likely appropriate or unavoidable depending on the technical application, the decision to alter a working canine's training should not be taken lightly.

"Natural" Interactions?

Additionally, our preliminary findings have raised questions about what it means to observe 'natural' behaviour in regard to dogs interacting with technology. A pet dog that doesn't have any training at all is essentially not an option for most usability training and will need a baseline of training even to participate, whereas a highly skilled active assistance dog or search and rescue dog may or may not tell us things about *natural* interaction, because they are so well trained at the present point in their career that they may try very hard to find a way to do what their handler asks, even if it is not intuitive or even comfortable.

This raises the issue that it is potentially challenging to capture 'natural' behaviours in dogs when the dog already has a baseline of training and a working relationship with their handler; it's hard to separate the training a dog has had with its own desires and behaviours. Thus, there exists a tension here, in that we want to know what dogs 'like' and can do naturally; but we also need trained dogs in order to accomplish any sort of directed usability tasks. When working with totally untrained dogs, researchers and handlers may have essentially no way to express to the dogs how they might be able to interact with a technological interface. Indeed, in many situations, it could be that the true "natural" behaviour of a non-trained pet dog is to simply ignore any objects that are not food or very toy-like. We note that there may be a subset of CCI projects that this issue does not apply to, such as smart toys, smart collars, or smart food bowls for pet dogs, and any other technologies that are specifically created for dogs to use without any training required.

LOOKING FORWARD

While the work outlined here is in progress, it has already exposed that there are many dimensions to canine participant selection, and that decisions made surrounding participant selection and study design can have significant implications depending on the approach taken. The authors posit that training is inextricably linked to canine participant's suitability for particular CCI studies. We propose that a screening questionnaire of some sort could be leveraged to effectively select canine participants, for example one that contains questions that avoid asking if a dog is 'well trained' or 'well behaved' but, rather if the dog has experience with a specific behaviour (such as trick training or advanced obedience work) or framework (such as positive reinforcement clicker training). The authors also propose a new methodology in CCI whereby researchers use canine informants to help design studies (not collect data) before actual data collection begins. This could be in the form of a pilot study.

CONCLUSION

One could argue that CCI practitioners should simply always work with end users as participants. This is potentially problematic because of the issues outlined here such as accessibility and potential harm to existing training. Taking into consideration the existing body of CCI work, specifically in relation to canine participant selection and screening, it is clear that moving forward, more consideration of different contextual factors, as well as more transparency and detail of the selection process and training for canine participants, is necessary.

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