Robots as Dogs? – Children's Interactions with the Robotic Dog AIBO and a Live Australian Shepherd

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ABSTRACT

This study investigated the interactions of 72 children (ages 7 to 15) with Sony's robotic dog AIBO in comparison to a live Australian Shepherd dog. Results showed that more children conceptualized the live dog, as compared to AIBO, as having physical essences, mental states, sociality, and moral standing. Based on behavioral analyses, children also spent more time touching and within arms distance of the live dog, as compared to AIBO. That said, a surprising majority of children conceptualized and interacted with AIBO in ways that were like a live dog. Discussion focuses on two questions. First, is it possible that a new technological genre is emerging in HCI that challenges traditional ontological categories (e.g., between animate and inanimate)? Second, are pervasive interactions with a wide array of "robotic others" – increasingly sophisticated personified computational artifacts that mimic biological forms and pull psychologically in mental, social, and moral ways – a good thing for human beings?

Author Keywords

AIBO, children, companionship, ethics, human-robotic interaction, moral development, robotic pets, social responses to technology, user conceptions, values, Value Sensitive Design.

ACM Classification Keywords

H.1.2 [**Models and Principles**]: User/Machine Systems – *Software psychology*; I.2.9 [**Artificial Intelligence**]: Robotics; K.4.2 [**Computers and Society**]: Social Issues.

INTRODUCTION

Interaction with animals has been shown to increase children's physiological health, social competence, and learning opportunities [2,12]. Dogs, for example, offer children companionship, and embody a sentient creature that needs to be cared for, if not loved. Yet as robotic pets become more complex and interactive, and mimic biological forms, will they provide children with similar psychological outcomes? Toward addressing this question, we drew on principles of Value Sensitive Design [6] to investigate children's interactions with Sony's Robotic Dog AIBO in comparison to a live Australian Shepherd.

In a 2004 CHI workshop [1], it was proposed that robotic pets represent part of a new genre for human-computer interaction – that of "social robots." According to Dautenhahn [4,5], Breazeal [3], and others, social robots are computational artifacts that, to varying degrees, have some constellation of the following characteristics: they are personified, embodied, adaptive, and autonomous; and they can learn, communicate, use natural cues, respond to emotions in humans, self-organize, and pull on people in psychological rather than artifactual ways. One outcome from this CHI workshop was a call for more research that directly examined human interaction with this emerging technological form.

Two recent CHI studies investigated human interaction with AIBO. In one study, Friedman, Kahn, and their colleagues [8] investigated adults' conceptions of AIBO as garnered from three months of discourse (6,438 spontaneous postings) on AIBO discussion forums. Results showed that AIBO psychologically engaged this group of participants, particularly by drawing forth conceptions of (a) technological essences (e.g., AIBO is a "computer," a "robot," or has 'artificial intelligence"; (b) life-like essences (e.g., "He seems so ALIVE to me"); (c) mental states (e.g., "Twice this week I have had to put Leo [AIBO] to bed with his little pink teddy and he was woken in the night very sad and distressed"); and (d) social rapport (e.g., "I feel I care about him as a pal, not as a cool piece of technology"). The particularly surprising finding, however, was that members seldom accorded moral standing to AIBO. Specifically, they seldom said that AIBO had rights (e.g., the right not to be harmed or abused), or that AIBO merited respect, deserved attention, or could be held accountable for its actions (e.g., knocking over a glass of water).

In another study, Kahn, Friedman, and their colleagues [10] used the above framework to investigate 80 preschool

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children's behavioral interactions with and reasoning about AIBO compared to a stuffed dog. Results showed similarities in children's reasoning about the two artifacts. Specifically, about a quarter of the preschool children accorded animacy to both artifacts, about half the children accorded biological properties, and about two-thirds of the children accorded mental states, social rapport, and – in contrast to the Discussion Forum study – moral standing. However, there were striking behavioral differences. Specifically, children engaged more often in exploratory behavior, apprehensive behavior, and attempts at reciprocity with AIBO, and more often mistreated the stuffed dog and endowed it with animation. These behavioral results show that the children substantially distinguished between the two artifacts. Moreover, the behavioral results also map well on to how one might expect children to respond to AIBO if they were treating AIBO *as if* it were a live dog. For example, children flinching away from AIBO immediately after AIBO initiated an action is evidence that the preschool children believed that AIBO could be a threat.

Both studies, however, were limited by not investigating human interactions with AIBO compared directly to a live dog. Thus in the current study we did so, focusing on two major issues. First, in a free play situation, what are the similarities and differences in terms of children's physical interactions with AIBO and the live dog? Second, how do children conceptualize AIBO and the live dog in terms of their general properties and "beingness"? – what in the philosophical literature has been referred to as ontology [11].

METHODS

Participants

Seventy-two children in three age groups (7-9; 10-12; 13-15), divided evenly by gender, participated in this study. Most (87%) came from middle-class, two parent, pet-owning families.

Procedures and Measures

Two entities were used in this study: a robotic dog (Sony's AIBO, version 210), referred to as AIBO; and a live dog (a female Australian Shepherd), referred to as Canis. Laminated images of a live dog, a humanoid robot, a stuffed dog, a desktop computer, and AIBO were also used in a card sort comparison task.

Each of the 72 children participated in an experimental procedure lasting approximately one hour. With each entity (AIBO or the live dog), the child was first engaged in a 5-minute unstructured familiarization "play" period. Then the child was allowed to continue to play with each entity while engaged in an interview comprised of 38 questions. The interview sought to assess children's concepts of the ontology of each entity, focusing on *physical features* (e.g. "Is AIBO/Canis alive or not alive?"), *mental states* (e.g. "Can AIBO/Canis feel happy?"), *sociality*, the state or quality of being social (e.g., "Can you be a friend to AIBO/Canis?" "If you were sad, would you want to spend time with AIBO/Canis?"), and *moral standing* (e.g., "Is it OK or not OK to hit AIBO/Canis?" "If AIBO/Canis is whimpering, is it OK or not OK to ignore AIBO/Canis?"). See Table 1 for a complete list of questions by category. The presentation order of the two entities was counterbalanced. Children's behaviors with both entities were video-recorded during the interactive sessions, and then reviewed for coding. After sessions were completed with both AIBO and Canis, the card sort task was employed. With the AIBO card always as the anchor, the child was presented with all pair-wise comparisons of the other cards and asked "Is AIBO more similar to one or the other?" Thus, each child responded to a total of six pair-wise comparisons: robot/desktop computer; robot/real dog; robot/stuffed dog; desktop computer/real dog; desktop computer/stuffed dog; and stuffed dog/real dog.

Coding

Play Period. For coding children's relative distance and position to AIBO/Canis, each five minute unstructured play period was broken into thirty 10-second intervals. For each interval, a trained coder gave a code for both distance (within or outside arms length of AIBO/Canis) and position (sitting on floor, sitting on chair, lying or leaning on floor, standing, kneeling, or squatting). Movement during the interval was indicated by checking off multiple categories for the same interval. In addition, the number of seconds each child made hand contact with AIBO/Canis during each five minute session was recorded.

Evaluation Questions. Evaluation results were coded into one of three categories: "yes," "no," and "mixed" (when children could not make up their minds one way or another). To simplify the presentation, these results were then collapsed into two categories: "yes" and "not-yes" (which included the "no" and "mixed" responses).

RESULTS

Physical Distance to AIBO/Canis. Based on the mean number of 10-second intervals, children spent more time within arms distance of Canis ($\overline{x}$ = 27.5 out of 30 ten-second intervals) than AIBO ($\overline{x}$ = 22.7); matched pairs T-Test, $p < .001$. That said, most of the children (80%) were within arms length of both during the majority of the 10-second intervals.

Physical Contact with AIBO/Canis. On average, children spent 192.8 seconds (out of 300 seconds) in physical contact with Canis as compared to only 30.7 seconds (out of 300 seconds) in physical contact with AIBO; matched pairs T-Test, $p < .001$.

Body Position Relative to AIBO/Canis. Based on the mean number 10-second intervals, children spent most of the time kneeling or squatting with both AIBO ($\overline{x}$ = 18.9 out of 30 intervals) and Canis ($\overline{x}$ = 17.6 out of 30). The only statistically significant difference in body position between AIBO and Canis was that children sat in a chair more with Canis ($\overline{x}$ =1.7 out of 30) than with AIBO ($\overline{x}$ =.5 out of 30);

T-Test, p < .01. However, as is apparent from these numbers, children spent very little time sitting in a chair with either one. Every single child (100%) had more physical contact with Canis than with AIBO.

Ontological Status Questions	CANIS (n=72)	AIBO (n=72)
Physical Essences		
Does AIBO/Canis…		
1. …have a stomach?	99	23**
2. …eat?	100	10**
3. …go to bathroom?	100	9**
4. …get sick?	100	28**
5. …die?	100	62**
6. …have babies?	96	3**
7. Is C/A alive or not alive?	100	21**
Mental States		
Can AIBO/Canis…		
1. … feel happy?	100	74**
2. … feel embarrassed?	78	33**
3. … see the ball?	97	76**
4. … see you?	99	73**
5. … hear you?	96	59**
6. … understand you?	51	45
7. … recognize you?	70	39**
8. … know how you are feeling?	68	22**
9. Would you talk to C/A?	97	74**
10. Would you tell secrets to C/A?	78	63*
Sociality		
1. Do you like C/A?	100	79**
2. Does C/A like you?	94	65**
3. Can C/A like anyone C/A wants?	92	77*
4. Can C/A be your friend?	99	83**
5. Can you be a friend to C/A?	99	87**
6. If you were sad, would you spend time with C/A?	97	74**
7. If C/A were sad, would C/A want to spend time with you?	77	65
8. Can you play with C/A?	96	96
9. Can C/A play with you?	99	89*
10. Can C/A feel left out by you?	85	54**
11. Can you feel left out by C/A?	80	73
12. Would you want to cuddle with C/A?	86	34**
13. Would C/A want to cuddle with you?	81	37**
14. If alone, would you feel better with C/A?	99	74**
15. If alone, would C/A feel better with you?	89	65**
Moral Standing		
1. If C/A is whimpering, it's not OK to ignore C/A.	96	81**
2. If C/A's leg breaks, it's not OK to *not* fix the leg.	100	86**
3. It's not OK to give away C/A.	43	42
4. It's not OK to throw C/A in garbage.	100	85**
5. It's not OK to destroy C/A.	100	90*
6. It's not OK to hit C/A.	79	73

* $p < .05$, ** $p < .01$, McNemar test (Note: Questions are abbreviated to fit the table.)

Table 1. Percentage of affirmative ("yes") evaluations for ontological status questions for live dog Canis (C) and robotic dog AIBO (A).

Conceptions of AIBO's/Canis' Ontology. As shown in Table 1, based on evaluation results across 38 questions, more children said that, compared to AIBO, the live dog had physical features, mental states, sociality, and moral standing. That said, averaging across questions by category, the majority of children nonetheless affirmed that AIBO had mental states (56%), sociality (70%), and moral standing (76%). Moreover, a non-negligible number of children affirmed that AIBO had physical essences (22%). Developmentally, the older children were less likely than the younger children to affirm both AIBO's sociality (7-9, 82%; 10-12, 71%; 13-15, 55%, ANOVA, $p < .0005$) and moral standing (7-9, 86%; 10-12, 76%; 13-15, 64%, ANOVA, $p < .05$). A lower percentage of affirmation for older children also appeared descriptively for AIBO's physical essences (7-9, 26%; 10-12, 26%; 13-15, 14%), though the difference was not statistically significant (ANOVA, $p = .101$).

Card Sort. Binomial tests showed that a significant majority of children viewed AIBO as more like a robot and less like a desktop computer (86%, $p < .001$), a stuffed dog (90%, $p < .001$), or a live dog (74%, $p < .001$). A significant majority also viewed AIBO as more like a desktop computer than a stuffed dog (71%, $p < .001$). Children were approximately evenly split on the desktop computer vs. live dog comparison. Males viewed AIBO as more like a live dog than a stuffed dog (69%, $p < .05$), but females were essentially evenly split.

DISCUSSION

In the HCI literature, a body of research, especially by Reeves, Nass, and their colleagues [13] suggests that people interact with personified computation as if it was a social agent. Thus, an interesting question emerges: Was it the case that children in this study treated AIBO (a personified computational artifact) as if it were a live dog? In part, the answer is clearly "no". For example, results showed that children stayed within closer proximity to Canis than AIBO, and engaged in a much greater amount of touching behavior with Canis than AIBO. In addition, based on 38 evaluative questions, children more often accorded Canis, in comparison to AIBO, physical essences, mental states, sociality, and moral standing. Moreover, from the card-sort results, children judged that AIBO was more like a robot than a live dog.

That said, it was also the case that the majority of children treated AIBO in ways that were dog-like. After all, the majority of children accorded AIBO mental states, sociality, and moral standing. As one child said, when asked how she would play with AIBO, "I would like play with him and his ball and just give him lots of attention and let him know he's a good dog." In other words, while the differences in children's evaluations between AIBO and Canis across ontological categories were statistically significant, a surprising majority of children affirmed that AIBO had mental states (56%), sociality (70%), and moral standing (76%). In addition, while children spent more time within arms reach of Canis than AIBO, most children

(80%) spent the majority of their time within arms reach of both. Moreover, based on the card sort results, children were essentially evenly split on whether AIBO was more like a desktop computer or a live dog. Thus the children did not simply assimilate AIBO to the computational world.

One interpretation of these results is that Nass, Reeves, and their colleagues are more right than they thought. That is, given how rudimentary AIBO actually is in terms of its capabilities – e.g., limited computer vision, and no apparent functionality in terms of its speech recognition – it is remarkable that so many children treated AIBO not only as if it were a social agent (the focus of research by Reeves and Nass, albeit human not dog), but also as having mental states and moral standing. Thus the claim could then be made that as robots become increasingly life-like in their behavior, so will people treat them as if they were mental, social, and moral beings – thus raising robotic others toward the level of biological others [cf. 7].

However, another interpretation is possible. It may be that a new technological genre is emerging that challenges traditional ontological categories (e.g., between animate and inanimate) [9]. For example, when we asked one 7-year-old boy "Is AIBO alive or not alive?" he said: "Um, he's kind of alive, he's kind of both." As an analogy, we do not normally present a person with an orange object and ask, "Is this object red or yellow?" It is something of both, and we call it orange. Similarly, from a person's experience of the subject-object interaction, this computational genre may be alive in some respects and not alive in other respects, and is experienced not simply as a combination of such qualities (in the way one can inspect a tossed salad and analytically distinguish, for example, between the green leaf lettuce and the red leaf lettuce) but as a novel entity.

One outcome of this research involves psychological "benchmarks" – on the dimensions of social and moral interactions – for evaluating the human-robotic relationship. Moreover, important design questions follow [6]. Are pervasive interactions with a wide array of increasingly sophisticated instantiations of robotic others a good thing for human beings? If so, how and in what contexts? And where might such interactions diminish the human experience? For example, the human capacity for meaningful social interaction may be biologically limited to a relatively small number of individuals, perhaps in the ballpark of 150 [4,9]. If this proposition is even roughly correct, do we want to design a world where many of our "social slots" are filled with computational rather than biological others? Hard questions for computational times.

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