Robotic Pets in the Lives of Preschool Children

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Abstract

This study examined preschool children's reasoning about and behavioral interactions with one of the most advanced robotic pets currently on the retail market, Sony's robotic dog AIBO. Eighty children, equally divided between two age groups, 34-50 months and 58-74 months, participated in individual sessions that included play with and an interview about two artifacts: AIBO and a stuffed dog. Results showed similarities in children's reasoning about the two artifacts, but differences in their behavioral interactions. Discussion focuses on how robotic pets, as representative of an emerging technological genre in HCI, may be (a) blurring foundational ontological categories, and (b) impacting children's social and moral development. More broadly, results inform on our understanding of the human-robotic relationship.

Categories & Subject Descriptors: 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.

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INTRODUCTION

Animals have long been an important part of children's lives, offering comfort and companionship, and promoting the development of moral reciprocity and responsibility [5]. Yet in recent years there has been a movement to create technological substitutes for pets, such as the Tamagotchi, i-Cybie, Tekno, and Poo-Chi. In turn, researchers have begun to ask if technological pet counterparts, now or in the future, can provide children with similar developmental outcomes [7,10].

In this study, we investigated preschool children's reasoning about and behavioral interactions with one of the most sophisticated deployed personal robots on the market – Sony's robotic dog AIBO. This artifact, AIBO, represents the integration of two long-standing areas of research within the CHI community. The first area involves computer persona that exist on the desktop computer or through voice interfaces, including virtual embodied agents and social responses to computer technology [8]. The second area involves computational artifacts (without a persona) that link people to a physical world, including augmented reality, tangible computing, and telepresence [4]. By bringing both areas of research together – through the use of computation to embed interactive persona into physical artifacts – personal robots represent a new genre for human-computer interaction.

Building on Friedman, Kahn, & Hagman [3], and principles of Value Sensitive Design [1,2] we sought data that would inform on how robotic pets (as representative of this emerging technological genre in HCI) may be (a) blurring foundational ontological categories, and (b) impacting children's social and moral development.

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METHODS

Participants

Eighty children participated in this study, equally divided between two age groups, 34-50 months and 58-74 months. There were equal numbers of males and females in each age group.

Artifacts

Two main artifacts were used in this study: a robotic dog and a stuffed dog. The robotic dog was Sony's version 210 AIBO, at the time of data collection (2001-2002) the most advanced robotic animal on the retail market. The stuffed dog was roughly the same size as the robotic dog and made of a soft-plush fabric. Both the robotic and stuffed dog were black-hued in color.

Procedures and Measures

Each of the 80 children participated in an individual session lasting approximately 45 minutes. One part of the session involved an interactive period with AIBO, and another part an interactive period with the stuffed dog (which we called SHANTI). The presentation order of the two artifacts was counterbalanced.

With each artifact (AIBO or the stuffed dog), the child first engaged in a short (2-3 minute) unstructured introductory "play" period. Then the child was allowed to continue to play with the artifact while engaging in a semi-structured interview. In order to limit the total number of questions asked of any one child – to fit within the 45-minute session – children by sex and age were randomly divided into two groups. One group was asked 10 questions that pertained to each artifact's *biological properties* (e.g., "This is a dog biscuit. Do you think AIBO will eat this?"), and *mental states*, including intentionality (e.g., "This is a doggie toy. I'm going to put it here. Do you think AIBO will try to get the toy?") and emotion (e.g., "Can AIBO feel happy?"). The other group was asked 12 questions that pertained to each

artifact's *social rapport*, including reciprocal friendship relations (e.g., "Can AIBO be your friend?" "Can you be a friend to AIBO?" "If you were sad, would you want to spend time with AIBO?"), and *moral standing* (e.g., "Do you think it's OK that I hit AIBO?" "Is it OK to leave AIBO alone for a week?"). Then every child was asked 5 questions about each artifact's potential *animacy* (e.g., "Is AIBO alive or not alive?" "Can AIBO die?"). The interviewer asked the questions in as relaxed a format as possible, with the child often engaged in playing with AIBO or the stuffed dog. We believed this method increased the ecological validity of the interviews.

Children's behaviors with both artifacts were video-recorded continuously during the interactive sessions, and then reviewed for coding.

Coding and Reliability

Building on coding categories from [3], a detailed reasoning and behavioral coding manual [6] was developed from half of the data and then applied to the entire data set. 17.5% of the data was recoded by a second individual trained in the use of the coding manual. Intercoder reliability was assessed through testing Cohen's kappa at the .05 significance level. All tests were statistically significant. For evaluations, k = .85 (Z = 18.02), and for behavioral responses, k = .76 (Z = 45.21).

RESULTS

Averaging evaluations within question type, about a quarter of the children accorded animacy to both artifacts (AIBO 25%, stuffed dog 20%), about half the children accorded biological properties (AIBO 46%, stuffed dog 48%), and about two-thirds of the children accorded mental states (AIBO 66%, stuffed dog 64%), social rapport (AIBO 76%, stuffed dog, 82%), and moral standing (AIBO 63%, stuffed dog 67%).

Children's behavioral interactions with the artifacts were coded with the 6 overarching categories and 22 subcategories listed in Table 1. Intercoder reliability was established at the level of the 22 subcategories. The six overarching categories are exploration, apprehension, affection, mistreatment, endowing animation, and an attempt at reciprocity. Table 1 also provides a definition, example, and representative still image from the video data of each category; the video figure provides clips of each behavioral category. In total, 2,360 behavioral interactions were coded, 1,357 with AIBO (58%) and 1,003 with the stuffed dog (43%).

Statistical results (using the Wilcoxon signed-rank test) showed that children engaged in a comparable amount of affection with both AIBO (294 occurrences) and the stuffed dog (310 occurrences). But otherwise, across the five other overarching categories, children differed in their behavioral interactions with AIBO and the stuffed dog. Specifically, children more often engaged in exploratory behavior with AIBO (221 occurrences) than with the stuffed dog (150 occurrences) (p = .013); more often engaged in apprehensive behavior with AIBO (143 occurrences) than with the stuffed dog (1 occurrence) (p = .000); more often engaged in attempts at reciprocity with AIBO (683 occurrences) than with the stuffed dog (180) (p = .000); less often engaged in mistreatment of AIBO (39 occurrences) than with the stuffed dog (184 occurrences) (p = .000); and less often engaged in endowing animation with AIBO (20 occurrences) than with the stuffed dog (207 occurrences) (p = .000).

DISCUSSION

There was no difference in children's evaluations that pertained to AIBO and to the stuffed dog. One interpretation of these results is that the children engaged in imaginary play with AIBO in the same way and to the same degree that they engaged in imaginary play with the stuffed dog. Yet this interpretation is called into question by our behavioral results. Namely, 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. 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 (e.g., standing, walking, or approaching the child) is evidence that the children believed that AIBO could be a threat. Our findings are of a piece with research in the field of human-computer interaction [8] which shows that with minimal social cues computers can pull for social responses.

Our results also support the proposition that a new technological genre may be arising that challenges traditional ontological categories (e.g., between animate and inanimate). This genre comprises artifacts that are *autonomous* (insofar as they initiate action), *adaptive* (act in response to their physical and social environment), *personified* (convey an animal or human persona), and *embodied* (the computation is embedded in the artifacts rather than just in desktop computers or peripherals). If we are correct, then it may be that the English language is not yet well equipped to characterize or talk about this genre. As an analogy, we do not normally present people with an orange object and ask "is this object red or yellow?" It is something of both, and we call it orange. Similarly, it may not be the best approach to keep asking people if this emerging technological genre is, for example, "alive" or "not alive" if from the person's experience of the subject-object interaction, the object is 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. Thus the human-computer interaction question for the future may not be, "Do young children treat such new technologies as either X or Y?" (e.g., animate or inanimate, having agency or not, or being a social other or not) because the answer may not be

Table 1. Coding Categories for Behavioral Interactions

Behavioral Category	Definition and Example	Still Image from Video
1. Exploration 1.1 Anatomy Check 1.2 Touch/Move Limbs 1.3 Demonstrate w/ Artifact 1.4 Feed	Reference to the child's visual or tactile exploration, manipulation, inspection, pointing, and feeding of the artifact. *E.g., child explains to the interviewer that AIBO is a boy while inspecting the hind-quarters of AIBO.*	
2. Apprehension 2.1 Startle 2.2 Wariness	Reference to the child exhibiting a startle response, wariness, or other intentional movement away from the artifact. *E.g., child touches AIBO's head, AIBO begins moving, and child reacts with startle.*	
3. Affection 3.1 Non-exploratory Touch 3.2 Pet 3.3 Scratch 3.4 Kiss 3.5 Embrace 3.6 Verbal	Reference to the child engaging in petting, scratching, kissing, carrying, embracing, and one-way verbal greetings to the artifact. *E.g., child squeezes the stuffed dog in a big hug.*	
4. Mistreatment 4.1 Rough Handling 4.2 Thumping 4.3 Throwing	Reference to the child's behavior showing disregard for the artifact, including rough handling (e.g., hitting, squishing) and throwing. *E.g., child swings the stuffed dog overhead and then thumps it to the floor.*	
5. Endow Animation 5.1 Vocalize 5.2 Movement 5.3 Object-oriented Play 5.4 Feed	Reference to the child enlivening the artifact in order to perform a behavior or action with it, including making sounds and moving the artifact around. *E.g., child throws the doggie toy and says "Go get it!" Then child picks up the stuffed dog and begins to hop it toward the toy.*	
6. Attempt at Reciprocity 6.1 Motion 6.2 Verbal 6.3 Offering	Reference to the child's behavior not only responding to the artifact, but expecting the artifact to respond in kind based on the child's motioning behavior, verbal directive, or offering. *E.g., AIBO is searching for a ball. Child observes AIBO's behavior and puts the ball in front of AIBO and says, "Kick it!"*	

one or the other. Rather, what may be needed is a more nuanced psychology of human-robotic interaction that can uncover emergent categories in children's understanding of and relationships with this potentially new technological genre.

In the moral developmental literature [9], reciprocity is central to moral development, setting into motion concerns for the wellbeing of others and the construction of equality, fairness, and justice. Thus it was surprising to find that almost half of the children's behavioral interactions with AIBO involved an attempt at reciprocity (668 occurrences). While children may form certain types of moral relationships with robotic pets, it is our supposition that the nature of these relationships will be impoverished in several ways. First, what does it mean to morally care about an entity that (as the majority of the children recognized) is not alive? In this sense, a person can "care" very deeply about a car they have owned for decades, and cry when it is finally towed to the junkyard; but that would seem to us a derivative form of caring, supported only by the person's projection of animacy and personality onto the artifact, concepts which may first have to be developed in the company of sentient others. Second, to the extent interactions with the robot partially replace children's interactions with sentient others, and as long as the robot only partially replicates the entire repertoire of its sentient counterpart, then such interactions may impede young children's social and moral development.

Future studies could move in a number of important directions. One direction would be to conduct research that compared children's reasoning of and behavior with AIBO in comparison to a live dog (rather than a stuffed dog, as in the present study). Another direction would be to investigate differences in children's relationships with robotic humanoids compared to robotic animals. It is our intuition that because people do not expect full social responsiveness from animals, that children (and adults) will find human-animal robotic relationships more satisfying than human-humanoid robotic relationships, especially until the robotic technology is able to mimic more realistically human behavior.

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