Can Children Have a Relationship with a Robot?

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Abstract. As the development of autonomous robots has moved towards creating social robots, children's interactions with robots will soon need to be investigated. This paper examines how children think about and attribute features of friendship to a robot. A total of 184 children between ages 5 to 16 years visiting a science centre were randomly selected to participate in an experiment with an approximate even number of boys and girls. Children were interviewed after observing a traditional small 5 degree of freedom robot arm, perform a block stacking task. A set of experiments was conducted to measure children's perceptions of affiliation with the robot. Content analysis revealed that a large majority would consider a relationship with the robot, and participate in friendship-type behaviors with it. Significant sex differences in how children ascribe characteristics of friendship to a robot were also found.

1 Introduction

Children's play time has changed significantly in recent decades. Leaving behind exploratory play in open fields, rivers and forests, children now spend the majority of their leisure time in a house, with some form of advanced technological device. Gaming systems provide highly engaging and interactive entertainment; computers are in widespread use for education, game play; and the Internet offers a medium for social support, identity exploration, and development of interpersonal and critical thinking skills, along with educational advantages due to extensive access to knowledge and worldwide cross-cultural interactions. Children spend 2-4 hours each day immersed in these forms of 'tech play' (Media Awareness Network, 2005). Another tech toy not yet on the market for widespread use but having a significant presence is robots. Millions of dollars in development are being spent on creating robots for various purposes including utilizing them as social and functional companions [1]. With some successful introduction of robots as toys to children it is plausible that in the near future children will spend significant amounts of time with them. Given the importance of play as a source of socialization for children, combined with the human need to feel connected to others through relationships, it is plausible that when interacting with a robot, children would develop an affiliation with it.

Children's use of and interactions with robots has, as of yet, received almost no attention in the research. Robots are computer operated machines that perform

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complex tasks. Children are becoming increasingly adept at operating computers and spend considerable time doing so. According to Statistics Canada, in 2000, 82% of parents reported that their children (aged 5 to 18 years) use computers. Studies have investigated the implications of computer usage on their physical and psychological well-being. Results are mixed documenting adverse/positive as well as no effect outcomes. While it remains unclear as to how computer use is related to children's social development, research has also to examine how children's interactions with robots affect their development. In recent years, robots have started being developed to mimic human behavior; thus, it is possible that when children interact with a robot they may develop friendship feelings towards it [2]. According to [3], children who regularly use electronic devices are more likely to attribute psychological characteristics to such devices. A recent study by Melson examined children's understanding of robotic (Sony's AIBO) versus living animals [4]. These studies suggest that children may treat technological devices as if they were social beings, which suggests the existence of a child-robot companionship. The development of friendships in childhood is crucial to subsequent mental and physical health. Thus, it is crucial to understand children's perceptions of friendship they may have in relation to a robot. The purpose of this paper is to explore whether children can have a relationship with a robot. For this we conducted a series of studies. The purpose of each was to determine how children perceive and engage with a robot.

2 Method

A series of experiments was conducted. Each one consisted of approximately 150 children who were visitors at a science centre in a major Western Canadian city. The set up consisted of a robot exhibit at the science centre in an enclosed and private space, 10 by 7 feet, for the experiment. It included a dextrous robotic arm with a chair facing it where each child sat and observe the robot completing a task. The robot was covered in foam and corrugated plastic to create a face with eyes, ears, and a mouth to appear pleasing to look at. The robot performed a block stacking task. Children observed the robot during this task and were able to assist stacking the blocks. Researchers observed their behaviours during the tasks and interviewed them at the end of the task.

2.1 Sample and Procedure

A total of 184 children (n = 98 female, n = 86 male) between the ages of 5 to 16 years (M = 8.18 years) were included in the study. Children were living in a medium to large city. Data collection occurred during the science center's opening hours for about 2 months. Families with a child in the specified age range were approached by a researcher and asked if their children would like to visit with a robot. Then the accompanying guardian was asked to sign a consent form. The researcher then escorted the child independently into the robot exhibit. The response rate was approximately 95%.

The robot exhibit was built with heavy curtains and dividers designed to reduce noise and discourage interruptions by visitors. There was also an adjoining space

behind a divider where the experimenter was located with 2 laptops. One laptop was mainly used to control the robotic arm while performing the task. The 2nd laptop was connected to a camera mounted on the wall behind and to the side of the robot. This allowed researchers to observe the child from behind the divider.

Children were not informed that they were being watched through the camera, and few noticed it. The researcher escorted the child behind the curtain and gave the request to be seated on the chair in front of the robot. The child was then informed that the researcher would be right back and then went behind the divider. The researcher then commanded the robot to execute a specific task and observed the child, whose behaviours were documented on a record form. Once the robot stopped, the researcher returned to the child and conducted an interview.

2.2 Description of Robot

The self-contained electric D.C. servo driven robotic arm used was a CRS-Plus small 5 DOF articulated arm. During the experiment the robot stacked small rectangular wooded blocks weighing only a few grams. The robot joints include a speed setting (both program and hardware) set to slower speeds for safety purposes. For added safety, children were positioned outside of the robot's workspace at all times. Gender neutral colors yellow, white, and black were chosen. To ensure that the robot appeared to pick up blocks with its mouth, the gripper of the arm was covered with a head so that its grip was situated in the mouth (Fig. 1). The rectangular blocks that the robot picked up were 2cm x 2cm x 4cm. They were placed in a line to the side of the robot in the craft foam that covered the platform. The robot's head was positioned raised to the height of the child, appearing to 'look' at the child.

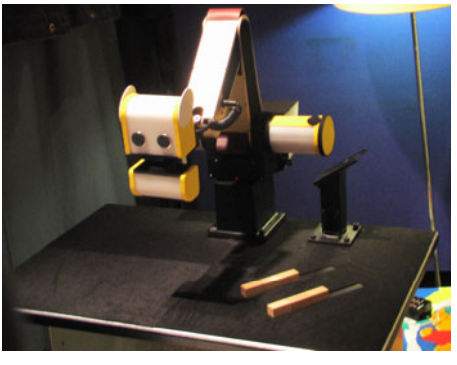

Fig. 1. 5 DOF robot platform with blocks

The robot was pre-programmed and then controlled at the science centre by a researcher via a GUI. The tasks performed by the robot consisted of stacking a number of blocks with a number of variations while doing so (e.g., dropping a block by slightly opening its grip as it turned toward the child). When this happened the robot would move back and forth to 'look' for the block it dropped making diverse attempts to pick it up. All movements were programmed to be smooth and included some form of interaction with the child (e.g., looking at him/her).

3 Analyses/Results

Chi square and content analyses were used to analyze the data in the studies. The first study asked six open-ended questions about whether children perceive the robot as possessing human characteristics. Regarding its cognition, about half of the children stated the robot would remember them, and more than a quarter thought it knew how

they were feeling. In terms of its affect, more than half of the children thought the robot liked them and that it would feel left out if not played with. In their behavioral descriptions, more than a third of the children thought it could see the blocks, and more than half of them thought the robot could play with them. Given that these 'human' abilities are expressed in typical relationships, and that many children considered the robot to be capable of these abilities, it is possible that children can develop a sense of affiliation in a relationship with a robot.

The second study observed children to determine whether and under what conditions they would show prosocial (i.e., helping) behaviours towards a robot. About half of the children assisted the robot with stacking the blocks and they were mostly likely to do so when an adult engaged in a friendly discussion with the child and then provided a positive introduction of the robot before the robot began the task. We interpret this result to suggest that the introduction allowed some opportunity for the adult and child to develop rapport. Then upon the child seeing the adult talk in a positive way about the robot this may have fostered a connection between the child and robot. This study suggests that children's relationship with a robot (at least in the form of helping behaviours initiated towards a robot) may be fostered by an adult.

In the third study children were interviewed and asked whether they would consider a robot to be a friend. The majority of children stated they would consider a friendship with the robot, and participate in friendship-type behaviors with it.

3.1 Use of Electronic Devices

A total of 95.5% of children (n = 169, n = 7 missing) stated they watch television, 81.9% of children (n = 145, n = 7 missing) reported playing on a computer at home, and 84.5% (n = 147, n = 10 missing) indicated they had electronic toys (e.g., robotic dog, remote control cars). Thus, the majority of children demonstrated familiarity with electronic devices.

3.2 Positive Affiliation

More than half of the children (64.0%) stated the robot liked them (Table 1). Other children thought the robot had positive intentions (e.g., "he wanted me to know my numbers by counting blocks"). Absence of harm was another reason for thinking the robot liked them (e.g., "never tried to bite me"), and their kind actions towards the robot led them to believe the robot would like them (e.g., "I encouraged the robot"). Few children (8.7%) stated the robot did not like them, citing reasons such as it ignored them and not allowing them to help it. There was no significant difference between the number of girls (n = 60) compared to boys (n = 58) who thought the robot like them, X 2(1) = 0.28, $p > 0.05$. In addition to feeling liked, 85.9% of children believed that the robot could be their friend and provided a variety of explanations (Table 1). Some children also judged their friendship with a robot based on their friendly acts towards it (e.g., "saying hi to the robot"). Few children (10.3%) indicated that a robot could not be their friend due to its limited abilities to move, communicate, or understand their thoughts or feelings. There was a significant difference found with more girls (n = 90) than boys (n = 68) saying the robot could be their friend, X 2(1) = 4.40, $p < 0.05$, effect size (Φ) = 0.15.

Table 1. Number and Percentage of Children Reporting Positive Affiliation with Robot ($N = 184$)

Robot likes you		Robot can be your friend	
Yes	118 (64.0%)	Yes	158 (85.9%)
Looks/smiles at me, friendly	38	Conditional	31
I was nice/did something nice	20	Being or doing things together	30
Did not hurt me	13		
It had positive intentions	9	Helpful	17
		Knows me	12
Do not know why	33	Kind	11
Not coded	5	Friendly	6
No	16 (8.7%)	Likeable	7
No thoughts/feelings	4	Friend to robot	4
Ignored me/didn't let me help	10	Do not know why	28
Do not know why	2	Not coded	12
Not coded	0	No	19 (10.3%)
Do not know	50 (27.3%)	Limited mobility	3
		Limited communication	2
		No familiarity	3
		No brain, feelings	4
		Do not know why	4
		Not coded	3
		Do not know	7 (3.8%)

3.3 Shared Activities

A vast majority of children (83.7%) stated they would play with the robot and provided a variety of ideas about how they would play together (Table 2). Most often mentioned were games of construction such as building towers. Several active types of games were also suggested including playing catch or fetch with a ball. Less physically intensive games were also identified such as playing board games. Several other suggestions included video games, coloring, and hand games. Few children (13.6%) stated they would not play with the robot with most of them stating it was due to its physical limitations (e.g., no legs). There was no significant difference between the number of girls ($n = 80$) and boys ($n = 74$) who stated they would play with the robot, $X\ 2(1) = 0.88$, $p > 0.05$.

3.4 Communication and Secrets

More than half of the respondents (67.4%) indicated they would talk to the robot (Table 3) because they like the robot or to become acquainted with it. Many children stated the condition that if the robot could talk, then they would talk. More than a quarter of the children (28.8%) stated they would not talk to the robot due to the fact that it could not talk or hear. There was a significant difference found with more girls

(n = 70) than boys (n = 54) saying they would talk to the robot, X 2(1) = 18.56, p <0.05, effect size (Φ) = 0.32.

In terms of secrets almost half of the children (45.7%) stated that they would tell the robot secrets and provided a variety of reasons (Table 3). Some children thought the robot would respond positively to secrets (e.g., "robot would remember them"). Half of the children (50.0%) stated they would not tell the robot secrets. Others stated that the robot has limitations preventing them from sharing secrets (e.g., "robot can't understand"), or that the robot is not trustworthy (e.g., "robot might tell"). There was a significant sex difference showing that more girls (n = 59) than boys (n = 25) would tell the robot secrets, X2(1) = 19.52, p < 0.05, effect size (Φ) = 0.33. Given that 24 children stated they would not tell secrets to anyone, we examined whether most of them were boys, as a possible explanation for why more girls would tell the robot secrets. There was no significant difference in the number of boys compared to girls who thought secrets should not be told, X2(1) = 1.49, p > 0.05.

Table 2. Number and Percentage of Children Reporting Support and Activities with Robot (N = 184)

Robot can cheer you up		Play with robot*	
Yes	145 (78.8%)	Yes	154 (83.7%)
Perform action for me	61	Construction	103
Perform action with me	12	Ball game	26
Cheerful appearance	20	Running game	12
Connects with me	20	Board game	12
Help me	7	Other	17
Do not know why	17	Do not know why	5
Not coded	8	Not coded	5
No	27 (14.7%)	No	25 (13.6%)
Limited abilities	16	Physical limitation	11
Does not like me	1	Other	4
Do not know why	8	Do not know why	6
Not coded	2	Not coded	4
Do not know	12 (6.5%)	Do not know	5 (2.7%)

Table 3. Number and Percentage of Children Reporting Communication with Robot (N = 184)

Talk to robot		Tell robot secrets	
Yes	124 (67.4%)	Yes	84 (45.7%)
I like the robot	16	Robot will keep secret	30
To get to know each other	6	Friendship with robot	13
Robot has mouth	6	Positive response to secret	7
If robot could talk	22	Other	4
Gave examples	30		
Do not know why	37	Do not know why	22
Not coded	7	Not coded	8
No*	53 (28.8%)	No	92 (50.0%)
Robot cannot talk	20	Secrets are wrong	24
Robot cannot hear	6	Robot has limitations	18
Not human	5	Robot not trustworthy	24
Looks unfriendly	9	Robot is not alive	9
Do not know why	11	Do not know why	12
Not coded	4	Not coded	5
Do not know	7 (3.8%)	Do not know	8 (4.3%)

* Some children provided more than one reason.

To determine the extent to which the different types of relationship characteristics are related, correlational analyses were conducted (Table 4). Children who thought the robot could be their friend were also likely to report that they would play with it, talk to it, and tell it secrets among other things. Many of these variables were low to moderately inter-correlated. Moreover, these results suggest that children who stated they would engage in these behaviors towards a robot, were also likely to state that robots could engage in these behaviors towards them.

Table 4. Spearman's Rank Correlation Coefficients of Friendship Characteristics (*N*=184)

	1.	2.	3.	4.	5.	6.
1. Likes you	1.00					
2. Friend	.34**	1.00				
3. Cheer up	.16	.49**	1.00			
4. Play	.20*	.36**	.16*	1.00		
5. Talk	.09	.35**	.40**	.23**	1.00	
6. Tell secrets	.17*	.31*	.31**	.20**	.34**	1.00

** p < .01 *p < .05.

4 Discussion

The above sources of evidence present some indication that children may develop a relationship with a robot. In many ways they regarded the robot as human: capable of friendship; possessing cognition, affect, and behaviour; and they provided assistance to it in much the same way they would towards a person who needs help. Across studies children seemed to project their own understanding of human capabilities onto the robot and expectations that the robot has these capabilities. We can interpret these results to suggest that children are inclined and open-minded towards interacting with and developing a relationship with a robot.

People experience many different types of relationships with people in their lives. Will a child-robot relationship be similar to a child-peer relationship? This is not likely, but rather may be a unique relationship that meets a basic human need of connection. Given the limited research in the area within the robotics scientific community at this point, based on our studies reported in this manuscript, we can only speculate as to how children would experience a relationship with a robot. Would they develop a sense of dependency on it for assistance with daily responsibilities such as homework and house chores? Would they seek it out for companionship to share experiences together such as playing computer games? Would they become resentful towards it because it would possess endless facts that they have to expend tremendous effort learning at school? Would they prefer to spend time with the robot than with family members and friends? As robots become increasingly sophisticated they will likely become integral in the daily lives of both adults and children. Although the construct of friendship in context with a robot is complex, our studies provide preliminary insights into the very possibility of this occurring! The nature and impact of a child-robot friendship clearly warrants considerable future research.

We asked children if they would engage in friendship-type behaviors with a robot. The majority of children responded affirmatively to a number of related questions in the areas of sharing activities (playing), communicating, etc. The extent to which these characteristics are related to friendship was examined.

Although our exploratory study provides evidence of characteristics of children's friendships applicable to child-robot relationships, there are some limitations. First, children experienced a brief interaction with the robot which may have created some initial excitement that may not be maintained over a longer period, which more accurately reflects a friendship. Thus, alternate characteristics other than those used in the present study should be explored in future research. Second, results of our study are based on children's own reports of their sense of friendship with a robot. Although this is the predominant means of researching friendship, these results must be substantiated with observations of children friendship-based behaviors towards a robot [5]. Also, it is possible that a social desirability effect occurred whereby children felt compelled to respond favorably to the questions about the robot. It would be worthwhile in future research to determine if children would respond similarly about the robot to someone who was seemingly unrelated to the robot exhibit. Third, children observed a robot conduct a task unsuccessfully, thereby eliciting a possible need for assistance from the child. This type of engagement, although prevalent in child-child relationships, may have created a sense of vulnerability and inclination towards friendship with the robot. Replication with other robots, differing tasks, and in a context outside of the science centre is needed. Our robot was not as sophisticated as more recently developed robots, so it is rather remarkable that children held thoughts in favor of friendship towards it. The method of our study is based on the premise that a willingness to engage in activities together with a robot suggest that children would befriend one.

Thus, we conclude that many children *may* be friend a robot given the large number of children who responded affirmatively to our questions, while future research must examine whether children actually do befriend a robot. In addition, we cannot conclude from these results that children's experiences of friendship with a robot are similar to those with another child. Research has yet to explore similarities and differences between child-robot and child-child friendships. Our study demonstrates that children are willing to perceive themselves as befriending robots – that is, as social beings. The majority of children believed that the robot liked them and could be their friend.

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