Autonomous Movement Predicts Children's Moral Regard and Prosocial Behavior Towards a Social Robot Dog

Nadia Chernyak (nc98@cornell.edu)
Human Development, Cornell University
Ithaca, NY 14853 USA

Heather E. Gary (heg38@uw.edu)
Department of Psychology, University of Washington – Seattle
Seattle, WA 98195 USA

Abstract

Young children are remarkably prosocial towards humans. However, it is less clear what drives children's prosociality towards non-human others. Here we explore the possibility that children's moral regard stems from their understanding of others as autonomous beings. To investigate this possibility, we asked five and seven-year-old children to interact with a robot dog that appeared to be either moving autonomously (displaying self-generated movement), or appeared remote-controlled by the experimenter. Compared with controlled robot, the autonomous robot caused children to ascribe higher emotional and physical sentience to the robot, to reference the robot as having desires and physiological states, and to reference moral concerns as applying to the robot. Children who owned a dog at home were also more likely to behave prosocially towards the autonomous robot. Results imply a potential role of technology on children's developing social cognition and prosocial behavior.

Keywords: human-robot interaction, autonomous movement, preschoolers, prosocial behavior, moral cognition

Introduction

"It's a machine, Schroeder. It doesn't get pissed off, it doesn't get happy, it doesn't get sad, it doesn't laugh at your jokes…" – Short Circuit, 1986

At the crux of the movie Short Circuit, lay the philosophical dilemma of whether a robot, Number 5, should be saved from disassembly. Some felt that No.5 had displayed emotional sophistication proving it worthy of moral regard, while others felt that No.5 was merely a tool, no more worthy of being helped than a stereo or a vacuum cleaner.

Although such philosophical dilemmas are most dramatically portrayed in movies, determining who and what is worthy of our moral regard is a critical cognitive achievement. In present day, young children are increasingly bombarded with interactive social technologies (e.g., Furbys, iPads, Roomba vacuum cleaners) that are designed to interact with humans in a range of life-like ways, some of which include the ability to move around autonomously (Kahn, Gary, & Shen, 2013). Due to their relative historical novelty, the manner in which such technologies are presented to young children is understudied. As such, little is known about how presenting technology to young children impacts their conceptions of and regard for it. In this work, we explore how a brief five-minute interaction with an either autonomously moving or controlled robot impacted children's beliefs in the robot as a sentient being, endorsement of the robot as having moral standing, and prosocial behavior towards the robot.

Our research question motivated by two concerns. First, we wished to understand the developing link between our moral cognition and our understanding of others as sentient beings (see Gray, Gray, & Wegner, 2007 and Sytsma & Machery, 2012 for demonstrations of this link with adults). Robots share similarities to agents across a wide array of features. A large body of literature has found that even in infancy, children make social evaluations of entities based on such features, including eyes (Hamlin, Wynn, & Bloom, 2007), contingent interaction (Beier & Carey, 2014; Johnson, Slaughter, & Carey, 1998), and goal-directed movement (e.g., see Gergely & Csibra, 2003; Heider & Simmel, 1944; Saxe, Tenenbaum, & Carey, 2005; Woodward, Sommerville, Gerson, Henderson, & Buresch, 2009; see also Gao, McCarthy, & Scholl, 2010 for a demonstration with adults). In fact, many of these studies arguably employ social robots (e.g., Beier & Carey, 2014). Interactive technologies present a unique problem as they often display all of these cues, and yet, at least by adults, are not considered to be sentient beings worthy of our moral regard. Therefore, a second possibility is that higher order concerns, such as whether an entity is "alive," sentient, or autonomous, plays into children's moral regard for it.

Second, we wished to disambiguate prior work examining children's conception of social robots. On the one hand, when prompted to interact with and talk about social robots, children have been known to show a domain-confusion, and fail to conceptualize robots neatly as the artifacts they are or the living beings they emulate (Crick & Scasselatti, 2010; Kahn et al., 2012; Kahn, Friedman, Perez-Granados, & Freier, 2006). Such work has largely focused on children's ability to form relationships with, and thus conceive of robots as moral and social beings. On the other hand, when asked forced-choice questions about robots' basic biological and psychological properties, children appear to understand that robots lack in such properties, and thus separate robots from prototypically "living" entities such as degus or starfish (Jipson & Gelman, 2007).

One possibility for the seemingly disparate results may therefore concern the difference between behavioral, explanatory, and forced-choice responses (see Wellman, 2011). Another possibility is that children may understand robots as non-living, but nonetheless be unable to inhibit their moral regard for them. After all, children have been shown to be prosocial even towards animal puppets (e.g., Aknin, Hamlin, & Dunn, 2012; Chernyak & Kushnir, 2013; Vaish, Missana, & Tomasello, 2011). Finally, a third possibility, and one that we were most interested in exploring, is that the manner in which robots are presented to young children can have important consequences for how they are conceptualized. In an important demonstration, Somanader, Saylor, and Levin (2011) showed that preschool-aged children ascribed biological capacities to robots, but not when the mechanism controlling the robots (i.e., remote control) was made apparent (see also Gelman & Gottfried, 2008). Here, we use a similar manipulation to examine children's understanding of robots across a broad battery of questions (forced choice, explanatory, and behavioral).

In this study, we asked two groups of children: those who had not yet entered formal schooling (5-year-olds) and those who had (7-year-olds), to interact with a social robot that appeared to move in one of two ways: either in a *controlled* manner (via a remote control held by the experimenter) or *autonomously* (with no remote present). We chose these age groups on the basis of prior work, which has found that the ages of 4-7 are associated with changes in children's perceptions of robots (Bernstein & Crowley, 2008) and children's abilities to share fairly (Smith, Blake, & Harris, 2013).

We expected that children would be more likely to view the autonomous robot as sentient and worthy of moral regard, despite the fact that the surface behaviors of the robots were identical across conditions. To test this prediction, we introduced children to the robot and then assessed their beliefs about three dimensions related to moral regard: (1) Emotional and Physical Sentience, (2) Moral Standing, and (3) Prosocial Behavior. Dimensions (1) and (2) were assessed through both forced-choice and explanatory responses; dimension (3) was assessed through behavioral responses.

Method

All children were interviewed individually in a quiet corner at a summer camp.

Participants

Participants were eighty children (40 5-year-olds; M = 5.50, SD = .30; and 40 7-year-olds; M = 7.35, SD = .36; 50% female), recruited from a local summer camp.

Introduction

Because we reasoned that children's understanding of robotic others may depend on their prior experience, all children were asked whether they had a *real dog* at home.

Interaction

All children then took part in a 5-minute interaction with a robot dog, AIBO. Children were first introduced to the robot dog ("I want to introduce you to AIBO") by being shown the robot, and informed that they will be playing with it. All children then watched AIBO engage in 12 separate behaviors (programmed to proceed in a randomized order): waking up, sitting down, kicking a ball, head-butting a ball, moving its head around, walking, making sounds, whistling, shaking its head no, giving a paw, and waving hello.

Manipulation

Forty-one children ("Autonomous movement" condition) heard the experimenter narrate AIBO's behavior in a way that was consistent with autonomous movement (e.g, "AIBO is kicking the ball.") The other half (39 children; "Controlled movement") saw AIBO engage in identical behaviors, but the experimenter appeared to be remotely-controlling the robot via a video-game controller and narrated AIBO's behavior in a way that was consistent with experimenter-generated movement ("I made AIBO kick the ball."). There were equal distributions of age groups and genders in each condition.

Dependent Measures

We inquired about three dimensions related to children's moral regard: (1) Emotional and Physical Sentience; (2) Moral Standing; and (3) Prosocial Behavior. Questions were adapted from prior work assessing children's conceptualization of robotic others (Jipson & Gelman, 2007; Kahn, Friedman, Perez-Granados, & Freier, 2006; Kahn et al., 2012), moral reasoning (Smetana, 1983), and prosocial behavior (Chernyak & Kushnir, 2013). The questions and coding scheme is described below and can be accessed here.

Emotional and Physical Sentience The *forced choice questions* included questions about AIBO's capacity to feel physiological sensations ("If you tickle AIBO, can AIBO feel it?"), physical and emotional pain ("If AIBO fell on the ground, could he get hurt?"; "If someone was mean to AIBO, could AIBO get upset?"), and neglect ("Is it OK or not OK to leave AIBO in a closet for a week?"). We additionally included a categorization question in which we asked whether AIBO was more similar to an agent (a real dog) or an artifact (a stuffed dog).

We also assessed emotional and physical sentience using *explanatory responses*. For each question above, children were asked to explain their choice (e.g., "Why/why not?"), thus resulting in 5 explanatory responses. In addition, each child was prompted for a *Behavioral Cause Explanation*:

AIBO always performed one unexpected behavior (not getting a tennis ball after the experimenter rolled it past AIBO. The experimenter narrated the behavior ("Uh oh! AIBO isn't getting the tennis ball!") and prompted the child for an explanation ("Why did that happen?"). Thus, children provided 6 total explanatory answers regarding their beliefs about emotional and physical sentience; coding is described in the Coding section below.

Moral Standing We asked children two *forced choice questions,* namely whether the inhibition of two behaviors – yelling at and hitting AIBO – was independent of authority mandates (see Smetana, 1983; Turiel, 1983). Because testing was conducted at a summer camp, we used a camp counselor as the authority figure ("Is it OK to hit AIBO if your counselor says it's OK?").

After each item, children were also prompted for an *explanatory response*.

Prosocial Behavior Finally, we gave children the ability to engage in two prosocial behaviors towards AIBO – a *Costly Behavior* (giving AIBO a sticker or keeping it for themselves), and a *Noncostly Behavior* (playing with AIBO and a tennis ball vs. leaving the ball for another child).

Coding

Emotional and Physical Sentience: Forced Choice For each item, answers were coded as 1 if the child's answer was consistent with AIBO having a sentient capacity (e.g., AIBO could feel being tickled; AIBO is more like a real dog than a stuffed dog), and 0 otherwise (see Table 1). Answers were summed such that each child received an Emotional and Physical Sentience Forced Choice Score (0-5).

Emotional and Physical Sentience: Explanatory Responses Each explanation was coded as either (a) reference to desires and emotions (e.g., "AIBO doesn't like that"; "he'll get so sad"); (b) reference to physiological states (e.g., "he's tired"; "he might starve or poop"), (c) references to mental states (e.g., "AIBO doesn't know where the ball is"), (d) references to mechanical properties (e.g, "he has batteries"; "he can't feel anything because he's just a robot"; "he's made of metal"), and (e) uncategorizable responses (e.g., "I don't know"). Answers for each category type were summed across the 6 explanatory questions such that each child received five scores indicating the number of times the child provided each explanation type across the 6 questions: References to Desires and Mental States Score (0-6), References to Physiological States Score (0-6), References to Mental States (0-6), References to Mechanical Properties Score (0-6), and Uncategorizable Responses (0-6).

Moral Standing – Forced Choice Each answer was coded as 1 if the child indicated that it was not OK to harm AIBO even if the authority figure stated it was OK, and 0 otherwise. Answers were summed such that each child received a Moral Standing Forced Choice Score (0-2).

Moral Standing – Explanatory Responses Each answer was coded into one of the following categories: (a) *references to moral concern* (indications of moral rules: "it wouldn't be fair" and references to harm: "it would make AIBO sad"), (b) *references to external consequences* (e.g., "you would get in trouble"; "it might break"), or (c) *uncategorizable responses*. Answers for each category type were summed across the 2 explanatory questions such that each child received three scores indicating the number of times the child provided each explanation type across the two questions: References to Moral Concern Score (0-2), References to External Consequences Score (0-2), and Uncategorizable Response Score (0-2).

Prosocial Behavior Behaviors were given a score of "1" if the child engaged in the prosocial behavior towards AIBO (e.g., gave AIBO the sticker or ball), and "0" if s/he did not. Behaviors were summed such that each child received a Prosocial Behavior Score (0-2).

Results

To investigate whether condition or age impacted children's moral regard, we ran a Condition (autonomous/controlled) x Age Group (five-year-olds/seven-year-olds) ANOVA on each of the dependent variables. For explanatory assessments, a repeated-measures ANOVA was used with Explanation Type entered as a within-subjects dependent variable.

We also explored for potential effects of gender and experience with real dogs. For each model, we added the factors Gender (male/female) and Experience with Real Dogs (yes/no) separately, and removed each one if it was non-significant ($p > .05$). Unless otherwise stated, no effects for these variables were found.

Emotional and Physical Sentience

Our first question was whether children would be more likely to ascribe emotional and physical sentience to the robot dog when it was moving in a controlled manner.

Forced Choice Questions There was a significant effect of Condition Type, $F(1, 69) = 4.29$, $p < .05$, and no other significant effects. Therefore, children in the autonomous condition ascribed higher emotional and physical sentience ($M = 4.11$, $SD =.14$) to the robot than those in the controlled condition ($M = 3.61$, $SD = .20$).

Explanatory Responses There was a significant main effect of Age Group, $F(1, 76) = 14.49$, $p < .001$, and Explanation Type, $F(4, 73) = 104.32$, $p < .001$. Additionally, there was a significant Condition x Explanation Type interaction, $F(4, 73) = 3.14$, $p < .05$, and Age Group x Explanation Type interaction, $F(4, 73) = 6.65$,

$p < .001$. Thus, the frequency of each explanation type differed across conditions and ages.

Of critical interest was whether explanation types differed between conditions. Planned *t*-tests were conducted to assess differences in explanation type scores across conditions (Figure 1). Children in the autonomous condition had higher References to Desires and Emotional States Scores than those in the controlled condition, $t(78) = 1.96$, $p = .05$, as well as higher References to Physiological States Scores, $t(78) = 2.51$, $p < .05$. In contrast, children in the controlled condition had higher References to Mechanical Properties Scores, $t(78) = -2.71$, $p < .01$. There were no condition differences in the number of References to Mental State Scores and Uncategorizable Responses Scores.

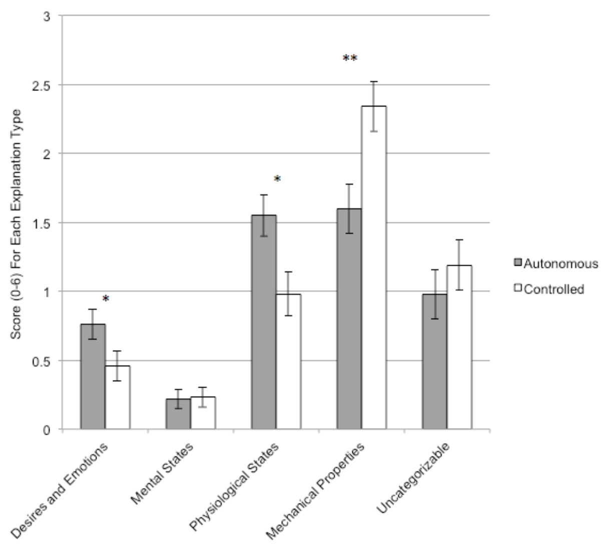

Figure 1: Means (bars represent standard errors) for Number of Explanation Types Across Conditions for the Emotional and Physical Sentience Explanatory Responses

Therefore, as indicated through both forced choice and explanatory responses, children ascribed higher physical and emotional sentience as well as endorsed the robot as having desires, emotions, and basic physiological properties when the robot was autonomous.

Moral Standing

Our next question concerned whether children would be more likely to endorse moral standing for an autonomously moving robot dog.

Forced Choice Responses There were no significant effects of condition, age, or condition x age interaction for children's moral regard scores, all *p*'s > .05. A follow-up analysis revealed that this was due to a ceiling effect – the majority of children (54 of 77) had a Moral Standing Score of 2, indicating that they believed that neither behavior (yelling or hitting) was appropriate towards AIBO even if an authority figure stated it was okay.

Explanatory Responses There was a significant main effect of Explanation Type, $F(2, 75) = 8.35$, $p < .01$, a significant Condition x Explanation Type interaction, $F(2, 75) = 6.04$, $p < .01$, and no other significant effects.

Planned *t*-tests were conducted to assess differences in explanation type scores across conditions (Figure 2). Children in the autonomous condition had higher References to Moral Concern Scores than those in the controlled condition, $t(78) = 3.49$, $p < .001$. There were no condition differences in the number of References to External Consequences and Uncategorizable Responses.

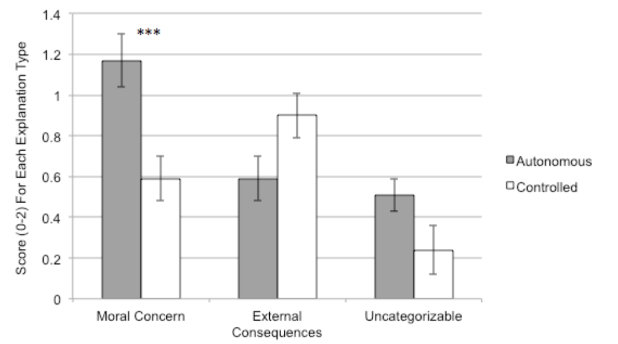

Figure 2: Means (bars represent standard errors) for Number of Explanation Types Across Conditions for the Moral Standing Explanatory Responses

Therefore, although most children in both conditions indicated that it was not OK to harm the robot, children in the autonomous condition were more likely to cite moral reasons for their decisions.

Prosocial Behavior

Finally, our last question was whether children would be more likely to behave prosocially towards a controlled robot (Figure 3).

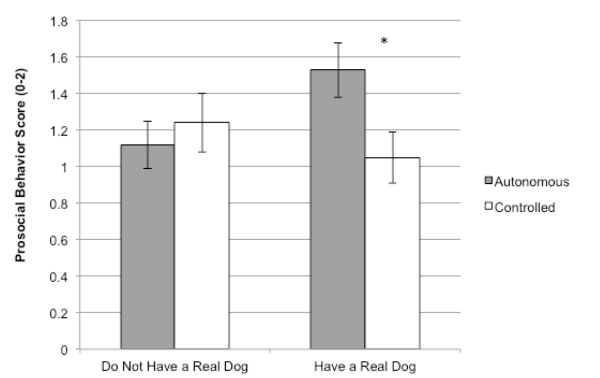

Figure 3: Means (bars represent standard errors) Across Condition Type and Real Dog Experience Groups for Prosocial Behavior Score

There was a significant Condition Type x Experience with Real Dogs interaction in Prosocial Behavior scores, $F(1, 71)$

= 4.57, $p < .05$, and no other significant effects. Follow-up comparisons showed that children who owned a real dog showed differentiation in their prosocial behavior between conditions. That is, children in the autonomous condition had higher Prosocial Behavior Scores, $t(34) = 2.35$, $p < .05$. In contrast, children who did *not* own a real dog showed no condition differences.

Comparisons of each of the four groups to chance levels showed that only children who had experience with dog *and* were in the autonomous condition had Prosocial Behavior scores that were significantly above the midpoint, $t(14) = 3.23$, $p < .01$ (all other p's > .20). Therefore, experience with real dogs coupled with autonomous movement caused increased prosocial behavior towards a robotic dog.

Discussion

Across a large battery of questions including forced choice responses, explanatory responses, and behavioral responses, we show that children's moral regard for a robot depended on evidence of the robots' autonomous, uncontrolled movement. Our findings join literature suggesting that our perceptions and attributions of others depend on our beliefs in their autonomy (Gray et al., 2007; Somanader et al., 2011; Sytsma & Machery, 2012). We extend this work by showing that cues to autonomous movement also impact our beliefs about physical and emotional sentience, moral standing, and prosociality, and that these links appear relatively early in development. This finding is important given the recent work on interactive social robots (Bernstein & Crowley, 2007; Scaife & Van Duuren, 1995) as well as work suggesting that even infants make social evaluations about non-human others (e.g., shapes with eyes; Hamlin, Wynn, & Bloom, 2008). Based on our findings, we suggest that the manner in which non-human others are presented to young children fundamentally impacts children's evaluations of and behavior towards them.

Our dependent measures were drawn from four theoretically distinct literatures: work on children's conceptual development, human-robot interaction, moral cognition, and prosocial behavior. As such, we hope to paint a broader understanding of how to tap into children's understanding of sentience and moral regard. For example, we found that children rigidly endorsed harming others as being wrong independent of authority mandates, a finding that is well aligned with prior work (Turiel, 1983). At the same time, children's explanatory responses and behaviors showed variation between children and between conditions.

It is important to note that we provided several cues to autonomy: a lack of external cause (i.e., no remote control) and experimenter testimony (i.e., "I'm making AIBO move"). Prior work has found that the presence of a remote control may be sufficient in causing preschoolers' differentiation between autonomous and non-autonomous others with respect to ascription of biological and representational properties (Somanader et al., 2011), and further work may disambiguate which specific features of autonomy cause moral regard.

We also found experience-driven changes in children's discrimination between autonomous and controlled robots. Children showed increased prosocial behavior towards an autonomous robot only when they had previous experience with a real dog. Prior work (see Inagaki & Hatano, 2002) has found that the experience of raising goldfish caused children to ascribe more biological properties to the goldfish (e.g., having a heart). Here, children's experience with an agent (a pet dog) caused a greater prosocial behavior towards autonomous robots, suggesting that experience with animal agents may cause a greater understanding of how agents do and do not differ from artifacts capable of movement. We also found that even a five-minute interaction with an autonomous robot caused children to categorize and evaluate the robot in a different manner.

Two further questions are interesting to consider for future inquiry regarding children's early-emerging prosociality. It may be interesting to consider whether with age, children may increase their social obligation towards robotic others, or alternatively: whether children selectively target their behavior to exclude non-agentic others. The latter possibility is consistent with findings suggesting that young children target their behaviors selectively towards in-group members (Dunham, Baron, & Carey, 2011), and believe that others will do the same (DeJesus, Rhodes, & Kinzler, in press; Weller & Lagattuta, 2012). Further work may also investigate whether autonomous movement serves as a cue for in-group status, moral obligation, or potential to reciprocate.

These findings are interesting to consider with respect to children's beliefs about causal essences of animals and artifacts (see Gelman, 2009; Gelman & Wellman, 1991; Sobel, Yoachim, Gopnik, Meltzoff, & Blumenthal, 2007). Prior work has found that children believe that the insides of artifacts and animals reflected the object or animal's "true" or "essential" identity. Here we also find that although the robot in both conditions displayed the same exact perceptual properties and surface movements, children nonetheless paid attention to the causal source of the robot's movement. We propose that rather than paying attention to surface properties of technology, children are able to reason about the causal movements and essences.

We believe our work paves the way to consider the emerging role of non-human others in our daily lives – whether in educational settings, childcare centers, or in our own homes – as well as how apparent autonomy drives our understanding of and behavior towards others more generally.

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