Effects of Framing a Robot as a Social Agent or as a Machine on Children's Social Behavior*

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Abstract— **The presentation or framing of a situation—such as how something or someone is introduced—can influence people's subsequent behavior. In this paper, we describe a study in which we manipulated how a robot was introduced, framing it as either a social agent or as a machine-like being. We asked whether framing the robot in these ways would influence young children's social behavior while playing a ten-minute game with the robot. We coded children's behavior during the robot interaction, including their speech, gaze, and various courteous, prosocial actions. We found several subtle differences in children's gaze behavior between conditions that may reflect children's perceptions of the robot's status as more, or less, of a social actor. In addition, more parents of children in the *Social* condition reported that their children acted less shy and more talkative with the robot that parents of children in the *Machine* condition. This study gives us insight into how the interaction context can influence how children think about and respond to social robots.**

I. INTRODUCTION

Social assistive robots are increasingly being developed and studied as companions for children in domains such as education, therapy, entertainment, and healthcare. In these domains, child-robot interaction studies test a robot's effectiveness as a tutor, companion, or coach. The focus is generally on the content of the interaction—what the robot is doing, how the robot is doing it, and how that affects the child. Researchers examine how different aspects of the robot's morphology, including appearance (e.g., [1]), embodiment (e.g., [2], [3]), and behavior (e.g., [4], [5]), influence how children respond.

In focusing primarily on what happens *during* a robot interaction, we may not give much thought to what happens at the *beginning* of an interaction—specifically, to children's first impression of the robot. First encounters and priming effects can significantly influence subsequent behavior and perception, as is well known in the social cognition and social psychology literature (for an extensive discussion, see [6]; also see [7]). For example, students rated an instructor as more considerate, sociable, and humorous when they were told beforehand that the lecturer was warm-hearted rather than cold-hearted [8]. People may be more likely to stop and help another person on their way to give a talk if they were told that they had plenty of time, versus being told they had to hurry up [9].

Recent human-robot interaction (HRI) research suggests that framing or priming could effect how humans respond to robots as well. Stenzel and colleagues [10] told participants that a humanoid robot was either an active, intelligent agent or a mechatronic device merely following commands. Then participants performed the Social Simon Task (a go/no-go task in which people perform faster when they do the task with another person than when alone). The participants performed faster with the robot presented as being more human-like. They also attributed more intentionality to it. Klapper and colleagues [11] performed a similar belief manipulation to examine how people's beliefs about an agent's animacy influenced their automatic, unconscious imitation of the other's actions. Participants who believed that the other was animate automatically imitated more than when they believed it to be inanimate. Darling, Nandy, and Breazeal [12] found that participants who read a story about a Hexbug robot's experiences hesitated more when asked to hit the robot with a mallet, as opposed to participants who did not read a story.

In this paper, we ask whether factors independent of the robot's morphology can also influence people's reactions to the robot. In particular, we ask whether how we introduce the robot to children changes how they perceive it and how they behave while playing with it. Coeckelbergh [13] suggested that by framing a robot by talking *to* it rather than *about* it—that is, using personal second-person pronouns to address the robot directly rather than using impersonal third-person pronouns to talk about it indirectly—our perception of the robot will shift from thinking of the robot as "machine-like" to thinking of it as a "social other." Coeckelbergh [13] argues that the language used to frame the robot partially constructs our relation with it. To this end, we investigated whether how an adult introduces a robot can affect a child's behavior.

II. METHODS

A. Research Questions

We asked how an adult's initial introduction of a robot to a child as either a social agent or as a machine-like being would influence how the child perceives and responds to the robot. Furthermore, would subtle linguistic framing influence children's behavior and affect while playing with the robot?

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B. Hypotheses

We expected that *Social* framing would lead children to treat the robot more like a social other, while *Machine* framing would lead children to treat the robot more like a technological game or machine, based on prior work on the linguistic framing of robots [10]–[13], as well as work suggesting that children follow the cues of adults to learn how to interact with new people and objects [14].

We expect that children in the *Social* condition would speak in more "social" ways. They might narrate their own actions more, since narrating one's actions can enable partners to share understanding [15]. These children may spend more time speaking overall, since a robot that is socially-framed may be understood as a potential interlocutor, while conversing with a machine-framed robot may feel less natural, since we do not generally converse with machines. These children may also ask more questions, since questions can help coordiante social action or monitor common ground [16]. Asking more questions may reflect a greater social awareness of the robot. Additionally, we expected that *Social* children would more use second-person pronouns to refer to the robot or the robot's name, while children in the *Machine* condition would use less second-person pronouns and more third-person pronouns, since by nature the second-person is used to refer to one's interaction partners.

We expected that children would look at the robot more often, since gaze can indicate preference for an interaction partner [5] and that they may be more empathetic toward the robot if they perceive it as a social agent. They may also laugh more, since people tend to laugh more in social situations [17].

We expected children in the *Social* condition would behave more courteously toward the robot (such as allowing it to finish its turn in a game) and say goodbye when they left. Some research suggests that courteous behaviors can build rapport or be reflective of connecting with the other [18], [19]. In human-human interactions, we indicate intent to leave an interation and ask permission to leave rather than simply leaving [20], but we do not say good-bye to out computers when we are done using them. Thus, saying goodbye to the robot could indicate that a child views the robot as a social agent.

Finally, we expected that the framing may have stronger effects initially and these effects may "wear off" over time as children reacted to the robot's social presence in the moment as it was encountered, rather than based on what they were told about the robot by the experimenter. Thus, we expected that children would act more socially with it later in the interaction. Research on priming has shown that priming effects may be subtle and relatively short in duration [7], though in some cases can influences ratings after an interaction or game (e.g., [8]).

C. Participants

Twenty-two children aged 3–7 years ($M = 5.04$, $SD = 1.23$, $\min = 3.12$, $\max = 7.42$) were recruited from the Greater Boston Area for the study. Ten were female; 12 male. There was no significant difference in age across conditions. All parents signed a consent form for their children and all children verbally assented to participate. Parents reported demographic information for their children: 63.6% were White, 13.6% were Asian, 13.6% were mixed, and 9.09% (two participants' parents) declined to answer. Most children were familiar with technology: 77.3% were familiar with playing games or watching videos on phones, computers, and tablets, while 9.09% rarely or never did these activities. 13.64% did not report this information. All children except one were typically-developing. One girl had a sensory processing disorder and she did not complete the robot interaction, so she was excluded from the behavior analysis.

Fig. 1. Children played a sorting game with the robot Tega, which was designed for interactions with young children.

D. Robot

We used the Android phone-based robot Tega (Figure 1), a fluffy "squash and stretch" robot developed by the Personal Robots Group at the MIT Media Lab. The robot was teleoperated by Experimenter 1, primarily to deal with language understanding. The teleoperator was trained by an expert robot teleoperator on how to puppeteer the robot as a believable character. The teleoperator followed a script for triggering speech, emotional body actions, and facial expressions. The robot's speech was recorded by a female adult and the pitch was shifted higher so it would sound more child-like. The teleoperator attended to children's speech and to their actions in the sorting game to determine which phrases to playback next. These capabilities allowed the robot to appear autonomous to participants.

E. Procedure

The study followed a between-subjects design with two conditions (*Social* x *Machine*). This protocol is partially based on a pilot study performed with adults, described in [21]. Each child participated in one study session with two experimenters.

First, Experimenter 1 asked the children questions about what they thought about robots. The questions probed whether children had played with robots before and what they thought the emotional, physical, and mental capabilities of robots were. The experimenter led the child in the

Anomalous Picture Task (APT). In this task, each child was invited to look at three pictures of animals in strange situations (e.g., a giraffe in a dining room; an elephant driving a car) with their interlocutor. The goal was to see how many spontaneous questions, comments, and laughs the child produced, and to see who or what the child looked at during the task. We expected that children would perform more of all these behaviors and look more at the pictures than at their interlocutor when doing the task with the experimenter (versus with the robot) and in the *Social* condition. During this task, the interlocutor stayed silent unless the child spoke first; then, the interlocutor would comment positively, such as "Wow, I never saw that before!" or "That's so silly!". After ten seconds of silence, we advanced to the next picture.

Next, the child was led to the robot interaction area, where Experimenter 2 performed the framing manipulation. During the framing manipulation, Experimenter 1 left the area so as to remain blind to the framing condition for each child. In the *Social* condition, the robot was introduced as a friend, using inclusive language and second-person pronouns, e.g., "You two are going to play a game together," and "Make sure you tell your new friend how to play, okay?" In the *Machine* condition, the robot was referred to in the third-person and was introduced as a robot rather than as a friend, e.g., "You are going to play a game with it," and "The robot will give you directions on how to play."

Following the framing manipulation, Experimenter 2 left the robot area and the robot interaction began. Experimenter 1 teleoperated the robot (more details below). The robot introduced itself and asked the child about their favorite color and what they liked to do for fun. Then the robot led the child in a second session of the APT.

After this task, children played a sorting game with the robot. The game involved sorting a set of objects by color, size, and shape. The robot began by sorting by one attribute ("Can you put all the blue shapes in the same pile for me?"), then invited the child to sort by a different attribute (Figure 1). The robot and child each got three turns.

When the robot began to take its fourth turn in the game, Experimenter 2 returned and, based on the methodology in [22], interrupted the robot's turn, saying, "It's time for me to put you away in your box!" Experimenter 2 asked the child whether they thought the robot should be allowed to finish its turn or not. This allowed us to see whether the framing manipulation had influenced the child to be courteous (allowing the robot to finish its turn), or whether the child would treat the robot as any other technological device, and leave without saying goodbye [20].

After the robot interaction was complete, Experimenter 1 asked children follow-up questions to determine whether their thoughts and feelings about the robot had changed. We also asked children's parents to fill out a brief questionnaire pertaining to their child's social abilities and behavior to learn whether their behavior with the robot was characteristic of the child or not.

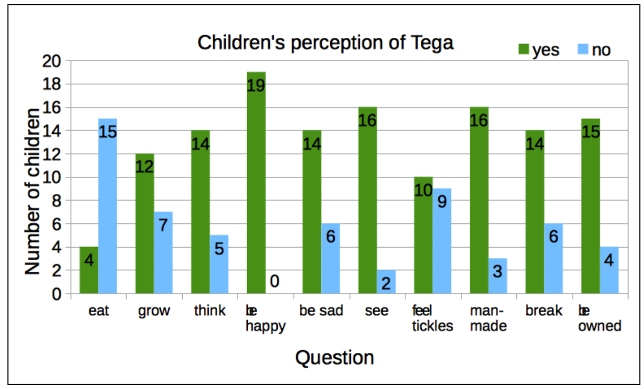

Fig. 2. Children thought of the robot as a social agent with mental and perceptual abilities.

III. DATA ANALYSIS

We recorded audio and video of the interactions, along with all questionnaire responses. One child did not complete the robot interaction and two children's video data were missing due to equipment malfunction, resulting in 19 videos.

Two raters were trained to code the videos for children's speech (i.e., what words were said), gaze patterns (i.e., were children looking at the robot, at the table/activity, at the experimenter, or elsewhere), smiles (coded for intensity of smile on a 1 [low intensity]–4 [high intensity] scale), and laughter (coded for intensity of laughter on a 1 [low intensity]–4 [high intensity] scale). They coded each phase of the interaction (e.g., during the framing, the APT, the sorting game, and so forth). The reliability sample consisted of one of the videos, randomly selected. Each coder also independently coded an additional 9 videos. Cohen's kappa was used to determine the level of agreement between the raters from the reliability sample. There was high agreement between the raters' judgments for gaze, smiles, and laughter, $\kappa = 0.823$, $\kappa\_max = 0.921$. Inter-rater agreement for speech coding was 98.5%.

We performed independent samples t-tests to compare children's responses across conditions, and paired t-tests to compare children's pretest to posttest responses.

IV. RESULTS

A. Engagement and perception

Children's responses to the pretest and posttest questionnaires were not different between conditions or from pretest to posttest. A majority of children liked playing with Tega, insofar as they said they wanted to play with it again (90.0%), that it could be their friend (94.4%), and that one of their friends would want to play with it (84.2%).

Children thought of the robot as a social agent with mental abilities, insofar as they said the robot could think (73.7%), could be happy (100.0%), and could be sad (70.0%) (Figure 2). One child qualified her answer by saying a robot could only think "if you make it with brains," suggesting that "robots are kind of just like people." Children thought the robot had perceptual abilities, insofar as they said the robot could see (88.9%) and would feel tickles (52.6%). A

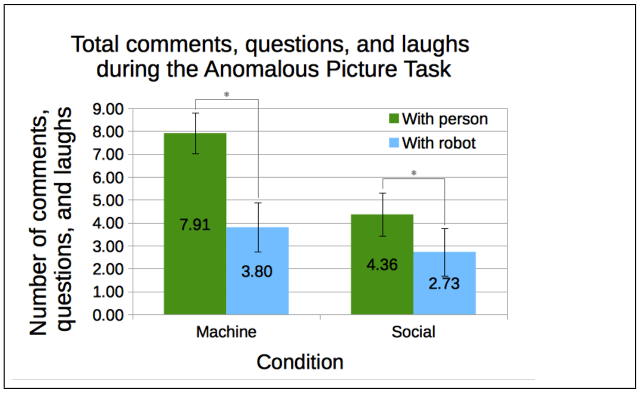

Fig. 3. Children commented, questioned, and laughed more when doing the APT with the experimenter than with the robot later. The * denotes p < 0.001.

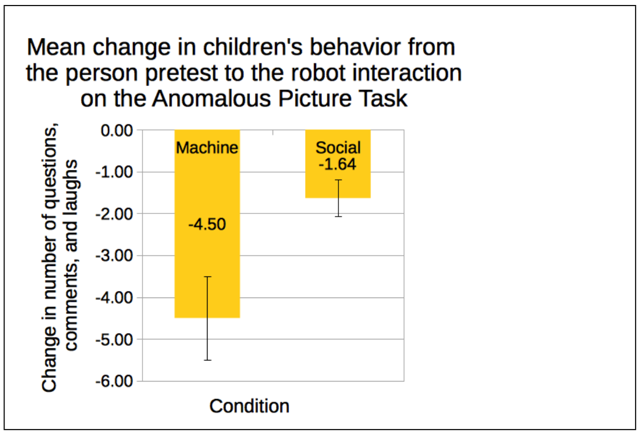

Fig. 4. Children in the *Machine* condition changed their behavior more from the APT with the experimenter to the task with the robot than did children in the *Social* condition.

majority of children thought of the robot as having properties of both living beings and artifacts, insofar as they said the robot could eat (21.1%), could grow (63.2%), was made by a person (84.2%), could break (70.0%), and could be owned by a person (79.0%). One child said we could build a robot bigger to make it grow. Another said that we cannot own the robot, we "must share it."

B. Speech

There were no statistically significant differences in the amount of narrations, questions asked, or pronouns used by children between conditions or during different phases of the interaction. Children in the *Machine* condition trended toward talking more than children in the *Social* condition, but further analysis revealed that this was due to one child in the *Machine* condition who was particularly talkative.

C. Anomalous Picture Task

We found a difference in the number of total comments, questions, and laughs children performed during the APT, where children exhibited more of all three behaviors with the person in the pretest ($M = 6.14$ instances of the three behaviors, $SD = 4.40$, 135 instances total) than with the robot ($M = 3.24$ instances of the three behaviors, $SD = 4.60$, 68 instances total), $t(20) = 3.81$, $p = 0.001$ (Figure 3).

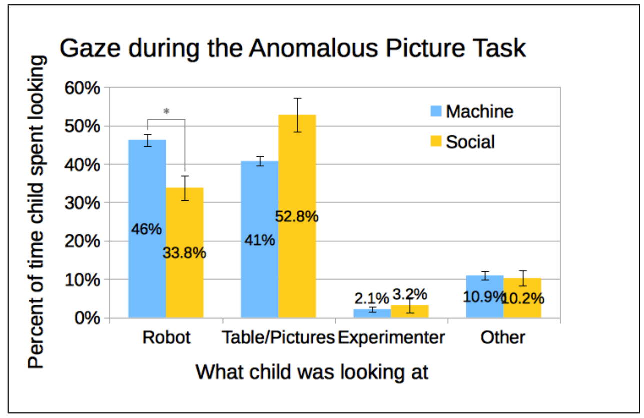

Fig. 5. Children in the *Machine* condition spent more time looking at the robot during the APT than children in the *Social* condition. The * denotes p < 0.05.

Although there were no statistically significant differences between conditions in the number of each of these behaviors children performed, we saw an interesting trend. Children in the *Machine* condition changed their behavior more from the pretest with the person to the test with the robot, performing a mean of 4.50 ($SD = 4.45$) fewer behaviors with the robot than with the person, while children in the *Social* condition performed a mean of 1.64 ($SD = 1.96$) fewer behaviors with the robot, $t(20) = 1.93$, $p = 0.067$ (Figure 4).

We saw statistically significant differences in children's gaze patterns during this task. Children in the *Machine* condition spent significantly more time looking at the robot ($M = 46.2\%$ of the time, $SD = 6.77\%$ of the time) during the task than *Social* children ($M = 33.8\%$, $SD = 13.3\%$), $t(17) = 2.25$, $p = 0.038$ (Figure 5).

D. Gaze

As reported above, children looked at the robot more in the *Machine* condition during the APT. We also saw that during the robot's third turn in the sorting game, children in the *Social* condition looked at the robot more ($M = 48.5\%$ of the time, $SD = 29.6\%$ of the time) than *Machine* children ($M = 19.5\%$, $SD = 20.3\%$), $t(17) = 2.21$, $p = 0.041$. Children in the *Machine* condition tended to look more at the table during this phase instead ($M = 77.1\%$, $SD = 24.4\%$) than *Social* children ($M = 45.7\%$, $SD = 34.7\%$), though this was statistically significant, $t(19) = 2.04$, $p = 0.057$. There were no other statistically significant differences in children's gaze patterns.

E. Smiles and Laughter

We saw no statistically significant differences between conditions in children's amount of smiling and laughing during the robot interaction or during different phases of the interaction.

F. Courteous behavior

We did not see differences between conditions in whether or not children said goodbye to the robot or in children's

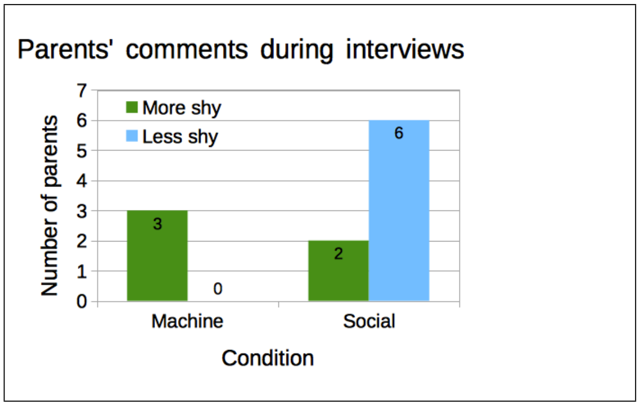

Fig. 6. More parents of children in the *Social* condition commented that their child was less shy or more talkative than normal than parents whose children were in the *Machine* condition.

responses to the interruption of the robot's final turn in the game. A majority of children thought it was okay to stop the robot's turn (57.9%) or for a grown-up to stop the robot's turn (80.0%), justifying their answers by saying it was okay because the robot needed to play with someone else, could play next time, or sometimes gets tired. Grown-ups could stop turns because they were grown-ups or if the robot was doing something wrong. The children who said it was not okay said it was not fair or made the robot sad. A majority of children also said it was okay to put Tega in a box (68.4%) or for a grown-up to put the robot in a box (65.0%). They cited reasons such as "it's Tega's home," "Tega lives in the box," and "she's a robot." Some of the children who said it was not okay were concerned that Tega may not fix in the box and that the robot should be able to choose when to go in the box.

G. Parent reports

There were no statistically significant differences in parents' reports of their children's sociality between conditions.

During the parent interview and debriefing following the study, we asked parents to comment on their children's behavior with the robot. We found differences in how often parents commented on their children's shyness and social behavior, despite the fact that we did not prompt parents to talk about how social or not social their child was with the robot (Figure 6). More parents of children in the *Social* condition (54.6%) commented that their child was less shy than normal or talked more than usual than parents whose children were in the *Machine* condition (0.0%), $t(20) = 3.27$, $p = 0.004$. In addition, 30.0% of parents with children in the *Machine* condition commented that their child acted more shy than normal, compared to 18.2% of parents of children in the *Social* condition.

V. DISCUSSION

This study investigated whether introducing a robot as a social agent or as a machine-like entity impacted children's social behavior with the robot. We found several subtle differences in children's gaze behavior and in their parents' reports of their social behavior, though we did not see the differences in speech patterns or courteous behaviors that we had expected. First, the robot framing did not seem to affect children's conscious behavior. No differences were found between conditions in children's responses to the pretest and posttest questionnaires or in their responses to the interruption of the robot's turn, suggesting that their conscious evaluations of the robot were not influenced by the framing.

The lack of differences in children's speech patterns may be a result of the activity. Only 7 kids used any kind of pronoun and none called the robot by name during the interaction. A different activity with the robot may prompt more pronoun use, e.g., if children interacted with the robot in a group, because then they may need to address one particular interlocutor.

In [22], children aged 9, 12, and 15 years generally said it was not all right to stop the robot's turn in a game or put it in a closet. The population we worked with was much younger (3–7 years), and in contrast to this prior work, they tended to say that it *was* okay. Age is likely the biggest factor here—these children justified their answers by saying that adults could stop turns and put robots away. They showed greater deference to the authority of the experimenter in making decisions about the robot, which reflects their own deference to their parents' authority.

The differences we saw in children's gaze behavior may reflect children's unconscious or subconscious views of the robot as a social agent. When using the APT before [23], we saw that children tend to gaze more at their partner versus at the pictures when their partner is a robot than when their partner is a person. The pattern we saw here is reflective of these past results: Children gazed more at a machine-framed robot than at a socially-framed robot. Perhaps this is because a machine-framed robot is perceived as more novel, and thus attracts a larger proportion of children's attention than the task. Meltzoff and colleagues have found that infants are more likely to follow a robot's gaze when it acts in a social-communicative way [24], so perhaps children were more likely to gaze at the pictures with the robot in the *Social* condition.

Later in the interaction during the sorting game, we saw children gazing more at the robot in the *Social* condition. This may be because people tend to look at people during conversation, and the sorting game involved more conversation than did the earlier APT. Meltzoff and colleagues have found that infants look significantly longer and smile more at people who act like them [25]. Extrapolating, it may be that children looked longer at the robot because it was "like them," a social agent.

Overall, we saw that the framing of the robot influenced some, but not all, of children's behaviors. Changing factors about the interaction, such as how we frame the robot or what activity children perform with the robot, could lead to greater differences in children's behavior. We think one way framing may change people's perceptions of a robot is through manipulating people's understanding of social distance. According to construal-level theory (CLT), the psychological distance of something from oneself in the here and now changes how one thinks about it (e.g., far away things may be construed in more abstract terms, while near things may be construed as more concrete) [26]. One dimension of psychological distance is social distance. Numerous HRI studies have found that manipulating social distance, e.g., through in-group and out-group biases, can change how people think about robots as social agents [27], [28].

In this study, introducing the robot as a machine-like entity versus as a social agent may have set children's expectations about the kind of interaction they expected to have with the robot via defining the robot's social distance. We hypothesize that the human-like and social qualities of a robot change its perceived social distance. For example, robots that are perceived to have similar capabilties to humans—such as having their own experiences or being social agents—as well as robots that are perceived to be part of one's own social group may be better understood and felt as closer to oneself psychologically. They may be rated as more competent or be more accepted [27], [28] Framing a robot as being less like oneself—e.g., by introducing it as a machine or presenting it as part of an out-group—could be felt as more distant, and thus, may be thought of as more strange and less accepted.

VI. Future Work

Our future work will examine other effects of priming and framing. For example, a child may react more strongly to the framing if the robot is introduced by a a trusted parent, sibling, or friend, rather than by an adult stranger (the experimenter), given children's trust in information from their parents [29]. We may also study whether social versus machine framing has any persistent effects lasting throughout multiple interaction sessions with a robot, whether the framing has greater effect for different tasks (e.g., for more socially-oriented tasks involving cooperation), or for different levels of embodiment (e.g., versus a virtual agent or telepresent robot), since these may already be construed as having greater psychological distance from the self, and thus, may interact in interesting ways with how the social versus machine framing affects construals of social distance.

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