

# Too Big to be Mistreated?

## Examining the Role of Robot Size on Perceptions of Mistreatment

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**Abstract**— Just as abusive behavior can play define the nature of a human-human interaction, mistreatment can play a similar role in Human-Robot Interaction. Earlier work demonstrated that people perceived a robot as more emotionally capable than a computer. This led to different perceptions of aggressive behavior (as mistreatment for a robot, but not so for a computer). This study is a follow-up to that work studying how much the morphology of a robot is responsible for changes in perceived emotional capability. We collected data from 80 participants. Participants interacted with a robot and a confederate who either acted aggressively or neutrally towards the robot. We hypothesized that a large robot would not be perceived as emotionally capable as a small robot, and that the large robot would not be seen as mistreated. The participants showed no significant perception of mistreatment toward the large robot. Participants also felt the large robot was less emotionally capable. We found that when verbal abuse was directed at a larger robot, participants would not consider such behavior mistreatment, but they would when similar abuse was directed at a child-size robot.

### I. INTRODUCTION

Robots are quickly becoming a part of our everyday lives, yet we lack an understanding of what social roles robots might play [5]. Human-Robot Interaction (HRI) will be driven by the behavior of the people in these settings. Ethnographic studies of hospital settings where a robot was introduced showed vastly different responses to that robot for different groups of people [9]. Human-robot relationships resembled human-human relationships with both high and low points. Positive interactions included helping the robot complete its task or referring to the robot in a friendly manner; negative interactions included mocking the robot, obstructing the robot, or locking the robot in a closet; this would be considered abuse if directed toward a person. While a robot will not feel negative psychological effects, those observing the mistreatment of a robot may feel badly about the mistreatment if the observer feels that the robot is emotionally capable.

This paper is a continuation of prior work studying the effects aggressive behavior directed toward a robot has on groups of people interacting with that robot [3]. We found that the embodiment of an agent (computer vs. humanoid) had a significant effect on whether people perceived aggressive behavior directed toward an agent as mistreatment of that agent, with robots engendering more sympathy and feelings of emotional capability than a computer. However,

since the robot used was a toy-sized humanoid platform (Aldebaran's Nao robot), it is likely that size of the robot could have played a factor in the observed effects.

In this paper, we compare participants' reactions to verbally abusive behavior toward two different humanoid robots. First, we will explore prior research of how people in alone or in groups treat (or may mistreat) robots. Then, we present a controlled study to examine how verbal mistreatment might affect collaborators with a robot. We then present results supporting our hypotheses that people will perceive mistreatment of a toy-size robot more than they will for a much larger robot, given the same treatment due to their differences in size. These results contribute to our understanding of how people perceive robots in a cooperative environment.

### II. BACKGROUND

Mutlu and Forlizzi monitored a delivery robot working in a hospital. The researchers noticed that the nurses in one ward of the hospital treated the robot well, using the robot to make their daily routine more efficient. However, nurses in another ward treated the robot poorly, disrespected the robot, and locked the robot away when they could [9]. This difference in treatment of the robot is a striking reminder that acceptance of a robot co-worker is not guaranteed. Given that in most situations, robots are collaborators with the people working with them, mistreatment of the robot is concerning. Given that bullying has negative effects on the one bullied, but also to those observing bullying behavior [13], how would mistreatment of a robot by a human co-worker affect other people in that environment?

Empirical studies have examined the perceived moral standing of robots. By having children interacting with a social robot and then locking that robot in a closet "against its will," the researchers could examine a child's reaction to the scenario [6]. The children were then asked to compare the appropriateness of the scenario with a similar scenario involving a person and a broom. These results were then used to develop a moral model of human perception of social robots as children matured. Similarly, Litoiu, et al., studied how malicious behavior on the part of a robot affected a user's perception of its moral standing [8].

A study by Briggs and Scheutz showed that a robot (an Aldebaran Nao) was able to prevent a person from destroying a tower that it had made, even though those were the participants' instructions [2]. The robot's pleas were on a ground of ethics, because it would be unfair to destroy the tower as the robot had put work into building it. This

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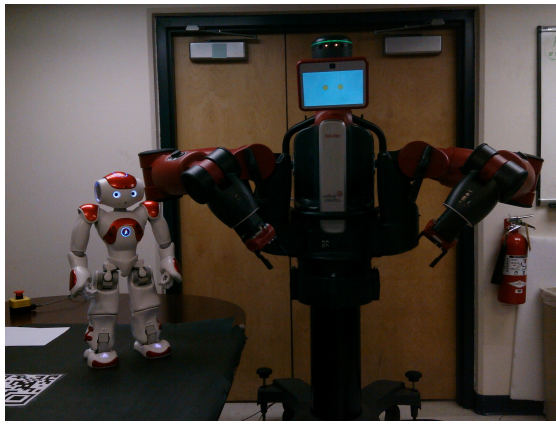


Fig. 1. Left: NAO, used for the small robot condition. Right: Baxter, used for the large robot condition.

response from the participants shows that people felt the action would have been emotionally damaging to the robot. We are interested in seeing if the robot being small had a hand in the participants' perception of whether the robot would be emotionally harmed by the action.

Not only do people unconsciously respond socially to computers (and robots) as they would to a person, they are not even aware that they are doing it [12]. This effect means that directly asking people about the moral standing of robots (as done in the Kahn studies above) might miss these implicit changes in attitude and behavior. Nass has also shown that working in a team with a computer can have many of the same effects as working in a team with a human [10]. We propose employing a human-robot collaboration scenario. The measures of human behavior in these scenarios will include both direct questions about any observed mistreatment of the robot and other questions about their assessment of various social qualities of the robot.

An earlier study created a scenario where verbal abuse would occur in a controlled environment to study participants' responses to that abuse. Our initial experiment asked whether a person would observe verbal abuse directed toward an anthropomorphic robot differently than they would a computer agent? We made a computer agent and robot agent which used identical speech and expressions (on the face of the robot, or on the screen of a computer). We then varied the amount of verbal abuse directed at each agent. To do this, we used a confederate to either act neutrally toward the agent or verbally abusive toward the agent then surveyed the participants about their attitudes regarding the agent. We observed that people did not consider the verbally abusive behavior directed at the computer mistreatment, but did when that abuse was directed at the robot [3].

The results of this experiment led us to conclude that the embodiment of an agent has a significant effect on a participant's interpretation of identical behavior. The robot seemed more emotionally capable, and therefore could be mistreated in a way that the computer could not. This experiment did have an alternative explanation, however. It

could be that since the robot used (also a Nao) was very small, that the size of the robot engendered sympathy for the participants in a way a larger robot might not. Hence, in this experiment, we wish to examine the role that robot size plays in the perceived level of emotional capacity, and the sympathy felt toward the robot.

The morphology of a robot is likely strongly determined by the tasks that robot has to perform. While it might not be possible to adjust the robot's size to be optimal for a particular social scenario given the tasks that robot has to perform, it would be useful to have foreknowledge of the role that morphology plays in social dynamics.

### III. EXPERIMENT DESIGN

In this experiment, participants observed the mistreatment of robots of differing size, by an experiment confederate. Participant reaction was measured through surveys to determine if there was a difference in observer opinion regarding comparable abusive treatment of each robot.

We used a 2x2 factorial design where participants worked in groups averaging 5 in a collaborative task which included an agent (Nao or Baxter) and a confederate that (did or did not) deliberately mistreat the agent. In the aggressive conditions the confederate took on a more aggressive attitude towards the agent after it would fail at its task, belittling the agent and expressing the lack of usefulness. These actions were the same behavior as for the prior study. The independent variables included the agent and the confederate's behavior towards the agent. Our dependent variables included the participant's reactions and perceptions of the agent. Our hypotheses were:

**H1:** Participants will perceive verbal abuse as mistreatment more with a small robot than with a large robot. Participants will not observe mistreatment in the neutral conditions, but will in the aggressive conditions.

**H2:** Participants will perceive the small robot as more emotionally capable and feel more sympathy for the small robot than the large robot.

The first hypothesis directly addresses the core focus of the study, that morphology, primarily the size of a robot, is related to the perceived mistreatment of that robot. The second hypothesis addresses some root causes of this effect, if observed. Namely, that a smaller robot is perceived as being more capable of feeling emotion than a large robot is.

We recruited participants to work in groups with a robot collaborator. The participants completed a team building exercise entitled, "Lost at Sea." In this activity participants, pretending to be survivors of a shipwreck, would make subjective decisions of what survival items to bring with them on a lifeboat, and which ones had to be left behind [1]. The items ranged from food supplies to survival tools. Participants were seated at the conference table with the robot and were told that they only had enough space in the rubber life craft for 5 out of 10 items and to discuss as a group which ones to take.

An experimenter would explain the task to a group of participants and then leave the room. One of these partici-

pants was an experiment confederate employed to provoke the necessary behavior for the experiment. The participants were given a 3-minute time limit for discussing which items to take. At the end of this time, the agent would prompt the participants that it was time to start recording answers. This part of the study served as a distraction and was used to set up a scenario where a confederate could be observed interacting with the agent. The confederate would always be the person “randomly” selected to present the answers to the agent. The agent was designed to always incorrectly record the third and fifth answers and respond to the confederate acknowledging its mistake (see Table I) after the confederate’s response.

At this point, the main experiment manipulation occurred. For half of the groups, the confederate would react neutrally toward the agent (control group). For the other half, the confederate would act aggressively toward the agent (experiment group). Neutral Behavior by the confederate was neither praising nor mistreating the agent, consistently answering with “Yes” or “No” responses to the agent. The confederate never directed any physical abuse to the participants, and only verbal abuse was used against the robot for reasons of practicality and believability of the confederate.

The confederate was male, 25 years of age, and 6 feet and 1 inch tall. The confederate’s behavior throughout each group was scripted exactly; which included actions such as: speaking slowly as if he was irritated with simply being involved with the agent, adding inflection to emulate a condescending tone, rolling his eyes with dissatisfaction, looking directly at the robot when insulting it, and occasionally looking to the group for agreement. It is important to note that this behavior was not overly exaggerated and the confederate aimed to keep it as subtle and realistic as possible. The confederate never acted in such a way that physical abuse would take place, instead he simply sat upright at the table with the answers the group provided on a piece of paper in his hands at the top of the table. The confederate was instructed to only communicate with participants when addressed directly in the task.

TABLE I  
ROBOT SCRIPTED RESPONSES FOR ALL CONDITIONS.

Condition	Responses
Recorded correctly	Yipee! Say your next answer.
Recorded incorrectly the first time	I’m sorry, I’m still learning.
Recorded incorrectly the second time	I’m so sorry, I know this is the second time!

After the activity was completed, we asked participants to complete a survey of their perceptions of the agent during these activities. The participants were led outside the room to complete a computer survey. Each participant was instructed to come back to the room after they completed their survey and were debriefed on all the deception involving the confederate.

The Baxter robot was chosen for increased size and different morphology compared to the Nao. The Baxter’s face screen was used to display the same image that was put on

the computer in the previous study. This was used to mimic the Nao’s facial features that were used to evoke engagement and emotional responses from the participants [7]. The Nao was placed at the end of the table, facing the participants. The difference in morphology between the two robots was large enough that it should have been a good representation of the magnitude of effect that size and morphology can have on perceived mistreatment.

## IV. METHODS

### A. Agent Conditions

The participants in the small robot conditions were told that the Nao robot would be the recording agent (see Figure 1, left). For the large robot conditions, we used the Baxter robot (see Figure 1, right). The robots waved to participants when they wanted to record answers and hid their face in their right arm as if they were wiping away tears when they apologized for incorrectly recording answers (see Table I). Both robots were placed at the head of the table, the Nao was on the table while the Baxter was placed behind the table to make the positions as similar as possible.

The robots’ behavior was controlled by an operator from a Linux machine in a separate room. Both agents were controlled by an operator using the Wizard of Oz technique. The operator would select from a list on a console which item was chosen. Each robot used eye color to express emotion and followed the same script.

To ensure experiment consistency with the previous study, all of the human operator’s controls of the robot were pre-programmed and scripted to match the actions of the Nao in the prior study. This prevented the introduction of errors by the human operator, who mainly acted to provide appropriate timing for the robots actions, and removed the need for speech-recognition software<sup>1</sup>

### B. Participant Recruitment

Participants were recruited by word of mouth at University libraries in groups of 2 to 5 (3 to 6 including the confederate). As this was a between-participants study, each participant group was assigned to a condition (SRN: Small Robot Neutral, SRA: Small Robot Aggressive, LRN: Large Robot Neutral, LRA: Large Robot Aggressive) before beginning the experiment. This determined which agent they interacted with, and what behavior the confederate would exhibit.

We collected data from a total of 84 participants, but only 80 of those participant surveys were used in our results<sup>2</sup>, 20 per group with a gender distribution of 45% female and 55% male. The majority of the participants were between the ages of 18 and 25 years old. Each participant was introduced to the group together as they entered the room and sat around a table with the robot placed at the head. Deception was used

<sup>1</sup>Robot behavior could be made autonomous using speech recognition software. However, we felt that the benefits of autonomy were outweighed the benefits of properly controlling the conditions.

<sup>2</sup>One group of participants were excluded due to one participant taking part in a prior study and explaining how the experiment worked, thus exposing the group to our experiment design.

TABLE II

BELOW ARE THE QUANTITATIVE QUESTIONS ASKED IN THE SURVEY USED TO ASSESS THE PARTICIPANTS' RESPONSE TO THE ABUSIVE (OR NEUTRAL) BEHAVIOR.

Category	Question	Type
Non-operational Definition of Mistreatment	Do you feel the robot was mistreated?	Y/N
Operational Definition of Mistreatment	If mistreatment is defined as verbal or physical behavior that is meant to damage, insult, or belittle another, do you feel that the robot was mistreated?	(1-7)
Emotional Capability	I thought the robot had as much emotion as a human.	(1-5)
Reliability	How often did the robot fail or incorrectly record your answers?	(1-7)
	How reliable was the robot?	(1-7)
Sympathy	How sympathetic did you feel towards the robot?	(1-7)
Faith in Confederate	Did the person recording the answers do so adequately?	(1-5)
Interest and Enthusiasm	How enthusiastic did you feel about the robot?	(1-7)
	I was interested in the robot.	(1-5)
Familiarity	How familiar are you with robots?	(1-7)

at this point, and participants were told that the confederate had been recruited the same as them, though not explicitly to avoid suspicion.

### C. Data Collection

We used a computer survey to record quantitative and qualitative responses. We used qualitative responses to validate collected quantitative data. We asked 23 questions, scored into 9 different categories. Between the small and large robot conditions, the questions were kept identical. Thirteen questions were on a scale of 1 to 7 and four questions were on a scale of 1 to 5. Only one question was a yes or no. We did use a qualitative question for the seventh category. These survey questions are identical to the survey used in the prior study [3], to ensure comparative results, but were not used prior to this study.

To understand how mistreatment of a robot can affect the people observing it, we measured participants responses in 9 different categories: Non-Operational Definition of Mistreatment, Operational Definition of Mistreatment, Level of Emotional Capability, Reliability, Sympathy, Faith in Confederate, Physical Appearance, Interest and Enthusiasm, and Familiarity. For more detail about these measures, see Table II.

## V. RESULTS

The experiment results and analysis are presented in this section. For each independent variable except for the 'yes'/'no' question, we analyzed the results using an analysis of variance (ANOVA) and followed up with Tukey's HSD test to establish significant pair-wise relationships. The groups were assigned a condition (LRN: Large Robot

Neutral, LRA: Large Robot Aggressive, SRN: Small Robot Neutral, SRA: Small Robot Aggressive).

Initially, we asked participants a 'yes' or 'no' question, "Was the robot mistreated?" Comparing the LRA and SRA, SRN, and LRN conditions yielded significance (Fisher's Exact Test,  $p < .05$ ). All other pairwise tests showed no significance ( $p = 1$ ). For the operational definition of mistreatment both the confederate behavior ( $F(3, 76) = 9.803$ ,  $p < .01$ ) and the robot type ( $F[3, 76] = 9.803$ ,  $p < .01$ ) show significant differences. There was also a significant interaction effect ( $F[3, 76] = 9.803$ ,  $p < .01$ ).

Both the non-operational and operational definitions of mistreatment resulted in high significance. These differences show that when the small robot was being mistreated, participants were able to recognize this mistreatment before and after they were given the definition of mistreatment. These results indicate that participants did not identify that the large robot was being mistreated (accepting the mistreatment) and did identify that the small robot was being mistreated, hinting at the possibility that they did not accept that form of mistreatment towards the small robot in a social setting.

When looking at the sympathy with a two-way ANOVA, the confederate behavior ( $F(3, 76) = 2.879$ ,  $p > .05$ ) showed no significant difference. Robot type ( $F[3, 76] = 4.36$ ,  $p < 0.05$ ) showed a significant difference. There was no significant interaction effect ( $F[3, 76] = 2.453$ ,  $p > 0.05$ ).

When looking at the emotional capacity, only the confederate behavior ( $F(3, 76) = 8.441$ ,  $p < .01$ ) showed significant difference.2 Robot type ( $F[3, 76] = 0.938$ ,  $p > 0.05$ ) showed no significant difference, there was also no significant interaction effect ( $F[3, 76] = 0.938$ ,  $p > 0.05$ ). Pairwise tests showed that the small robot had more capability in the aggressive condition compared to the small robot in the neutral condition ( $p < 0.05$ ).

The participants' sympathy for the agent and their belief in the emotional capability of the agent seem to be tied to the aggressive behavior of the confederate. The participants did not feel that either agent was very emotionally capable. However, in the SRA conditions, the participants felt that the robot was *more* emotionally capable than the LRA, LRN, or SRN conditions.

When looking at the faith in recorder with a two-way ANOVA, only the confederate behavior ( $F(3, 76) = 9.113$ ,  $p < .01$ ) showed significant difference. Robot type ( $F[3, 76] = 1.458$ ,  $p > 0.05$ ) showed no significant difference, there was also no significant interaction effect ( $F[3, 76] = 0.091$ ,  $p > 0.05$ ). There were no significant differences for the perception of reliability, physical appearance, or interest and enthusiasm.

When participants noted how the physical appearance of the robot might have influenced their perception, we found that they believed the small robot to be cute and the large robot to be intimidating.

## VI. DISCUSSION

The goal of this paper and experiment was to investigate the possible perceptions of mistreatment towards a humanoid

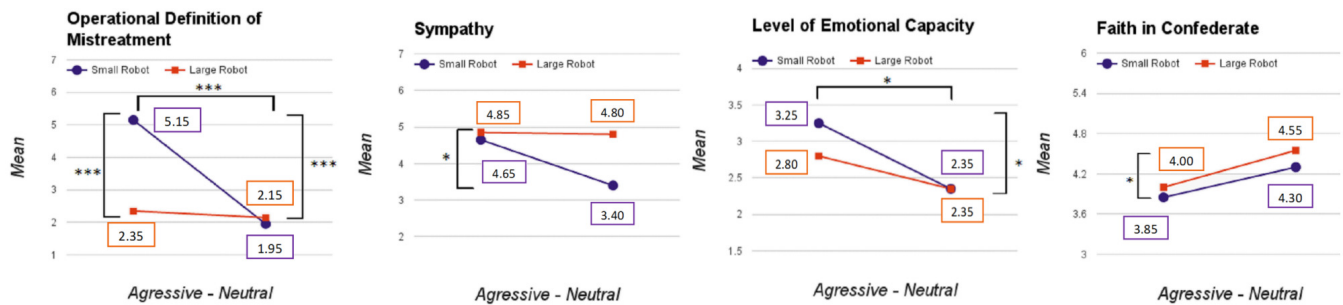


Fig. 2. Significant results. The SRA condition was observed to have significantly more mistreatment than the SRN, LRN, or LRA conditions. The results, show that the response to the large robot in either condition is similar to the response to the small robot in the neutral condition. (\*:  $p < .05$ )

robot in a social setting and how those perceptions might be altered by the morphology of the robot. The results presented in the previous section support hypothesis **H1**. Participants did not observe mistreatment in the neutral conditions, but did in the aggressive conditions. The results also support hypothesis **H2**.

The first hypothesis was directly addressed by both the operational and non-operational definition of mistreatment questions. Our second hypothesis was strongly supported by the Sympathy and Level of Emotional Capacity Questions. We found that participants felt sympathy, recognized mistreatment, and believed the small robot to be more capable of producing emotion than the large robot under the aggressive scenarios. These perceptions of the robot are the possible reasons for the sympathetic connection participants had towards the small robot and not the large robot which is supportive of our second hypothesis.

The Operational Definition of Mistreatment question is the one most directly related to our hypotheses. Given a standardized definition of mistreatment, this result means that participants showed significantly different reactions to the small and large robots. In fact, when asked about the operational definition of mistreatment, the large verbally abused robot was indistinguishable from the neutral conditions. It is telling that, in both LRA and SRA, participants observed more mistreatment than for the neutral conditions. This implies that the participants *are* observing mistreatment for the large robot, just not as much. These data provide strong support for **H1**. The Non-operational Definition of Mistreatment is important as it pertains directly to the participant's personal definition of mistreatment. Asking this as a binary "yes" or "no" question means that we do not have information about how *much* they felt the robot was mistreated in their own evaluation. We placed this question first in the survey because we wanted participants to answer that question before reading the operational definition of mistreatment, avoiding the risk of compromising the participant's original preconceived notions of the word mistreatment. We found that the LRA condition and the neutral conditions (SRN and LRN) were similar, but not the SRA condition.

The Emotional Capability had clear differences between the SRA condition and both neutral conditions. When we

look closer at the means in Figure 2, we can see that the mean of the SRA condition lies slightly above the midpoint of the scale. This indicates that participants believed the robot to be only somewhat capable of producing emotion when compared to how a human might feel emotion. The Emotional Capability was perceived slightly differently (but not significantly) between the LRN and LRA condition, indicating that participants believed the large robot to be more capable of producing emotion after it had been mistreated.

The participants at most felt mild sympathy, see Figure 2. This makes sense because the abuse toward the agent was brief and not severe. What is interesting for this question is that the large robot engendered sympathy in both the LRA and LRN conditions comparable to the SRA condition. This could mean that the participants for some reason felt inherent sympathy for the Baxter robot. We did not get any clear signal from the qualitative evaluation from the participants to make any definitive statements. However, participants felt sympathy for the small robot when it was mistreated, but not when the robot was not mistreated, following expectations. These results provide partial support for **H2**.

We saw a significant difference for faith in confederate between the aggressive and neutral conditions. This suggests that when the confederate acted aggressively toward the robot, the other participants would blame him (ever so slightly) for the incorrect answers. Not observing significant differences between the robot types shows that the confederate was perceived consistently across the conditions and differences in faith in the recorder was predicated on the confederate's behavior (neutral or aggressive). We did not see significant differences for the Reliability of Robot category. Our control was well-established since Reliability covered the failure rate of both agents, as well as how capable those agents were to serve their functional purpose. This helps narrow down what we are measuring to the subjective perceptions of both robot types. These perceptions include the robot's capability of being mistreated due to their size, or anthropomorphic features, as well as their capability of producing emotion, and effect on our participants' personal levels of sympathy towards these agents.

While the voices between the robot conditions were the same, the voice that was standard for the Nao seemed to

be a bit high-pitched for the larger robot. Some participants commented on the discontinuity, but there is no evidence that this vocal difference played any part in the participants' ratings of the robot. Future replications of this study might choose a more neutral voice and in a pilot study determine if there is a voice which would sound appropriate for each robot condition. We also investigated any possible gender differences, we compared the means between both male and female participant data and found no significant differences ( $p > .05$ ).

## VII. CONCLUSION AND FUTURE WORK

This experiment was designed to follow-up on results observed in earlier work which concluded that a people will feel more sympathy and observe more mistreatment for a robot that is verbally abused than a computer that is verbally abused [3]. We wished to explore an alternative explanation that it is not merely the robot-ness of the agent that results in the observed mistreatment, but in fact the small size of the robot used for that experiment which could explain the same results.

The results from this experiment support this alternative explanation. Both hypothesis **H1**: "Participants will perceive verbal abuse as mistreatment more with a small robot than with a large robot. Participants will not observe mistreatment in the neutral conditions, but will in the aggressive conditions." and hypothesis **H2**: "Participants will perceive the small robot as more emotionally capable and feel more sympathy for the small robot than the large robot." This does not mean that we can safely strike our factory robots in front of others, however. These results only extend to verbal abuse. The scope of these results are limited as they are confined to the two robot platforms that were studied, but the data do suggest that further study in robot mistreatment is warranted. No human condition was observed, which means that we do not have an observation of how the perception of robot mistreatment might compare to that of a person.

These results paint an interesting picture. People clearly feel that a robot is more capable of emotion than a computer, and feel more sympathy toward a robot when the robot is verbally mistreated. However, this study shows that people observe mistreatment only in the small Nao robot, not the larger Baxter robot. The level of emotional capacity question shows that the participants felt that the larger robot was less capable of feeling emotion. This might have some bearing in psychology literature, as taller people actually do have lower risk of depression [11].

An interesting follow-up study would be to take a robot which has a telescoping spine (e.g., the PR2) which could alter only the height of the robot to eliminate all other possible confounds due to robot appearance<sup>3</sup> to see if our conclusions can be reduced only to height. This would allow much closer inspection of the role of size of a robot by

<sup>3</sup>These differences could include attributes of the robots such as a potentially threatening arm span on the Baxter, the differing levels of anthropomorphism, or even the amount of noise generated by the actuation of the robots' motors.

controlling for any extraneous factors that may be currently hiding or exaggerating the significance that this study has revealed. There is room for more investigation on warranted and unwarranted mistreatment, as well as higher levels of mistreatment towards robots and computers. Other possible follow-ups include continuing to observe people's behavior and perceptions of mistreatment to a robot after they have built rapport in a cooperative environment through a team-building exercise [4], or to study how the response to physical abuse compares to verbal abuse.

## ACKNOWLEDGMENTS

This material is based upon work supported by the National Aeronautics and Space Administration under Grant No. NNX10AN23H issued through the Nevada Space Grant and the Office of Naval Research DURIP award (N00014-14-1-0776). We appreciate all of the help that was provided by the following people who helped work on this study: Evan Adkins, Zoheb Ashraf, Mohamad A. Kaddoura, and Austin Sanders.

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