Robot-Directed Speech as a Means of Exploring Conceptualizations of Robots

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ABSTRACT
Decades of research have shown that speakers adapt the way in which they speak to meet the needs of listeners, and that speech modifications can illuminate speakers' conceptualizations of their listeners' cognitive and communicative abilities. The present study extends this line of research into human-robot communication by analyzing the linguistic features of commands given to a robotic dog. The results indicate that males and females differed in the way in which they spoke to the robot, suggesting that there was not a uniform expectation of the robot's communicative capacities.

Categories and Subject Descriptors
I.2.9 [**Artificial Intelligence**]: Robotics – *operator interfaces.*

General Terms
Experimentation, Languages, Theory.

Keywords
HRI Communication.

1. INTRODUCTION
One fundamental aspect of human communication is that people adjust their language to meet the perceived needs of their listeners. For example, adults raise their pitch and exaggerate pitch contours when they talk to infants or children [2, 3, 4, 5]. These pitch modifications serve the purpose of gaining attention and communicating emotion. Conversely, when talking to non-native adult conversation partners, speakers hyperarticulate their speech (which is also characteristic of IDS [6]), but do not elevate pitch or exaggerate pitch contours [8]. This is because non-native speakers, like children, are trying to learn the sounds of the language, but do not have attentional deficits. Grammatical structures and vocabulary have also been shown to be simplified in speech directed to children, non-native listeners, and people identified as having cognitive impairments [1, 7], as all of these populations have limited linguistic abilities.

HRI'09, March 11–13, 2009, La Jolla, California, USA.
ACM 978-1-60558-404-1/09/03.

This study examined the speech modifications that people make when they talk to a robot, and what those adjustments can tell us about people's conceptualizations of robots. Using what is known about human-directed speech, our work has assessed the features of robot-directed speech and explored the preconceptions that underlie specific characteristics of robot-directed speech.

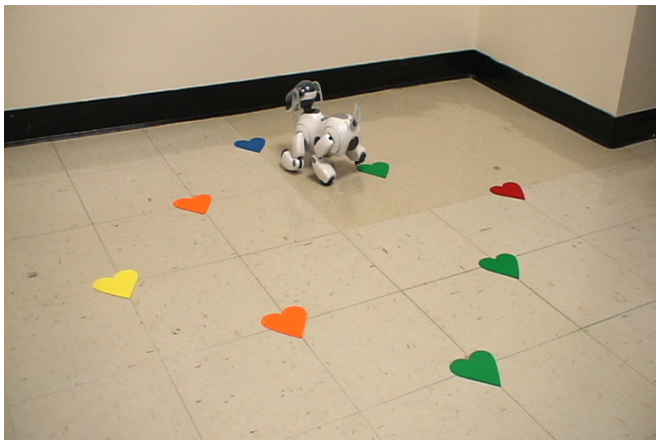

Figure 1. Experimental setup. Participants asked AIBO to fetch certain objects in an array.

In a laboratory experiment, we used a within-subjects design to evaluate the features of robot-directed speech. Fifteen participants (8 female) made requests for objects to a Sony AIBO robot. These commands were compared to a speech baseline, in which the participants made similar requests out loud, but without directing their speech to an addressee.

2. PROFILES OF ROBOT-DIRECTED SPEECH
Each participant's robot-directed speech was compared to his/her baseline speech in order to test how participants altered their speech when talking to the robot. Speech was measured for pitch, pitch variability, loudness, request length, and grammatical structure.

Compared to their baseline speech, females exhibited higher pitch, pitch variability, and loudness when they directed their speech to Aibo. Men also increased their pitch slightly when they talked to the robot, however they did not exhibit higher pitch variability (also called 'singsong quality') when they spoke to Aibo. Both men and women became louder when their speech was directed to the robot.

Men produced significantly shorter requests than women. A qualitative analysis of the requests indicated that the males gave not only significantly shorter requests, but were much more likely to give ungrammatical requests. Four of the seven males spoke to the robot in telegraphic utterances, omitting obligatory function words such as "the." For instance, males gave requests such as, "Fetch blue square," whereas females tended to produce longer, well-formed requests like, "Please get me the red circle."

The findings reported above illuminate two distinct patterns of features that seem to be employed when naïve American adults speak to a robotic dog. Table 1 outlines these profiles. The speakers who used the singsong profile conceptualized the robot as human- or animal-like, whereas the speakers who used telegraphic language seemed to treat AIBO less like an animal and more like a machine. The two different profiles loosely follow gender divisions, with the singsong profile appearing more often in female speakers' requests and the telegraphic profile occurring only in male participants' data.

Table 1: Two profiles of robot-directed speech

Singsong Profile (Female dominant)	**Telegraphic Profile** (Male dominant)
Increased pitch	Small increase in pitch
Increased pitch variability	No increase in pitch variability
Increased loudness	Increased loudness
Normal rate of speech	Normal rate of speech
Moderate length requests, grammatical syntax	Short requests, telegraphic syntax

3. CONCLUSIONS

These findings lead us to a better understanding of humans' conceptualizations of a robotic dog as a communicative partner. While it seems that men and women tend to speak to Aibo differently, the important point of the finding is not necessarily the gender difference, but that there was not a single uniform conceptualization of the robot's communication needs. The findings also present some implications for the design of natural language systems. Many current natural language systems do not handle word stress or pitch fluctuations well, and most syntactic parsers work under the assumption that the language being processed is grammatical. This study suggests that natural language systems may need to have a much higher degree of versatility across a number of areas than was traditionally thought.

4. ACKNOWLEDGMENTS

This research was conducted while the first author was a National Research Council Postdoctoral Associate at the U.S. Naval Research Laboratory. Support was provided by the Office of Naval Research under work order number N0001402WX20374. The views and conclusions contained in this document should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Navy.

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