

Does a Robot that Can Learn Verbs Lead to Better User Perception?

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ABSTRACT

The current understanding is that human-likeness of a robot leads to better human perception. However, the factors have not been thoroughly studied. We conducted a laboratory experiment to examine two questions: how verb acquisition ability affects human perceptions on human-likeness and familiarity of a humanoid robot, intention to use the robot, and enjoyment and satisfaction of the interaction, and whether human-likeness mediates the links between the effects of interaction of verb acquisition between the human perceptions. The experiment involved 48 participants, and we found that the robot that was able to acquire two Japanese verbs, "oku (to put/to place)" and "hanasu (to move away from)," was perceived by participants as more familiar and satisfying than the one that knew the verbs from the beginning. We also found that human-likeness mediated the links between the effect of verb acquisition ability and other perceptions toward the robot.

Categories and Subject Descriptors

H.1.2 [Models and Principles]: User/Machine Systems—*human factors*; H.5.2 [Information Interfaces and Presentation]: User Interfaces—*evaluation/methodology, user-centered design*

General Terms

Design, Experimentation, Languages, Human Factors

Keywords

Language Acquisition, Verb, Human Perception

1. INTRODUCTION

Language acquisition ability, through which humans learn unknown words and grammatical structures, even from a small number of examples, is one of the most human-like abilities. However, it is not clear how language acquisition ability influences human perception, in particular, on human-likeness, familiarity, intention to use, enjoyment, and satisfaction. It is also unclear how a user's mental model works on the relationships among the perceptions. Powers et al.[2] found that human-likeness mediates links between



Figure 1: Settings

an effect of human-like short chin of a robot and perceptions of sociability and intelligence. Thus, we believe that human-likeness mediates links between effects of language acquisition ability and other human perceptions.

In this paper, we report the results of our empirical study. Our experiment was conducted in Japanese, and we used *italic* when giving Japanese words or sentences. As a starting point of our research, we focused on verb acquisition ability for two verbs, "oku (to put/to place)" and "hanasu (to move away from)," and explored how verb acquisition ability led to better human perceptions of a robot and whether human-likeness mediated the links between the effect of verb acquisition ability and the human perceptions. Our hypotheses are: (H1) verb acquisition ability leads to better human perceptions toward a robot, (H2) human-likeness mediates the links between the effects of verb acquisition ability and perceptions of familiarity, intention to use, enjoyment, and satisfaction.

2. EXPERIMENT

We conducted a one by two, between-participants study in which we manipulated a robot's verb acquisition ability and measured how the manipulation might affect human perception of the robot.

The settings of our experiment are shown in Figure 1. Participants were asked to interact with a robot¹ by ordering movements. In the interaction, the participants were able to order the robot perform 8 specific movements by keyboard input (e.g. *Migitewo atamani oite* (Put your right hand on your head) or *Migitewo hidaritekara hanashite* (Move your right hand away from your left hand)). They were asked

¹Kondo Kagaku Co. Ltd, <http://www.kondo-robot.com/>

to input the orders one by one. We randomly assigned the participants to one of two conditions described below.

Verb Acquisition Condition

The two verbs, "oku (to put/to place)" and "hanasu (to move away from)," are not embedded in advance. The participants are instructed that if the robot failed to move, they should teach the correct movement by performing it in front of the web camera equipped on the display. The robot is programmed to perform no movement, when an order is input for the first time; to perform an incorrect movement on the second time, and to perform correct movements at the third and the fourth time.

Language Input Condition

The two verbs are embedded in advance. The robot replies with correct movements to the participants' orders.

After the interaction, the participants answered a questionnaire with a seven-point Likert scale anchored by "Strongly Disagree" and "Strongly Agree" for all items to measure their perceptions of the robot. The questionnaire consists of 23 questions which ask about familiarity, intention to use, enjoyment, satisfaction, human-likeness, and verb acquisition ability. The questions about verb acquisition ability of the robot are to confirm our control. The participants were paid 1,000 yen (approximately US\$12) as compensation.

3. RESULTS

A total of 50 participants (23 males, 27 females, 20 undergraduate students, 30 graduate students) took part in the experiment. All participants were native Japanese speakers and were recruited by flyer on campus of Hokkaido University in Japan. The system suddenly stopped during the experiment of 2 participants in Verb Acquisition Condition, so we excluded these sessions from the data.

We found no significant difference in the duration of the interaction between the two conditions. The average duration was 508 seconds ($\sigma = 12.5$) in Verb Acquisition Condition and 487 seconds ($\sigma = 15.2$) in Verb Input Condition (t-test, $p = .31$). This was because, the robot took a significantly longer time to move for the sake of participants' safety when compared to the time participants took to teach movements.

Our analyses using the student's t-test showed that the participants judged that the robot in Verb Acquisition Condition had stronger verb acquisition ability than the robot in Verb Input Condition ($p < .01$). The participants, in addition, perceived the robot in Verb Acquisition Condition as more familiar ($p < .01$), satisfying ($p < .01$), and human-like ($p < .01$) than the robot in Verb Input Condition. However, we found no significant difference on intention to use.

We then examined human-likeness as a mediator in a test for simple mediation using Baron & Kenny's causal steps strategy[1]. We found significant effects of verb acquisition ability on familiarity ($\beta = .23, p < .05$), enjoyment ($\beta = .28, p < .01$), satisfaction ($\beta = .27, p < .01$) and on human-likeness ($\beta = .39, p < .01$) but not on intention to use. We also found significant effects of human-likeness on familiarity ($\beta = .63, p < .01$), enjoyment ($\beta = .53, p < .01$), satisfaction ($\beta = .42, p < .01$). The effects of verb acquisition ability on the outcomes was reduced markedly and became

statistically non-significant when controlled for the effects of human-likeness on familiarity ($\beta = .09, p < .83$), enjoyment ($\beta = .11, p = .36$), satisfaction ($\beta = .16, p < .11$).

We also tested for simple mediation using Baron & Kenny's step with bootstrapping methodology for indirect effects based on 1000 bootstrap resamples to describe the confidence intervals of indirect effects. Interpretation of the bootstrap data is accomplished by determining whether zero is contained within the 95.0% confidence intervals (thus indicating the lack of significance). The results showed that the 95.0% confidence intervals did not contain zero except for ITU. Thus the causal steps test and the bootstrapping test agreed that human-likeness was a simple mediator for familiarity, enjoyment, and satisfaction.

4. DISCUSSION

We showed the effect of the interaction of verb acquisition on perception of the robot. However, we did not fully control the duration of the interaction though the differences were not statistically significant. Nor did we not manipulate the factors of mistake and teaching. These factors are inevitable parts of the interaction to acquire language, but, the mistake and teaching are individual factors which are often seen not only in the interaction of language acquisition but in our daily life, and these could affect perception of the robot. Thus, the effect of verb acquisition ability still remains not clear. We need to explore the effects of mistake and teaching. We also think that verb acquisition ability has interaction effects with the factors of mistake and teaching.

5. CONCLUSIONS AND FUTURE WORKS

We examined how verb acquisition ability affected human perceptions in terms of human-likeness, familiarity, intention to use, enjoyment, and satisfaction, and whether human-likeness mediated the links between the effects of verb acquisition ability and perceptions of intention to use, enjoyment, familiarity, and satisfaction. As a result of the experiment, we found that participants judged the robot that learned the two verbs as more human-like, enjoyable, familiar, satisfying than the one that knew the verbs from the beginning. The results indicated a possibility that verb acquisition ability has effects on the perceptions. Our analyses also showed human-likeness mediated the links between the effects of interaction of verb acquisition and human perceptions on enjoyment, familiarity, and satisfaction.

In our future work, we will further investigate the individual effect of verb acquisition ability, mistake and teaching. We will also explore the interaction effects between language acquisition ability and the factors of mistake and teaching.

6. REFERENCES

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