Exploring Influences of Robot Anxiety into HRI

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Categories and Subject Descriptors

K.4.2 [**Social Issues**]: Assistive technologies for persons with disabilities

General Terms

Human Factors.

1. INTRODUCTION

Robot anxiety is defined as state-like anxiety that may be evoked by robots, and it has been suggested that this anxious feeling predicts humans' communication avoidance behaviors toward robots [1]. However, it is not clear how robot anxiety influences human-robot interaction, in particular, what factors this anxiety has interaction effects with. Mutlu, et al., [2] found interaction effects of gender and task structures on human perceptions of a humanoid robot (ASIMO). Thus, it is guessed that robot anxiety has interaction effects with several factors such as robot behaviors and contexts.

Clinical psychologists suggest that persons having higher social anxiety or communication apprehension are extremely sensitive for a specific type of others' behaviors, which does not influence persons without these feelings. Analogue to this, it is estimated that a specific type of robot behaviors influences only persons having higher robot anxiety. For exploring interaction effects of humans' robot anxiety and behavioral factors of robots, we conducted a preliminary experiment of human-robot interaction. This paper reports results of the experiment and discusses their implications.

2. Method

2.1 Date and Subjects

The experiment was conducted at June, 2010. The experimental group consisted of 20 Japanese persons (11 males and 9 females) with a mean age of 21.6. They were university students or faculty staffs in a laboratory.

2.2 Procedures

Each subject faced a humanoid robot shown in Figure 1, alone in an experiment room. The robot firstly uttered the greetings, and then performed utterances of six questions toward the subject, related to the subject's name, hobby, recent situation, and current schedule. After the subject answered for one question or a

constant time (20 s) passed just after one question utterance, the next question utterance was performed. These behaviors of the robot were controlled based on Wizard-Of-Oz method.

In the experiment, we focused on the robot's behavior of looking the other way while subjects answered the questions. From clinical psychological perspectives, this behavior is assumed to influence human perceptions of others. In the experiment, two conditions were prepared. In the controlled condition, the robot fixed its face toward the subjects during the experiment. In the experimental condition, the robot moved its face toward the subjects' right side. This behavior was performed per 2 seconds, three times while the subjects answered for the first and fourth questions. In both conditions, the robot did not perform any feedback behavior toward the subjects' answers like nodding and chiming.

2.3 Measures

To measure the subjects' robot anxiety, Robot Anxiety Scale (RAS) [1] was conducted before and after interaction with the robot. This scale originally consists of eleven items and three subscales. In the experiment, two subscales were used; anxiety toward communication capability of robots (three items; e.g., "whether the robot might talk irrelevant things in the middle of a conversation") and anxiety toward discourse with robots (four items; e.g., "how I should talk to the robot"). Each item is scored on a six-point scale: 1) I do not feel anxiety at all; 2) I hardly feel any anxiety; 3) I do not feel much anxiety; 4) I feel a little anxiety; 5) I feel quite anxious; 6) I feel very anxious, and an individual's score on each subscale is calculated by adding the scores of all items included in the subscale.
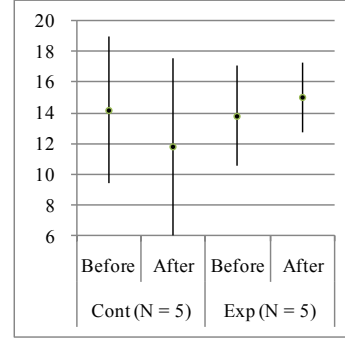

Figure 1. The Robot Used in the Experiment
(Robovie R-2 Developed by ATR Intelligent Robotics &
Communication Laboratories)
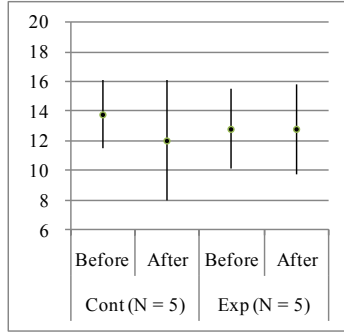
Subjects having lower anxiety toward communication capacity of robots

	F	p	partial η^2
With/Without "Looking the Other Way"	.004	.952	.000
Before/After	.684	.432	.079
Interaction	.684	.432	.079

Subjects having higher anxiety toward communication capacity of robots

	F	p	partial η^2
With/Without "Looking the Other Way"	1.309	.286	.141
Before/After	.285	.608	.034
Interaction	11.782	.009	.596

Figure 2. Means and Standard Deviations of the Subscale Scores of Anxiety toward Discourse with Robots, and Results of ANOVAs (Cont: condition without "looking the other way" behavior, Exp: condition with "looking the other way" behavior)

3. Results
3.1 Influences of Robot Anxiety

Nomura, at al., [1] found the increase of human anxiety toward discourse with robots after interaction with a humanoid robot. Thus, we analyzed a change of the subjects' anxiety toward discourse with robots before/after interaction with the robot. In the analysis, the subjects were classified into two subgroups based on the mean score of anxiety toward communication capability of robots; those having higher anxiety toward communication capability of robots and those having lower anxiety. Then, a mixed ANOVA was conducted for the subscale scores of anxiety toward discourse with robots, in each subject group on anxiety toward communication capability of robots.

Figure 2 shows the means and standard deviations of the subscale scores of anxiety toward discourse with robots, and the results of the ANOVAs. In the subjects having lower anxiety toward communication capacity of robots, the ANOVA did not find either main or interaction effect. In the subjects having higher anxiety toward communication capacity of robots, the ANOVA found the interaction effect between before/after interaction and the condition with/without "looking the other way" behavior, and the effect size was at a moderate level.

3.2 Discussion

The above results suggest the following fact; only if persons feel higher anxiety toward communication capacity of robots, their anxiety toward discourse with robots increases when the robot looks the other way during interaction with them, and decreases when the robot fixes the face. It means an interaction effect between a specific type of robot behavior and anxiety toward communication capacity of robots, to anxiety toward discourse with robots. Since robot anxiety itself may affect human behaviors toward robots, we should be careful for a possibility that a specific type of robot behavior may prevent persons having higher anxiety toward robots from interaction with robots.

The experiment was preliminary and the number of samples was small. Thus, the generality of our findings is limited at the current stage. Moreover, the robot's behavior in the experiment, looking the other way during interaction with humans, is not realistic from practical perspectives of human-robot interaction. We are going to explore behavioral factors of robots having interaction effects with robot anxiety in more realistic contexts, such as healthcare assistance that Bickmore and Picard [3] focused on.

4. ACKNOWLEDGMENTS

5. REFERENCES
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