

Measurement of Rapport-Expectation with a Robot

Tatsuya Nomura
Department of Media Informatics
Ryukoku University
Otsu, Shiga 520-2194, Japan
nomura@rins.ryukoku.ac.jp

Takayuki Kanda
ATR Intelligent Robotics and
Communication Research Laboratories
Keihanna Science City, Kyoto 619-0288, Japan
kanda@atr.jp

Abstract— The focus on humans’ expectation of rapport with robots as a factor in long-term human-robot interaction. The research has been on developing a psychological scale for measuring the rapport. This paper reports the development process and the results of the pilot test showing the possibility that the scale can measure the differences of individuals’ expectations of rapport with robots dependent on their types and contexts.

Index Terms— Psychological scale; human-robot relationships; rapport

I. INTRODUCTION

A lot of studies in human-robot interaction (HRI) have been aiming at establishing a rapport between humans and robots. For this aim, the recent research on HRI has been focusing on several human psychological constructs influencing it, including perception of ease and intention to use, enjoyment, trust, attitudes and anxiety [1,2]. The existing studies revealed that these constructs could affect short-term interaction with robots. However, few studies paid attention to psychological indices related to long-term interaction with robots.

Bickmore and Picard [3] validated the effects of human relational strategies in long-term interaction with a software agent. Zhao, et al., [4] took into account relationship irreplaceableness in human-avatar relationship closeness, which is an influential factor into sustainability of virtual worlds. However, these existing studies did not directly deal with humans’ expectations of a rapport with robots and agents. Kahn, et al., [5] focused on the psychological dimensions of mental, social, and moral aspects in children’s relationships with a mechanical humanoid robot (Robovie). Although their study partly included expectation of a rapport with the robot, it did not deal with general measurement tools distinguishing human feelings on rapport dependent on types of robots and individual differences.

Assuming that expectation of a rapport with robots grows in humans as their interaction with the robots is encouraged, and that they encourage further interaction, the research is aimed at developing a psychological scale for measuring expectation of a rapport with robots as an influential factor in long-term human-robot interaction, “Rapport-Expectation with a Robot Scale”. The paper reports the preliminary stage in the development.

II. METHOD

A. Pilot Survey

Although a rapport between humans and robots can frequently be observed in science-fiction movies of which themes include human-robot relationships such as “Bicentennial Man” [5], these robots have still not appeared in daily life. In order to develop a scale that can measure rapport expectation with these types of future robots, a survey based on open-ended questions and video clips of science-fiction movies was conducted for 20 university students to assemble item candidates. In the survey, each participant watched the following three video clips where robots appeared, in a randomized order:

- “Andrew” in “Bicentennial Man” [5] (a scene where the robot communicated with a woman)
- “C3PO” in “Star Wars” [6] (a scene where the robot provided with information for the hero)
- “WALL-E” [7] (a scene where the robot put things in order in the room that humans had previously lived)

Then she/he freely responded about their feelings for these virtual robots after watching each video clip. As a result, a total of twenty item sentences including expectation of rapport with robots were extracted from the open-ended responses. Moreover, eight items were added from the previous research on human feelings of robots and existing psychological scales about human interpersonal relationships.

B. Pilot Test

For the aim of item selection, a pilot test was conducted for 20 university students. In the same way as the pilot survey, each participant watched three video clips of “Andrew” in “Bicentennial Man”, “C3PO” in “Star Wars” and “WALL-E” in a randomized order. After watching each video clip, she/he responded to a questionnaire consisting of twenty-eight items assembled through the pilot survey. Subjects were asked about their expectations of rapport with each virtual robot. Each item was assigned with a seven-choice answer (1: absolutely disagree – 4: undecided – 7: absolutely agree). A total of sixty samples (20 participants x 3 types of robots) were finally collected.

III. RESULTS

A. Item Selection and Subscale Extraction

An exploratory factor analysis with maximum-likelihood method and Promax rotation was conducted for the sixty samples. Two-factor structure was chosen based on the scree plot and item consistency. Then, two subscales, consisting of eighteen items (first factor: 11 items, second factor: 7 items), were extracted based on the factor loadings, the contents of the items, and the results of items analysis in each subscale, which consisted of I-T correlations and α -coefficients.

The first subscale consisted of the items mentioning the value of the robot as a communication partner (e.g., “The robot seems to be a good communication partner”, “If the robot ignores my addressing, I will feel sad”), and was named “expectation of rapport with the robot as a communication partner”. The second subscale consisted of the items mentioning the value of the relationship with the robot (e.g., “If the robot has been staying with me since my birth, I will want to be together with it until my death”, “The robot may understand me”), and was named “expectation of deeper rapport with the robot”. Cronbach’s α -coefficients were .919 for the first subscale and .848 for the second subscale.

B. Effects of the Robot Type

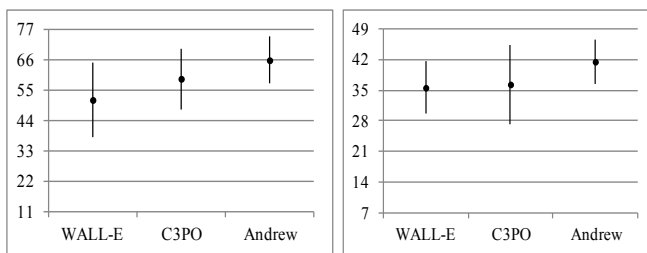
Each subscale score was calculated as a sum of the corresponding item scores. This score calculation was conducted for each video clip. Considering the contents of the video clips, it was hypothesized that expectation of rapport with “Andrew” (the robot staying with a human family) was stronger than the other robots (information provider and pet-like). To validate the hypothesis, one-way repeated measures ANOVAs with the type of robot video clips were conducted for the subscale scores. Figure 1 shows the means and standard deviations of the subscale scores and the results of the ANOVAs.

The effects of the type of video clips were at statistically significant levels in both the subscales. Post-hoc analyses using paired t-tests with Bonferroni correction revealed that the expectation of a rapport with “Andrew” as a communication partner was stronger than those with “C3PO” ($p < .05$) and “WALL-E” ($p < .001$), although the difference between “C3PO” and “WALL-E” was at a statistically significant trend level ($p < .1$). Moreover, expectation of deeper rapport with “Andrew” was stronger than those with “C3PO” ($p < .05$) and “WALL-E” ($p < .01$).

IV. DISCUSSION

The subscale scores reflected the meanings of the robots intended in the scenes of the video clips in the sense of human-robot relationships. It suggests the possibility that the scale can measure differences of individuals’ expectation of rapport with robots dependent on their types and contexts.

As future works, we plan to conduct a psychological experiment where human subjects communicate with a really embodied robot. The aim of the experiment is to verify the



Left: Expectation of rapport with the robot as a communication partner ($F = 13.919, p < .001, \text{partial } \eta^2 = .423$)

Right: Expectation of deeper rapport with the robot ($F = 7.468, p < .01, \text{partial } \eta^2 = .282$)

Fig. 1. Means and Standard Deviations of the Subscale Scores and Results of ANOVAs

measurement of individual differences on rapport expectation with robots, and the predictive validity of the scale based on some behavioral indices. Moreover, the scale was constructed based on the samples from the Japanese younger generation. Thus, we need to verify the validity using a wider range of samples including people of other cultures and the elderly.

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